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Evacuation Commands for Optimal Passenger Management

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Abstract

This report describes a two-phase research program undertaken by Cranfield University in collaboration with Virgin Blue Airlines. Phase I involved a best practice forum, initiated via the Asia Pacific Cabin Safety Working Group of the Australian Society of Air Safety Investigators, to investigate current practice in managing passengers in emergency situations. The forum was followed up with a questionnaire survey of, and discussions with, various operators. The results showed that operators used a variety of commands to manage passengers in emergency situations, and that while some operators provided stringent procedures, others accepted that cabin crew may need to adapt commands and procedures to deal with the situation at hand.

The results from Phase I were used to design an experiment conducted as Phase II of the research. This second study was conducted at Cranfield University in the UK; it involved 159 members of the public taking part in a series of experimental evacuation trials. Participants first completed a questionnaire detailing the commands that they thought would be effective in managing passengers in emergency situations. The results provided an insight into passenger expectations of commands and emergency instructions.

The same participants then took part in a session of four evacuation trials using the Boeing 737 simulator and Large Cabin Evacuation Simulator, both located at Cranfield University in the UK. In the Boeing 737 simulator, the independent variables were an active or a passive safety briefing, and the level of situation specific instruction provided by the cabin crew. In the Large Cabin Evacuation Simulator, the independent variables were the visibility of the cabin crew and the use of dual-lane commands. Analysis was undertaken of time-coded evacuation footage and post-evacuation questionnaires. The results showed that an active safety briefing had significant advantages over a passive safety briefing, and that the visibility of the cabin crew influenced passenger perceptions of evacuation effectiveness. Implications for operators are discussed.

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ABBREVIATIONS

ABP(s)	Able Bodied Passenger(s)
ANOVA	Analysis of Variance
APCSWG	Asia Pacific Cabin Safety Working Group (of the Australian Society of Air Safety Investigators)
ATSB	Australian Transport Safety Bureau
CAA	Civil Aviation Authority (UK)
CAAP	Civil Aviation Advisory Publication
CASA	Civil Aviation Safety Authority (Australia)
FAA	Federal Aviation Administration (US)
FAR(s)	Federal Aviation Regulation(s)
FSED	Full Scale Evacuation Demonstration
ICAO	International Civil Aviation Organization
ISO	International Organization for Standardization
JAR(s)	Joint Airworthiness Regulation(s)
LCES	Large Cabin Evacuation Simulator, located at Cranfield University in the United Kingdom
NTSB	National Transportation Safety Board (US)
PAX	Passengers
PSU	Passenger Service Unit
UK	United Kingdom
UL1	Upper deck left forward door in an aircraft with two decks, as in the LCES at Cranfield University
UR1	Upper deck right forward door in an aircraft with two decks, as in the LCES at Cranfield University
US	United States

EXECUTIVE SUMMARY

Cranfield University in the United Kingdom, working in collaboration with Virgin Blue Airlines in Australia, applied to the Australian Transport Safety Bureau for an aviation safety research grant in 2004. The grant was awarded to support a two-phase research project into evacuation commands used by cabin crew in managing passengers during evacuations. The first phase was a best practice forum and survey, supported by members of the Asia Pacific Cabin Safety Working Group of the Australian Society of Air Safety Investigators, to establish the commands, policies and procedures currently in use among Australian and Asian operators. The results of this survey informed the development of the research aims for the second phase of the project.

The second phase involved both survey and experimental work, with members of the public participating as passengers. Four groups of up to 40 members of the public were recruited to take part in this phase of the research; all participants completed questionnaires asking for demographic information. In addition, participants were asked about the commands that they would expect to hear in a range of safety-related and emergency situations. The data from these questionnaires were used to explore passenger expectations and comprehension of emergency commands. The results indicated that participants generally had a low understanding of why they might be required to take certain actions in emergency situations. This suggested that it is important that operators take passenger expectations and comprehension into account when devising evacuation commands.

The same participants then took part in one of four sessions of four evacuation trials at Cranfield University in the United Kingdom. In each test session, two evacuations were from the Boeing 737 cabin simulator, and two from the Large Cabin Evacuation Simulator (LCES). The aim of the experimental tests was to investigate the effectiveness of selected cabin crew commands in managing passengers during evacuations. All trials were video-recorded in order that footage from the trials could be time-coded and analysed.

In the Boeing 737 simulator, the first aim was to investigate the use of active and passive safety briefings. Two groups of participants received an active safety briefing, in which the cabin crew generated a high level of interaction in briefing passengers on safety procedures. On the other two test days, participants received a passive safety briefing. Research in cognitive psychology had suggested that actively-briefed passengers would be better able to recall and act on that information if (or when) the need arose. The Boeing 737 evacuation trials were also used to investigate the extent to which having the cabin crew provide passengers with additional relevant instruction would enhance evacuations in poor visibility conditions. The results indicated that while the active safety briefing did not improve evacuation times, passengers rated this briefing as significantly more useful and helpful, and stated that the active safety briefing significantly improved their confidence in evacuating the cabin.

In the LCES, the first aim was to investigate the influence of crew commands during evacuations from a wide-bodied cabin simulator, given that the exits and slides on such aircraft types are typically rated for a dual-lane flow[1]. Dual-lane flows significantly increase

1 The over-wing exits in a typical wide-bodied jet aircraft are full size doors, which allow for dual-lane flow, rather than the smaller push-out exits typical of narrow-bodied jet aircraft.

evacuation rates, and yet results from Phase I showed that many operators do not require their cabin crew to command passengers to move through exits two at a time.

The second aim of the LCES tests was to manipulate the extent to which participants could see the cabin crew during the early stages of an evacuation. These tests aimed to gauge the effectiveness of gestures, eye contact and other non-verbal communications used by the cabin crew in managing passengers.

The results showed that evacuations without dual-lane flow commands were faster, but more disorganised. With a larger passenger load, dual-lane flow commands could be useful for managing the evacuation in a more orderly and less congested fashion. Visibility had a pronounced effect. The half-height bulkheads meant that cabin crew gestures could actually be seen be passengers, who rated the crew's non-verbal communication as significantly more useful in the high-visibility evacuations. The high visibility also gave passengers something to aim for in the evacuations – they had sight of the exit. Hence, it was significantly easier for them to move out of their seats and along the aisles in the half-height bulkhead conditions.

The results of this research could provide useful input to cabin crew training (initial and recurrent), to the design of best practice evacuation procedures and commands, and also potentially to the design of bulkheads and cabin configurations. In addition, the results could assist in designing safety information which is more closely aligned with passenger expectations, and therefore more likely to be effective.

1 INTRODUCTION

1.1 Background

Statistically, air travel is relatively safe. A fatal accident will occur approximately once for every 1.4 billion miles flown. The risk of being in a commercial jet aircraft accident where there are multiple fatalities is approximately one in every three million departures. An individual would need to fly once a day for 8,200 years to accumulate this number of departures. The accident record also shows that most accidents occur during take-off, approach or landing. These are the most critical phases of flight (Matthews 1997).

Air travel is projected to increase. The International Civil Aviation Organization predicted in July 2005, that world airline passenger traffic, measured in passenger kilometres performed (PKPs), was projected to increase by between 6.2% and 7.6% over the three year period 2005 to 2007 (ICAO 2005). Air travel also has a strong safety record. In the decade to 2005, there had been a steady decline in the numbers of fatal accidents and fatalities; 2005 went against this trend, but was slightly better than the annual average for the preceding 10-year period (Learmount 2006). However, while the accident rate is very low, projected increases in departures and miles flown mean that the actual number, or frequency, of accidents is likely to rise. It is the number of accidents, rather than the rate, which attracts media and public attention, and so the aviation industry must work increasingly hard to improve its safety performance.

Generally, aircraft accidents can be classified into three different categories. Some accidents are fatal, or not survivable. These are accidents in which the impact forces are beyond human tolerance, and as such, nobody survives. The second category includes those accidents where some of the crew and passengers survive. These accidents are known as technically, or partially, survivable. The third class of accidents refers to those in which all crew and passengers survive, and these are known as survivable accidents. The NTSB recently found that the overall survivability rate for Part 121 carriers involved in accidents between 1983 and 2000 was 95.7% (NTSB, 2001). However, media representations of the most serious accidents distort the public perception of survivability.

Stringent crashworthiness standards require the aircraft cabin to be designed in such a manner that occupants are protected as far as possible from impact forces (FAA, 1991). The aim is to ensure that as many occupants as possible survive the impact in a condition that will allow them to escape the airframe. However, crashworthiness issues are compounded by the risk of a post-crash fire: if a fire enters the cabin, there are typically less than 2 minutes before conditions deteriorate to the extent that human life cannot be supported. Hence, it is essential that the surviving occupants can be evacuated efficiently and expeditiously.

1.2 Factors influencing evacuation outcomes

The regulatory authorities need to be confident in certifying a new aircraft type or derivative that all passengers can be evacuated quickly and safely in the event of an emergency. It is a requirement of the Federal and Joint Aviation Regulations (FAR/JAR 25, Appendix J) that a Full Scale Evacuation Demonstration (FSED) is conducted to demonstrate that all passengers and crew can evacuate the aircraft within 90 seconds, using only half of the exits. While the

regulatory authorities may accept analyses based on partial tests or computer-modelled evacuation results, this is only permitted in lieu of a full scale evacuation demonstration where archive data are available for validation purposes (FAA, 1989). Hence, the FSED remains the primary tool by which the regulatory authorities assess the evacuation capabilities of an aircraft cabin.

Snow, Carroll and Allgood (1970) proposed that the factors influencing a successful emergency evacuation could be classified into four groups: configurational, environmental, bio-behavioural, and procedural. Configurational variables relate to the physical layout of the aircraft cabin, and include the access to emergency exits, the size and location of these exits, the seating density, and the location and width of aisles, passageways and crew-assist spaces. The environmental aspects of an evacuation are determined by the particular situation. Examples of environmental factors would be the presence of smoke, fire and/or heat, the level of lighting, and the weather outside the cabin. Bio-behavioural factors relate to the passengers themselves, including whether they paid attention to the safety information, their physical fitness and age, and their level of motivation. Finally, procedural factors are the regulatory and operating practices governing the evacuation situation, including the standard operational procedures and the training, experience and behaviour of the crew. All of these factors can influence the speed and success of an evacuation in the event of an accident; many of them have also been the subject of passenger evacuation research.

1.3 Configurational factors

At Manchester in 1985, a Boeing 737 with 131 passengers and 6 crew was departing for Corfu. During the take-off, the left engine sustained an uncontained failure, and a wing fuel tank access panel was penetrated. Leaking fuel rapidly ignited. By the time the aircraft came to a complete stop, the cabin was filled with black, acrid smoke, which rapidly instilled fear and alarm among passengers. Many passengers attempted to move forward along the aisle before the call to evacuate; motivated to move because of deteriorating conditions. Passengers stumbled and collapsed in the aisle, creating a tangle of people struggling to move forward. Some passengers climbed over seat backs to avoid the congestion, although as the passageway through the bulkheads leading to the front exits was only 22.5 inches wide, this exacerbated the problem.

In addition to the congestion among passengers, there were problems in making the exits available quickly. The cabin crew encountered difficulties in operating the Type I exits[2] at the front of the cabin. The slide on the left door had to be operated manually, and this door was made available approximately 10 seconds after the aircraft had stopped. The right door jammed on the slide container lid, and this door was not opened until 1 minute and 10 seconds after the aircraft had stopped. Similarly, the passenger seated at the Type III over-wing exit[3] experienced problems in operating the hatch, and two other passengers had to

2 US Federal Aviation regulations define a Type I exit as ‘a floor-level exit with a rectangular opening of not less than 24 inches wide by 48 inches high, with corner radii not greater than eight inches’ (FAR25.803).

3 US Federal Aviation regulations define a Type III exit as ‘a rectangular opening of not less than 20 inches wide by 36 inches high with corner radii not greater than seven inches, and with a step-up inside the airplane of not more than 20 inches. If the exit is located over the wing, the step-down outside the airplane may not exceed 27 inches’ (FAR25.803).

assist in making this exit available. Overall, it took approximately 45 seconds to make the Type III exit available for evacuation. The accident investigators concluded that restricted access to exits and the problems in making the exits available had contributed to the 55 fatalities (King, 1988).

The UK type certification of the Boeing 737-200 took place in 1970. In this FSED, 130 passengers and 5 crew evacuated in 75 seconds; 15 seconds within the 90-second requirement. The accident investigators and the regulatory authorities were keen to understand how there could have been 55 fatalities in an accident that did not involve impact forces, and which involved an aircraft that had met the FSED requirements. They commissioned the Human Factors Group at Cranfield University to conduct a series of research evacuation trials to investigate passenger behaviour in evacuations. Of particular interest was passenger behaviour under the highly motivated conditions that had been evident within the aircraft cabin at Manchester.

