Should We Stay or Should We Go?

BY SHANNON FORREST

Flight crews must consider many factors in deciding whether to order an evacuation.

The last day of aircraft recurrent training for airline pilots typically concludes with an evacuation. When conducted in a simulator, the exercise is tightly scripted. The instructor sets up a condition that jeopardizes the occupants and requires the pilot-in-command to make an important decision — leave the aircraft or remain aboard?

The time factor adds complexity. A series of small events that evolve into an emergency provides time for preparation; hence the term "planned evacuation." Unplanned evacuations require a rapid assessment and instantaneous decision.

In training, experienced pilots have come to anticipate the drill and typically accomplish the required tasks in a precise manner. Few pilots experience an actual evacuation, however.

Because the simulator cannot replicate post-event conditions or unpredictable human behavior, the efficacy of the evacuation can never be assessed. The practical test standard for airline transport pilot certification in the United States, for example, specifies that a pilot must exhibit knowledge of and demonstrate the evacuation procedure, placing the emphasis more on methodology than on decision making.

Because no suitable metric exists, success is indirectly judged by whether the evacuation checklist is completed. Once the final item is complete, the exercise is over. The next step is never addressed. The abrupt end and lack of feedback leaves several unanswered questions: Was the decision appropriate? What is the best way to evacuate? How will the passengers react?

Pilots seeking to develop best practices may benefit by studying prior evacuations. Although no two scenarios are exactly alike, common elements exist. Sound judgment and practices can decrease the probability of additional injury or loss of life if an evacuation becomes necessary.

The U.S. National Transportation Safety Board (NTSB) has generated a wealth of information on evacuations. In 2000, the board published a report summarizing 46 evacuations that occurred between September 1997 and June 1999. Although all the aircraft were operated under U.S. Federal Aviation Regulations (FARs) Part 121 (air carrier operations), some airframes were similar in size and characteristics to those used by Part 91 (general operating rules) and Part 135 (commuter and on-demand operations) operators.

The report was concerned with four topics related to evacuations: certification issues, equipment effectiveness, communication and procedural guidance.

It also generated statistics about the circumstances and the 2,651 people involved. Unplanned evacuations happened more frequently than planned evacuations, and 39 percent of the time, they began with indications of an engine fire.

The presence of smoke (in the cockpit, cabin or cargo area) was the number two reason for an evacuation. A March 2014 search of the U.S. National Aeronautics and Space Administration Aviation Safety Reporting System (ASRS) database found that there were 91 evacuation events in the preceding three years. Consistent with the NTSB report in 2000, fire and smoke were indicated most often.

As most aircraft accidents are initially survivable, identifying the most expeditious means to evacuate safely is vital. The ideal situation is for occupants to exit using a normal aircraft entry door. Familiarity and size reduce the time required to exit. Secondary egress points provide options in the event the primary route is not viable.

The number and type of secondary exits are set by aircraft certification requirements. Currently, aircraft with fewer than nine passenger seats and with a maximum takeoff weight below 12,500 lb (5,670 kg) can be certified within Part 23 (airworthiness standards for smaller airplanes) in the normal or utility category. Under that standard, a seating capacity of two or more requires an emergency exit on the opposite side of the fuselage from the main door (canopy aircraft are exempt). Compliance can be achieved via an additional door, a window, or a movable panel, provided the opening can accommodate a theoretical ellipse that measures 19 by 26 in (48 by 66 cm).

Low-performance, single-engine aircraft operated under Part 91 represent the vast majority of Part 23 certifications. However, twins,

turboprops and jets can also be manufactured to fall within the standard. In the 1970s, the proliferation of higher-capacity turboprops necessitated an additional distinction. Multi-engine aircraft with a maximum takeoff weight of 19,000 lb (8,618 kg) and no more than 19 passenger seats were permitted to be certified within Part 23 under a "commuter" category. In addition to the main door and the opposite-side exit prescribed under the Part 23 rules, up to two additional exits are required, depending on the actual seating capacity.

Part 25 rules (airworthiness standards for transport category airplanes) apply an alpha-numeric ranking system to classify doors and exits. Each letter or number is correlated with minimum dimensions. The letter A, B or C denotes floor-level doors common to large transport category aircraft. Roman numerals I through IV describe smaller openings typical of narrowbody aircraft, business jets and turboprops.

A Type I exit is always a conventional door; the other numerals are pathways used only for egress. A larger number means a smaller exit. For example, the Boeing 777-300 is certified with five pairs of Type A exits (all doors), whereas the Airbus A319 is fitted with two pairs of Type I (doors), and one pair of Type III (overwing) exits. A Gulfstream IV business jet has a single Type I door and two pairs of Type IV overwing exits. The number of exits, in concert with the classification, determines the maximum number of passenger seats allowed.

