Operation of a conventional Type III exit hatch: Passenger perceptions and performance

Lauren J. Thomas, Katie J. Robinson, Ann M. Mills[†] and **Helen C. Muir**

Department of Human Factors and Air Transport, Cranfield University, Bedfordshire, MK43 0AL.

Abstract

The findings from three recent research studies conducted by the Human Factors Department at Cranfield University are discussed. The first study examined passenger perceptions of the Type III exit operation task under various seating configurations. The second study investigated the influence of having a member of cabin crew in the vicinity of the Type III exit to provide real-time instruction to exit operators. The final study examined the effectiveness of various briefings provided to passengers within the Type III exit row. Together, the findings from these studies provide valuable qualitative information on the difficulties which naïve passengers face when trying to operate the conventional Type III exit in various seating configurations. The results also suggest that the overall time taken for naïve exit operators to make the Type III exit available can be reduced by providing detailed briefings to passengers, in order to reduce uncertainty about when to operate the exit.

[†] Ann M. Mills is now at Railway Safety.

Introduction

Passenger difficulty in correctly operating a conventional Type III exit has been well documented. A recent safety study by the National Transportation Safety Board (NTSB, 2000) investigated a number of evacuations in which Type III overwing exits were used. In these cases, the overwing exits were eventually made available, although passenger difficulties in operating the exit caused unnecessary delays. In the cases studied, these delays did not appear to directly contribute to injury or fatalities. However, this finding is probably due to the fact that the study included a large number of precautionary evacuations.

In genuine emergency situations, delays in making the Type III exits available have been known to contribute to the number of injuries and fatalities. In an evacuation of a Boeing 737 at Manchester, England in 1985, the major cause of fatalities was rapid incapacitation due to the inhalation of dense smoke, which was aggravated by evacuation delays (King, 1988). In this accident, the passenger seated at the Type III exit attempted to open the door by pulling on the arm rest mounted on the exit hatch. The hatch was eventually opened by the passenger seated in the middle seat of the exit row, although both passengers were unprepared for the hatch to fall inwards. The hatch was finally moved with the assistance of a male passenger in the seat row behind, who placed it across the seats in his row. This exit was not made available for passenger evacuation until some 45 seconds after the aircraft had stopped.

Some of the difficulties that passengers have in making the Type III exit available are due to the cabin configuration, in that they arise from the design of the hatch and the seating layout within the cabin. For example, previous research has shown that a major reduction in the weight of the hatch can improve the time taken to make the exit available. In addition, the seating configuration at the exit can also influence passenger ability to operate the exit, since passengers need to be provided with space in which to open the hatch, turn it, and manoeuvre it through the exit opening (Fennell & Muir, 1993).

Unlike cabin crew, passengers who may be required to operate the Type III exit are not trained in emergency procedures prior to boarding. Although passengers seated in the exit row are screened and briefed, the stress of an emergency situation may make it difficult for such a person to perform the exit operation task successfully. Even where the briefing has been understood, passengers may not recall the information when the emergency arises, and they may not always check the external conditions before attempting to open the hatch. In addition, passengers will have their own expectations of the way in which this hatch will operate, and their beliefs about the task requirements may not always reflect reality.

In order to investigate in detail passenger perceptions of the exit operation task, the first study reported in this paper involved conducting in-depth interviews with naïve exit operators (Robinson, 2000). Seven independent groups of up to nine passengers were required to evacuate a Boeing 737 cabin mock-up through the Type III exit. The seating configuration within the cabin was either dual 6” vertically projected passageways with outboard seat removed, or 7”, 10”, 13”, 18”, 20” or 25” vertically projected passageways. After the evacuation, participants returned to the cabin to discuss their experiences in a focus group. The tape-recorded group interviews conducted after each of the evacuations were transcribed in order that all of the comments could be analysed. The quotations from participants were split into categories for ease of analysis, and relevant categories are reported here.

Passenger perceptions of the Type III exit operation task

One of the main findings was that exit operators were unprepared for exit to operate the way it did, as was the case at Manchester in 1985. One exit operator said of the hatch:-

> *"I did not expect it to come to me first, and once I released it, I thought if anything it would be trying to fall away from me, but it needed to come forward first of all". (Robinson, 2000, p86)*

Comments from other exit operators also made the same point:-

> *"I would expect it to go out… I would always expect a door to go out… I would never imagine a door to come in…. I would think it would go out that way (pointing outwards)…. I would never think it would come in, definitely…" (Robinson, 2000, p86)*

> *"I was expecting the door to have some kind of hinge to take the weight… well, like a normal door I suppose, and all I would have to do would be to push it out of the way… I was surprised it was a pull out door" (Robinson 2000, p86)*

