



Malfunctions, Procedural Errors Contribute to Entry-door Incidents

Failure to correct mechanical problems involving fuselage-door systems, inattention to jamming hazards and improper operation of doors in unusual circumstances have been cited in international reports. Anticipating these risk factors enables flight attendants to take appropriate action.

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FSF Editorial Staff

Functional safety standards for fuselage entry doors provide the basis for training cabin crewmembers, gate agents, pilots, maintenance technicians and others who may open and close them on pressurized passenger airplanes. On some aircraft, the structural integrity of the fuselage would be compromised if a door is not fully closed, latched and locked; on others, an open door would prevent safe aircraft rotation during the takeoff roll or interfere with aircraft controllability to an unacceptable level, said an advisory circular (AC) issued in April 2005 by the U.S. Federal Aviation Administration (FAA).¹

Timely maintenance, standard operating procedures and crew training help ensure that each entry door functions as designed without increasing risks of injury to occupants or aircraft/equipment damage. Nevertheless, investigations of a number of recent accidents and incidents involving entry doors — and related events voluntarily reported by aircraft crewmembers — show a variety of causes. Handles and other door-control mechanisms, latching systems, locking systems, hinges, doorframes, seals, stops and other components sometimes have been involved in incidents and accidents. Although rare, these have included fatal accidents in which doors opened inadvertently during pressurized flight and unpressurized flight.



Entry doors on passenger transport jets normally have powered² latch actuators and alternative drive systems that protect the latches and the locks from overload conditions. The typical door operator's station(s) provides a positive method of determining that all required operations to close, latch and lock the door have been completed. Examples are labels/markings showing final handle positions and indicating lights. Moreover, for any door that could be a hazard if unlatched, the flight attendant at the door operator's station should expect a clearly visible and obvious means of recognizing that the door is not fully closed, latched and locked. Methods vary for manually operated doors, for systems in which the position of the door obviously shows that the door is not closed (i.e., held open by the latches in their latched position) and for remotely operated doors.

“Sometimes the [door] operator is required to carry out several actions in sequence to complete the door opening and closing operations,” said FAA AC 25.783-1A, *Fuselage Doors and Hatches*. “Failure to complete all actions in sequence during closure can have serious results. Service history shows that several incidents of doors opening during flight have been caused by the failure of the [door] operator to complete the door closing, latching and locking sequence. Other incidents

have been attributable to incorrect adjustment of the door mechanism, or to failure of a vital part.”

Improved standards for doors — issued by FAA in May 2004 — rely on “multiple layers of protections against failures, malfunctions and human errors” by requiring a latching system, a locking system, door indication systems³ and pressurization-prevention means.⁴ Applicability of specific standards to a given airplane depends partly on the category of the entry door (e.g., one category comprises doors for which initial opening is inward and that could become a hazard if they became unlatched).

A general principle in the standards is that no assessment or deductive reasoning by a crewmember can be required to determine the status of a door. The crewmember’s direct viewing (or indirect viewing using optical devices or indicator flags) immediately and unambiguously should make the door status clear from any viewing angle and should preclude a false-latched indication or a false-locked indication. If placards and instructions are necessary to interpret the status of the latches and locks, they must be provided using a permanent marking method.

Cabin crew vigilance also can help ensure that optical devices or windows to view latches and locks provide a clear view and are not fogged, and that dislodged material does not obstruct the crewmember’s view.

To help prevent total failure or inadvertent opening of a door, current U.S. Federal Aviation Regulations (FARs) and European Joint Aviation Requirements require aircraft manufacturers to consider possible events including failure of the door and the door supporting structure, excess flexibility in structures and linkages, failure of the door operating system, erroneous signals from the door indication systems and likely errors in operating and maintaining the door.

All Door Markings Must Remain Legible

Failures of fuselage doors have involved factors such as “wear; excessive backlash; excessive friction; jamming [e.g., by misplaced barrier straps or debris caught between a door and frame]; incorrect assembly; incorrect adjustment; parts becoming loose, disconnected or unfastened; [and] parts breaking, fracturing, bending or flexing beyond the extent intended,” the AC said. Another important element of door safety is that all markings for cabin crew and for maintenance technicians should remain clearly identifiable, resisting heavy wear, lubricants and cleaners.