The primary challenge in researching human behaviour is to ensure that realistic data are collected, without putting participants at risk of physical or psychological harm. Ethical considerations preclude the use of real fire or toxic smoke to motivate people to escape from the cabin. Cranfield's approach was instead to draw people through the available exits using an innovative system of cash bonus payments (Muir, Marrison and Evans, 1989). In this study, the first 50% of participants to evacuate a Trident airframe through the available exits were given a £5 bonus, payable as soon as they exited onto ramps outside. Tests were conducted with groups of up to 60 members of the public, using both Type I and Type III exits. Various configurations within the cabin were tested. The passenger evacuation rates from these tests were then compared.

The results indicated that evacuation flow rates through the Type I exits were optimal when the width between the bulkheads was 30 inches. Flow rates were quicker when one of the bulkhead walls was removed completely, but in these situations, the cabin crew member had no protection from the oncoming stream of evacuating passengers, and was sometimes ejected from their position. Evacuation rates through the Type III exit were optimal when the vertically projected distance[4] at the exit row passageway was between 13 and 25 inches. Interestingly, the seating plans in the experiment had been arranged so that although participants were required to evacuate the airframe on four occasions, each participant had an equal chance of earning an average of two bonuses. However, when the data were analysed, it was evident that younger males were more likely to achieve three or more bonuses. This suggested that bio-behavioural variables, as well as configurational factors, could have an influence on evacuation outcomes.

1.4 Environmental factors

Environmental factors such as the presence of smoke are also known to have a significant influence on evacuation outcomes. Smoke from an aircraft fire is likely to contain a cocktail of toxic chemicals. Trimble (1996) reports on one case where a DC-9 made an emergency landing because of an in-flight fire. During the descent, the cabin filled with black acrid smoke. Passengers attempted to cover their noses and mouths with clothing or towels

4 The vertically projected distance is the distance between the rearmost point on the forward seat, and foremost point on the seat behind.

distributed by the cabin crew. By the time the aircraft landed, survivors reported that they could not see their hands in front of their faces. One survivor reported that she only realised she was at an available exit because she felt a draft at the back of her knees. Those survivors who used the over-wing exits stated later that they barely had the strength and presence of mind to negotiate the exits. Hence, the cognitive and behavioural impairments caused by toxic fumes can delay survivors in making their escape, and thereby increase their exposure to harmful toxins. This debilitation-induced evacuation suppression continues as the situation progresses, making escape less and less likely.

Several research studies have been conducted to assess the effect of non-toxic smoke on evacuation efficiency. For example, Muir, Marrison & Evans (1990) conducted a series of evacuations from a Trident airframe, in which visibility was severely restricted by the use of non-toxic smoke. Clearly, non-toxic smoke does not induce the cognitive and behavioural impairments known to occur with exposure to toxic fumes in real accidents. However, non-toxic smoke does allow passenger behaviour to be investigated within an ethically acceptable test program. These trials showed that the presence of non-toxic smoke significantly slowed the evacuations, and these results were later replicated with a range of cabin configurations, and with passengers highly motivated to evacuate quickly by the use of competitive bonus payments (Muir, Bottomley & Hall, 1992).

1.5 Bio-behavioural factors

The way that passengers will behave in an emergency is often dependent on how well they have prepared for the situation in which they find themselves. Should an emergency arise, passenger preparedness can be a significant factor in survivability, evacuation efficiency and injury rates. In one study, the US National Transportation Safety Board investigated 21 accidents that occurred between 1962 and 1984. They found that a ‘passenger’s risk of injury or death in these accidents could have been reduced had they: 1) paid attention to the flight attendant’s oral safety briefings and demonstrations, 2) read the safety card to familiarize themselves with the location and operation of safety equipment; and 3) been better motivated and thus better prepared to act correctly during an emergency situation’ (NTSB, 1985, page 5). In some of these cases, not only were passengers generally very poorly prepared, but sometimes they behaved inappropriately, or even contrary to cabin crew instructions.

Because of the association between paying attention to the safety information and passenger survival, regulatory authorities require all operators to brief passengers on emergency procedures. In the United Kingdom, operators are required to provide a briefing to passengers on the position and method of use of emergency exits, seat belts, oxygen equipment, life jackets, floor path lighting systems and any other equipment intended for use by passengers in the event of an emergency. Similarly, in the United States, Federal Aviation Regulations require passengers to receive a briefing on smoking, emergency exits, seat belts and flotation devices. However, it can be very difficult to engage passengers in the safety briefing, and studies have repeatedly shown that passengers do not always pay attention to this information.

For example, the US National Transportation Safety Board completed a study of 46 evacuations that occurred between September 1997 and June 1999 (NTSB, 2000). As part of the study, questionnaires were sent to all passengers involved in the 30 most serious evacuations, which were defined as those involving suspected fire, actual fire, or use of the evacuation slides. Of the 457 passengers who returned their questionnaires, 54% said that

they had not watched the entire safety briefing because they had seen it before. Another 15% said that they had not watched the entire briefing because the information it contained was common knowledge. Passengers were also divided on how effective the briefing had been. Over half of the respondents said that the briefing had not contained information specific to their evacuation. They reported that they would have liked more information on exit routes, how to use the slides, and how to get off the wing after leaving the cabin via an over-wing exit.

In an earlier study, Fennell and Muir (1992) sent questionnaires, via travel agents, to a sample of air passengers. The questionnaire asked respondents about the pre-departure safety briefing, and the role of the cabin crew on board the aircraft. One of the main findings was that passengers thought the pre-departure safety information would be more effective if it was introduced appropriately, perhaps by telling passengers that the safety equipment on all aircraft differs, and that it is in their own best interests to pay attention to the safety information since their lives may depend on it. Passengers also thought that the cabin crew should appear to be more interested in the way they presented the information, perhaps reminding people that the information could save lives. While operators may be reluctant to include such information in their safety briefings, perhaps arguing that such an introduction would be likely to cause passengers unnecessary anxiety and alarm, this does not appear to be backed up by the research evidence.

1.6 Procedural factors

Procedural factors are also known to have a significant impact on evacuation outcomes. In one study, the Boeing 737 cabin simulator at Cranfield University was used to investigate the influence of cabin crew actions and commands on passenger evacuation rates (Muir & Cobbett, 1996). In some of the evacuations, the cabin crew provided passengers with assertive, concise and positive evacuation commands, using physical gestures and assisting passengers where appropriate. In other tests, cabin crew politely requested passengers to evacuate, and did not exhibit assertive behaviours or commands. In the final series of tests, the cabin crew evacuated before any of the passengers, to simulate conditions where the crew were incapacitated. The results indicated that evacuation rates obtained with non-assertive crew were similar to those obtained when no cabin crew were present. In contrast, passenger evacuation rates when the crew were being assertive were the fastest. These findings emphasise the importance of procedural factors in ensuring an efficient evacuation, and also highlight the contrast between the service and safety aspects of the cabin crew role.

Cabin crew are required to be on board the aircraft for safety, rather than service, reasons. Research suggests that passengers themselves also acknowledge this. Fennell and Muir (1992) sent questionnaires, via travel agents, to a sample of air passengers. The questionnaire asked respondents to rank various cabin crew tasks in order of importance. The responses indicated that passengers thought the three most important cabin crew tasks were responsibility for passenger safety in an emergency situation, helping passengers in an emergency, and informing passengers of the safety procedures. The service aspects of the cabin crew role, such as looking after passengers who become ill, being pleasant to passengers, serving meals and drinks and selling duty-free goods, were not deemed to be so important. Thus, passenger perceptions of the cabin crew role appeared to match the perspective of the regulatory authorities.

However, this finding may be a double-edged sword (Thomas, 2003). Passengers who believe that the cabin crew are responsible for passenger safety may be less likely to take responsibility for their own safety in an emergency situation. The duties and workload of the cabin crew in an emergency may make it impossible for them to provide assistance to every passenger. In addition, there is always the risk that, should an emergency situation arise, the cabin crew themselves may be incapacitated. Nevertheless, regulators require cabin crew to be trained to rigorous standards, and undergo regular recurrent training, in order to improve the probability that they are able to assume a robust and assertive leadership style in an emergency situation, and able to clearly communicate evacuation commands to passengers, using both voice commands and non-verbal communication.

1.7 Cabin crew and passenger interface

Standard procedures and cabin crew commands vary among operators, and there is no common set of commands and procedures that apply to passenger evacuations. This is perhaps to be expected since no list of commands can apply to every conceivable situation. Further, it is necessary for cabin crew to be able to adapt to an unfolding emergency situation, and vary, as appropriate, the commands and instructions that they use. However, it is possible that some operators have found particular commands to be extremely useful, or that certain practices and procedures have been demonstrated to provide particular value. With this in mind, Phase I of the current research aimed to investigate the range of commands and procedures in use, in order to share best practice and the most effective processes across the industry.

In Phase II, selected crew commands and procedures that were identified during the best practice review, were evaluated in passenger evacuation trials. This second phase of the research had a dual purpose. The first aim was to examine what commands passengers expect to hear in a number of situations, since passenger comprehension may be related to their expectations of the situation. The second aim was to trial a series of cabin crew commands in evacuation experiments, and obtain passenger ratings on the effectiveness of cabin crew commands and gestures under a range of conditions.

2 METHODOLOGY

2.1 Phase I – Best practice forum

Phase I was designed as a preliminary stage of the research, to assist in selecting variables for further study in Phase II of the work. The aim of Phase I was to collect information on the range of evacuation procedures and commands in current use among Australian and Asia Pacific operators, and if possible, to collect some background information regarding evacuation training and safety policies/procedures.

In order to complete Phase I, a best practice forum was initiated by Virgin Blue[5]. This forum took the format of a presentation to, and discussions with, operators at the Australian Society of Air Safety Investigator's Asia Pacific Cabin Safety Working Group. The APCSWG was chosen because of the diversity of the operators who are members of this group. Following these initial discussions, a questionnaire was developed and used to survey a range of operators. The questionnaire data was primarily qualitative, since many questions were open-ended in order to explore the full range of commands and procedures in current use. Once completed questionnaires were received, further detail, clarification and/or discussion was sought from the operators where necessary.

The questionnaire was designed by a cabin safety researcher at Cranfield University, working in collaboration with Virgin Blue. Items on the questionnaire were partially devised on the basis of discussions held with different operators at the forum. Other items were devised based on known issues in cabin safety research (for example, the difficulties in briefing passengers at Type III exits, e.g. Cobbett, Liston & Muir, 2001; Thomas, 2003). A copy of the questionnaire is provided in Appendix A.

The questionnaire covered four distinct areas, and allowed adequate response space for participants to provide detail of commands and procedures. Operators were also asked to provide supporting documentation, such as procedures, training manuals and safety cards where relevant. The areas covered by the questionnaire were as follows:

Section A: Cabin crew training

This section aimed to assist in providing an indication of what topics, in regard to land/ditching evacuations, were discussed during initial and recurrent training in the classroom, and also practised in cabin simulators. Operators were also asked to give an estimate of how much time was spent on these training sessions. The aim was to collect background information to give an indication of the types of topics covered and the extent to which cabin crew were prepared in training for dealing with passengers.

Section B: Passenger evacuation procedures and policies

Section B was the main part of the questionnaire. This section required operators to indicate what policies or operating procedures they had in place with regard to a number of passenger

5 The forum was held at the Asia Pacific Cabin Safety Working Group Meeting & Civil Aviation Safety Authority Infant Restraint Conference, 22-23 November 2004.

management issues. For example, questions asked about what commands the airline required cabin crew to use to gain passengers' attention prior to the safety demonstration; the policy on briefing passengers seated at over-wing exits; and how cabin crew were required to profile passengers, identifying likely sources of assistance during boarding and in preparation for an emergency situation. This section also required operators to give the specific commands that cabin crew were required to use in a wide range of safety-related situations. Finally, they were asked to comment on whether these commands were given to passengers during the pre-flight safety briefing, on the safety instruction card, or during a safety brief for a planned evacuation. This was considered important, as each information source should provide consistent instructions and commands (Thomas, 2003).

Section C: Evacuation incidents in your airline

This section asked operators to comment on any recent changes to training, policy or procedures. The aim was to capture any changes made as a result of an incident with the airline, or as a result of research, which could then be shared with other operators to improve evacuation and passenger management, or to reduce the likelihood of similar problems arising in the future.

Section D: Your organisation

Section D included a question to capture the range of aircraft types that each airline operated, and also allowed responding organisations to request anonymity.

The data from eight completed and returned questionnaires were collated and assembled into a spreadsheet at Virgin Blue, and the data were then analysed. Operators who returned completed questionnaires operated a wide range of aircraft types: fleets included B737, B747, B777, A300, A320, A340, Dash 8, MD81/87/90, and BAe146. The reporting of results in Section 3 focuses on the primary command and instruction issues related to passenger management, that is, Section B of the questionnaire. Background information provided by operators is only included where it is relevant in addressing the research aims.