Exit operators generally felt that the exit was not intuitive to operate. Some commented that the requirement to bring the hatch forward into the cabin was contrary to what one might expect in an emergency situation:-

> *"But in a way, before you can go out, you've got to come back in! Only for a second, but when you are faced with death it doesn't feel like you should do that… you are panicking, and you don't think to go back in!" (Robinson, 2000, p90)*

Others expressed surprise at the weight of the hatch:-

> *"What surprised me was the weight of the door, pulling it out was no problem, but as soon as you tilt it, it is the weight, literally, as you turn it, the weight of it comes into play" (Robinson, 2000, p87).*

With regard to the seating configuration, exit operators in evacuations with narrow passageways at the exit explained that there was little room in which to operate and manoeuvre the hatch:-

> *"I was bent over double, struggling with it at about knee level, which did not help at all" (6" OSR, Robinson, 2000, p102).*

> *"There was just no space to move… it's hard, because it comes inwards, it comes into a space like that that (point to the door), and you twist it sideways, and then you are trying to chuck it out at the same time" (7" vertical projection, Robinson, 2000, p100).*

However, participants in trials with wider passageways at the exit also expressed the view that lack of space had influenced their performance on the task:-

> *"It's a little bit difficult having to twist and pull, having to jiggle it around and then get it out… it is difficult… you need a lot of space to move in to do that it" (20" vertical projection, Robinson, 2000, p100).*

> *"You need more space to get the door out" (25" vertical projection, Robinson, 2000, p100).*

Exit operators were asked what could be done to make the exit easier to operate. Comments included making both the upper and lower handle on the door more obvious, by colouring them more brightly, and by making it more obvious that the hatch was in fact an emergency exit. For example:-

"I didn't even notice that handle at the bottom there (the lower recess)… no wonder I found it difficult!" (Robinson, 2000, p91)

"I think the top handle is fine… I would say you definitely need a brighter colour there (points to lower handle)… I mean, it is a white handle on a white door!" (Robinson, 2000, p 91)

"It's so similar to the rest of the wall that in bad lighting at a glance, if you didn't see this red bit here (pointing to upper handle), you might not see it" (Robinson, 2000, p 92)

"I don't know why the whole door isn't red or a fluorescent colour or something, so that straight away you think 'that has got to be the exit'" (Robinson, 2000, p92)

Many participants made comments suggesting that that the safety information could be made more realistic:-

"By the look of the pictures… there are nice clips of the lady there and it's nicely supported and it's swinging out beautifully… it's not like that!" (Robinson, 2000, p125)

"If you do a video, don't do one that shows it all smooth and beautiful to give the illusion that it's an easy thing to do… so show that it's heavy, show that it might get stuck, show the things that are potential things that can happen, so people are ready for what really happens…. And not have it all pink and flowery!" (Robinson, 2000, p130)

Other participants said that they had assumed cabin crew would make the door available in an emergency situation, even though all exit operators had been briefed on the possible requirement to open the exit at the start of every trial:-

"I've been on a few planes and sat by the exit a few times… you just automatically presume that the staff on the plane will do it… you think they know all the ins and outs…" (Robinson, 2000, p117)

"Even if you're sat next to it, you think, no…, no… cabin crew will miraculously appear in front of you and do it!" (Robinson, 2000, p117)

These comments serve to highlight the fact that some members of the public may expect cabin crew to assume responsibility for their safety in an emergency situation. Some participants commented that a member of cabin crew should be allocated to the door:-

"Perhaps another member of cabin crew sitting up near the door would have helped" (Robinson, 2000, p80)

"If you are going to put cabin crew there, you might as well seat one here (in the exit seat)… someone who knows what they are doing, someone who doesn't have to think about it" (Robinson, 2000, p84)

Some participants made additional comments about their own experience of opening the exit during the trial, and how taking part in this research might have increased their own awareness of safety:-

"If I ever fly again, I don't want to sit here" (Robinson, 2000, p132)

"I think the reason I came to this, was the reason that I wanted to know what it felt like, and to become more aware and that sort of thing, and I certainly feel much more confident after being involved in this today" (Robinson, 2000, p133)

These findings firstly suggest that raising public awareness of personal responsibility for safety in the event of an accident could be of benefit. The information also suggests that the briefing of passengers could include emphasis on the demands of the task. It could be pointed out that cabin crew will not normally be located at the exit, and that in the event of an emergency, it will be the operators' responsibility to make the exit available for themselves and other passengers.