Where the exit is placed is also important. Overwing exits have a maximum step up and step down distance, limiting vertical placement on the fuselage. Some aircraft, such as the McDonnell Douglas MD-80 and the Boeing 727, use a ventral or tail cone exit to increase passenger capacity, as well.

Common to Part 23 and Part 25 is the directive that each exit be free from interior obstructions and appropriately marked and lighted. Cargo doors that are accessible from the passenger compartment are not considered exits (for certification purposes) unless they comply with the criteria. This can be confusing because some pilot training materials and checklists refer to cargo doors as secondary or alternate escape routes.

Additionally, all exits more than 6 ft (2 m) off the ground (with the landing gear extended) require a means to assist the passengers to traverse the vertical distance. If the escape route is over the flap, the measurement is taken from that reference point, in either the takeoff or landing flap position (whichever is higher).

A slide or slide/raft is the preferred method of assistance. Data show that a slide is also the safest way to evacuate an aircraft, other than the normal use of a main door, of course. Injuries tend to occur when using overwing exits, especially when a significant height for a jump is involved. There's also a psychological variable in play; a slide is more comforting than an uncontrolled descent through open air. A slide can also accommodate different body types and ages more appropriately.

The logic of the 6-ft rule has always been dubious, yet it remains the norm. Shortening the distance would likely reduce injuries but at the same time cause design headaches and additional costs for manufacturers. According to the NTSB study, 37 percent of the evacuations involving slides had at least one slide failure. A slide is far from perfect, but, given an option, it's a better choice than climbing down a wing, a rope or a ladder when conditions are stable.

The evacuation of an Embraer ERJ-170 in Cleveland, Ohio, U.S., in February 2007 illustrates a gap in knowledge applied to decision making, however. After overrunning a short, contaminated runway, the aircraft slid through a fence and the nose gear collapsed. The NTSB's final report says that the captain, along with the aircraft rescue and fire fighting crew, wanted to deplane using the slide. The company dispatcher advised that the chief pilot, who was not on the scene, did not want the slide deployed "at any cost" because of potential injuries. Instead, passengers exited via the service door using a ladder anchored in snow.

From a human factors standpoint, all exits should be easy to operate. In 1996, a Beech 1900C collided with a Beechcraft King Air A90 at the non-towered Quincy Municipal Airport in Illinois, U.S. The NTSB determined that the impact forces were survivable and that nearly everyone perished from inhalation of carbon monoxide and byproducts of combustion. Three pilots who arrived at the scene first — including two who were qualified on the aircraft — reported signs of life and verbal contact with the captain of the Beech 1900. They were unable to open the main door from the outside, however.

Analysis indicated the main door cam locks were still engaged, most likely because of cable slack caused by structural deformation during the accident. The left side emergency exit was initially free from fire and offered a viable escape route, and the first officer apparently attempted to reach it but became incapacitated in the process.

Why the passengers did not open the hatch and egress remains a mystery. Airlines are required to screen passengers before seating them in an exit row; however, surveys reveal that some passengers pay little attention to written safety instructions. Others may be physically or psychologically unprepared for the challenge of removing a heavy panel and awkwardly squeezing through a hole in the fuselage.

Evacuation demonstrations are supposed to expose flaws in design that hinder the evacuation process, but not all aircraft are required to undergo such a demonstration before they can be certified. The requirement for Part 23 commuter aircraft and Part 25 aircraft with more than 44 seats calls for physical proof by full-scale evacuation, not analysis of computer models, that the maximum number of occupants can get out within 90 seconds with half of the exits blocked and simulated carry-on luggage impeding egress as specified.

When operations permit, having a properly trained and proficient flight attendant or a cabin crew is invaluable. Combined crew resource management (CRM) training — in which the pilots and flight attendants attend class together — promotes teamwork and improves situational awareness and communication skills, including criteria to be followed by the cabin crew to initiate the evacuation in the absence of a command from the flight crew. Airlines commonly use this practice, and a few corporate flight departments have followed suit. Some training sessions use scripted evacuation scenarios in a simulator with the flight attendant in the observer seat, allowing the flight attendant to gain awareness of pilot workload and task prioritization from the onset of the abnormal condition. Because things play out in real time, the flight attendant becomes acutely aware of the actual time remaining to prepare the passengers.

