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Recommendations Warn Against Opening Cabin Doors While Airplanes Are Pressurized

Two flight attendants were killed and two flight attendants were injured during three separate occurrences in which cabin doors burst open after the door handles were turned and the flight attendants were ejected forcibly onto the ramp by outflowing air, the U.S. National Transportation Safety Board said.

FSF Editorial Staff

Investigations of a U.S. air carrier accident that occurred in November 2000 and a Tunisian air carrier accident that occurred in October 2001 have prompted the U.S. National Transportation Safety Board (NTSB) to recommend that the U.S. Federal Aviation Administration (FAA) take steps to prevent the opening of cabin doors by crewmembers while an airplane is overpressurized, including revising standards for pressure-relief systems of newly certificated transport category airplanes, reviewing relevant procedures and training of all air carriers, and requiring specific warnings to crewmembers. Overpressurization means that the airplane is pressurized at a level higher than the intended pressure level for that phase of flight. To safely open nonplug-type cabin doors after landing — whether they are used for normal deplaning or as emergency-exit doors — the cabin must be depressurized fully so that the cabin-differential-pressure gauge[1] on the flight deck shows 0 pounds per square inch (0 kilopascals) — i.e., air pressure inside the airplane equals the air pressure outside the airplane. Because of their design, plug-type doors will not open while the airplane is pressurized.

The first NTSB recommendations based on the November 2000 accident — issued in May 2001 and applicable specifically to the Airbus A-300-600 — refer to safety issues in opening "cabin doors" for normal deplaning and for emergency evacuation.[2] Additional NTSB recommendations issued in August 2002 — applicable to all air carriers and to other types of transport category airplanes — specifically refer to opening "emergency-exit doors" but also discuss the general danger of opening cabin doors while an airplane is overpressurized.[3] (For clarity in this article, the term "cabin door" is used except where "emergency-exit door" is required by the context.) NTSB's investigation of the U.S. accident is continuing.

Prevention of accidents involving airplane overpressurization requires correct actions by pilots and flight attendants. The flight crew must ensure that an airplane has been depressurized before permitting flight attendants or gate agents to open any cabin door and before signaling flight attendants to begin an emergency evacuation. The cabin crew must recognize immediately signs of airplane overpressurization and cease any further attempts to open cabin doors until the airplane has been depressurized fully. Signs that an airplane has not been depressurized on the ground may include a hissing sound around exits and failure of the cabin doors to open when normal forces are applied to the door handles.

"NTSB is concerned that because of this lack of information about the signs of an overpressurized airplane on the ground,

flight [crewmembers] and cabin crewmembers might not recognize the signs of an overpressurized airplane," NTSB said. "NTSB notes [from investigation of the U.S. accident] that if the flight attendants had been trained to recognize signs of overpressurization, the flight attendant/purser [who was killed] would not likely have attempted to forcibly open the [left-front (1L)] emergency-exit door. Further, the [NTSB] recognizes the need for information about the signs of overpressurization and exit operation for flight [crewmembers] and cabin crewmembers regardless of whether the airplane is equipped with pressure-relief systems on its emergency-exit doors.

"The type of overpressurization event that occurred in these accidents could occur in any air carrier airplane equipped with [cabin] doors of a similar design if it is not fully depressurized when the [cabin] doors are opened and if it is not equipped with systems on its emergency-exit doors to relieve pressure. All transport category aircraft have outflow valves that regulate pressure inside the cabin. [The two outflow valves open and close during flight and on the ground to maintain control of cabin pressurization.] If air is prevented from flowing through the outflow valves because of a command to close the valves or a blockage of the valves, this type of overpressurization event could occur again."

When cabin doors are equipped with a system to relieve pressure, they can be opened on the ground only after a safe differential-pressure level is attained. Standard operating procedures (SOPs) and training for flight attendants should be tailored to the systems on specific airplane models.

