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How Airbus emptied a packed A380 12 seconds faster than necessary.

BY WAYNE ROSENKRANS

'Over in a Flash'

When 873 people jumped out of an Airbus A380-800 onto slides in 78 seconds last March, two pursers and 16 flight attendants helped validate the airplane's new evacuation technology, procedures and training. Although this full-scale emergency evacuation demonstration in Hamburg, Germany, was certified within days by the European Aviation Safety Agency (EASA) and the U.S. Federal Aviation Administration (FAA), cabin safety researchers likely will spend years analyzing the data.

At Flight Safety Foundation's International Air Safety Seminar (IASS) in Paris in October 2006, an Airbus official added details of how a Lufthansa cabin crew guided about 11 passengers per second off the airplane, which has 16 doors, through the eight doors on the right side. Francis Guimera, A380 program safety director, said, "Without a doubt, cabin crew are the most important element in case of an emergency [or] an evacuation demonstration. ... Never before have so many people been safely evacuated from an aircraft. Because of the double-deck configuration, a single-shot [demonstration] — both decks at the same time — was requested by EASA and FAA to identify any possible slide interference."

The A380-800 — which received joint EASA/FAA type certification on Dec. 12, 2006 — is an all-new four-engine jet transport airplane that typically is expected to have 555 passenger seats in three classes with two aisles per deck, but can be configured to carry more than 800 passengers in high-density seating. A passenger seating configuration of 110 seats is allowed by EASA/FAA regulations for each pair of Type A exits.¹ The A380 is equipped only with Type A exit doors, with the eight pairs designated forward to aft on the main deck as M1, M2, M3 (overwing), M4 and M5, and on the upper deck as U1, U2 and U3. This airplane preferably will be evacuated as two separate cabins, and forward and aft staircases will offer a potential secondary escape route. The demonstration established a maximum passenger-seating capacity of 853 with the minimum 18 flight



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attendants. Another demonstration would be required to raise that seating number.

The demonstration's purpose was to determine if this airplane type can be evacuated in a timely manner, that is, within 90 seconds, as required by Part 25.803 and Appendix J to Part 25 of the EASA Joint Aviation Requirements and the U.S. Federal Aviation Regulations (FARs). The demonstration also is intended to confirm the adequacy of emergency procedures and the effectiveness of crew training.

Engineering innovation was critical for evacuation to be feasible. "For an aircraft of such size, you find it necessary first to imagine the appropriate evacuation means," Guimera said. Overall, the evacuation system comprises eight door-mounted slides and two fuselage-mounted overwing slides for the main deck, and six fuselage-mounted slides for the upper deck. Beside each door is a door-and-slide indication panel that helps any crewmember to correctly handle the powered-door operation and to confirm that slides are fully inflated. Briefing cards and

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After the demonstration, hangar lighting reveals evacuation system equipment — including predeployed upper deck slides — that had been visually concealed beforehand from volunteer passengers and crewmembers.



placards inform passengers how to operate the system.

Because the upper deck door sills are 7.87 m (25.80 ft) above the ground, the corresponding slide/ramps provide integral blinder walls and a curved ramp to mitigate passenger fear of heights. Each of these slides is 14.7 m (48.25 ft) long. They are designed so that the maximum velocity of a person arriving at the ground is no faster than that for a person descending from a current single-deck aircraft.

Manufacturer Goodrich's Tribrid gas-generator module — along with new slide fabrics, adhesion methods and light-emitting diode (LED) exterior lighting — exemplify the new technology developed for the system. A reservoir within the module for each slide contains carbon dioxide in liquid form as a coolant, and a gaseous mixture of carbon dioxide and nitrogen. “The [electrically fired squib and solid] propellant provide the energy to expand the primary gases that transform the liquid coolant into a mixed gas discharged into [slides],” Guimera said.

Another evacuation innovation is the “intelligent” slide for each M1 door, i.e., a ramp extension operated automatically by aircraft-attitude sensors. This means that if an A380 is sitting on the ground in a tail-low attitude with the main gear extended — causing the door sill to exceed the normal 5.1 m (16.7 ft) height — an electrically actuated cutter releases an additional length of ramp that will rest on the ground.