In order to investigate in further detail the potential benefits of placing cabin crew at the Type III exit, a second research project was conducted (Robinson, 2000). This research was funded by Transport Canada, and involved running a series of large group evacuation trials using the Boeing 737 cabin simulator. Groups of up to 48 participants were recruited to evacuate the cabin through the Type III exit. In all trials, a member of cabin crew was located at each end of the cabin. In half of these trials, a third member of cabin crew was located in the seat behind the Type III exit operator. In these conditions, the additional cabin crew member provided instruction to the exit operator on the call to evacuate. This instruction included a command to open the exit, and commands on how to open the exit and dispose of the hatch. All of the trials were filmed on video. The footage was time-coded, and the times taken to make the exit available were documented.

Influence of cabin crew seated behind the exit operator

In order to analyse in detail the times taken for exit operators to make the Type III exit available, the exit operation times were split according to the time taken for the operator to make two distinct behaviours. The first was reaction time, which was the time an exit operator took from the call to evacuate to placing their hand upon the exit handle. The second time measured was the exit operation time, which was the time taken from the exit operator first placing their hand on the handle, to the moment when the exit was disposed of on the wing. The total of these two times may therefore be regarded as the overall time taken to make the exit available. Average times taken for exit operators in each condition are given in Table 1.

Table 1: Average reaction times, exit operation times, and overall exit availability times (in seconds) for cabin crew present or absent at the Type III exit

	Cabin crew located behind exit operator providing instruction	**No cabin crew at Type III exit**
Average Passenger Reaction Time	1.65	3.18
Average Passenger Exit Operation Time	5.13	4.12
Average Total Exit Availability Time	6.78	7.3

As the data show, the presence of a member of cabin crew at the Type III exit reduced the time it took for exit operators to respond to the call to evacuate and place their hand on the exit handle. On the video footage, exit operators in conditions without the additional member of cabin crew were observed to hesitate before reaching for the exit handle. This suggests that having a crew member in the vicinity of the exit reduced operator uncertainty about when it might be appropriate to open the exit, and when to reach for the handle.

A statistical test was conducted on this data to assess the probability of these results having arisen by chance. The results showed that the lower reaction times obtained when a crew member was present were unlikely to have occurred by chance alone. Having a member of cabin crew at the Type III exit therefore significantly reduced the time it took for an exit operator to respond to the call to evacuate and to start operating the exit ($t= -3.66$, $p<0.05$, 9 degrees of freedom). Perhaps the crew member located at the exit provided the operator with increased confidence in decision making.

Interestingly, the average exit operation time when a member of cabin crew was present at the Type III exit was slightly longer than when no additional crew member was present. A statistical test on the exit operation times showed that this difference may have occurred by chance ($t=0.931$, $p>0.05$, 9 degrees of freedom). The observed difference between the two conditions may therefore have been due to random differences between the two groups. The slightly longer exit operation time obtained when a crew member was present may be

due to the fact that operators were concentrating on the instructions being provided, as well as trying to operate the exit hatch.

The average total exit availability time was lower for conditions where a member of cabin crew was in the vicinity of the Type III exit. Exit availability time is the total of reaction time plus operation time. It would appear that the slightly slower speed in exit operation which occurred when a crew member was present was offset by the faster reaction times which were obtained in these situations. Although, on average, having a crew member present did mean exit operators were able to make the exit available more quickly, a statistical test showed that this difference could be due to chance alone ($t= -0.376$, $p>0.05$, 9 degrees of freedom).

In view of the aim to improve the performance of Type III exit operators, a third research study was conducted to examine the effects of different types of briefing provided to passengers seated within the exit row. This research was commissioned and funded by the Safety Regulation Group of the UK Civil Aviation Authority (Cobbett, Liston & Muir, 2001). Fifty six groups of three naïve participants were recruited to evacuate the exit row of the Boeing 737 cabin mock-up. Half of the groups were comprised of two males and one female, and the other 28 groups were comprised of one male and two females. In all instances, the minority participant was seated next to the Type III exit.

Methods of briefing passengers at the Type III exit

Four different types of briefing were used in this study. The first was a no briefing condition, in which the exit row group received only a pre-flight safety briefing. The second condition was known as the minimum briefing. Groups in this condition received a pre-flight safety briefing, and were also informed by cabin crew that they were seated at an emergency exit that they may have to operate in the event of an emergency. In addition, attention was drawn to the exit operation diagrams on the safety card and on the seat backs in front of the group.

The next two briefings were known as the verbal and written briefings. These both contained identical information, informing participants that they were seated next to an exit that may need to be opened in the event of an emergency. In these conditions, participants' attention was also drawn to the exit operation diagrams on the safety cards and on the seat backs in front of them. In addition, participants were informed about when the exit should be operated and how to operate it, and were given a clear indication that the exit was a hatch and not a hinged door. The cabin crew also pointed out the exit operation handle and the lower recess handle, and participants were informed of the weight of the hatch and the need to dispose of it outside the fuselage. In the verbal briefing, this information was delivered orally by cabin crew, and in the written briefing, the information was presented in printed format.