Examples of such problems from U.S. incident reports — some involving inadequate preflight observation of a door’s condition — include the following:

- In August 2004, the flight attendant of a Bombardier Canadair Regional Jet 200 told the flight crew that a

whistle-like noise could be heard from the vicinity of door 1L during the initial climb. The flight crew said in a report, “All the doors were showing closed, and the aircraft was pressurizing normally. ... After landing, an inspection was made of the door area. A crack was found on the fuselage of the aircraft. ... [We] found that it had been forcefully closed with the pins at the center of the door extended. The metal lip, which the rubber seal seals against, had been bent and split by the impact on the forward and aft center of the door. We did not notice this during preflight, and the flight attendant did not slam the door prior to flight. We can only conclude that [damage occurred] on a previous flight. All three of us walked through the door and missed the damage”;⁵

- In March 2002, the flight attendant on a BAE Systems Jetstream 41 was unable to open the entry door after arrival. The incident report said, “After the aircraft arrived at the gate, the flight attendant attempted to open the passenger door but could not. After several attempts by the crew from the outside, it was decided to exit the passengers through the rear emergency exit and the aft cargo compartment. ... After a couple of attempts, maintenance was able to release and open the door. The investigation revealed that the right-hand cam block ... may have been worn beyond limits, causing the door latch not to work properly”;⁶
- In August 2004, the captain of a Bombardier Canadair Regional Jet CL65 declared an emergency and then landed the airplane without incident. A report by the captain said, “I received a master warning, ‘PAX DOOR,’ open in flight. [This was an] indication only. The door never actually opened. I complied with the quick-reference handbook and all procedures”;⁷
- In March 2004, the flight crew of a Boeing 737-700 declared an emergency during initial climb when the aircraft could not be pressurized because of a “false-latched” door, which was not indicated on the flight deck. Their report said, “Passing about 3,000 feet, the ‘A’ flight attendant called to tell us that there was a loud noise coming from the forward entry door. We thought that it might be an improperly seated door seal and asked her to let us know if it got better or worse in the next few minutes. ... I informed the passengers, and [the air route traffic control] center cleared us direct to [another airport 177 nautical miles (328 kilometers) away] at 8,000 feet. We left the door closed at the gate so maintenance could look at it from the outside. It turned out that when the operations agent at [the departure airport] closed the door, only the forward latches had fully engaged. ... Before the door was opened after the incident flight, the flight crew and flight attendants conducted an interior inspection and concluded, ‘There was no way this door could not be closed and latched. ... It was very difficult to see from the flight attendant position that the rear latches weren’t

engaged properly.’ The external inspection revealed that the aft end of the door stuck out with the forward end closed and faired with the fuselage”;⁸ and,

- In June 2004, flight attendants heard air leaking at an entry door shortly after takeoff in a Boeing 737-800; the flight crew received no indication. A report by the flight crew said, “Shortly after takeoff, the flight attendant by the 1L door notified the cockpit [crew] that the 1L door wasn’t sealed properly and that there was a deafening rush of air noise (which could be clearly heard in the background of the interphone transmission). She verified that the handle was in the ‘DOWN’ position. ... [After landing, maintenance technicians] meeting the flight found that the door had sagged on its hinges enough to allow the roller mechanism to engage down into position on the wrong side (inside) of the mating latch fixed to the door jamb.”⁹

Current FAA standards also require design solutions that prevent fuselage doors from being opened during flight either inadvertently by a crewmember or intentionally (e.g., by a suicidal passenger) to reduce door-opening risk during unpressurized flight, such as during landing.

In some pressurized aircraft in current fleets, intentional opening of a door is possible when the differential pressure (pressure difference between the cabin air and the outside air) is relatively low during takeoff, approach and landing, the AC said. Manufacturers can comply with corresponding FAA airworthiness regulations by incorporating a handle-operating force greater than 300 pounds (136 kilograms) when the cabin is pressurized.

In recent years, accidents and incidents have occurred in which one or more cabin crewmembers opened a door while the aircraft was pressurized.¹⁰ Doors are designed to prevent pressurization to an unsafe level — that is, a level that creates the hazard of ejecting from the aircraft the person opening the door — when the door is opened or the door appears to be closed and latched but has a failure or malfunction of the latching mechanism, or jamming is caused by a mechanical failure or by door-blocking debris.

“Clearly, emergency conditions may dictate that the exit be opened regardless of the differential pressure,” the AC said. “Ideally, the door would be operable with the highest differential pressure that is safe for the operator, but no higher than that.”