2.2 Phase II – Evacuation trials

2.2.1 Test facilities

Given the range of aircraft operated by respondents in Phase II, it was decided to conduct evacuation trials that would provide useful and valid information for both narrow-bodied and wide-bodied aircraft types. Hence, the test facilities used were the Boeing 737 cabin simulator and the upper deck of the Large Cabin Evacuation Simulator (LCES), both located at Cranfield University in the United Kingdom. Diagrams of each facility are provided in Appendix B.

The Boeing 737 cabin simulator at Cranfield University is an ex-cabin crew training facility, modified to be suitable for research purposes. It is a single-aisle facility, containing ten rows of seats, a fully functional Type III exit, two Type I exits and a service door. It is fitted with a Public Address (PA) system, emergency lighting and a floor proximity escape path marking system. Experimental trials can be filmed using a video system, and infra-red and thermal imaging allows footage to be taken in conditions of darkness or smoke. Evacuations

from this facility took place via the emergency escape slide fitted to one of the Type I exits at the rear of the cabin.

The LCES is a twin-aisle, double-deck modular cabin simulator. It can be reconfigured to replicate the interior of a range of wide-bodied and blended-wing aircraft. Galleys, toilet units, staircases, seating and walls can all be relocated according to the research aims. For the current trials, the aircraft was left in standard format, being similar to an A340. Again, a video system allowed footage of the evacuation trials to be captured both inside and outside the cabin. Only the upper deck was used, and evacuations took place onto platforms through the UL1 Type A exit[6]. However, participants were led to believe that the R1 Type A exit would also be available, until approximately 10 seconds into the trial, when an exit re-direction took place. This was to simulate a slide being unavailable on the right-hand side of the cabin.

2.2.2 Experimental design

The aims of these experimental evacuation trials were firstly, to investigate the commands that passengers might expect to hear in response to various emergency situations on board an aircraft; and secondly, to investigate the effectiveness of evacuation commands and crew behaviours in achieving optimal passenger management.

In order to address these aims, four groups of up to 40 members of the public were recruited to act as passengers in one of four test sessions. Each test session required that group of passengers to complete four evacuations.

All participants were firstly required to complete a questionnaire, which outlined a number of issues relevant to safety briefings, asking for their perspective on the best way to communicate requirements to other passengers. The questionnaire then asked participants to provide a series of commands that cabin crew could use in a range of situations, to help passengers understand what was required.

There were sixteen evacuation trials with four in each test session. It was decided to conduct eight trials in the Boeing 737 cabin simulator and eight trials in the Large Cabin Evacuation Simulator. Different independent variables could then be manipulated in each cabin to allow issues of relevance to both narrow- and wide-bodied aircraft to be investigated. For the Boeing 737 trials, there were two independent variables, each with two levels, resulting in a 2x2 factorial experimental design. In the LCES, there were also two independent variables, again with two levels each, resulting in a second 2x2 factorial design. In each design, one independent variable was tested within participants, and one between.

In the Boeing 737 cabin simulator, the eight trials were used to investigate a number of aspects of cabin crew commands and passenger evacuation behaviours. The first independent variable was whether the cabin crew used an active or a passive safety briefing. This was

6 Doors are coded ‘U’ for upper deck, ‘L’ or ‘R’ for left or right side of the aircraft facing forward, and numbered from 1 being the most forward door – refer to photo L11 in Appendix L that shows the UL1 exit in the LCES. US Federal Aviation Regulations define a Type A exit as ‘a floor-level exit with a rectangular opening of not less than 42 inches wide by 72 inches high, with corner radii not greater than seven inches’ (FAR25.803). These exits are designed to be wide enough to allow passengers to evacuate in a dual-lane flow (two abreast).

aimed at investigating the level of interaction which cabin crew could generate in briefing passengers on safety procedures. For example, research in cognitive psychology had suggested that if cabin crew engage the passengers actively in the safety briefing, passengers will process the information provided in the briefing more meaningfully, and will be better able to recall and act on that information if, or when, the need arose. The passenger safety briefing is, however, only one determinant of passenger behaviour in emergency situations. It is also important that the cabin crew supplement whatever knowledge they provide in the safety briefing with real-time, assertive, relevant, and credible commands.

Assertive cabin crew have been shown to significantly improve evacuation rates. Research shows than non-assertive cabin crew achieve similar evacuation rates to evacuations where the crew were incapacitated or unavailable (Muir & Cobbett, 1996). Indeed, the commands provided by crew and the safety knowledge of passengers may be particularly critical in those evacuations where conditions are difficult – such as in low visibility, where the aircraft has landed at an usual angle, or in the presence of smoke.

The second independent variable for the Boeing 737 trials was the extent to which the cabin crew provided additional instruction relevant to evacuation in poor visibility. Trials were conducted in low-level lighting and passengers were either commanded to feel their way to the exits, or were told to hurry and provided with no specific information on how to negotiate the escape route. The two levels of this 'tactile command' independent variable were therefore the use or absence of additional, situation-specific commands from the cabin crew.

Together, these independent variables allowed for an examination of the extent to which there might be a synergy between the safety briefing and cabin crew instructions. This effect might be expected as long as the information provided via the safety briefing and the cabin crew instructions was consistent.

In the LCES, the first aim was to investigate the variables of crew commands during the evacuation of a wide-bodied cabin, given that the exits and slides on such aircraft types are typically rated for a dual-lane flow. Although dual-lane flows significantly increase evacuation rates, the results from Phase I showed that many operators do not require their cabin crew to command passengers to move to exits two at a time. In order to investigate this, participants were required to evacuate the upper cabin of the LCES onto a platform. Either they were asked to form two lanes during the slide deployment time, in anticipation of increased flow during the evacuation, or they received no such instruction. In order to provide a further test of the efficacy of the commands, an exit redirection took place, in which participants were instructed to move from the UR1 exit to the UL1 exit after approximately 10 seconds (the estimated slide deployment time). It was hypothesised that passengers already in dual lines, in anticipation of double-flow evacuations, would move through the exit more fluidly and be able to negotiate a redirection in a more orderly fashion.

The second aim of the LCES tests was to manipulate the extent to which the passengers could see the cabin crew during the early stages of an evacuation. The tests were performed in an attempt to gauge the effectiveness of gestures, eye contact and other non-verbal communication used by the cabin crew in managing passengers. This was operationalised by the building of two bulkhead walls, one at each exit on the upper deck. The top half of these bulkheads had a removable panel, such that the bulkheads could act as a screen at either half height or full height. The visibility of the cabin crew was therefore manipulated so that, in some tests, passengers within the cabin would be able to see the cabin crew from the waist

up at the exits. In the other tests, the cabin crew were obscured from view by the full-height bulkheads.

Because of the requirement to counterbalance passenger experience as far as possible, and thereby minimise any effects of practise, learning and/or trial order, careful consideration was given to the design of the experiment and the ordering of the trials. To summarise, there were eight test conditions, composed of two 2 x 2 factorial experiments, each in a different simulator. The independent variables were as follows:

In the Boeing 737 simulator:

- active or passive passenger safety briefing
- basic commands or additional cabin crew instruction.

In the LCES:

- whether or not cabin crew provide dual-lane flow commands
- whether or not passengers could see crew through the bulkheads.

The independent variables were manipulated in the following conditions:

- A: Boeing 737 Active safety briefing, crew give additional tactile commands
- B: Boeing 737 Active safety briefing, no additional commands from crew
- C: LCES High crew visibility (half-height bulkheads), no dual-lane commands
- D: LCES Low crew visibility (full-height bulkheads), no dual-lane commands
- E: LCES High crew visibility (half-height bulkheads), dual-lane commands
- F: LCES Low crew visibility (full-height bulkheads), dual-lane commands
- G: Boeing 737 Passive safety briefing, crew give additional tactile commands
- H: Boeing 737 Passive safety briefing, no additional commands from crew.

In order to avoid carry-over effects from an active safety briefing into a passive safety briefing trial, all participants on a single test day received either an active or a passive safety briefing (relevant to Boeing 737 trials only). Similarly, to avoid any possible carry-over effects from dual-lane flow instructions into subsequent trials that did not include dual-lane commands, participants on a single test day either received dual-lane flow instructions or a simple evacuation command (relevant to LCES trials only). The experimental schedule is shown in Table 1.

The dependent variable of interest in most evacuation trials is the evacuation time, which is normally extracted from video footage of the trials. However, it was not anticipated that the cabin crew commands would have a marked effect on evacuation rate in the current trials. This was because the cabin crew were behaving in an assertive manner in all trials (as reported by Muir & Cobbett, 1996). Therefore, little variation in evacuation times was expected, since the variation in evacuation rates attributable to differing versions of assertive crew commands was likely to be small. It was anticipated that the more useful dependent

variables would be passenger ratings of the effectiveness of crew commands and communications, as provided on the post-evacuation questionnaires.

Table 1: Experimental schedule

	Configuration and Test Day			
	Boeing 737 *Active Briefing*	*Boeing 737* *Passive Briefing*	*Boeing 737* *Active Briefing*	*Boeing 737* *Passive Briefing*
	LCES *Dual-lane Flow*	*LCES* *Dual-lane Flow*	*LCES* *No Flow Commands*	*LCES* *No Flow Commands*
Trial	***19 April 2005***	***21 April 2005***	***26 April 2005***	***28 April 2005***
1	Condition A Boeing 737 Crew to give pax tactile commands	Condition F LCES Low visibility (full bulkhead)	Condition C LCES High visibility (half-height bulkhead)	Condition H Boeing 737 No additional crew commands
2	Condition E LCES High visibility (half-height bulkhead)	Condition G Boeing 737 Crew to give pax tactile commands	Condition B Boeing 737 No additional crew commands	Condition D LCES Low visibility (full bulkhead)
3	Condition B Boeing 737 No additional crew commands	Condition E LCES High visibility (half-height bulkhead)	Condition D LCES Low visibility (full bulkhead)	Condition G Boeing 737 Crew to give pax tactile commands
4	Condition F LCES Low visibility (full bulkhead)	Condition H Boeing 737 No additional crew commands	Condition A Boeing 737 Crew to give pax tactile commands	Condition C LCES High visibility (half-height bulkhead)

2.2.3 Participants

Participants were members of the public who took part in a single test session only. Participants were recruited via local and regional advertising and the Human Factors Department research participant database. On responding to a recruiting advert, participants were sent a letter detailing the practical arrangements for their chosen test session, including the location and time, the appropriate clothing to wear, and health and safety considerations.

In order to reduce the risk of injury or longer term medical problems exacerbated as a result of participation, participants with any of the following conditions were only permitted to take part with the explicit consent of the medical practitioner: heart disease, high blood pressure, fainting or blackouts, diabetes, epilepsy or fits, deafness, chronic back pain, ankle swelling, depression, anxiety, other nervous/psychiatric disorders, fear of enclosed spaces, fear of heights, fear of flying, brittle bones, asthma, bronchitis, breathlessness, chest trouble, lumbago sciatica, or any other serious illness.

Volunteers who were pregnant, or who thought they might be pregnant, were excluded from participating. In addition, participants who had recently undergone surgery, who had recently had an ankle or leg injury, or who were receiving medical treatment at the time of the trials, were excluded. For insurance purposes, participation was restricted to people aged 20-50, who were normally fit and healthy.

Copies of the recruiting advert and letter are provided in Appendix C.

2.2.4 Procedure

On arrival at the test session, participants were issued with a bib showing clearly their participant number, and a clipboard. Each participant was also given two stickers detailing their seating location for each of the four trials – one to wear, and one for reference on the clipboard. The clipboard contained the Volunteer Information Sheet, outlining the insurance, health and safety, payment and anonymity and confidentiality arrangements for the trials (a copy is available in Appendix D).

The weight and height of each participant was measured and documented by members of the research team. Participants were also asked to complete a medical questionnaire, which was checked and signed by the nurse. The nurse was able to contact the on-call medical officer in the event of a query regarding any participant's fitness to volunteer. Once participants had received medical clearance to take part, they were able to sign the consent form. A copy of the medical questionnaire and consent form is provided in Appendix E.

Participants also completed a background information questionnaire for the purpose of providing demographic and background information. The questionnaire also contained items to address one of the research aims – to investigate the commands that passengers might expect to hear in response to various emergency situations on board an aircraft. The questions were included on the background information questionnaire in order that they would be answered before participants had any experience of the trial evacuations (a copy is available in Appendix F).

Participants then received an briefing from one of the research team. This briefing included general background on the cabin safety research program at Cranfield University. It also thanked participants for volunteering to take part and provided details of the procedure for the test session. The details included information on the command to evacuate, which was 'Undo your seat belts and get out!'. Participants were advised that no bonus payments would be made for evacuating the airframe quickly, but were asked to imagine a genuine life-threatening situation and to behave accordingly throughout the evacuations. The briefing

also included full details of the emergency stop procedure. This was a rape alarm[7] to be sounded by one of the research team should an individual be at an immediate risk of harm. A copy of the briefing is provided in Appendix G.

