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CABIN CREW SAFETY

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U.S. Study: Pathway Widths and Distances Are Key in Emergency Evacuation Times

The U.S. Federal Aviation Administration has mandated new rules designed to improve access to Type III overwing emergency exits. A recent study examines which seat and exit configurations offer the best egress values.

Editorial Staff Report

Cabin evacuation times through emergency overwing exits in transport airliners can be significantly enhanced by increasing pathway widths, a recent U.S. Federal Aviation Administration (FAA) study says.

The study on egress times for Type III overwing emergency exits was conducted by the FANs Civil Aeromedical Institute (CAMI) in Oklahoma City, Oklahoma. Results of the study, the second conducted during the past several years on the subject by the institute, were released late last year.

The study was conducted at the CAMI Evacuation Research Facility (ERF) in Oklahoma City. The study was commissioned after the FAA regulations branch issued a Notice of Proposed Rulemaking designed to require improved access to Type III (typically smaller) overwing emergency exits in transport category airplanes with 60 or more passenger seats.

The proposed rules were adopted in June. The changes require that access to the exit must be provided by an 11 unobstructed passageway that is at least 10 inches in width ... [when] adjacent seat rows on the exit side of the aisle contain no more than two seats, or 20 inches in width ... [when] those rows contain three seats." Prior to the FAA action, specific passageway widths were not defined for Type III exits, although minimum access requirements resulted in a passageway of about six inches. [FAA officials say subsequent tests indicate that egress flow rates do not improve significantly with passageways wider than 13 inches in the three seat rows and rule modifications are under consideration.]

The research employed a "within -groups" experimental design in which four groups of 39 subjects were required to exit the ERF using four exit and seat configurations (Table 1, page 2).

According to the FAA study, a counterbalanced experimental procedure was used to compensate for the effects of evacuation experience (learning the task) and other variables including motivation and fatigue. The FAA said that test subjects ranged in age from 19 to 61 years, with no more than 60 percent of either gender in each group. All tests were recorded on video cameras.

In single-exit trials, the study concluded that "the fastest times and highest flow rates occurred with a 20-inch pathway between triple seats or a 10-inch pathway between double seats.

"Double exits produced 36 percent shorter egress times, although flow rates declined 11 percent and exit [hatch] plug removal times increased 32 percent, compared with single exits," the study said. "Efficient egress requires optimization of the space around the exit."

But the study added: "Generally, wider pathways and fewer obstructions enhance this process. However, when available space exceeds individual passenger needs, conflicts may be produced that inhibit egress."

Table I
Counterbalanced Research Design

Group	Configuration			
1	A	B	C	D
2	D	C	B	A
3	B	D	A	C
4	C	A	D	B

Source: U.S. Federal Aviation Administration

The four exit and seat configurations were designed to test evacuation times under a variety of situations.

Configuration A (Figure 1, page 2) was an interior cabin arrangement that consisted of triple passenger seat assemblies located on both sides of the center aisle, "with seat assembly set aft of the Type III exit positioned so that the front edge of the seat cushion extended no more than 5 inches forward of the aft edge of the exit opening." The seat assembly located forward of the exit was

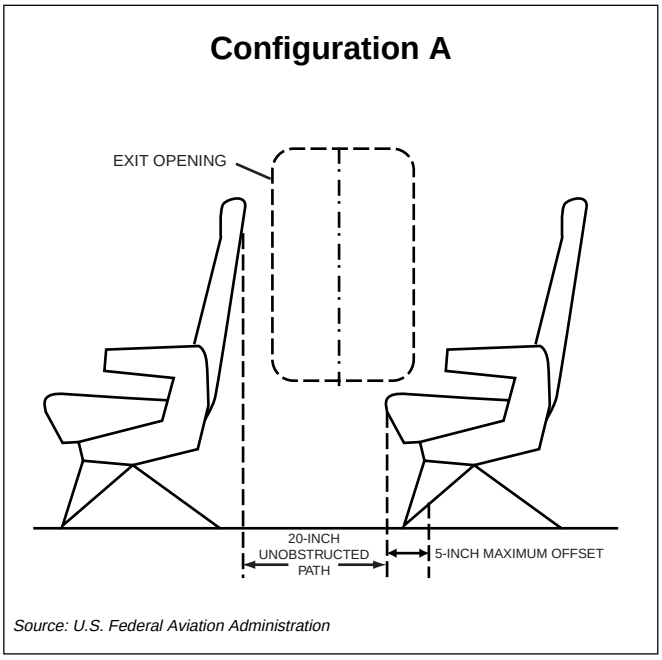


Figure 1

positioned with the aft edge of its seatback located 5 inches in front of the exit opening.

"This combination of seat assembly locations provided a 20-inch-wide pathway from the center aisle to exit opening," the study said. The center aisle was 19 inches wide at the inboard armrests of the seat assemblies.

