National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: June 25, 1990
In reply refer to: A-90-93 through -99

Honorable James Busey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On October 14, 1989, about 1411 mountain daylight time, a fire erupted on N530DA, a Boeing 727-232 that had been parked at gate C4 at Salt Lake City International Airport (SLC), Salt Lake City, Utah. The airplane had been operated under Title 14 Code of Federal Regulations (CFR) Part 121 as Delta Air Lines flight 1558, a scheduled international revenue passenger flight from Los Angeles, California, to Edmonton, Alberta, Canada, with a stop at SLC. Three flight crewmembers, 4 flight attendants, and 12 through passengers who had boarded at Los Angeles were onboard the airplane when the fire erupted. The second officer was seated at the flight engineer's console while the captain and first officer, who had just entered the airplane, were standing just forward of the entrance to the cockpit. A Delta Air Lines mechanic was in the electrical equipment (EE) compartment below the cabin servicing the passenger oxygen system.

Shortly after the gate agent had begun preboarding SLC originating passengers, a sound, described as a muffled "bang" or "boom," emanated from an area near the forward galley. Almost immediately thereafter a flight attendant, who had been standing near the third row of passenger seats, noticed flames extending several inches from a vent adjacent to seat 3-D. She turned aft and shouted "fire" in a loud voice.

The flight attendants began evacuating the passengers through the airstair, located at the aft end of the airplane. Within seconds thick black smoke started to fill the cabin and flames began to burn through the forward right side of the fuselage. All passengers and crew were evacuated safely. One passenger, the second officer, and three Delta ground employees were treated at a local hospital for smoke inhalation and released. The aircraft cabin was destroyed by the fire. A hole, several feet in diameter, burned through the fuselage, just behind the right, forward-galley service door near fuselage station 460.

Most components of the passenger oxygen system are located below the EE bay, on the forward right side of the airplane. The system is composed of

two oxygen cylinders, each charged initially to a pressure of 1,850 psi.[1] The cylinders supply oxygen through steel tubing to the flow control unit, which reduces the pressure of the oxygen and then controls its flow to the passenger masks. The steel tubing contains thermal compensators to absorb heat generated by compression of the oxygen passing through the tubing.

Because of Federal Aviation Regulations (FARs) stipulating the dispatch of an airplane with fully charged oxygen cylinders, Delta required an inspection of the cylinders before each flight. The cylinders were changed or refilled as needed. During a preflight inspection of the airplane in SLC, a Delta mechanic found that the quantity of oxygen in the passenger system was below the acceptable level[2]. The cylinders were changed on N530DA.

The Delta mechanic who had serviced the oxygen system said that as he was about to leave the EE bay he saw sparks emitted from an area beneath a battery pack, adjacent to the fuselage sidewall and above and behind the oxygen cylinders. He then heard a muffled noise and saw a flash of white light that enveloped the oxygen system flow control unit. He quickly left the EE bay and attempted to initiate fire and rescue efforts.

Other witnesses stated that they saw a 3- to 4-foot flame extending sideways from the area adjacent to the EE bay. The flame, which was impervious to the initial fire suppression efforts of individuals using hand held extinguishers, continued to burn. The fire damage to the airplane was greatest in the area above the EE bay.

Components of the passenger oxygen system were later removed and examined at the Boeing Airplane Company under the supervision of the Safety Board. Although the extensive destruction of oxygen system components precluded a determination of the exact cause of the fire, based on the evidence, the Safety Board believes that the fire most likely originated in the passenger oxygen system's flow control unit.

The Safety Board believes that because of the rapidity with which the fire and smoke propagated, a great potential existed for loss of life had more passengers been on board the airplane at the time of the initial "explosion." In point of fact, the probability of encountering difficulties from a faulty oxygen system is highest either at the time the system is serviced or shortly after it has been fully pressurized when the heat generation from the pressurization is greatest.

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[1] On the Boeing 727, a cylinder supplying oxygen to the flightcrew is located adjacent to the two passenger cylinders, although it is part of a different system.

[2] Delta rules specified that the passenger and crew oxygen cylinders contain a minimum 1,100 and 1,000 pounds per square inch (psi) respectively during a trip check, the type of check conducted at SLC. The requirements for service checks and layover checks were the same, a minimum of 1,500 and 1,300 psi for passenger and crew cylinders, respectively.

In 1971, the Safety Board addressed the potential danger of servicing oxygen systems following its investigation of a ground fire aboard a United Airlines Boeing 737 that occurred at Washington National Airport, Washington, D.C., on December 31, 1970. As a result of its investigation, the Safety Board issued the following Safety Recommendation to the FAA:

A-71-018

Institute appropriate regulatory action to prohibit the servicing of oxygen systems while passengers are on board.