In preparation for the demonstration, a pool of 42 Lufthansa cabin crewmembers trained in Toulouse, France, completing a three-day subset of the full A380-800 cabin crew curriculum. They also spent a half-day visiting the demonstration aircraft. “We addressed only topics that were relevant,” Guimera said. “[We told them,] ‘Make yourself heard, help those in the vicinity of the [assigned cabin] area and verify that

no occupants are still remaining in the aircraft.’ In stair management, we were very interested to see if there was any possibility of migration between the upper deck and the main deck. We succeeded [during the demonstration] ... there was no movement of people between the upper deck and the main deck.”

In Hamburg on the morning of the demonstration — Sunday, March 26 — 18 cabin crewmembers from the 42 on standby were called to the Airbus hangar. They received a briefing about the on-site safety plan, in which 80 slide assistants would handle all evacuees as they reached the ground. Otherwise, this briefing was highly restricted in its content per EASA/FAA regulations. Afterward, recalling his experience with the volunteer passengers, Lufthansa flight attendant Stefan Kaiser said, “It

was all over in a flash. All we had to do was dictate the pace for them to jump.”

Airbus photos of before-and-after demonstration activities do not show the low level of illumination that evacuees actually experienced. At the evacuation signal, normal cabin lighting changed to floor-proximity emergency escape path lighting and outside illuminated slides — yellow LEDs integrated into railings — outlined the escape route. Forty infrared-sensitive video cameras were used, and two videos were shown and discussed at the IASS.

Table 1 shows that the upper deck was evacuated in the same amount of time as the main deck. The rate at every door — ranging from about 1.3 to 1.8 evacuees per second — exceeded the theoretical average rate of 1.2 evacuees per second per door required to evacuate the occupants within 90 seconds.

Airbus A380-800 Emergency Evacuation Demonstration¹

Door Designation	Evacuation Start Time ²	Door Begins to Open ³	First Evacuee on Slide	Last Evacuee on Ground	Time Elapsed From Start (Seconds)	Rate (Evacuees per Second)	Passenger Evacuees	Crew Evacuees ⁴	Total Evacuees
Five Main Deck Doors Used – Right Side									
M1	16:27:37	16:27:42	16:27:50	16:28:49	72	1.5	105	3	108
M2	16:27:37	16:27:42	16:27:50	16:28:48	71	1.4	98	3	101
M3 (overwing)	16:27:37	16:27:41	16:27:48	16:28:55	78	1.4	106	3	109
M4	16:27:37	16:27:42	16:27:49	16:28:54	77	1.8	137	2	139
M5	16:27:37	16:27:42	16:27:50	16:28:52	75	1.3	92	2	94
Main deck subtotal							538	13	551
Three Upper Deck Doors Used – Right Side									
U1	16:27:37	16:27:43	16:27:49	16:28:51	74	1.4	101	1	102
U2	16:27:37	16:27:43	16:27:47	16:28:52	75	1.3	94	4	98
U3	16:27:37	16:27:43	16:27:49	16:28:55	78	1.6	120	2	122
Upper deck subtotal							315	7	322
Total							853	20	873

Notes

1. These unofficial data are based on two exterior infrared video recordings presented by Airbus at Flight Safety Foundation’s International Air Safety Seminar in Paris in October 2006. Accuracy is subject to screen resolution of the videos, a limited view of the M3 overwing slide and other factors.
2. These are local times in Hamburg, Germany, on March 26, 2006. Sudden darkness in the cabin, except for emergency lighting, signaled the evacuation start time.
3. Each time represents the first visible motion of the door on the videos. Only a very low level of exterior illumination was allowed during the demonstration.
4. Crewmembers comprised two pursers, 16 flight attendants and two pilots. They were unaware of which doors to use until the evacuation signal.

Source: Flight Safety Foundation

Table 1

The fastest time, at the M2 door, appeared to be about seven seconds better than slowest time at the M3 overwing and U3 doors.