On completion of the briefing, participants boarded either the Boeing 737 simulator or the LCES for the first trial. Seats within the simulators were allocated on a random basis as follows. In each simulator, 40 seats were identified for use throughout the tests. These seats were randomly allocated to participants, with the exception that no-one sat in the same seat twice. A copy of the seating plan is provided in Appendix H.

When all participants were seated according to the pre-defined seating plan, participants were given a live pre-flight safety briefing by the cabin crew. Safety briefings were supported by safety cards: a copy of the Boeing 737 card[8] is provided in Appendix I and a copy of the LCES upper deck safety card is provided in Appendix J. The briefing given differed depending on the experimental schedule.

For Boeing 737 evacuation trials, two test days were designated as 'active safety briefing' days. On these days, the following safety briefing was given, along with accompanying actions and demonstrations:

Boeing 737 Active passenger safety briefing

> Ladies and gentlemen, welcome on board. Cranfield Airways takes your personal safety very seriously. Emergencies are extremely rare, but in the unlikely event of an evacuation, passengers who have paid attention to the safety briefing are better prepared. Therefore, we ask you to give your full attention to this safety demonstration, even if you have flown on similar aircraft before.
>
> Our emergency exits are clearly marked and are being pointed out to you. These are the door at the front of the cabin, and the two doors at the rear of the cabin.
> *(Cabin crew point out exits).*
>
> Please can all passengers now point out the direction of the forward exit to show that you know where it is. Please also now turn and point to the rear exits.
> *(Cabin crew check that all participants are pointing towards the exits, turning heads as necessary. Where participants are not doing this, ask them to do so).*
>
> In the event of an emergency, floor level lighting will illuminate, showing the routes to these exits.
> *(Cabin crew point out low-level lighting along the floor of the main aisle).*
>
> In conditions of low visibility, you may need to feel your way to the exits using the seat backs.
> *(Cabin crew demonstrate how to feel a route along the seat backs).*

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7 A rape alarm is a small, hand-held device which emits an extremely shrill and very loud alarm when operated. Such devices are so named because they are sometimes carried by women in order to attract attention should they be attacked.

8 The actual safety card used for the Boeing 737 trials was designed for a Boeing 757, and was used with the permission of the operator. The cabin interiors of both aircraft types are similar and the instructions for the use of exits and escape slides are typical of a narrow-bodied aircraft of either type.

Please now count the seat rows to your nearest exit forward and behind you.
(Cabin crew encourage all passengers to count seat rows forward and aft to nearest exit).

For those of you unfamiliar with the operation of the seat belt, it is fastened and adjusted as demonstrated…. and unfastened like this.
(Cabin crew demonstrate how to fasten, adjust and unfasten seat belt).

We would also like to advise you of the emergency oxygen supply on board. Should additional oxygen be required throughout the cabin, the panel above your head will open automatically, and masks like these will drop down.
(Cabin crew tap PSU panel[9], and let mask unfold from hands).

Remain seated, pull the mask towards you, place over nose and mouth and breathe normally. Adults should fit their own masks before assisting children.
(Cabin crew demonstrate how to don the oxygen mask).

In the seat pocket in front of you there is a safety card, which the captain would like you to read carefully before takeoff. This contains details of the brace position.
(Cabin crew point out brace position on the safety card).

To brace for impact, ensure your feet are placed back on the floor underneath your seat. Place your hands on your head and push your head down firmly against the seat in front of you.
(Cabin crew demonstrate placing hands on head).

Please adopt the brace position now. This is the position you must adopt in the unlikely event of an emergency landing.
(*Cabin crew individually encourage all passengers to adopt this position, and provide feedback on incorrect posture where necessary).*

Thank you for taking part in this interactive safety briefing. Please now ensure that your seat table is folded away, your seat back is upright with the arm rest down, and your seat belt is tightly fastened.
(Cabin crew check that passengers are prepared for take off).

Thank you for your attention. We would like to wish you a pleasant flight.
(Cabin crew pack up demonstration kit and get into seats for take off).

The remaining two test days of the Boeing 737 evacuation trials were designated as ‘passive safety briefing’ days. On these days, the following safety briefing was given along with accompanying actions and demonstrations:

Boeing 737 Passive passenger safety briefing

Ladies and gentlemen, welcome on board. For your comfort and safety, please pay attention to the following safety briefing.

9 The Passenger Service Unit (PSU) is the panel which contains oxygen masks, and lighting and crew call controls for passenger use.

The emergency exits are clearly marked and are being pointed out to you. These are the door at the front of the cabin, and the two doors at the rear of the cabin.
(Cabin crew point out exits).

In the event of an emergency, floor level lighting will illuminate, showing the routes to these exits.
(Cabin crew point out low level lighting along main aisle).

For those of you unfamiliar with the operation of the seat belt, it is fastened and adjusted as demonstrated…. and unfastened like this.
(Cabin crew demonstrate how to fasten, adjust and unfasten seat belt).

We would also like to advise you of the emergency oxygen supply on board. Should additional oxygen be required throughout the cabin, the panel above your head will open automatically, and masks like these will drop down.
(Cabin crew tap PSU panel, and let mask unfold from hands).

Remain seated, pull the mask towards you, place over nose and mouth and breathe normally. Adults should fit their own masks before assisting children.
(Cabin crew demonstrate how to don the oxygen mask).

In the seat pocket in front of you there is a safety card, which the captain would like you to read carefully before takeoff. This contains details of the brace position.
(Cabin crew point out brace position on the safety card).

Please now ensure that your seat table is folded away, your seat back is upright with the arm rest down, and your seat belt is tightly fastened.
(Cabin crew checkthat passengers are prepared for take off).

Thank you for your attention. We would like to wish you a pleasant flight.
(Cabin crew pack up demonstration kit and get into seats for take off).

The LCES briefing remained the same for all LCES trials, and this was as follows:

LCES Upper deck passenger safety briefing

Ladies and gentlemen, welcome on board. As the safety equipment on this aircraft may differ from that on other aircraft, it is in your own best interests to pay attention to this safety briefing.

The emergency exits are clearly marked and are being pointed out to you. These are the two doors located at the front of the cabin.
(Cabin crew point out exits).

In the event of an emergency, floor level lighting will illuminate showing the routes to these exits.
(Cabin crew point out low level lighting along main aisle).

For those of you unfamiliar with the operation of the seat belt, it is fastened and adjusted as demonstrated … and unfastened like this.
(Cabin crew demonstrate how to fasten, adjust and unfasten seat belt).

We would also like to advise you of the emergency oxygen supply on board. Should additional oxygen be required throughout the cabin, the panel above your head will open automatically and masks like these will drop down.
(Cabin crew tap PSU panel, and let mask unfold from hands).

Remain seated, pull the mask towards you, place over nose and mouth and breathe normally. Adults should fit their own masks before assisting children.
(Cabin crew demonstrate how to don the oxygen mask).

In the seat pocket in front of you there is a safety card, which the captain would like you to read carefully before takeoff.
(Cabin crew show safety card).

Please now ensure that your seat table is folded away, your seat back is upright with the arm rest down, and your seat belt is tightly fastened.
(Cabin crew check that passengers are prepared for take off).

Thank you for your attention. We would like to wish you a pleasant flight.
(Cabin crew pack up demonstration kit and get into seats for take off).

The same cabin crew members were used at the same exits throughout the trials. One was a member of licensed crew currently working in a cabin safety role. The other crew member was a cabin safety researcher at Cranfield University who was familiar with the evacuation procedures of a number of airlines. Both cabin crew members received extensive training and practice in the specific commands, procedures and protocol required for the experimental conduct of these evacuation trials.

On completion of the appropriate safety briefing, passengers then heard one of several evacuation scenarios; each differed so that passengers were unable to anticipate precisely the call to evacuate. The call to evacuate was an announcement from the captain to ‘Undo your seat belts and get out!’. In the Boeing 737, lighting then dimmed to emergency light levels; in the LCES, light levels remained constant. The evacuation scenarios were as follows:

Evacuation Scenario 1

Ladies and gentlemen. This is your captain speaking. We are currently in a queue of aircraft and should be airborne in a few minutes. Engine noise, followed by ‘Undo your seat belts and get out!’.

Evacuation Scenario 2

Long period engine noise, followed by the sound of a small explosion. Then the command to ‘Undo your seat belts and get out!’.

Evacuation Scenario 3

Short burst of engine noise, followed by ‘Undo your seat belts and get out!’.

The cabin crew then acted in accordance with the test protocol. For Boeing 737 tests in which no additional crew commands were given, the cabin crew urged passengers towards the functional exit at the rear. The crew member at the front of the cabin called commands such as: ‘Move to the rear of the cabin’ and ‘Go back! Go that way’ while pointing to the rear of the cabin. When the flow had been established, this crew member called ‘Faster!

Faster!', 'Keep moving', and 'Quickly, quickly' as appropriate. The crew member at the rear of the cabin called 'Come towards me!' on the call to evacuate, and then opened the exit, shouting 'Come this way'. Once the exit was opened, the cabin crew member commanded 'Jump, Jump!', 'Quickly!' and 'One at a time!' as appropriate, maintaining a robust flow through the exit.

For trials in which additional tactile cues were given instructing passengers to feel their way to the exits in the darkness, the crew member at the front of the cabin called 'Move to the rear of the cabin' and 'Use your hands', 'Feel your way!' to establish a flow to the exit. All other commands remained the same. No slide deployment time was built into the Boeing 737 evacuation trials since it was important that the evacuation occurred in darkness. It was also desirable to keep dark adaptation to a minimum.

For trials in the LCES, cabin crew actions again depended on the test protocol. Cabin crew always initially called passengers towards both exits (UL1 and UR1), and held them for approximately ten seconds to simulate the estimated slide deployment time. However, the commands used during this period depended on whether or not the tests included dual-lane flow commands. On days with no dual-lane flow commands, both crew members called 'Come this way, come towards me' – calling passengers to both UL1 and UR1. On the whistle signal to indicate the end of the estimated slide deployment time, the crew member at UL1 made her exit available. The crew member at UR1 called 'Exit blocked! Move across the cabin', pointing and gesturing down the cross-aisle to UL1. Meanwhile, the crew member at UL1 began the evacuation on opening the door, calling 'Go!', 'Quickly' and 'Move!'.

For tests in dual-lane command conditions (i.e. the other two test days), both crew members called 'Form two lanes' and 'Get into two lines' – calling passengers to both UL1 and UR1. On the whistle which signalled the end of the estimated slide deployment time, the crew member at UL1 made the exit available. The crew member at UR1 called 'Exit blocked! Stay in line! Move across the cabin! Two at a time!', pointing down the cross aisle to UL1. While the exit redirection was occurring, the crew member at UL1 began the evacuation by opening the door, calling 'Two at a time!', 'Move in pairs!' and 'Go, quickly!'.

The other variable to be manipulated in the LCES was the visibility of the cabin crew. This was controlled experimentally by use or removal of the screens that formed the top half of the bulkheads. Cabin crew commands and gestures remained as described above, regardless of the visibility condition under test or whether half-height bulkheads (for high visibility) or full-height bulkheads (for low visibility) were used.

When each evacuation was finished, participants completed a colour-coded post-evacuation questionnaire attached to their clipboards. A copy of the post-evacuation questionnaire is provided in Appendix K. Following this, they boarded the relevant simulator for the next trial. When all trials were complete, participants were thanked, debriefed on the nature of the trials, and paid. A selection of photographs, showing the conduct of the trials, is provided in Appendix L.

3 RESULTS

3.1 Phase I – Best practice forum

3.1.1 Background

Section B of the questionnaire – passenger evacuation procedures and policies – asked respondents to provide information relating to four main areas:

- Methods used to gain passenger attention prior to the pre-flight safety briefing.
- Company policies and procedures regarding Type III Exits.
- Passenger profiling and able-bodied passengers (ABPs).
- Evacuation commands, and whether they were included in safety briefings or safety instruction cards.

Each of these areas will now be discussed in turn.

3.1.2 Passenger attention to the pre-flight safety briefing

The importance of gaining a passenger's attention for the pre-flight safety demonstration has been recognised for many years. Paying attention to the safety briefing is a key factor for passengers in taking responsibility for their own safety, and in preparing themselves for an emergency situation. The research and accident record shows that passengers who have paid attention to the safety information will tend to be able to evacuate more quickly, and with fewer injuries, than those passengers who have not paid attention to the safety information. For example, the US National Transportation Safety Board investigated 21 accidents that occurred between 1962 and 1984. They found that a 'passenger's risk of injury or death in these accidents could have been reduced had they: 1) paid attention to the flight attendant's oral safety briefings and demonstrations, 2) read the safety card to familiarise themselves with the location and operation of safety equipment; and 3) been better motivated and thus better prepared to act correctly during an emergency situation' (NTSB, 1985, p5).