In July 2004, for example, the force of outrushing air from a parked Bombardier Canadair Regional Jet CL65 pulled the flight attendant out of the aircraft as she operated the door latch at the request of the flight crew. The flight crew said in a report, “AC ground power was connected via a portable ground power unit, and the main cabin door was closed. ... I asked the flight attendant to open the service door to get the [ramp worker] to

reestablish [interrupted] ground power. The low-pressure (air conditioning) air was still connected to the aircraft, causing the flight attendant to be pulled out the service door and onto the ramp. ... At this time [after checking the condition of the flight attendant, who had a small red mark on her knee], I noticed that both the high-pressure [ground air] and low-pressure ground air were connected to the aircraft.”¹¹

In designing entry doors, aircraft manufacturers also are required to consider “jams or nonfrangible debris that could hold the door open just enough to still allow pressurization, and then break loose in flight after full pressurization is reached,” the AC said.

Some regulations require that pilots receive an aural warning prior to or during the initial portion of the takeoff roll if any door is not fully closed, latched and locked and its opening would prevent a safe takeoff and return to a safe landing. Examples of incidents include the following:

- In March 2002, the flight crew of a Fairchild Dornier 328-100 rejected takeoff at 100 knots when the forward passenger door opened during departure. The accident report said, “Prior to the planned flight, the forward passenger door was closed and locked. The flight crew confirmed the correct positioning of the door during their pre-start checks. ... The door and locking mechanism were undamaged; however, the hinge arms of the integral airstairs were so severely damaged that it is unlikely that the door and the integral stairs would have remained attached had the aircraft continued to accelerate and become airborne. ... The most probable way in which the door opened was that the door handle was inadvertently operated during the takeoff run. The ergonomic features of the cabin crew station would have contributed to the handle being inadvertently grasped during this phase of flight. ... The senior cabin attendant ... recalled that, at some point during the takeoff run, she saw the door opening, felt a rush of air and heard a passenger shout that the door was open. She believed that she made a grab for the integral airstairs with her left hand but let go almost immediately as [the airstairs] fell away with the door”;¹²
- In October 2004, the pilot-in-command of a Boeing 737-800 rejected takeoff at 110 knots after receiving a master caution light for the 1R door during departure. In a report, the pilot said, “The on-board [lead flight attendant] told me that the handle to door 1R had moved up about three inches [eight centimeters]. The handle was reset, and we waited the appropriate amount of time for the brakes to cool before dispatching. The subsequent takeoff was uneventful”;¹³ and,
- In May 2004, the flight crew of a Fairchild Dornier 328-100 returned to the departure airport and landed normally. The incident report said, “On takeoff, the

cabin door came completely open. The flight attendant reached across the aisle to passengers in seats 1D and 1F for assistance. [A] commuter pilot deadheading in the back of the cabin came up front and pulled the flight attendant from her seat and to the rear of airplane.”¹⁴ A separate report by the captain said, “At approximately 100 feet above ground level (during gear retraction), we heard a loud pop or bang, followed by a rush of air. The red warning panel, master warning and triple-chime alerted us to an unsafe ‘DOORS’ condition. Further reference to the doors-system page confirmed that the main cabin door was open. ... The first officer visually confirmed that the main cabin door was still attached after quickly checking that all crewmembers and passengers were not injured. [During an FAA investigation, the flight attendant] could not recall whether or not she may have inadvertently rested her arm on the door handle while seated in the jump seat. Examination of the door and its locking mechanisms revealed no mechanical deficiencies.”¹⁵

Many aircraft provide a method for direct visual inspection of the closed position of the door and the status of each latch and lock so that the flight crew can determine whether to permit flight when observing only a remote indication of an unsafe door, the AC said. In the FARs, this method must be “permanent and discernible under operational lighting conditions or by means of a flashlight or equivalent light source.”

Miscommunication Increases Risk of Injury

Several international cabin safety guidelines¹⁶ in recent years have emphasized the importance of adequate training, adherence to procedures and consistent communication methods (including signals) for safe entry-door operation. The value of these has been suggested in situations such as the following:

