

This Way Out

More cabin crewmembers means more efficient evacuations.

BY RICK DARBY

A “strong relationship” was found between the number of operational cabin crewmembers and evacuation efficiency in accident evacuations in a study supported by the U.K. Civil Aviation Authority (CAA; Figure 1).¹ But there was “no apparent correlation” between evacuation efficiency and the ratio of passengers to operational cabin crewmembers, those not disabled during the accident (Figure 2, p. 50).

Those were among the findings described in a CAA paper based on the Aircraft Accident Statistics and Knowledge Database (AASK), a collection of data in which narratives of evacuations in aviation accidents have factors coded for analysis.

The study reports on the analysis of an updated version of AASK, V4.0.² The latest AASK includes data provided mostly by the CAA and the U.S. National Transportation Safety Board. Accident information covers the period April 4, 1977, through Sept. 23, 1999, and consists of 105 accidents, 1,917 individual passenger records from survivors, 155 records based on cabin crew interview transcripts and 338 records of passenger and crewmember fatalities. Many of the evacuations studied were considered precautionary rather than emergency events.

Evacuation efficiency was defined as the theoretical shortest distance to the nearest viable exit divided by the actual distance traveled, both averaged for all passengers and for each aircraft. “The ratio ... is a measure of the additional travel distance incurred by the

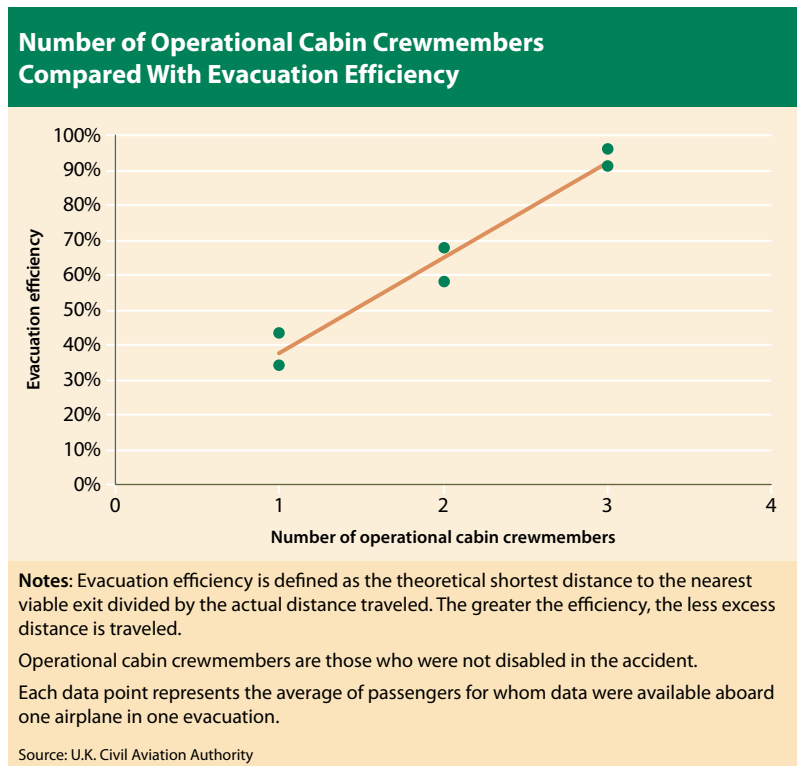


Figure 1

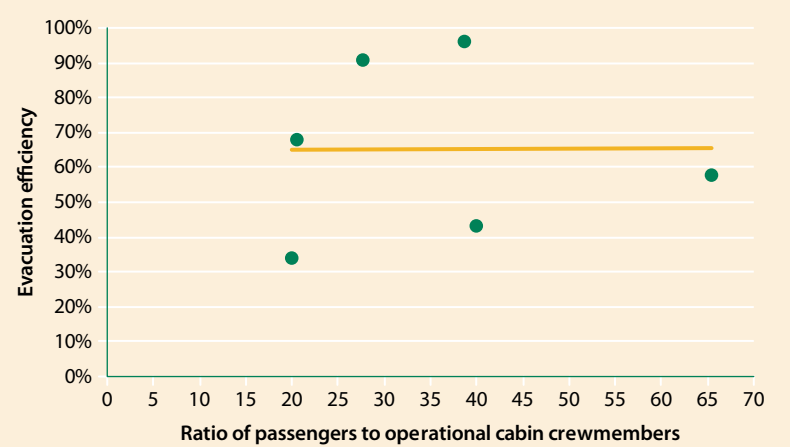
passengers due to sub-optimal exit choice,” the report says. “An evacuation efficiency of 100 percent indicates that all the passengers made use of their nearest viable exits, whereas values less than 100 percent indicate that not all of the passengers made use of their optimal exits.”