Regulators such as the FAA and CASA have published advisory circulars recommending that the briefing should be as attractive, engaging and interesting as possible to increase the likelihood that passengers will pay attention. In addition, guidance is provided to cabin crew to ask that they speak clearly and succinctly, be animated and make eye contact with as many people as possible (for example, FAA AC 121-24B, CASA CAAP 253-2(0)). In an attempt to capture the attention of their passengers, and engage them with the safety briefing, operators may accompany their brief with a video to increase passenger attention and provide more detailed safety instruction.

In response to the best practice forum, two operators disclosed that they have added humour to the beginning of their briefing to make the presentation more appealing, and these operators reported that this could often be effective. Of the eight operators who returned completed questionnaires, only two did not provide a statement at the beginning of their pre-flight safety demonstration to highlight the importance of the briefing. Key phrases such as 'it is important you are familiar' and 'we ask for your full attention' were common.

3.1.3 Policies and procedures relating to the Type III exit

Where operators had Type III Exits, six respondents stated it was a requirement for both check-in staff and cabin crew to screen the exit row passengers for their suitability to sit in these rows. As cabin crew are the last line of defence it is reassuring to see that they are not the only staff monitoring this requirement. The only airline that left this responsibility with the cabin crew was a private operator. Only four operators gave specific instructions for passengers to check for fire/obstructions before operating the Type III Exit, and only three operators outlined the operation of the exit in their brief.

In general discussion, concerns were raised about cabin crew providing detailed instructions on operation of the door because, in the past, some passengers had then opened the exit to demonstrate the instructions. Those operators who did not provide detailed instructions on the operation of the exit in the pre-flight briefing did so in their planned evacuation safety briefing[10].

3.1.4 Passenger profiling and able-bodied passengers

Results from the questionnaire also showed that operators unanimously trained cabin crew to assess passengers who could be possible able-bodied passengers (ABPs), to provide assistance to cabin crew in safety-related tasks during an evacuation. All operators had procedures regarding the identification of potential ABPs for a planned emergency, and five operators required their cabin crew to make this assessment during boarding.

3.1.5 Evacuation commands

Commands to brace (question 15)

Passengers should adopt the brace position in preparation for impact in order to reduce flailing or uncontrolled swinging of the body, and thereby reduce secondary impact injuries. The importance of this command was evident through the survey results, which showed that this command was included in seven of the operators' safety demonstrations for a planned evacuation. However, only one operator included the command in their standard pre-flight safety briefing.

Survey results showed that four operators began their brace command with the words 'Brace, brace, brace'. Three of these operators then went on to repeat the instruction 'Heads down, stay down'. None of these operators included the brace command in their pre-flight safety briefing, so it is not clear that passengers would know what 'Brace, brace, brace' actually meant, or how to react to the command. Indeed, this has been found in previous passenger safety research on the brace position (Johnson, 1998). Later discussions with one of the operators provided some clarification – the command initially began with the flight crew stating the words 'Brace, brace' as a signal to the cabin crew to brace. Cabin crew would

10 A planned evacuation briefing is an additional refresher briefing provided to passengers when an emergency landing is imminent and when sufficient time is available. It is only possible to conduct this briefing when the flight crew are aware that an emergency landing will be required, and hence the cabin crew are briefing passengers specifically for a planned evacuation.

then repeat this command before starting the ‘Heads down, stay down’ command, given for the benefit of passengers and continually repeated.

An ATSB investigation report from an accident at Bangkok in 1999 showed that 45% of all passengers braced or put their heads down for impact, but 38% of the passengers, some of whom heard the brace command, did nothing (ATSB, 2001). After the first impact, six cabin crew in two zones of the aircraft started calling ‘Heads down, stay down’ or ‘Brace, brace’. The investigation revealed that some cabin crew reported not knowing the distinction between the two commands. It is possible that some passengers did not react accordingly when the brace commands were given because the two commands overlapped or caused confusion, or because passengers near cabin crew using the ‘Brace, brace’ command did not know how to brace. It may be easier for passengers to hear a command that also contains the instruction and/or required action, for example, ‘Heads down, stay down’ or ‘Heads down, feet back’.

Although five operators directed passengers to adopt a brace position of ‘Heads down, stay down’, one operator directed passengers to have their ‘Heads down, feet back’. This latter command, instructing passengers to adopt a legs back braced position, was the brace for impact position recommended by a UK Civil Aviation Authority study (CAA, 1995). This study suggested that the lower legs should be inclined backwards at the knees, with the feet placed flat on the floor. This position was found to avoid flailing of the lower legs and reduced the number of injuries.

Commands to reach for and don lifejackets (questions 16 and 17)

The responses received for instructing passengers to reach for and don their life jackets were varied. Some carriers included in their commands an instruction as to where the life jacket is located, ‘Life jackets are under your seat’, where others just direct their passengers to ‘Fit life jackets’. Three operators included the command ‘Do not inflate yet’ after the instruction was given to grab, retrieve or put on your life jacket.

The importance of this direction was highlighted when an Ethiopian Airlines Boeing 767 ditched in Comoros in 1996, and many passengers drowned ‘as a result of having inflated their life jackets inside the cabin’ (CASA, 1998). In discussions during the forum, some operators stated that passengers were told to inflate their life jacket outside of the aircraft during the pre-flight safety briefing, although they thought that little of this would be remembered if a ditching emergency arose.

One of the operators stated that the commands for the retrieval and fitting of life jackets were improvised by crew. This airline explained that cabin crew were required to adapt to the ever-changing scenario, and that they did not want cabin crew to get caught up in mandatory procedures during an evacuation. This operator was involved in the conduct of research evacuation trials (Wilson, Thomas & Muir, 2004), during which they found that not all passengers reacted to the set commands. In response to this, cabin crew then had to change the words slightly to make the passenger respond appropriately. Although the ability of crew to adapt to a situation and think laterally is an essential skill, commands that are not synchronised may not be clearly audible in a smaller aircraft where crew are close together, and may result in confusion.

Commands to operate Type III exits (question 18)

Only four operators stated that their cabin crew gave commands for passengers to operate the exit. Two operators responded that passengers operate the exit on their own because they are given an individual brief prior to the flight. These four operators all included an instruction for passengers to check for obstructions prior to the exit being opened. However, only two operators briefed individual passengers on checking for obstructions prior to opening the exits in the pre-flight briefing.

Commands to undo seat belts (question 19)

There were only two variations used by operators to instruct passengers to remove their seat belts. These were 'Unfasten seat belts' used by five operators and 'Open seat belts' used by three operators. Although in this study unfasten was favoured, one operator stated that the reason for their command using 'Open your seat belts' was due to research that showed 'unfasten' caused confusion and as a result they changed their command to 'open'. However, the operator was unable to provide a reference for this finding. Half of the operators stated that they included this command in their safety brief for a planned evacuation.

Commands to move towards exits (question 20)

One operator emphasised the importance of having cabin crew give the 'Come this way' command only once their door was opened. The reason given was that recent research trials, in which this operator had participated, had highlighted that some confusion was caused when the command was said prior to the door being opened (Wilson, Thomas & Muir, 2004). This was because the research trials involved an element of redirection – some exits were unavailable throughout the evacuation. A number of other operators were found to follow the same practice, only giving the command once the door was open. At this stage, additional instructions could be used to redirect passengers from unavailable exits, such as, 'Go forward. No exit. Go across.', and to encourage passengers to move quickly, 'Hurry'.

Commands to leave behind personal belongings (question 21)

With the exception of one, all operators employed a command to direct passengers to leave behind their personal belongings. The most common command, used by five operators, was 'Leave everything behind'. The other two commands used were 'Leave all hand baggage behind' and 'No baggage'.

Although it is important for cabin crew to direct passengers to leave behind their personal belongings, it is also essential that cabin crew are trained on what to do when passengers do not follow this command. This is particularly important when one considers that attachment to personal belongings is a key issue for many passengers, and that cabin crew who have been involved in precautionary and emergency evacuations have reported difficulty with items of luggage that passengers will not leave behind. For example, an NTSB safety study, reported that cabin crew had actually argued with passengers over luggage (NTSB, 2000). This would clearly have a negative impact on evacuation efficiency, not just for the passenger(s) concerned, but for other travellers.

There is also the difficulty of what to do with baggage left by passengers at the exit. Luggage at the top of a slide or in an emergency escape path can cause blockages. An ATSB

investigation report (ATSB, 2001) showed that in a 1999 accident, some passengers were allowed to take baggage with them as they evacuated. Where cabin crew enforced instructions to leave bags behind, the passenger flow was less orderly.

From these two reports it is evident that giving a command to leave bags behind solely during the evacuation is too late, and there is therefore a case to be made for including this instruction in the pre-flight safety briefing. Once passengers have brought their bags to the exit, the options for the cabin crew are limited. If the cabin crew try to take the bags from passengers, the galleys, aisles and assist-spaces could become congested or blocked. Cabin crew may also receive resistance from passengers when they try to take the bags away, which in turn would represent wasted effort and an inefficient evacuation. The NTSB safety study (2000) stated that some passengers indicated, by survey, that the pre-flight briefing should mention the requirement for carry-on luggage to be left behind. In this research, only one operator stated that they include the instruction 'No baggage' in their pre-flight safety briefing, while three operators included this command in their planned evacuation safety briefing. Another two operators stated that they included the requirement for passengers to not take any bags in their planned evacuation safety brief; however, these operators did not provide the exact command.

Commands to move through exits (question 22)

The reason for commands that encourage passengers to 'Jump' or 'Jump and slide' when evacuating is to achieve the required flow rate of 70 people per lane per minute down the slide (FAA, 1990). This rate could not be achieved if a procedure of 'Sit and slide' was used, as the act of sitting takes valuable time. One study found that if 100 passengers were to sit on the slide, they would take 33 seconds longer to evacuate than 100 passengers who jumped (see Johnson, 1984). This difference may not seem a lengthy period of time, but in an emergency evacuation delays can cost lives.

The questionnaire results showed that all respondents used 'Jump' or 'Jump and sit' in their commands. 'Jump and sit' may cause confusion, as it is possible that some passengers might interpret this to mean that either jumping or sitting is acceptable. These commands were reported to be used in conjunction with various other instructions, including commands such as 'High heels off' and 'Move well away'. Three operators included this command in their planned evacuation safety brief. The command 'Jump and slide' may increase the speed of the evacuation, and could therefore have an impact on the injuries sustained by passengers. This is not likely to be a key issue in a genuine emergency situation, such as where a post-crash fire is present. However, in precautionary emergency evacuations, where the airframe is evacuated 'just in case', it is possible that passengers will not tolerate a higher injury rate where it later transpires that the evacuation was not strictly necessary (Thomas, 2001).

Commands to able-bodied passengers (question 23)

Half of the operators surveyed had prescriptive instructions for able-bodied passengers (ABPs) in an evacuation. These predominantly required ABPs to stay at the bottom of the slide and assist passengers off. One operator used an ABP to protect the crew member, and the other operators stated that the commands were improvised. While improvised commands allow cabin crew to adapt to an unfolding emergency situation, they still need to be trained on the options for using ABPs to assist during evacuations. Suggested instructions and commands may also prove helpful.

Commands to unresponsive passengers (question 24)

'Unresponsive' describes those passengers who fail to comply with cabin crew commands and instructions. Four operators provided the instructions that they would give to passengers who are not following their directions. These included commands to reiterate and emphasise the required action, such as 'Hurry', 'Move faster', 'Jump, jump, jump'. No operators included these commands in their pre-flight and planned evacuation safety briefings, as clearly they are only required as emphasis during the evacuation situation.

3.1.6 Conclusions

The collation of operating policies/procedures and evacuation commands used by various operators from Australia and Asia, and by one operator from the United Kingdom, shows the extensive range of policies and commands that are being used by operators. There was some consistency with regard to the instructions that were given to passengers, such as commands to brace, to move towards exits, and to leave bags behind. However, there were areas where there was a relatively high degree of variation. Many operators appear to be keeping their commands to a minimum, as several expressed a preference for using short, concise and positive commands (for example, after Muir & Cobbett, 1996).

One operator also required cabin crew to improvise commands such as the fitting of life jackets. The reasoning for this was to allow cabin crew some freedom to adapt commands to an unfolding evacuation situation. The danger of this approach is that it is widely recognised in the literature on learning and skill acquisition that over-training can often be required to ensure competence in infrequent events (Buckley & Caple, 2000). In essence, this means that where a skill is rarely used at work, such as with emergency evacuations, a high level of practice is required to ensure retention over time. This is because people lack opportunities for demonstrating that skill or behaviour in their day-to-day work routines. Hence, improvisation should be permissible, but supported by thorough training in commands and procedures to use as a fall-back mechanism.