- In May 2004, a flight attendant aboard a Boeing 757-200 was injured during operation of an entry-door handle. The incident report said, “[The] gate agent opened aircraft door 1L while the flight attendant still had her hand on the handle. The flight attendant sustained a fractured wrist”;¹⁷
- In April 2003, the cabin crew of an Airbus A330-200 were preparing for departure; the two forward left doors (DL1 and DL2) were closed, and the airbridges were retracted. The incident report said, “The passenger and baggage counts were lower than had been expected, and the aircraft weight-and-balance data differed from the load sheet that had been provided to the flight crew. ... The cabin crew customer service manager reopened DL2 to allow the ground-based service agents to board the aircraft [to supervise the movement of the passengers to reassigned seats] without seeking permission from

the pilot-in-command [per the operator’s procedures]. [Changes of two door symbols from green to amber] were the only visual indications available to the flight crew to indicate that door DL2 had been reopened. No aural warning would have accompanied those changes ... because the aircraft engines had not been started. The flight crew previously had verified that the aircraft doors were closed, and there was no requirement for them to conduct another check of the doors before commencement of the pushback. ... As the aircraft moved rearwards, the opened door DL2 impacted the airbridge. The door and airbridge were deflected into the aircraft fuselage, causing significant damage to the fuselage skin and associated structure”;¹⁸

- In February 2004, the captain of a Boeing 757 said that a gate agent failed to notify the flight crew before reattaching an airbridge (jetbridge) and reopening an entry door to board two last-minute passengers at a gate. A report by the captain said, “The door already had been closed. ... I had [told the ground crew,] ‘Parking brake released, cleared to push.’ However, a split second before the ground crew pushed the jet, they asked, ‘Why [is] the jetbridge back?’ At that time, I felt the door open and then close, and the jetbridge being pulled from the aircraft. ... I debriefed the purser about allowing the door to be opened without informing the captain. ... We came close to killing someone today”;¹⁹ and,
- In June 2004, a flight attendant aboard an Airbus A320 inadvertently deployed an evacuation slide at a gate while attempting to resolve an open-door indication on the flight deck. A flight crewmember said in a report, “The door was closed and slides were armed. ... I asked the no. 1 flight attendant if the door was closed, and she said, ‘Yes.’ I asked if she minded opening and closing the door, and she agreed to do so. She disarmed the slide and opened the door and closed it to no avail. Before I could get maintenance [on the radio], she tried to open the door again, but forgot to disarm the slide.”²⁰

Some voluntary reports by flight attendants showed that intermittent door-operation problems may generate significant concern for them. For example, one U.K. flight attendant’s report in 2004 said that repeated jamming of one entry door could not be replicated by maintenance technicians.²¹

“On arrival ... I went to open the L1 door,” the report said. “I lifted the red handle, and the door cracked open, letting in daylight. When I pushed the ‘DOWN’ button, nothing happened. I tried again and still nothing. I informed the flight crew, and also tried pushing the door out — the door was jammed and wouldn’t move. I then tried the ‘UP’ button to see if I could realign the door and try again. Nothing. A member of the flight crew tried to push the door out, putting full force against it, and nothing happened. The dispatcher was asked to open the door from the outside using the external

door controls. This was successful. An engineer [maintenance technician] was called, closed the door and opened it again twice with no problems. The defect was signed off; service was resumed. ... After the next sector, the door worked as normal. Arriving back ... the same thing happened; the door jammed. An engineer was called. He brought the door in and opened it again various times, and it worked as normal. He suggested that I hadn't lifted the red handle all the way up, and maybe I was at fault. [When] he asked me for a demonstration on how I opened the door, it opened. ... When I next operated on this aircraft, I asked if the defect had been [corrected]. It hadn't; the engineer explained that they couldn't find any problems. I felt exasperated by the whole situation ... [and] feel that a door jamming two out of four sectors should be seen as unserviceable."

In April 2002, the flight crew of a Boeing 747-300 in flight observed illumination of the no. 5 left main entry door warning light. The incident report said, "The flight engineer investigated and found that the door handle had moved from its fully locked 4-o'clock position to an unlocked 3-o'clock position. The flight engineer, with the assistance of one of the cabin crew, attempted to move the handle back to the fully locked position but was unable to do so. ... The cabin crew were advised to monitor the door for the rest of the flight.