The arrangement of Configuration B (Figure 2) was similar to that of Configuration A, the study said. "However, the seat assembly forward of the exit opening was moved aftward to place the aft edge of its seatback at the forward edge of the opening and the seat assembly aft of the exit opening was moved 5 inches farther forward to encroach upon the exit opening by 10 inches. This placement provided a 10-inch pathway completely adjacent to the opening of the Type III exit. The seatbacks on the seat assembly

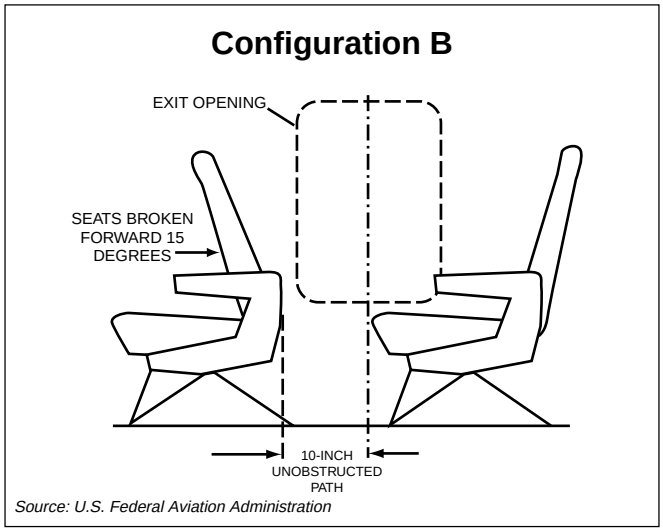


Figure 2

immediately forward of the exit opening were fixed in a broken-over position 15 degrees (forward) past plumb."

Configuration C (Figure 3) was designed with a 10-inch pathway based on the method used in Configuration B, except that double seat assemblies were placed on the side closest to the exit. Triple seat assemblies were placed on the other side of the center aisle, resembling an aircraft with five-abreast seating (e.g., a DC-9). The center aisle width in this configuration was also 19 inches.

Configuration D (Figure 4, page 3) comprised a cabin interior arrangement using triple seat assemblies as found

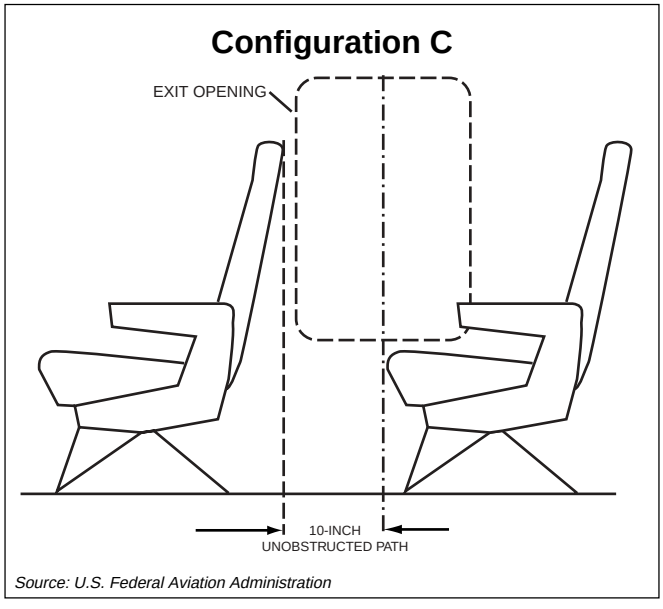


Figure 3

Table 2
Total Time in Seconds for All Subjects to Egress

	Configuration			
Group	A	B	C	D
1	91.67	74.03	81.86	72.36
2	74.90	82.50	87.37	39.00
3	64.20	89.83	80.93	46.60
4	77.16	82.54	62.36	43.90
Mean	76.98	82.23	78.13	50.47
Std. Dev.	9.79	5.59	9.43	12.93

Source: U.S. Federal Aviation Administration

in Configuration A, with two Type III exits set up to provide a 29-inch distance between their vertical center lines. "However, two double seat assemblies replaced the triple seat assemblies adjacent to the exits; these double seat assemblies were positioned to simulate triple seat assemblies from which the outboard seat had been removed. This configuration provided three 6-inch pathways: one fore, one aft, and one between the two double seat assemblies," the FAA study said.

A 19-inch center aisle width was also used for the Configuration D tests.

The total time for each group to evacuate the ERF in each of the configurations is shown in Table 2. The times include the time required to remove the exit hatch plug and the cumulative time for all 39 subjects to exit the facility completely.

"The subjects who were seated at the exits chose these seats themselves," the study said. "No attempt was made by the research team to choose an obviously able subject to sit in that location. The only attempt to ensure that the subject seated at the exit opening was capable of opening the hatch was to ask him or her after being seated if opening the hatch would be a problem."

The FAA report also said that no attempt was made to instruct subjects on how to operate the hatch, except for telling them to read the briefing card located in the seatback. "Thus, while these total evacuation times are necessary to provide a complete view of the evacuation processes, their usefulness in determining the effectiveness of any particular seating or exit configuration is ... [limited] by the strategies and abilities of the subjects who were responsible for opening or removing the exit [hatch] plug."