"Some models of transport category aircraft are equipped with systems to relieve pressure, such as vent doors or gates, on emergency-exit doors," NTSB said. "For example, in some cases, floor-level emergency-exit doors are equipped with a vent door that is linked to the door handle and relieves cabin pressure to a safe level before the emergency-exit door can be opened. NTSB is concerned that, on airplanes like the Airbus A300 that do not have pressure-relief systems for their emergency-exit doors, forcing open the doors when the airplane is overpressurized could result in events similar to those described earlier or in more serious events. If the [cabin] doors on the [accident] airplanes had been equipped with pressure-relief systems, the flight attendants would likely not have been able to open the doors until the pressure was relieved."

Pressure-relief systems on cabin doors typically do not depressurize the airplane as quickly as when pilots operate the pressurization controls (outflow valves) on the flight deck; nevertheless, these systems provide some protection against injury or death by reducing the risk of sudden forcible ejection of a flight attendant through a cabin door, NTSB said.

"Further, if the [U.S.] accident airplane had pressure-relief systems for its emergency-exit doors, they may have depressurized the airplane at a faster rate than the flight crew's opening of the outflow valves, which were partially blocked," NTSB said. "NTSB notes that some new production transport category aircraft are not being equipped with emergency-exit-door pressure-relief systems. NTSB considers any pressure-relief system that prevents the opening of [cabin] doors on overpressurized airplanes on the ground until a safe differential-pressure level is attained to be beneficial to safety."

FAA issued the following comments in response to the four NTSB safety recommendations of August 2002:[4]

- NTSB Safety Recommendation A-02-20 said, "Require that all newly certificated transport category airplanes have a system for each emergency-exit door to relieve pressure so that they can only be opened on the ground after a safe differential-pressure level is attained." FAA said, "The FAA agrees that this safety issue needs to be addressed in a manner that improves the safety of persons operating exits without compromising safety in any other area. The FAA is developing revised requirements for fuselage doors and will consider this issue when proposing new requirements;"

- NTSB Safety Recommendation A-02-21 said, "For those transport-category-airplane emergency-exit doors that can be opened on the ground when the airplane is overpressurized, require air carriers to provide specific warnings near the emergency-exit doors (such as lights, placards or other indications) that clearly identify the danger of opening the emergency-exit doors when the airplane is overpressurized." FAA said, "The FAA agrees that notification is needed on airplanes where it is possible to open emergency-exit doors under unsafe differential pressure. The FAA is identifying which airplanes are affected and will propose corrective actions to add specific warnings on those affected airplanes;"

- NTSB Safety Recommendation A-02-22 said, "Review all air carriers' flight [crew training manuals and programs] and cabin crew training manuals and programs and require revisions, if necessary, to ensure that they contain information about the signs of an overpressurized airplane on the ground and the dangers of opening emergency-exit doors while the airplane is overpressurized." FAA said, "The FAA agrees with the intent of this safety recommendation and will issue a notice to principal operations inspectors (POIs) of air carriers who operate airplanes with nonplug-type doors to describe the circumstances surrounding this accident [American Airlines Flight 1291, Airbus A300B4-605R, Nov. 20, 2000]. The notice will direct POIs to stress to their respective air carriers' director[s] of safety the importance of including information in their cabin crew training programs and operating manuals regarding signs of an overpressurized airplane. The notice will include

guidance on the signs of an overpressurized airplane on the ground and the dangers of opening emergency-exit doors while the airplane is overpressurized for inclusion into affected air carriers' training programs and operating manuals. It is anticipated that the notice will be issued by December 2002;" and,

- NTSB Safety Recommendation A-02-23 said, "Require that cabin crew training manuals and programs contain procedures to follow during an emergency evacuation when the airplane is overpressurized." FAA said, "The FAA agrees with the intent of this safety recommendation and will discuss the importance of incorporating procedures for depressurizing an airplane prior to executing an emergency evacuation in the notice in response to Safety Recommendation A-02-22. The notice will provide guidance to air carriers who operate airplanes that are not equipped with traditional plug-type doors to include procedures for depressurizing their aircraft in their operating manuals. It is anticipated that the notice will be issued by December 2002."

Facts revealed to date by the two accident investigations show how the design of cabin doors and other emergency exits can affect procedures, and how the content of operating manuals and training manuals for pilots and flight attendants influences their ability to recognize and respond to airplane-overpressurization situations.