When discussing commands and best practice with operators, it was evident that they often thought the evacuation procedures they had in place were satisfactory or best practice. This is understandable - no operator would use commands or procedures if they felt that they were substandard, or would not achieve the required aim. However, there were some instances where operators had been involved in evacuation trials or cabin safety research, and while they had learnt from the experience, this information was not always available to other operators. With regard to specific commands that could be used, there is no known research that supports the use of one variant over another. However, sometimes there was supporting evidence for a particular procedure or command, such as the CAA-recommended brace for impact position, and operators were not always using the latest research to develop and refine their operating procedures.

Finally, all operators involved in the survey and forum discussions agreed that they were not 100% confident that their commands would ensure optimal management of passengers in an emergency. To be fair, it is probably the case that the best test of any airline's procedures is a genuine emergency situation – and these of course are the very circumstances which operators seek to avoid. The research in Phase II aimed to address some of the concerns identified by operators during the first phase by producing commands and procedures that are closely matched to passenger understanding and expectations, and which are backed up with experimental data on their effectiveness in evacuation situations. It was hoped that the

results may enhance the confidence of operators, assuring them that they have developed their processes and practices using the best available knowledge.

3.2 Phase II – Evacuation trials

3.2.1 Completed trials

All planned trials were successfully completed, and no trials were halted under the emergency stop procedure. There were four participant withdrawals during the trial sessions[11]. There was one reported injury: a sprained ankle sustained while using the Boeing 737 slide. No other injuries were reported.

3.2.2 Sample details

The final sample comprised 159 participants (including the later withdrawals), including 84 males and 75 females (52.8% and 47.2% respectively). Participants ranged in age from 20 to 50, with a mean age of 30.9 years (standard deviation 8.1 years)[12]. Of the total, 97.5% had not participated in an aircraft evacuation test within the previous six months, and none had ever had to perform an evacuation from a commercial aircraft. However, many had experience flying in a commercial aircraft, with only 2 people (1.3%) having never flown. When asked about how many return flights they had taken within the previous twelve months, 19.5% had made no return trips, 53.5% had made 1-3 return trips, 19.1% had made 4-7 return trips, and 7.5% had made more than 8 return trips. Participants were also asked if they had paid attention to the safety briefing on flights taken within the previous twelve months. Only 53.2% said that they had paid attention to all of it. Of the sample, 11.3% was left-handed, and 46.5% had corrected vision. Most participants also reported being able to swim confidently a distance of at least 10 metres (96.2%).

3.2.3 Data preparation

The quantitative data from the background information questionnaires and the post-evacuation questionnaires for all trials were entered into a statistical package for analysis. Qualitative comments from the questions relating to passenger expectations of cabin crew commands in a variety of situations were typed verbatim, ready for analysis. The video footage of both the Boeing 737 and the LCES trials was edited and time-coded to one-tenth of a second, in order that accurate evacuation times could be extracted from the footage.

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11 Participant 201 withdrew after the second trial, participant 207 withdrew after the third trial, participant 219 refused to use the slide on the second trial, and participant 434 sustained a minor ankle injury on the Boeing 737 slide after the first trial.

12 The standard deviation is a measure of the variability in a set of values. It describes the amount by which, on average, a value deviates from the mean.

3.2.4 Expectations of cabin crew commands

Data relating to the commands that passengers expect to hear in a range of emergency situations were obtained on the background information questionnaire. Hence, these responses were provided before participants had experienced any experimental evacuations. Since a large number of comments were provided, only a representative selection is provided here. However, the discussion encompasses the full range of responses given.

Safety briefings (Question 13)

The first question in this section of the questionnaire (question 13) related to issues relevant to the pre-flight safety briefing. This question began with the statement:

'Airlines use safety briefings to tell passengers important safety information. However, sometimes these safety briefings are not very effective. Please tell us how you would explain the following information to members of the public, using phrases that they would be likely to understand. Remember, this is about the words that you think other people would understand best, and not what you personally would expect to hear in a safety briefing'.

This 'third person' approach was taken because research into comprehension of safety signage and symbols requires people to estimate what other people would understand; it is believed to be a more accurate approach than asking individuals what they personally expect or understand (ISO, 2001). Hence, by asking passengers what commands other people might expect or understand, it may be possible to gain a more representative perspective. The two items within this section related to how cabin crew could try and encourage passengers to pay attention to the safety briefing and how cabin crew could best explain that passengers were to don their own oxygen masks before assisting others.

a) Drawing attention to the pre-flight safety briefing

A number of suggestions were made here, many very similar. Most stated that the cabin crew should say that it was important, or in passengers' own best interests to pay attention to the safety briefing, and that they should draw attention to the fact that even frequent flyers need to pay attention. A small number of participants also thought that the cabin crew should provide a statement to the effect that listening to the safety briefing could save lives in an emergency situation. Here is a selection of comments:

- 'However many times you have flown or heard the following, please can we have your full attention and co-operation.' (P103)
- 'For your own safety and the safety of those around you, please listen to the following safety announcement.' (P110)
- 'To avoid death or injury in the event of an accident, please listen carefully to the following information.' (P224)
- 'It is essential that all passengers pay attention to the following safety information. If passengers are talking/reading etc, crew should embarrass them publicly.' (226)
- 'Listen to this briefing. It could save your life.' (P323)
- 'Get everybody up and get them to do the safety procedure.' (P404)

- ‘First thing is that crew shouldn’t announce the briefing automatically like they did it 1000 times (regardless of the fact that they did). Clear, loud, and with direction (concentration) words already used are sufficient already.’ (P415)
- ‘Even though flying is one of the safest means of travelling, please pay attention to this safety briefing as your personal safety could depend on it.’ (P416)
- ‘Perhaps drop the ‘comfort’ – it’s for safety so just say so.’ (P435).

b) Donning own oxygen mask before assisting others

This question asked passengers about appropriate phrasing for the information relating to oxygen masks, particularly the need to don one’s own before assisting children. It was also evident from the responses that some people had not grasped the fact that if people did not act quickly, they would lose consciousness:

- ‘Please help yourself before helping others, with the exception of small children.’ (P319)

Many participants suggested that this should be made clear and explicit within the pre-flight safety briefing. It was also evident that most people would assist family, friends and travelling companions first, and that they did not always appreciate that they had to put their own mask on first in order to be able to do so. A selection of comments is provided below:

- ‘If we have a decompression of high altitude [sic], you may only have a few seconds of consciousness so it is vital that you protect yourself before you help other people.’ (P102)
- ‘Put your mask on first before assisting others, failing to do so could result in yourself losing consciousness.’ (P221)
- ‘Please put on your own oxygen mask first so then you can help a family member or friends more effectively.’ (P227)
- ‘If you don’t put your mask on before you help other people you may pass out and die.’ (P323)
- ‘If you fall unconscious you cannot help your wife etc. Don’t think you are being selfish or uncaring, you are just doing the right thing.’ (P407)
- ‘They never mention unconsciousness, they must do that. As it is usually done, it sounds a bit selfish – you first.’ (P430)

Emergency commands and instructions (Question 14)

The second question in this section of the background information questionnaire related to cabin crew commands and instructions once an emergency was underway. Hence, this question (question 14) related specifically to emergency and evacuation commands. The question began with the statement:

‘Cabin crew are legally required on board an aircraft to manage passengers in an emergency situation. Airlines train cabin crew to use short, positive and assertive commands with passengers. This is because there is not much time to explain things in detail, and cabin crew need to get passengers to respond very quickly. Please think about the commands that you think members of the public would understand in the following emergency situations.

Remember, this is about what you think other people would understand best, not what you would understand.'

The items within this question asked about commands relating to life jacket use in a ditching, the requirement to brace against impact, the need to leave all personal belongings behind, removing high heeled shoes, exit redirection and commands for unavailable exits, and commands to use in darkness and/or smoke. Responses for each are discussed in turn.

a) Emergency landing on water

Passengers were asked about how best to communicate the need to don the life jacket before landing, to stay in the seat with the seat belt fastened until the aircraft had landed, and to only inflate the lifejacket once outside the aircraft. Passengers suggested the following:

- 'Do not inflate life jacket before evacuation.' (P105)
- 'Put on life jacket – do not inflate. Remain seated. Inflate on exit. (Repeat commands).' (P114)
- 'Please do not inflate your life jackets until you leave as this will slow down your and others' evacuation [sic].' (P136)
- 'Stay seated, put on your life jacket but do not inflate your lifejacket. Keep your seat belt on.' (P219)
- 'Prepare for impact and be ready to follow instructions.' (P237)
- 'Please put on your life jackets and remain in your seats. Fasten the seat belts as for a normal landing. Don't inflate the life jackets in the aircraft as you won't be able to pass through the aisle.' (P317)
- 'Don't panic, stay calm and listen carefully. If you inflate your life jacket too soon you could hinder yourself or fellow passengers in evacuating quickly – don't hold others up.' (P407)
- 'Because it's an emergency situation sentences should be short, direct and understandable. Stay in your seat. Fasten your seat belt. Don't blow your life jacket.' (P418)

b) Bracing for impact

This part of the question asked about commands relating to the emergency brace position. As found by Johnson (1998), there was a wide range of commands associated with this requirement. Passengers suggested a range of instructions and commands that other passengers might expect to understand, some of which illustrated that some passengers did not appreciate the correct brace position:

- 'Brace, brace, brace. The passengers should be scared enough to remain in position until otherwise told.' (P102)
- 'Stay down, tuck up tight, stay down.' (P117)
- 'Hug your knees.' (P128)
- 'Hands on head and head down to brace.' (P130)

- ‘To continuously call out brace, put your hand behind your head and lean forward.’ (P201)
- ‘Stay seated, keep knees straight and place your hand on your knees with your head down.’ (P223)
- ‘Arms crossed at shoulders.’ (P228)
- ‘Please place your head in between your legs.’ (P232)
- ‘Brace. Emergency landing position.’ (P308)
- ‘Bend forwards now.’ (P327)
- ‘Heads down, face the floor, stay down.’ (P334)
- ‘Down, down.’ (P409)
- ‘Get down, get down.’ (P422)
- ‘Hands on your head. Get down.’ (P425)

c) Commands to leave luggage behind

Question 14c asked passengers what commands cabin crew could use to try and improve the probability that passengers would leave all luggage, bags and shopping behind when evacuating. Most passengers suggested clear commands that were unambiguous and which highlighted the importance of leaving everything behind. However, it is also true that there are instances on record when passengers have not done as they were asked.

Passengers are more likely to attempt to leave the aircraft with luggage if they do not perceive a clear and immediate threat to safety – such as in a precautionary evacuation. This is because people are generally very attached to their personal belongings, particularly things which are difficult to replace, such as personal items and items of particular subjective or sentimental value. However, they are less likely to try and take baggage if they are fleeing clear and present danger such as smoke and/or flames, since in these situations there is a clear trade off between survival and possessions. The problem is this trade-off since, where passengers cannot see an immediate threat, they need to be convinced of the urgency of an evacuation. Some passengers made suggestions which clearly included reference to this life/luggage trade-off. Comments on this group of commands included the following:

- ‘In the event of an emergency, leave personal and all other belongings behind, as this will slow evacuation and damage or puncture the evacuation slides.’ (P110)
- ‘Taking baggage will cost lives.’ (P227)
- ‘Leave all items on board, they will be recovered in due course.’ (P235)
- ‘Save yourself only.’ (P328)
- ‘Basically, they need to emphasise the importance of leaving these things by giving the potential danger description.’ (P329)
- ‘Put your hands on your forward neighbour’s shoulder – all hands visible – all hands free.’ (P337)
- ‘Save your life before your luggage.’ (P418)

However, the majority of passengers suggested the simple ‘Leave all belongings’ and ‘Leave everything behind’ or ‘Leave everything’. Of these, perhaps ‘Leave everything behind’ or ‘Leave everything’ might be preferred, because they clearly allow for no exceptions to the command. The suggestion to put hands on the shoulders of the person in front would prevent passengers from taking items of baggage to the exits, and would also assist in evacuations where visibility is low. However, unless passengers perceive a clear and immediate threat, they may be unlikely to comply with such commands.

d) Removing high heeled shoes

Passengers were asked about commands which could be used by cabin crew to ensure that passengers wearing high-heeled shoes removed them before using slides and escape chutes. As with the commands to brace for impact, there was a variety of suggestions. Some gave commands that could be interpreted as meaning that most or all passengers should remove shoes:

- ‘Shoes off, go.’ (P101)
- ‘Ladies, remove your heels.’ (P116)
- ‘No shoes allowed.’ (P231)
- ‘Shoes off, shoes off.’ (P409)

Others gave suggestions that indicated perhaps that socks and hosiery should also be removed:

- ‘Remove all footwear.’ (P129, P301)
- ‘Get barefoot.’ (P438)

Others gave suggestions which would be more likely to capture the intended meaning:

- ‘Remove heeled shoes before exit.’ (P107)
- ‘Take your high heels off.’ (P210, 211)
- ‘No sharp heels please.’ (P422)

One passenger said, with regard to using an appropriate command:

- ‘Don’t. Ban them from planes in the first place. Why compromise safety?’ (P419)

e) Exit redirection commands

Question 14e asked passengers to provide details of what commands passengers would expect to hear if an exit was unavailable due to damage or became unavailable during an emergency evacuation. Post-evacuation questionnaires from previous trials at Cranfield University have suggested that passengers do not always realise that some exits may be unavailable (Wilson, Thomas & Muir, 2004; Wilson, Muir & Jolly 2003). Because the test protocol in these trials included an exit redirection, it was therefore decided to include the issue on the background information questionnaire. Selected comments are given below, some of which suggest that passengers do not always appreciate the nature of the problem.