Evacuees at the upper deck doors appeared to show no hesitation. On the main deck, however, one passenger at M5 stepped through this door toward the slide, grabbed the right door frame, turned back and climbed toward the door before turning again and jumping onto the slide. For about four seconds, other evacuees jumped around this passenger without delay.

Guimera noted that one video shows a crewmember at the U1 door taking about 10 seconds to jump after the last person from his area had jumped. “An interesting thing to see is the delay because [this flight] attendant was checking that all of his area was free of passengers,” Guimera said.

Crowding on the M3 overwing slide for about 17 seconds caused its inflated barrier to fold down and outward so that about a half dozen passengers appeared to lose their balance and/or fall onto the slide before they descended. “It was a concern, so we had to reinforce the barrier on the M3 overwing slide,” Guimera said.

Videos shot inside the cabin show pursers and flight attendants shouting commands and assertively directing the evacuees to the best alternate exit whenever crowding slowed the flow at the exit the crewmember was monitoring, he added. Guimera cited a few examples of how Airbus interpreted the videos, measuring a “normal rate” of 1.85 evacuees per second. “We have five [aft] slides so it was more crowded,” he said. “[For the M4 door,] we have an excellent report — 137 passengers were evacuated within 75 seconds.”

Injuries during evacuation demonstrations for airplane certification long

have been a concern. One of FAA’s most cited figures is that 269 (4.6 percent) of 5,797 evacuees were injured in 19 demonstrations conducted from 1972 to 1991 — a rate that FAA called “unacceptable” in 2004 while advocating safer alternatives. Thirty-three passengers and no crewmembers were injured during the A380 demonstration; Airbus categorized the injuries as minor and cited one fractured femur, friction abrasions, sprained knees and bruises.

In addition to standard EASA and FAA certification requirements, the agencies created various special conditions for “novel or unusual design features,” a standard term in certification regulations. Special conditions relevant to evacuation addressed the A380’s full double-deck passenger cabins and very large seating capacity; forward and aft staircases connecting the main and upper decks; method of outside viewing from closed doors; slide/rafts for all upper deck doors for ditching; performance of escape systems installed in nonpressurized compartments after cold soak from a long flight and with 25-kt wind from the critical angle; the unique slide-inflation subsystem; and escape and/or removal of crewmembers from crew rest compartments.

The demonstration was one of many forms of extensive evacuation-related testing. Goodrich alone expected to conduct up to 2,500 tests of the A380 evacuation system, as one example. “This also was the first time that the authorities have requested that the manufacturer simultaneously inflate all the slides on one aircraft [using only battery power],” Guimera said, referring to a test completed successfully in June 2006.

Another special condition noted by Guimera was FAA’s requirement for

satisfactory slide operation at minus 55 degrees C (minus 67 degrees F). “This new requirement is setting a new standard,” Guimera said. “[A380 certification] was also the first time that the authorities were not satisfied to demonstrate the slide/raft capability only by a simple analysis.” So Airbus conducted full-scale tests in the Pacific Ocean in which one A380 slide/raft was inflated and boarded adjacent to a floating platform, then detached into open water for a sea trial.

A380 evacuation tests continued after the March 26 demonstration. Three days later, for example, Airbus conducted a full-scale migration test. “We installed 150 passengers on the main deck forward part and 70 on the upper deck,” Guimera said. “We opened only ... the forward left door [on the main deck] ... to evaluate the crowding of people coming from the upper deck to the main deck. Finally, we succeeded in evacuating 220 people within two minutes ... with no [adverse] interaction.”

Guimera also addressed questions about computer simulation of evacuations. “Unfortunately, evacuees may create bottlenecks and confusion at the top of slides,” he said. “[Software does not yet] simulate such anticipation [or how] migration between decks is to be avoided by appropriate gestures and correctly positioning [cabin] crew during the preflight briefing. We cannot support the idea to have a demonstration done only by simulation — the real test is certainly more revealing.” ●

Note

1. A Type A exit is a floor-level exit with a rectangular opening of not less than 106.7 cm (42 in) wide by 182.9 cm (72 in) high with corner radii no greater than one-sixth of the width of the exit.