Table 3
Total Time in Seconds to Remove the Exit Hatch Cover

	Configuration				
Trial	A	B	C	Da	Db
1	6.83	5.37	6.43	13.10	8.57
2	4.47	8.86	4.14	5.53	6.30
3	5.13	4.87	4.03	5.87	5.80
4	4.16	4.87	4.03	5.87	5.80
Mean	5.15	5.70	5.46	7.79	6.57
Std. Dev.	1.03	1.92	1.40	3.09	1.18

Da = Forward exit; Db = Aftward exit

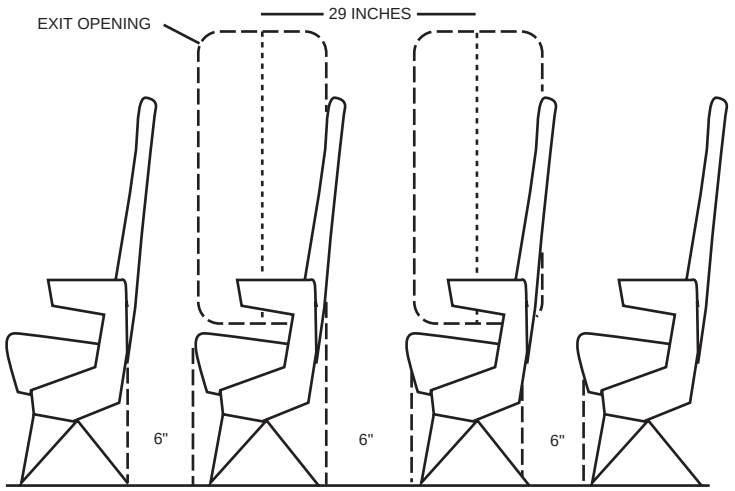
Source: U.S. Federal Aviation Administration

The study said that to provide a more useful view of the time required for exit hatch opening and flow rates, total evacuation times were divided into two phases: the time required to open and remove the hatch plug and the time required for the third through the 37th subject to evacuate.

"The time required for the first subject to enter the opening was excluded in this phase because of the likelihood that this subject would be out-of-position relative to the normal approach to the door, and that any repositioning time necessary to get oriented to the exit would affect the results. Similarly, the second subject out of the ERF was excluded from both analyses to provide a buffer between exit opening/removal and steady egress, to obtain as pure a measure of flow rate as possible. The last two subjects to get out were also excluded to control for the lack of 'push' from subjects behind them," the FAA said.

Times for exit hatch opening and removal are shown in Table 3. The mean time required for subjects to egress completely are shown in Table 4 (page 4).

Configuration D



Source: U.S. Federal Aviation Administration

Figure 4

Table 4
Mean Time in Seconds for Subjects to Egress

	Configuration				
Group	A	B	C	Da	Db
1	2.21	1.78	1.92	3.10	2.91
2	1.80	1.96	2.13	1.53	1.46
3	1.53	2.14	1.92	2.00	1.93
4	1.86	2.04	1.48	2.22	1.75
Mean	1.85	1.98	1.86	2.21	2.01
Std. Dev.	.72	.67	.68	1.12	1.20

Da = Forward exit; Db = Aftward exit

Source: U.S. Federal Aviation Administration

The FAA study said its results supported and extended earlier findings by other researchers.

"The 'A' seating/exit configuration with the 20-inch pathway leading from the center aisle to the single Type III exit provided the most efficient egress of any single Type III seating/exit configuration studied," the FAA said. "In all three categories (total egress time, exit hatch plug removal time and individual subject egress time), the 'A' configuration provided the fastest performance."

The study concluded that Configuration 13, with pathway width reduced to 10 inches, resulted in the longest egress times, even though the seats forward of the exit were 15 degrees forward past plumb.

Configuration C, in which five-abreast seating with a 10-inch pathway was used, provided egress times "intermediate to the 'A' and 'B' configurations." The study said that egress times for Configuration C much more closely resembled those for Configuration A than for Configuration B.

Differences in exit hatch plug removal times among the three single-exit configurations were small and contributed little to the seating configuration effects shown on total egress time, the FAA study said.

"This combination of results indicates that, of the total egress time required to exit through a single Type III exit, the amount of time needed for a passenger to move from the center aisle through the pathway and out the exit is highly dependent on the ergonomic restrictions encountered around the exit hatch opening. This effect is highlighted in the shorter egress times shown when either 'A' (increasing the pathway width) or 'C' (decreasing the restricted distance to be traversed) configurations were tested, relative to the most ergonomically restrictive 'B' configuration."

The study suggested that additional egress time reductions could be achieved by combining both configuration A and C to reduce ergonomic restrictions.

Previous studies, the FAA said, have indicated that in "competitive egress" situations (emergencies) evacuation times can be decreased if space around the exit hatch allows passengers to compete for that space.

The FAA said that studies have found that egress times through Type III exits can be improved by increasing the pathway width to 25 inches, "after which increasing the pathway width causes the flow rate to decline."♦

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