The evacuation efficiency formula was designed to eliminate variables that could bias the results. For example, in precautionary deplaning situations where there was no immediate danger, cabin crewmembers often directed passengers to use a particular exit for safety and convenience rather than speed, so those evacuations were eliminated from the analysis. Among the other possible confounding factors excluded was the size of the aircraft, which would affect travel distance to an exit and the number of available exits. Six accidents, involving 247 passengers and single-aisle airplanes, satisfied the selection criteria.

Evacuation efficiencies in the six accidents ranged between 34 percent and 96 percent (Table 1).

“In cases where only a single crewmember is available, passengers have traveled as much as three times further than was theoretically necessary, whereas when three crewmembers are available, passengers traveled on average only 1.1 times further than was theoretically necessary,” the report says. Pointing out that all cabin crewmembers might not be available to direct an evacuation, it says, “If the relationship between evacuation efficiency and cabin crew numbers suggested by [Figure 2] can be generalized, then the loss of even a single cabin crewmember may have serious implications

Ratio of Passengers to Operational Cabin Crewmembers Compared With Evacuation Efficiency



Note: Evacuation efficiency is defined as the theoretical shortest distance to the nearest viable exit divided by the actual distance traveled. The greater the efficiency, the less excess distance is traveled.

Operational cabin crewmembers are those who were not disabled in the accident.

Each data point represents the average of passengers for whom data were available aboard one airplane in one evacuation.

Source: U.K. Civil Aviation Authority

Figure 2

Evacuation Efficiency in Six Accidents

Accident	Maximum Passengers	Passengers on Board	Cabin Crewmembers on Board	Operational Cabin Crewmembers	Theoretical Passenger/Cabin Crewmember Ratio	Actual Passenger/Cabin Crewmember Ratio	Evacuation Efficiency
McDonnell Douglas DC-9-32	100	41	3	2	33	21	68%
Saab 340-B	34	20	1	1	34	20	34%
Boeing 737-300	128	83	4	3	32	28	91%
McDonnell Douglas DC-9-20	78	40	2	1	39	40	43%
Boeing 737-236	130	131	4	2	33	66	58%
Boeing 727-223	146	116	3	3	49	39	96%

Note: Data about exiting were available for 247 passengers. In the accident involving the Boeing 737-236, the one passenger more than the maximum was a child sharing a seat with a parent.

Source: U.K. Civil Aviation Authority

Table 1

for passenger safety. This will be particularly relevant in evacuation situations where any extra time spent in egress will compromise the survival chances of the passengers, such as situations involving fire.”

The report analyzed variables among passengers who had difficulty releasing their seat belts in evacuations. A breakdown was made according to gender and three categories: those who helped other passengers; those who had difficulty and were helped; and those who had difficulty but managed without help.

“It is clear that males [in these accidents] have fewer problems with seat belts than females and that males are also more likely to render assistance to others than females [adjusted for the gender proportion],” the report says. It speculates that this could be because “males may be physically stronger than females and therefore are more able to deal with buckle difficulties” and “males may be less prepared to seek assistance than females and so they continue to struggle with the buckle and eventually succeed in releasing the belt.”

Passengers were not generally asked about whether they had climbed over seats to reach an exit, so the data could offer no information about actual numbers or percentages of passengers who resorted to seat climbing. Of the 91 passengers who reported climbing over seats and whose age was known, the average age was 32.9 years, compared to the average 40.3 years of the surviving passengers.

“The mean age for female seat climbers has increased significantly from that in AASK V3.0 (which was previously 22.7 years), while the mean age for males has remained virtually unchanged,” the report says. “In the female population reporting seat climbing, nine were aged 46 years and over. For the remaining 41 females (82 percent of all females both climbing seats and providing age), the average age is 25.4 years. These results suggest that there are more females climbing seats of various ages than previously estimated, but largely only younger females are prepared or able to tackle this task.”

Direction of Travel and Distance Traveled in Evacuations				
Direction	Number of Passengers	Traveled Minimum Distance?	Number of Passengers	Mean Distance (Seat Rows)
Forward	530/866	Yes	339/540	4.4/4.5
		No	191/326	11.3/12.4
Aft	300/511	Yes	200/334	5.1/4.9
		No	100/177	10.7/11.3
Exit row	49/64	Yes	49/64	0

Note: Figures before the “/” indicate starting and exit locations known from passenger self-reporting; those following are inferred.

Source: U.K. Civil Aviation Authority

Table 2

Among the 42 passengers who gave a reason why they had taken an over-seat route, the largest number — 12 males, five females — claimed that it was the shortest distance to an exit. The next most frequent reason cited — by four males and five females — was “aisle too congested.”

“Within the aviation industry, it [is] a commonly held belief that most passengers evacuate via the most familiar exit, thereby ignoring closer but unfamiliar emergency exits,” the report says. But the AASK analysis indicated otherwise. Based on passenger descriptions in which the seat location and exit used were identified or could be reliably inferred, such as from accounts by other passengers, it was found that 85 percent of passengers used the nearest available exit. The most common reasons for *not* doing so were “following cabin crew instructions,” cited by 125 passengers, “following other passengers” by 65, “passenger thought this was the nearest exit when it was not” by 64 and “choice made before egress” by 27.