- ‘Explain before departure.’ (P101)
- ‘Exit at the next door only.’ (P107)

- ‘Door blocked.’ (P127)
- ‘Use another exit.’ (P132)
- ‘Find another exit.’ (P212)
- ‘Guide/inform to nearest door.’ (P213, 214)
- ‘This door is out of order.’ (P216)
- ‘Put a red cross on the doors, or have a red cross light that goes on if the door is faulty.’ (P319)
- ‘Shout instructions.’ (P437).

f) Commands to use in smoke or darkness

The final question in this section of the questionnaire (question 14f) related to commands the cabin crew could use when visibility is poor. A large majority of the comments here related to commands to follow the lighting or signage, a smaller number suggested following the voice of the cabin crew member giving the commands. Fewer comments related to holding onto the person in front, but no comments were made about feeling seatbacks and finding the route to an exit by feel. Selected comments are provided below, the full responses are available in Appendix M.

- ‘Follow the lights on the floor.’ (P116)
- ‘Follow my voice – exit here.’ (P128)
- ‘Hold hand with person in front/behind. Stay close at all times.’ (P140)
- ‘Use emergency lighting.’ (P214)
- ‘Stay low, follow floor lights.’ (P222)
- ‘Directional information: forward, back, to me, or find a reference, towards the curtains, away from the fire.’ (P308)
- ‘Follow the low level lighting.’ (P410)
- ‘Doors should have a sound so as people get nearer it gets louder ie make use of senses which are not impaired in the dark, voices and instructions are confusing.’ (P435)
- ‘Use your hands.’ (P439).

3.2.5 Effect of crew instructions and briefing type

In the experimental trials conducted within the Boeing 737 cabin simulator, there were two variables of interest. The briefing independent variable had two levels: groups of participants received either an active or a passive safety briefing. The cabin crew instruction independent variable also had two levels: additional commands relating to feeling the way to the exit or no additional commands.

It was acknowledged at the outset that the most useful data would probably be obtained from the post-evacuation questionnaires, since this would allow the effectiveness of the cabin crew commands to be evaluated from the passengers’ perspectives. However, evacuation

data were also extracted from the video footage, in order to see whether there was an effect of crew instruction and briefing type on evacuation times. Descriptive statistics are provided in Table 2: these are calculated based on the two evacuations within each condition.

Table 2: Descriptive statistics for evacuation times in Boeing 737 evacuation trials, by briefing type and crew instructions (evacuation times are given in seconds)

Boeing 737 Evacuations	Additional tactile commands		No additional crew commands	
	Mean	*SD*	*Mean*	*SD*
Active briefing	44.34	22.14	42.05	22.16
Passive briefing	45.45	24.46	44.88	23.53

As can be seen, there are differences between mean evacuation times within each condition. To assess whether these differences were statistically significant[13], a 2x2 factorial independent ANOVA[14] [15] was conducted on the data. The results are shown in Table 3.

Table 3: ANOVA results for evacuation times in Boeing 737 evacuation trials, by briefing type and crew instructions

Source	Sum of squares	df	Mean square	F	p
Main effects					
Tactile commands	158.96	1	158.96	0.30	0.59
Type of briefing	302.41	1	302.41	0.57	0.45
Interaction					
Commands x briefing	57.8	1	57.8	0.11	0.74
Error	163521.1	307	532.6		
Total	770680.5				

As can be seen in Table 3, there was no significant effect on evacuation times of the use of tactile commands. This shows that the differences in evacuation times between trials conducted with and without tactile commands are likely to have arisen by chance. Similarly, there was no significant effect of the type of briefing. Passengers evacuating in trials where an active safety briefing had been provided did not evacuate more quickly than passengers who had received a passive safety briefing.

Data from the post-evacuation questionnaires provided additional information on the passenger experience, although not all questions were relevant to the Boeing 737 trials.

13 In this context, statistical significance means that the probability that the observed differences are due to the experimental effects is over 95%.

14 ANOVA is a statistical technique which analyses the variability with a set of scores, and determines the probability that the observed differences between groups are likely to have arisen by chance.

15 Independent ANOVA was used throughout, because it was not always possible to identify participants on the video footage; this is of course a prerequisite for repeated measures ANOVA. However, independent ANOVA does not remove variance associated with individual differences, and hence it is less likely that a significant effect will be detected.

However, certain questions did ask about the extent to which passengers found the safety briefing and the cabin crew instructions and commands useful. Question 1 asked participants to rate the extent to which they listened to the safety briefing on a seven-point scale, where 1 was giving the briefing full attention, and 7 was paying no attention. The descriptive statistics are shown in Table 4.

Table 4: Descriptive statistics for ratings of extent to which participants paid attention to the safety briefing (question 1), by briefing type and crew instructions

Boeing 737 Evacuations	Additional tactile commands		No additional crew commands	
	Mean	*SD*	*Mean*	*SD*
Active briefing	1.62	0.92	1.53	0.93
Passive briefing	1.82	1.24	1.71	1.36

As can be seen from the standard deviations, there was greater variability in the ratings provided by participants in the passive briefing conditions. A 2x2 ANOVA showed that the differences between groups were not statistically significant. This indicated that participants in each group reported giving roughly equal attention to the safety briefing.

Question 2 asked participants to rate, on a seven-point scale where 1 was very helpful and 7 was not at all helpful, the extent to which the safety briefing assisted in the evacuation they had just completed. Descriptive results are shown in Table 5.

Table 5: Descriptive statistics for ratings of extent to which participants said the safety briefing assisted in their evacuation (question 2), by briefing type and crew instructions

Boeing 737 Evacuations	Additional tactile commands		No additional crew commands	
	Mean	*SD*	*Mean*	*SD*
Active briefing	1.90	1.05	1.86	1.14
Passive briefing	2.69	1.66	2.85	1.77

To assess whether these observed differences were statistically significant, a 2x2 ANOVA was conducted on the data. The results are shown in Table 6.

Table 6: ANOVA results for ratings of extent to which participants said the safety briefing assisted in the evacuation (question 2), by briefing type and crew instructions

Source	Sum of squares	df	Mean square	F	p
Main effects					
Tactile commands	0.29	1	0.29	0.14	0.70
Type of briefing	61.99	1	61.99	30.37	<0.01
Interaction					
Commands x briefing	0.77	1	0.77	0.38	0.54
Error	626.66	307	2.04		
Total	2361.00	311			

The results in Table 6 show that there was a significant main effect, such that participants who received the active briefing rated it as significantly more helpful in the evacuation than the passive briefing. The probability of this result having occurred by chance was less than 1%. There was no significant effect of the use of tactile commands indicating that the differences in ratings between trials conducted with and without tactile commands are likely to have arisen by chance.

Participants were also asked whether they thought the briefing that they had received would have assisted in a real emergency (question 3). The descriptive statistics for these ratings, where 1 was very helpful and 7 was not at all helpful, are shown in Table 7.

Table 7: Descriptive statistics for ratings of extent to which participants said the safety briefing received would assist in a real emergency (question 3), by briefing type and crew instructions

Boeing 737 Evacuations	Additional tactile commands		No additional crew commands	
	Mean	*SD*	*Mean*	*SD*
Active briefing	2.06	1.14	2.11	1.22
Passive briefing	2.94	1.60	2.97	1.59

To assess whether these observed differences shown in Table 7 reached statistical significance, a 2x2 ANOVA was conducted on the data. The results are shown in Table 8.

Table 8: ANOVA results for ratings of extent to which participants said the safety briefing received would assist in a real emergency (question 3), by briefing type and crew instructions

Source	Sum of squares	df	Mean square	F	p
Main effects					
Tactile commands	0.15	1	0.15	0.08	0.78
Type of briefing	58.28	1	58.28	29.86	<0.01
Interaction					
Commands x briefing	0.00	1	0.00	0.00	0.97
Error	599.28	307	1.95		
Total	2624.00	311			

The results in Table 8 show that there was no significant effect of the tactile commands, and no interaction between the commands and the safety briefing. However, there was a highly significant main effect for briefing, such that participants who received the active briefing said it would provide significantly more assistance in a real emergency situation.

A number of questions on the post-evacuation questionnaire asked participants to rate the difficulty of a number of evacuation tasks. All ratings were provided on a seven-point scale, where 1 was very easy and 7 was very difficult. Hence, a higher rating indicates that passengers perceived the task to be more difficult. Analysis of the ratings for undoing the seat belt (question 6), moving out of the seat (question 7) and moving down the main aisle (question 8) did not reveal any statistically significant differences between tactile command or safety briefing conditions.

There were a number of significant effects for finding an open door (question 9), moving through the exit itself (question 10), and using the evacuation slide (question 12).

With regard to the difficulty of finding an open door (question 9), participants in the active briefing condition rated finding a door as significantly easier than participants in the passive briefing condition. There was also a significant interaction of the main effects, such that additional commands were associated with lower difficulty ratings, but only in the active briefing condition. In the passive briefing condition, additional commands from the cabin crew were associated with higher difficulty ratings. Descriptive statistics for question 9 ratings are shown in Table 9, and the ANOVA results are shown in Table 10.

Table 9: Descriptive statistics for difficulty ratings of finding an open exit (question 9), by briefing type and crew instructions

Boeing 737 Evacuations	Additional tactile commands		No additional crew commands	
	Mean	*SD*	*Mean*	*SD*
Active briefing	2.08	1.15	2.22	1.33
Passive briefing	2.72	1.48	2.21	1.28

Table 10: ANOVA results for difficulty ratings of finding an open exit (question 9), by briefing type and crew instructions

Source	Sum of squares	df	Mean square	F	p
Main effects					
Tactile commands	2.71	1	2.71	1.57	0.21
Type of briefing	8.01	1	8.01	4.65	0.03
Interaction					
Commands x briefing	8.24	1	8.24	4.79	0.03
Error	526.72	306	1.72		
Total	2190.00	310			

Question 10 asked about the difficulty rating of moving through the exits itself. Descriptive statistics are provided in Table 11 and ANOVA results are in Table 12.

Table 11: Descriptive statistics for difficulty ratings of moving through the exit itself (question 10), by briefing type and crew instructions

Boeing 737 Evacuations	Additional tactile commands		No additional crew commands	
	Mean	*SD*	*Mean*	*SD*
Active briefing	2.03	1.15	2.19	1.23
Passive briefing	2.55	1.59	2.39	1.53

Table 12: ANOVA results for difficulty ratings of moving through the exit itself (question 10), by briefing type and crew instructions

Source	Sum of squares	df	Mean square	F	p
Main effects					
Tactile commands	<0.00	1	<0.00	<0.00	0.98
Type of briefing	10.41	1	10.41	5.40	0.02
Interaction					
Commands x briefing	2.01	1	2.01	1.04	0.31
Error	593.55	308	1.93		
Total	2240.00	312			

The results in Table 12 show that there was a significant effect of type of briefing, such that differences between the active and passive briefings were very unlikely to have arisen by chance. Moving through the exit itself was rated as significantly more difficult by participants in the passive briefing condition.

Question 12 asked about the difficulty of using the evacuation slide. Again, participants were asked to rate difficulty on a seven-point scale, where 1 was very easy, and 7 was very difficult. Hence, a low rating indicates that the task is easier. The descriptive statistics of the ratings for question 12 are shown in Table 13, the ANOVA results are shown in Table 14.

Table 13: Descriptive statistics for difficulty ratings of using the evacuation slide (question 12), by briefing type and crew instructions

Boeing 737 Evacuations	Additional tactile commands		No additional crew commands	
	Mean	*SD*	*Mean*	*SD*
Active briefing	1.78	1.02	1.84	1.03
Passive briefing	2.18	1.28	2.10	1.26

Table 14: ANOVA results for difficulty ratings of using the evacuation slide (question 12), by briefing type and crew instructions

Source	Sum of squares	df	Mean square	F	p
Main effects					
Tactile commands	0.02	1	0.02	0.01	0.91
Type of briefing	8.40	1	8.40	6.34	0.01
Interaction					
Commands x briefing	0.39	1	0.39	0.29	0.59
Error	399.891	302	1.32		
Total	1597.00	306			

The results in Table 14 show that there was a significant main effect for briefing, such that participants in the active briefing evacuations rated using the evacuation slide as significantly easier than participants in the passive briefing evacuations. There was no significant effect for additional tactile commands, and the interaction term was also not significant.