In response to the recommendation, the FAA stated on April 15, 1971, that it would begin a study to address all servicing functions that may have an adverse effect on safety. In 1972, the FAA stated that it would issue a Notice of Proposed Rulemaking (NPRM) dealing with the servicing functions examined in its study. However, as of 1978 the FAA had not changed the rule regarding servicing of oxygen systems. As a result, on February 16, 1978, the Safety Board closed the recommendation and classified it "Unacceptable Action."

The accident involving N530DA demonstrates that a potential catastrophe remains a probability as long as oxygen systems are serviced while passengers are onboard. Consequently, the Safety Board again urges the FAA to prohibit air carriers from servicing airplane oxygen systems while passengers are onboard.

The second officer, the last person to evacuate N530DA, stated that just after he had assisted in the evacuation of two older passengers seated in row 11, who were having difficulty exiting the airplane, he became engulfed in thick black smoke. The second officer described the smoke as being so thick that he could not see beyond the distance to his own hands. He got on his knees and attempted to crawl to the airstair in the aft end of the cabin but realized that he would be unable to reach it before he would be overcome by the smoke. He attempted to find the overwing exit. However, because the floor emergency escape-path lighting was not illuminated, he could not find it. He proceeded across the row of seats and attempted to find any window exit by feeling for the latch. He stated that had it not been for his fortuitous proximity to an overwing emergency exit, he would have been quickly overcome by smoke before he located the emergency exit. After the accident, he estimated that about 45 seconds elapsed between the explosion and his locating the exit.

FARs specify that the emergency lighting system, including the emergency escape-path light system, be capable of being activated from the cockpit and from one flight attendant station. However, because there was no one in the cockpit at the time of the fire, and the cockpit area could not be approached because of the fire, some crewmembers were unable to illuminate the emergency lighting system from their assigned stations.

The emergency lighting system can also be illuminated from the aft flight attendant's station. In this accident, the reason that the switch was not activated by a flight attendant is unclear. However, because flight attendants are generally at the forward part of the airplane during passenger boarding, it is possible that no attendant was near the aft portion of the airplane at that time and the evacuation developed too quickly for the system to be illuminated. The Safety Board believes that had there been a capability to illuminate the emergency floor escape-path lights from any flight attendant station, the lights may have been illuminated and the second officer may have been able to evacuate more expeditiously. The Safety Board recognizes that the cost of modifying aircraft to allow illumination from all flight attendant stations may be very expensive if the modification was not done as part of a regularly scheduled maintenance inspection, such as a "D" check, which allows access to aircraft wiring. Consequently, the Safety Board recommends that the FAA require that transport airplanes be modified during a regularly scheduled maintenance inspection, which allows access to the proper aircraft wiring, but no later than the date when the next "D" maintenance check would normally be performed, to permit illuminating the emergency floor escape-path lights from all flight attendant stations.

The Safety Board also believes that air carriers should require both pilots and flight attendants to illuminate the emergency lighting system during an evacuation, regardless of the perceived ease with which an evacuation can be accomplished. Delta had no such requirement and it is likely that other air carriers also do not. This accident demonstrates the rapidity with which smoke and fire can spread and endanger the lives of passengers and crewmembers attempting to evacuate a parked airplane with no deformation to the exits. Therefore, the Safety Board recommends that the FAA require air carriers to implement procedures requiring that all emergency lighting be illuminated during an evacuation.

The Safety Board is also concerned about difficulties encountered during the initial notification of firefighters, when quick response was most critical. Several Delta employees attempted, without success, to notify authorities of the fire. After the fire erupted, the captain and first officer quickly left the airplane through the main boarding door, out the jetway and into the terminal to notify a gate agent of the fire. Thereafter, they were unable to reenter the airplane to assist in the evacuation because of the intensity of the smoke and fire. The second officer, for reasons stated, was also unable to return to the cockpit. As a result, the flightcrew could not use the airplane radios to notify authorities of the emergency. The mechanic who had changed the oxygen cylinder attempted, using his hand-held radio, to notify his maintenance supervisor of the need for firefighting equipment, but the supervisor did not answer. Consequently, several minutes were lost before firefighting authorities were notified of the fire. A security guard in the gate area, who had seen the airplane on fire, used his portable two-way radio to inform the airport control center of the need for firefighting efforts. The airport control center immediately informed the firefighting units.

The Safety Board believes that Delta lacks, and other air carriers may lack, explicit emergency notification procedures to employ while an airplane is on the ground. Consequently, the Safety Board urges the FAA to require those air carriers that do not have explicit emergency notification procedures, while an airplane is on the ground and passengers are onboard, to establish such procedures.