The first accident discussed in NTSB's August 2002 recommendations occurred Nov. 20, 2000, about 1222 local time, when a flight attendant/purser was killed during emergency evacuation of American Airlines Flight 1291, an Airbus A300B4-605R (A300), at Miami (Florida, U.S.) International Airport. The airplane was overpressurized until the flight attendant/purser opened the 1L cabin door; he was then forcibly ejected from the airplane, NTSB said. Three passengers were seriously injured; 18 passengers and one flight service director[5] received minor injuries; and the two pilots, six flight attendants, one off-duty flight attendant, one flight service director and 100 other passengers reported no injuries. Minor damage to the airplane occurred.

The scheduled international passenger flight was operating under U.S. Federal Aviation Regulations Part 121 in visual meteorological conditions; an instrument flight rules flight plan was filed. The flight had departed from Miami International Airport en route to Port-au-Prince International Airport, Haiti. About eight minutes after takeoff, the flight crew had a problem with the automatic pressurization system.

Based on information provided by the captain of the accident airplane, NTSB said that "the automatic cabin-pressurization controllers would not control cabin pressure when the airplane was climbing through 16,000 feet and the electronic centralized airplane monitor (ECAM) display[6] indicated that the forward outflow valve[7] was fully open." The cabin altitude was increasing at a rate of 2,000 feet per minute, and the cabin altitude indicator showed 7,000 feet.

The captain began to operate the pressurization system in its manual mode and, about 11 minutes after departure, told air traffic control (ATC) that he would return to Miami International Airport. The flight crew then began performing the American Airlines A300 Cabin Pressurization Manual Control Checklist,[8] part of the company's A300 operating manual.

Flight attendant call chimes sounded erratically, and the lavatory smoke detectors sounded continually while the aircraft was returning to Miami; passengers and flight attendants complained about pressure in their ears.

NTSB said, "About three minutes before landing, the captain declared an emergency to ATC and requested that aircraft rescue and firefighting (ARFF) personnel stand by for the landing. After the airplane landed at Miami International Airport, ARFF personnel checked the exterior of the airplane and reported no signs of fire. The cockpit voice recorder (CVR) indicates that a flight attendant reported smelling smoke to the flight crew. The captain indicated to NTSB investigators that he observed the illumination of a cargo loop light[9] on the cockpit overhead panel. The captain then ordered an emergency evacuation of the airplane, and the American Airlines A300 Ground Evacuation Checklist was performed.

"The flight attendants heard the sounding of the evacuation-signaling system and attempted to open the emergency-exit doors to begin the emergency evacuation but were having difficulty doing so. One flight attendant requested and received assistance from a passenger to open the 3L emergency-exit door, but the door could not be opened. Flight attendants at the 3L and 4L emergency-exit doors then announced to passengers that their exits were blocked. A flight attendant reported to the flight crew that the doors would not open.

"While the flight attendant/purser was struggling to open the 1L emergency-exit door of the airplane, the door suddenly burst open, and he was forcibly ejected onto the ramp and was killed. Preliminary findings from the investigation revealed that excess air pressure inside the cabin caused the door to burst open when the flight attendant/purser attempted to open it. After the 1L emergency-exit door opened, all of the other emergency-exit doors with handles in the open position opened, and the escape slides deployed."

The Airbus A300 has eight cabin doors used as emergency exits with door-stop fittings along each side of the door and fuselage-stop fittings[10] along each side of the fuselage frame. These doors do not have built-in systems to relieve pressure before they are opened, and they move sequentially upward, outward and forward parallel to the fuselage when operated. Airbus analysis showed that a person of the same height (five

feet 10 inches [1.8 meters]) and weight (183 pounds [83 kilograms]) as the accident flight attendant/purser could exert enough force on the handle to open a cabin door on an overpressurized airplane, NTSB said.