Disparity in time perception among aircraft crewmembers can be fatal. The NTSB discussed this point in its final report on the crash of Atlantic Southeast Airlines Flight 529 on Aug. 21, 1995. After a propeller blade separation at 18,100 ft rendered the Embraer EMB-120 unable to hold altitude, the pilots attempted to land in a field. The flight attendant was informed seven minutes prior to impact and neither received nor sought any additional information. A brace command was not provided. It was only after she saw treetops that she returned to her seat and strapped in. Although seriously injured, she is credited with saving several lives. Had she not serendipitously looked outside, she might have been fatally injured, precluding her from rescuing others.

Part 91 and Part 135 operators that use cabin aides in lieu of designated flight attendants need

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to clearly delineate roles and expectations prior to emergency situations. By definition, cabin aides are not crewmembers and do not require safety-related training. After a well-publicized runway excursion at Teterboro (New Jersey, U.S.) Airport during takeoff involving a Bombardier Challenger 600-1A in February 2005, investigators determined that the cabin aide failed to conduct a seatbelt compliance check prior to the takeoff roll (*ASW*, 7/08, p. 40). Several passengers were unbelted at the time of the overrun, exacerbating their injuries. Most disturbing was her lack of familiarity with operating the main cabin door in the event of an emergency. She was tasked with these items (and the safety briefing) despite the fact that she lacked training to accomplish them effectively. Because the two pilots were initially restrained in place by debris, the evacuation responsibility was left to the unprepared cabin aide.

Except for guidance from a crewmember briefing/instruction when possible or written instructions, passengers are on their own during evacuations. Research shows few people can operate a Type III or Type IV overwing exit correctly without such instruction or practice. Some aircraft manufacturers have addressed this by replacing the plug-style hatch with a hinged door that swings outward when a release is pulled.

Because frightened occupants might try to open an exit without assessing outside conditions, potentially making the situation worse, communicating safety instructions before starting engines is essential. Pilots responsible for briefings need to be aware of the tendency toward complacency associated with constant repetition and should not assume that passengers have heard the instructions before or that they know what to do.

For example, two passengers escaped in September 2008 from a Lear 60 after it became engulfed in flames following a rejected takeoff and runway excursion at Columbia (South Carolina, U.S.) Metropolitan Airport (*ASW*, 5/10, p. 24). Two pilots and two passengers were killed. One survivor recalled the captain's before-takeoff safety briefing and used the information to locate and activate the aft emergency escape hatch. That passenger guided the other to safety. Because a lavatory partition prevented seeing the hatch from the passenger cabin, the NTSB concluded that the briefing was a key survival factor.

When smoke or fire is involved, success hinges on the ability to locate an exit in reduced visibility. Cabin simulators that use theatrical smoke provide training in finding an exit by feel; however, they have shortcomings. The breathable innocuous vapor used to simulate smoke is not representative of the toxic environment typical of combustion, and unless the doors and exits are exact replicas of those used on the aircraft of the trainee, the experience can induce false confidence.

Practice opening the actual aircraft emergency exit while wearing a blindfold can enhance proficiency and provide the realism the generic simulator lacks, as well as proof that exits will open as designed. The exits did not open as designed on Dec. 1 2004, when a Gulfstream IV landing in Teterboro departed the right side of Runway 24 and came to rest in the grass. Trees jammed against the main door, preventing it from opening. The copilot pulled the release handles on the four remaining emergency exits, but only one hatch was able to be removed (with help from passengers). The investigation showed that recent interior cosmetic modifications interfered with operation of the exits.

Merriam-Webster's dictionary defines an evacuation as "removal from a dangerous place" or "withdrawal from a place in an organized way, especially for protection." Not explicitly mentioned is the time element. The perceived sense of urgency drives the decision to deplane normally or conduct an evacuation. The decision should be based on which option offers the most relative safety.

Operations manuals should provide guidance for likely scenarios — including fire, smoke, fuel leak, gear collapse or aircraft sinking in water — but need to allow flexibility in unpredictable situations.

When evacuating, the pilot-in-command needs to assume a survival mindset. Circumstances that led to the evacuation are no longer important, and this is not the time for introspective thoughts about blame, certificate action or legal implications. Using reason instead of emotion is also key (and difficult to do when adrenalin is surging).

As a pilot, keep in mind that when the simulator session is over, and the training is signed off as complete, the real test hasn't started yet. According to author Laurence Gonzales in his book *Deep Survival*, "only about 10 to 20 percent of people can stay calm and think in the midst of a survival emergency. They are the ones who can perceive their situation clearly; they can plan and take correct action, all of which are key elements of survival." Try to be in that group.

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