A slightly higher percentage of passengers who moved aft chose the nearest exit, but the majority of forward- and aft-moving passengers traveled the minimum necessary distance (Table 2). “This suggests that the overriding inclination of the passengers is to exit via their nearest exit, rather than to travel forward,” the report says. “In addition, this further suggests that exit selection is based on a rational decision, at least for the survivors.”

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Distribution of Rows to Nearest Viable Exits for Survivors and Fatalities in Evacuations

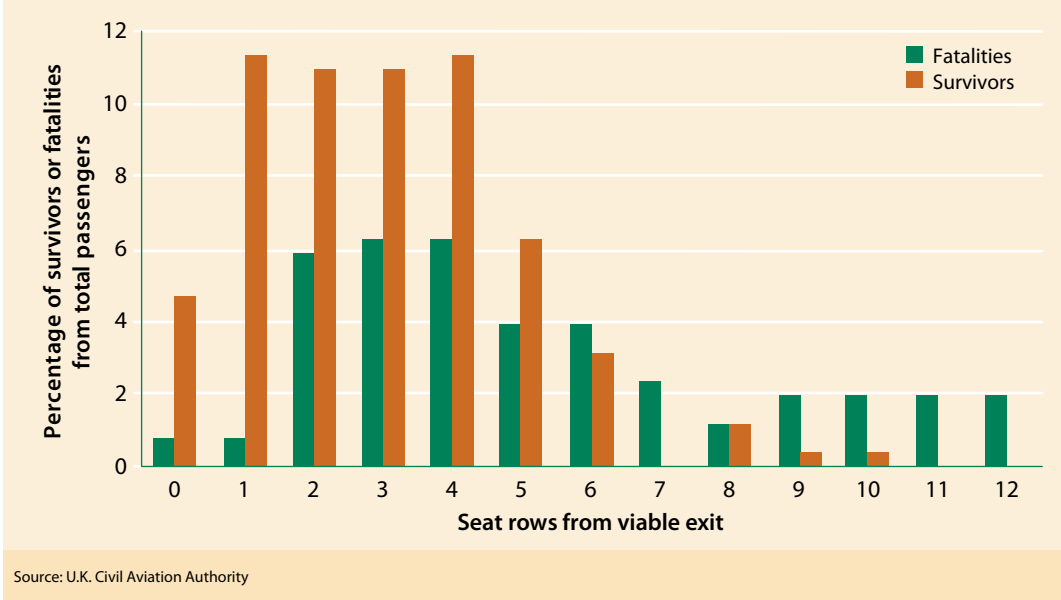


Figure 3

Survival Rate for Front- and Rear-Seated Passengers in Four Evacuations

Aircraft	Survival Rate of Front-Seated Passengers	Survival Rate of Rear-Seated Passengers
McDonnell Douglas DC-9-32	33%	100%
Boeing 737-236	87%	30%
Boeing 737-300	53%	89%
McDonnell Douglas DC-9-20	75%	67%
Average	65%	53%

Note: Front and rear were measured from the middle row.

Source: U.K. Civil Aviation Authority

Table 3

Four accidents in the latest version of the AASK were found to have enough fatalities and known seat locations to compare survival rates with seat distances from a usable exit (Figure 3). All four accidents involved single-aisle airplanes. Analysis suggested that in those accidents there were three critical seating zones.

“In the first zone, identified from zero to one seat row from a viable exit, the number of survivors far outweighs the number of

fatalities,” the report says. This suggests that passengers seated this close to an exit are most likely to survive. In the second zone, identified as two to five seat rows from a viable exit, while passengers are more likely to survive than perish, the difference between surviving and perishing is greatly reduced. Finally, the third zone is identified as being six or more seat rows from a viable exit. Here, the chances of perishing far out-

weigh [chances] of surviving.”

On average, the survival rate of passengers seated on the aisle was slightly higher than non-aisle-seated passengers, 64 percent versus 58 percent, the report says. In a division between the front and rear of the cabin, measured from the middle row, “on average there appears to be little difference between the two options,” the report says. “However, variability between accidents is pronounced. On average, passengers seated in the front of the aircraft have a slightly higher survival rate than those seated in the rear” (Table 3).

Notes

1. U.K. CAA. *A Database to Record Human Experience of Evacuation in Aviation Accidents*. CAA Paper 2006/01. June 2008. The report is available at <www.caa.co.uk/application.aspx?catid=33&pagetype=65&appid=11&mode=detail&id=3176>.
2. Version V4.0 added data from 50 additional accidents, accounts from 622 additional passengers and 45 additional crewmembers, and data related to 11 fatalities. The earlier version, AASK V3.0, is available on request via the Internet at <fseg2.gre.ac.uk/AASK>.