NTSB said, "[According to the flight service director,] the flight attendant/purser told the flight service director that something was wrong, entered the cockpit and then returned to the cabin. The CVR indicates that, approximately 40 seconds before the [1L cabin door burst open], the flight attendant/purser made a comment about pressurization. The flight service director then noticed the flight attendant/purser try to open the 1L emergency-exit door using both hands on the door handle. The 1L emergency-exit door then burst open, forcibly ejecting the flight attendant/purser from the airplane."

Investigators found that the 1L cabin door's lower guide arm was fractured and its support arm was cracked; these observations were consistent with the door bursting open because of excessive air pressure. A section of each of this cabin door's aft eight door-stop fitting pins was flattened, consistent with the pins being forced up and over the fuselage-stop fittings before this cabin door burst open.

NTSB made the following observations about SOPs and training based on information analyzed so far in the U.S. accident investigation:

- The captain did not say specifically that a pressurization problem had occurred when he made a public-address announcement to the flight attendants and passengers;

- The pilots were not aware that the airplane was overpressurized when they directed flight attendants to begin the emergency evacuation and, with one exception, the flight attendants did not recognize that the airplane was overpressurized — i.e., they later told investigators that they were unsure why their assigned cabin doors would not open — as they responded to the evacuation signal;

- One flight attendant, whose experience included observation of an airplane-pressurization test, told investigators that she was aware that overpressurization was the reason that the cabin doors could not be opened. NTSB said, "On the accident airplane, she pulled 'up on the door handle and it went about half way up and then [she] put it back down.' She indicated that she informed the flight attendants at the 4L emergency-exit door that they would not be able to open their emergency-exit doors because the airplane was not depressurized, and they both ceased trying to open their doors;"

- The flight attendant safety manual did not address situations in which all of the cabin doors fail to open during an evacuation and did not teach flight attendants to recognize the signs of an overpressurized airplane;

- FAA cabin safety specialists later told NTSB that the flight attendant safety manuals and training programs of 12 air carriers (including American Airlines) did not include information about how to recognize the signs of an overpressurized airplane; and,

- The American Airlines flight crew operating manual and training program did not include information about recognizing the signs of an overpressurized airplane.

The second accident discussed in NTSB's August 2002 recommendations occurred Oct. 20, 2001. One flight attendant was killed and another flight attendant was seriously injured during the deplaning of TunisAir Flight TARB631, an Airbus A300-605R, at Djerba Airport, Djerba, Tunisia. Two pilots, 10 flight attendants and 134 passengers were on the scheduled international passenger flight from Geneva, Switzerland, to Djerba.

NTSB said that information from Airbus showed that during the flight to Geneva by the accident airplane immediately preceding the accident flight, the pilots received an excessive-cabin-altitude warning and placed the airplane's pressurization system in manual mode. In Geneva, after the airplane was landed safely, maintenance personnel inspected the airplane and found no anomalies.

While en route to Djerba, however, the flight crew received an excessive-cabin-altitude warning and immediately placed the pressurization system in manual mode.

NTSB said, "The remainder of the flight and the landing at Djerba were uneventful. The airplane was parked at Djerba, and the engine bleed air was still turned on, allowing pressurized air into the airplane. While an air stair was being positioned to the 2L door of the airplane, a flight attendant attempted to open the 2L door. Excessive cabin pressure caused the door to burst open, and the flight attendant who opened the door was ejected and sustained serious injuries. A flight attendant who was standing near the flight attendant who opened the door was also ejected from the airplane and was killed."

The recommendations said that NTSB investigators found in the U.S. National Aeronautics and Space Administration Aviation Safety Reporting System[11] database another similar occurrence in December 2000 involving injuries to a flight attendant. The flight attendant aboard a Bombardier (Canadair) Regional Jet CL65 turned the main cabin door handle while the overpressurized airplane was parked at the gate; outflowing air pushed open the door and she was ejected from the airplane, suffering minor injuries.[12]♦

[FSF editorial note: This article, except where specifically noted, is based on U.S. National Transportation Safety Board Safety Recommendations A-02-20 through A-02-23 to the U.S. Federal Aviation Administration (FAA) on Aug. 2, 2002, and FAA responses on Oct. 31, 2002.]