"Shortly before landing, the flight attendant seated adjacent to the door observed the handle moving slowly upwards. Just prior to touchdown, the door handle jumped to the 2-o'clock position, at which time a loud wind noise could be heard. Leaving his seat, the flight attendant grabbed the handle and forced it down. Paper was observed being sucked under the door as the passenger seated directly in front of the door (adjacent to the window) turned and grabbed the door handle, giving assistance in pushing the handle down towards the locked position. The handle reached the horizontal 3-o'clock position with the flight attendant keeping weight on it until the aircraft had landed and taxied to the terminal. ... Upon returning to the operator's main base [after a series of adjustments and recurrence of the problem during one of five flights], the door was removed and disassembled for an inspection of the door bearings. No defects were found and the door was returned to the aircraft, where it was refitted and a rigging check carried out."²²

In summary, these advisory materials and events from several countries suggest that cabin crews should anticipate safety risks involving entry doors in the following scenarios:

- Distraction or interruption before completing the door closing, latching and locking sequence;
- Unexpectedly reopening/reclosing a door on the ground or deliberately touching the door handle of a moving airplane for any reason;
- Apparent malfunctions, including those requiring greater force than normal to reposition the door or a handle;

- Abnormal sounds that may indicate air leakage around the door;
- Cracks, bending, dents and similar signs of damage involving the door or adjacent areas of the fuselage;
- Inadvertently grasping or leaning against a door handle during flight, especially during takeoff, approach or landing;
- Observing movement of a door handle when no force has been applied by a crewmember;
- Simultaneous operation of internal and external door handles/controls; and,
- Anomalies involving aircraft pressurization on the ground, including malfunctioning equipment, flight crew error or increased air pressure from external sources.♦

Notes

1. U.S. Federal Aviation Administration (FAA). Advisory Circular (AC) 25.783-1A, *Fuselage Doors and Hatches*. April 25, 2005. In FAA usage in the context of airworthiness, the term "door" by itself includes "entry/exit doors, emergency exits, openable windows, access panels, covers and similar devices on the exterior of the fuselage that do not require tools to open or close."
2. Electrical power, hydraulic power or pneumatic power may be used for latching/unlatching mechanisms and locking/unlocking mechanisms, and safety systems are used to prevent power failures from unlocking or unlatching a door during flight.
3. In U.S. Federal Aviation Regulations, door indication systems typically comprise remote door sensors (such as microswitches) connected to displays on the flight deck (such as an amber light or a red light in the master warning system) to signal to the pilots that a door is not fully closed, latched and locked. For some door categories, the system must be designed so that any failure or combination of failures would not indicate erroneously that doors are closed, latched and locked.
4. "Pressurization-prevention means" refers to a method of preventing cabin pressurization to an unsafe level if any door in the pressure vessel is not fully closed, latched and locked. Otherwise, the airplane would be at risk for explosive/sudden decompression during flight.
5. U.S. National Aeronautics and Space Administration (NASA). Aviation Safety Reporting System (ASRS) Report no. 628574, August 2004. NASA ASRS is a confidential incident-reporting system. 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.”
6. FAA. Accident/Incident Data System (AIDS) Report no. 20020319004649C, March 19, 2002.
 7. NASA. ASRS Report no. 629783, August 2004.
 8. NASA. ASRS Report no. 610728, March 2004.
 9. NASA. ASRS Report no. 622931, June 2004.
 10. FSF Editorial Staff. “Recommendations Warn Against Opening Cabin Doors While Airplanes Are Pressurized.” *Cabin Crew Safety* Volume 37 (November–December 2002). The article said, “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 door handles.” Normal residual pressure after the cabin is depressurized does not prevent opening of doors or create a hazard, said AC 25.782–1A.
 11. NASA. ASRS Report no. 624694, July 2004.
 12. U.K. Air Accidents Investigation Branch (AAIB). AAIB Bulletin no. 3/2004, 11 March 2004. *Dornier 328-100, Edinburgh [Scotland] Airport, 6 March 2002 Accident.*
 13. NASA. ASRS Report no. 633471. October 2004.
 14. FAA. AIDS Report no. 20040503019809C, May 31, 2004.
 15. NASA. ASRS Report no. 616370, May 2004.
 16. The *Cabin Safety Compendium, Issue 1*, developed by the Global Aviation Information Network (GAIN) Program in 2001 and the *Inflight Management Manual* produced by the International Air Transport Association in 2003 are examples.
 17. FAA. AIDS Report no. 20040531010539C, May 31, 2004.
 18. Australian Transport Safety Bureau (ATSB). Incident Report no. 200301435. March 1, 2004.
 19. NASA. ASRS Report no. 609983, February 2004.
 20. NASA. ASRS Report no. 621609, June 2004.
 21. U.K. Confidential Human Factors Incident Reporting Program (CHIRP). *Cabin Crew Feedback*, Autumn 2004.
 22. ATSB. Incident Brief, Occurrence no. 200201617, released Oct. 21, 2002.

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