The Safety Board also believes that this accident points to a need in airport ramp areas, gate areas, and jetways, for quick-access communication links to an emergency services agency, such as a telephone line with a direct or automatic 911 dialing feature. Many public-use areas in metropolitan centers are equipped with quick-access telephones or comparable radio systems, which allow immediate communications to an emergency agency. Had such a communication system been in place at SLC, valuable time might have been saved in alerting the firefighting units of the fire onboard N530DA. Therefore, the Safety Board urges the FAA to require airports certificated under 14 CFR Part 139 to provide quick-access communication links to an emergency services facility at ramp areas, gate areas, and jetways.

This accident also raised concern about the adequacy and effectiveness of airline maintenance trend-analysis programs. The Safety Board learned that a condition of low-oxygen quantity in the passenger oxygen system of this airplane had been noted in the airplane's maintenance log six times in a 4-week period. To facilitate maintenance, Delta monitored maintenance writeups through an automated system that "flagged" or brought to the company's attention aircraft components or systems that had been entered repeatedly in the maintenance log. Delta's system categorized the writeups so that the most critical maintenance items would be addressed quickly. In addition to coding them according to their severity, the system also coded the originator of the writeup, such as pilot, mechanic, flight attendant, or organization, such as the maintenance department. Depending on the source of the writeup, discrepancies were flagged if they had been entered in the log twice in 4 days, three times in 7 days or five times in 30 days.

In 1989, the passenger oxygen system on N530DA had been written up by mechanics on September 20 and 24, by a pilot on October 5, and by mechanics on October 9, 10, and 14, the day of the accident. Therefore, the total number of entries in the maintenance log prior to October 14 met the rate of writeup criterion of the automated maintenance problem alerting system. However, because the writeups did not meet the additional, separate criterion established for mechanic- and pilot-entered discrepancies, the repeated writeups for low quantity went unflagged, even though passenger oxygen-system depletions are abnormal unless caused by inflight use of the system, a highly unusual event. The Safety Board believes that even one low oxygen level reading in the absence of a pressurization problem should have prompted an inspection of the system to determine the cause of the oxygen depletion.

The Safety Board is concerned that Delta's failure to respond to repeated maintenance writeups, in the presence of a sophisticated maintenance-related trend-analysis program, suggests that the problem exists

at other air carriers as well. Therefore, the Safety Board urges the FAA to review airline maintenance-related trend-analysis programs to verify that such programs can detect leaking oxygen systems.

Following the accident, Delta changed the requirements of the maintenance-monitoring system so that repeated writeups of low-oxygen quantity would be flagged regardless of the source of the writeup. In addition, the airline inspected all airplanes in its fleet to determine if oxygen systems were leaking. The inspection, using a bubble test-leak check method,[3] found the following number of leaks in Delta's fleet: 2 of 30 Boeing 767-200 and -300s, 1 of 36 McDonnell Douglas DC-9-32s, 2 of 59 Boeing 737-200s, 0 of 13 Boeing 737-300s, 20 of 129 Boeing 727-200s, 0 of 52 Boeing 757s, 5 of 41 Lockheed L-1011s, and 5 of 45 McDonnell Douglas MD 80s. Delta took immediate action to correct the leaks.

Because leaking oxygen systems can lead to catastrophic fires and because such fires can propagate as quickly as the fire did on N530DA, the Safety Board is concerned that similar leaks may exist on other airplanes operated in passenger service. Therefore, the Safety Board urges the FAA to require air carriers to perform an inspection of the oxygen systems on their airplanes and promptly repair all leaks.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Prohibit air carriers from servicing oxygen systems while passengers are on the aircraft. (Class II, Priority Action) (A-90-93)
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> Require that transport airplanes be modified during a regularly scheduled maintenance inspection, which allows access to the proper aircraft wiring, but no later than the date when the next "D" maintenance check would normally be performed, to permit illuminating the emergency floor escape-path lights from all flight attendant stations. (Class II, Priority Action) (A-90-94)
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> Require air carriers to implement procedures requiring that all emergency lighting be illuminated during an evacuation. (Class II, Priority Action)(A-90-95)
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> Require those air carriers that do not have explicit procedures for notification of an emergency to airport authorities or air traffic control, while an airplane is on the ground and passengers are on board, to establish such procedures. (Class II, Priority Action)(A-90-96)

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[3] With this method a maintenance technician places a solution over oxygen system valves, tubes, and fittings to determine if bubbling occurs, indicating the presence of a leak.

Require airports certificated under 14 CFR Part 139 to provide quick-access communication links to an emergency services facility at ramp areas, gate areas, and jetways. (Class II, Priority Action)(A-90-97)

Review airline maintenance-related trend-analysis programs to verify that such programs can detect leaking oxygen systems. (Class II, Priority Action)(A-90-98)

Require air carriers to perform a one-time inspection of the oxygen systems on their airplanes and promptly repair all leaks. (Class II, Priority Action)(A-90-99)

KOLSTAD, Chairman, COUGHLIN, Acting Vice Chairman, LAUBER AND BURNETT, Members, concurred in these recommendations.

By: James L. Kolstad
Chairman