These evacuation trials were video recorded and time stamped, in order that the times taken for various exit operation tasks could be measured. Again, these times were split into reaction times and exit operation times. The sum of these two times is the total time taken to make the exit available. Results of the trials are given in Table 2.

Table 2: Average reaction times, exit operation times, and overall exit availability times (in seconds) for no briefing, minimum briefing, oral briefing and written briefing conditions

	No Briefing	**Minimum briefing**	**Oral Briefing**	**Written Briefing**
Average Passenger Reaction Time	7.7	5.4	3.8	2.9
Average Passenger Exit Operation Time	6.9	7.1	7.7	6.8
Average Total Exit Availability Time	14.4	12.5	11.5	9.7

As the data show, almost all of the three performance timings were lower in conditions where participants had received the fuller briefings. Reaction times were significantly shorter in the oral and written briefing conditions than they were in the no briefing and minimum briefing conditions. These differences in

hesitation times were unlikely to have arisen by chance ($F=7.71$, $p<0.05$, 3 and 55 degrees of freedom). There were no significant differences in the exit operation times for the four briefing conditions, indicating that the type of briefing provided had no significant effect on the time taken to actually open and dispose of the exit hatch ($F=0.29$, $p>0.05$, 3 and 55 degrees of freedom).

Overall total exit availability times were also subjected to statistical analysis, to examine the probability of the differences between the briefing conditions having arisen by chance. Results indicated that exit operators in groups that had received the written briefing took significantly less time than participants in the other briefing conditions to make the exit available overall ($F= 2.89$, $p<0.05$, 3 and 55 degrees of freedom). This finding is at least partly due to the difference in reaction times – operators from the fuller briefing conditions hesitated less when deciding whether or not to make the Type III exit available.

With regard to the accuracy of exit operator performance, the different briefings also had an effect. Twenty five percent of all participants who opened the exit left the hatch inside the cabin, either between or on seats in the exit row. A disproportionate number of those leaving the hatch inside the cabin came from the no briefing condition. Less than 50% of exit operators in the no briefing condition disposed of the exit correctly, compared to over 90% of operators in the remaining three briefing conditions. This finding could have serious implications in genuine emergency situations. In these cases, an exit hatch left inside the fuselage could be an obstruction to passengers attempting to egress through the Type III exit.

These findings suggest that providing exit row passengers with additional, detailed information about the operation of the Type III exit could potentially increase the probability that the exit will be disposed of quickly and correctly in an emergency situation.

Conclusions

The National Transportation Safety Board has recently made a recommendation to the Federal Aviation Administration suggesting that Type III exits on newly manufactured aircraft should be easy and intuitive to open, and have automatic stowage out of the egress path (NTSB, 2000). While this can be regarded as a positive step, conventional Type III exit designs are currently fitted on a large number of in-service aircraft.

The conventional Type III exit operating mechanism will probably be in-service for some considerable time. There are potentially a number of interventions that may improve the probability that passengers will be able to open this exit quickly and efficiently when required. The first would be to take additional steps to ensure that the hatch itself is easily distinguished from the rest of the cabin interior, and to ensure that the operating handle and lower recess hand hold are clearly marked. The second would be to provide cabin crew with detailed information which would enable them to give exit row passengers a detailed, personal briefing on when and how to operate the Type III exit. This could include consideration of some of the common difficulties experienced in operating this exit. Currently, personal briefings for exit row passengers are not required by the regulations, although some carriers routinely require cabin crew to provide such briefings to exit row passengers. Finally, in situations where passengers are required to open the over-wing exit, instruction from cabin crew during the emergency would be likely to reduce passenger hesitation. This could contribute to the exit being made available more quickly.

References

Cobbett, A.M., Liston, P. & Muir, H.C. (2001) *An investigation into methods of briefing passengers at Type III exits*. Civil Aviation Authority, London, Paper 2001/6.

Fennell, P.J. & Muir, H.C. (1993) *The influence of hatch weight and seating configuration on the operation of a Type III exit hatch*. Civil Aviation Authority, London, Paper 93015.

King, D.F. (1988) *Report on the accident to Boeing 737-236 series 1, G-BGJL at Manchester International Airport on 22 August 1985*. Air Accidents Investigation Branch, Department of Transport, HMSO, Aircraft Accident Report 8/88.

NTSB (2000) *Safety Study: Emergency Evacuation of Commercial Airplanes*. PB2000-917002, NTSB/SS-00/01, Washington DC 20594.

Robinson, K.J. (2000) *The passenger experience of a Type III exit evacuation and the effect of locating a flight attendant in the vicinity of the exit*. MSc Thesis, Human Factors Group, Cranfield University.