Notes

1. The U.S. National Transportation Safety Board (NTSB) said, "Differential pressure, indicated by a cabin-differential-pressure gauge on the pressurization panel in the cockpit, is the difference between the pressure inside the airplane and that outside of the airplane."

2. NTSB, in Safety Recommendations A-02-20 through A-02-23 issued Aug. 2, 2002, said, "On May 8, 2001, NTSB issued Safety Recommendations A-01-16 through [A-01-22] to the [U.S. Federal Aviation Administration (FAA)] regarding information contained in the Airbus Industrie A300-600 operating manual and checklists and A300-600 operators' operating manuals, checklists and training programs. Safety issues included the adequacy of information regarding depressurization of the airplane when the pressurization system is being operated in the manual mode; the need for the flight crew to verify that the cabin differential pressure is 0 pounds per square inch (psi) [0 kilopascals] before signaling the flight attendants to begin an emergency evacuation; and the need for the flight crew to verify that the cabin differential pressure is 0 psi before permitting the flight attendants or gate agents to open the cabin doors. In a Jan. 23, 2002, letter to the FAA, NTSB classified Safety Recommendations A-01-16, [A-01-17] and [A-01-20] 'open – acceptable response' and Safety Recommendations A-01-18, [A-01-19], [A-01-21] and [A-01-22] 'open – unacceptable response.'"

3. NTSB. Safety Recommendations A-02-20 through A-02-23.

4. Blakey, Marion C. Letter from the administrator of FAA to Carol J. Carmody, acting chairman of NTSB. Oct. 31, 2002.

5. NTSB said that flight service directors are language translators who are assigned to selected flights to assist flight attendants in communicating with passengers. Although flight service directors are required to observe the emergency-procedures training provided to flight attendants, they are not qualified as flight attendants.

6. NTSB said, "The [electronic centralized airplane monitor (ECAM)] display is a cathode-ray-tube screen located in the cockpit. The system is automatic and displays messages and system diagrams to pilots. It provides operational assistance for both normal and abnormal airplane-system situations."

7. NTSB said, "At this point in flight, the [outflow] valves would normally be over halfway closed. Postaccident examination of the airplane by the NTSB Systems Group revealed that insulation blankets partially blocked the forward outflow valve and almost fully blocked the aft outflow valve."

8. NTSB said, "The American Airlines A300 Cabin Pressurization Manual Control Checklist is similar to that of Airbus. The entire checklist cannot be performed at one time; rather, pilots must initiate the checklist and then complete it later in flight. According to the accident captain, he did not perform all of the items in the Cabin Pressurization Manual Control Checklist because of his other priorities at the time, including addressing the smoke indications and landing the airplane."

9. NTSB said, "Illumination of a light on the CARGO COMPT SMOKE DET panel may indicate a fire in the cargo compartment. No evidence of fire was found in the NTSB's postaccident examination of the airplane."

10. NTSB said, "A door-stop fitting consists of a steel bolt and a stop pin, and a fuselage-stop fitting consists of a steel tab. The door-stop-fitting pins along each side of the door must clear the top of the fuselage-stop fittings when the door is opened."

11. U.S. National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS) is a confidential incident-reporting system. The ASRS Program Overview said, "Pilots, air traffic controllers, flight attendants, mechanics, ground personnel and others involved in aviation operations submit reports to the ASRS when they are involved in, or observe, an incident or situation in which aviation safety was compromised. … ASRS de-identifies reports before entering them into the incident database. All personal and organizational names are removed. Dates, times and related information, which could be used to infer an identity, are either generalized or eliminated." ASRS acknowledges that its data have certain limitations. ASRS *Directline* (December 1998) said, "Reporters to ASRS may introduce biases that result from a greater tendency to report serious events than minor ones; from organizational and geographic influences; and from many other factors. All of these potential influences reduce the confidence that can be attached to statistical findings based on ASRS data. However, the proportions of consistently reported incidents to ASRS, such as altitude deviations, have been remarkably stable over many years. Therefore, users of ASRS may presume that incident reports drawn from a time interval of several or more years will reflect patterns that are broadly representative of the total universe of aviation-safety incidents of that type."

12. NASA ASRS report no. 494141, December 2000.

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