Questions 16 and 17 on the post-evacuation questionnaires asked participants to rate the extent to which instructions provided by the cabin crew assisted in the evacuation, and the extent to which gestures of the cabin crew assisted in the evacuation respectively. The response format was again a seven-point scale, where 1 was very helpful, and 7 was not at all helpful. Descriptive statistics of ratings given for each question are given in Tables 15 and 16 below. There were no significant differences between ratings given according to additional crew commands or briefing type.

Table 15: Descriptive statistics for ratings of extent to which cabin crew instructions assisted during the evacuation (question 16), by briefing type and crew instructions

Boeing 737 Evacuations	Additional tactile commands		No additional crew commands	
	Mean	*SD*	*Mean*	*SD*
Active briefing	2.24	1.53	2.58	1.59
Passive briefing	2.46	1.73	2.32	1.44

Table 16: Descriptive statistics for ratings of extent to which cabin crew gestures assisted during the evacuation (question 17), by briefing type and crew instructions

Boeing 737 Evacuations	Additional tactile commands		No additional crew commands	
	Mean	*SD*	*Mean*	*SD*
Active briefing	3.99	2.15	3.91	2.07
Passive briefing	4.36	2.18	4.22	1.96

Finally, participants were asked to rate their level of confidence while evacuating the cabin (question 27). The response format was a seven-point scale, where 1 was very confident and 7 was not at all confident. Hence, a lower rating indicated increased confidence in evacuating the cabin. Descriptive statistics are provided in Table 17, and the ANOVA results appear in Table 18.

Table 17: Descriptive statistics for ratings of confidence in evacuating the cabin (question 27), by briefing type and crew instructions

Boeing 737 Evacuations	Additional tactile commands		No additional crew commands	
	Mean	*SD*	*Mean*	*SD*
Active briefing	2.56	1.31	2.52	1.26
Passive briefing	3.13	1.57	2.91	1.53

Table 18: ANOVA results for ratings of confidence in evacuating the cabin (question 27), by briefing type and crew instructions

Source	Sum of squares	df	Mean square	F	p
Main effects					
Tactile commands	1.38	1	1.38	0.68	0.41
Type of briefing	17.55	1	17.55	8.72	<0.05
Interaction					
Commands x briefing	0.60	1	0.60	0.30	0.59
Error	615.97	306	2.01		
Total	3027.00	310			

The results in Table 18 indicate that participants in the active briefing evacuations reported a higher level of confidence in evacuating the cabin, compared with participants in the passive briefing condition. The crew instructions did not have a statistically significant effect on confidence ratings.

3.2.6 Effect of dual-lane flow commands and visibility

Tests of the effect of dual-lane flow commands and visibility were conducted in the Large Cabin Evacuation Simulator (LCES). The dual-lane flow independent variable had two levels: dual-lane flow commands provided by the cabin crew, or no dual-lane flow commands provided by the cabin crew. The visibility independent variable also had two levels: high crew visibility (half-height bulkhead) and low crew visibility (full-height bulkhead).

As with the Boeing 737 trials, it was acknowledged at the outset that the most useful data would probably be obtained from the post-evacuation questionnaires, since this would allow the effectiveness of the cabin crew commands and gestures to be evaluated from the passengers' perspectives. However, evacuation data were extracted from the video footage, in order to see whether the independent variables had any effect on participants' evacuation times. Descriptive statistics of evacuation times from the LCES, under each test condition, are provided in Table 19. These values were calculated based on the two evacuations in each condition.

Table 19: Descriptive statistics for evacuation times in LCES evacuation trials, by dual-lane flow command and visibility (evacuation times are given in seconds)

LCES Evacuations	High visibility (half-height bulkhead)		Low visibility (full-height bulkhead)	
	Mean	*SD*	*Mean*	*SD*
Dual-lane flow	20.34	3.82	21.28	3.97
No flow commands	19.52	3.44	20.13	3.43

As can be seen, there are differences between mean evacuation times within each condition. To assess whether these differences were statistically significant, a 2x2 factorial ANOVA was conducted on the data. The results are shown in Table 20.

Table 20: ANOVA results for evacuation times in LCES evacuation trials, by dual-lane flow command and visibility

Source	Sum of squares	df	Mean square	F	p
Main effects					
Dual-lane commands	75.87	1	75.87	5.62	0.02
Visibility (bulkhead)	47.06	1	47.06	3.48	0.06
Interaction					
Commands x briefing	2.16	1	2.16	0.16	0.69
Error	4159.91	308	13.51		
Total	133134.24	312			

The results in Table 20 show that there was a significant main effect of the dual-lane flow commands, although the main effect for visibility just failed to reach significance. Participants evacuating without dual-lane flow commands were significantly quicker than participants evacuating with dual-lane flow commands. Participants evacuating in high-visibility conditions (with half-height bulkheads) were not significantly faster than participants evacuating with low visibility (full-height bulkheads). The interaction term was not statistically significant.

Data from the post-evacuation questionnaires provided information on the passenger experience of these evacuations, although not all questions were relevant to the LCES trials.

Questions 6 to 10 asked participants to rate the difficulty in various evacuation tasks: undoing the seat belt, moving out of the seat, moving down the main aisle, finding an open door, and moving through the exit. The response format was a seven-point scale, where 1 was very easy and 7 was very difficult. Hence, a low score indicated that the task was rated as less difficult. There were no significant differences between conditions for the difficulty of undoing the seatbelt (question 6), in finding an open door (question 9), or for moving through the exit (question 10). However, there were significant differences between conditions for ratings of the difficulty of moving out of the aircraft seat (question 7, results in tables 21 and 22), and for moving down the main aisle (question 8, results provided in tables 23 and 24).

Table 21: Descriptive statistics for ratings of difficulty moving out of the seat (question 7), by dual-lane command and visibility

LCES Evacuations	High visibility (half-height bulkhead)		Low visibility (full-height bulkhead)	
	Mean	*SD*	*Mean*	*SD*
Dual-lane flow	1.80	1.02	2.27	1.38
No flow commands	2.03	1.23	2.18	1.37

A 2x2 ANOVA was conducted to assess whether the observed differences in Table 21 were statistically significant. The results, shown in Table 22, indicate that there was a significant main effect of visibility – participants in the high-visibility conditions reported that moving out of their seats was significantly easier.

Table 22: ANOVA results for difficulty ratings of moving out of the seat (question 7), by dual-lane command and visibility

Source	Sum of squares	df	Mean square	F	p
Main effects					
Dual-lane commands	0.34	1	0.34	0.21	0.65
Visibility (bulkhead)	7.55	1	7.55	4.74	0.03
Interaction					
Commands x briefing	1.90	1	1.90	1.19	0.28
Error	484.72	304	1.59		
Total	1816.00	308			

Table 23: Descriptive statistics for ratings of difficulty moving down main aisle (question 8), by dual-lane command and visibility

LCES Evacuations	High visibility (half-height bulkhead)		Low visibility (full-height bulkhead)	
	Mean	*SD*	*Mean*	*SD*
Dual-lane flow	2.16	1.32	2.48	1.47
No flow commands	2.26	1.20	2.78	1.72

A 2x2 ANOVA was conducted to assess whether the observed differences in Table 23 were statistically significant. The results, shown in Table 24, indicate that there was a significant main effect of visibility – participants in the high-visibility conditions reported that moving along the main aisle was significantly easier.

Table 24: ANOVA results for difficulty ratings of moving down the main aisle (question 8), by dual-lane command and visibility

Source	Sum of squares	df	Mean square	F	p
Main effects					
Dual-lane commands	30.04	1	3.04	1.46	0.23
Visibility (bulkhead)	13.76	1	13.76	6.62	0.01
Interaction					
Commands x briefing	0.77	1	0.77	0.371	0.54
Error	631.45	304	2.08		
Total	2451.00	308			

Question 16 asked participants to rate the extent to which the verbal instructions provided by the cabin crew assisted in the evacuation. Ratings were provided on a seven-point scale, where 1 was very helpful and 7 was not at all helpful. The descriptive statistics are shown in Table 25. An ANOVA conducted on these data showed that the differences were not statistically significant. Hence, ratings of the helpfulness of cabin crew instructions did not differ according to the provision of dual-lane flow commands or the level of visibility.

Table 25: Descriptive statistics for ratings of extent to which cabin crew instructions assisted during the evacuation (question 16), by dual-lane command and visibility

LCES Evacuations	High visibility (half-height bulkhead)		Low visibility (full-height bulkhead)	
	Mean	*SD*	*Mean*	*SD*
Dual-lane flow	2.31	1.44	2.70	1.91
No flow commands	2.29	1.64	2.36	1.65

Question 17 asked participants to rate, on a seven-point scale where 1 was very helpful and 7 was not at all helpful, the extent to which the gestures (e.g. pointing) of the cabin crew assisted during the evacuation. The descriptive and inferential statistics are shown in Table 26 and 27 respectively.

Table 26: Descriptive statistics for ratings of extent to which cabin crew gestures assisted during the evacuation (question 17), by dual-lane command and visibility

LCES Evacuations	High visibility (half-height bulkhead)		Low visibility (full-height bulkhead)	
	Mean	*SD*	*Mean*	*SD*
Dual-lane flow	2.65	1.56	3.33	1.87
No flow commands	3.08	1.87	3.29	1.86

Table 27: ANOVA results for ratings of extent to which cabin crew gestures assisted during the evacuation (question 17), by dual-lane command and visibility

Source	Sum of squares	df	Mean square	F	p
Main effects					
Dual-lane commands	2.88	1	2.88	0.90	0.34
Visibility (bulkhead)	15.18	1	15.18	4.74	0.03
Interaction					
Commands x briefing	4.32	1	4.32	1.35	0.25
Error	976.22	305	3.20		
Total	3944.00	309			

As can be seen in Table 27, there was a significant effect of visibility. Participants rated cabin crew gestures as significantly less useful in the low-visibility (full-height bulkhead) conditions.

Finally, question 27 asked participants to rate their level of confidence in evacuating the LCES, using a seven-point scale where 1 was very confident and 7 was not at all confident. The descriptive statistics for these ratings are provided in Table 28. Inferential testing (a 2x2 ANOVA) indicated that the differences between these means were not statistically significant.

Table 28: Descriptive statistics for ratings of confidence in evacuating the cabin (question 27), by dual-lane command and visibility

LCES Evacuations	High visibility (half-height bulkhead)		Low visibility (full-height bulkhead)	
	Mean	*SD*	*Mean*	*SD*
Dual-lane flow	1.97	1.11	2.14	1.36
No flow commands	2.15	1.02	2.33	1.12

4 DISCUSSION

First and foremost, the project was completed successfully, indicating that the international collaboration between Cranfield University and Virgin Blue had been effective. The project enabled a Cranfield University MSc student and a member of aviation safety staff at Virgin Blue to gain real-world experience of the nature of passenger safety and evacuation research. Further, operators from Australia, Asia and one from the UK participated during the program, allowing the sharing of safety-related information among operators, and the discussion of experience and best practice. The project culminated with an evacuation experiment conducted at Cranfield University in the United Kingdom, in which all trials were successfully completed and valuable knowledge of passenger management gained. The fulfilment of these aims provides an indication of what can be accomplished via the ATSB Aviation Safety Research Grant Program, through genuine collaboration and the desire to seek continuous safety improvements.

More specifically, the results from Phase I have provided a broad view of the wide range of practices and commands in use by operators. Discussions at the best practice forum, initiated and conducted via the Australian Society of Air Safety Investigator's Asia Pacific Cabin Safety Working Group, raised a number of issues. First was the extent to which cabin crew were able to use non-prepared commands on a situation-specific basis, to better encourage appropriate passenger responses in a range of safety-related situations. Clearly, cabin crew are likely to benefit from being able to tailor commands and responses as the situation unfolds, and they are also able to evaluate their instructions and respond accordingly. However, this flexibility should also be supported by a range of 'back-up' commands and procedures, to ensure that the confidence and ability to respond appropriately is additional to well-trained and practised commands, and not a substitute for them. This is because the research literature on learning, training and human performance clearly shows that practise is required for skill acquisition and retention (Buckley & Caple, 2000).

As with results reported by Johnson (1998), operators had several commands for the brace position, including 'Brace, brace', 'Heads down, stay down' and 'Heads down, feet back'. On the questionnaires completed as part of Phase II of the research, passengers reported that they would expect passengers to understand commands such as 'Hug your knees', 'Arms crossed at shoulders', 'Please place your head between your legs' and 'Get down, get down'. Clearly, passengers do not necessarily expect to hear 'Brace, brace', and neither do they necessarily appreciate what this actually means. Hence, commands that include specific instructions on *how* to adopt the position would be of use. For example, 'Heads down, feet back' gives clear information on how to comply with the instruction.

A similar issue arose with regard to the instructions for donning and inflating lifejackets. However, it is somewhat more difficult to find a short and concise command that accurately describes what to do, as donning the lifejacket, but not inflating it until evacuating, is a more complex scenario. One suggestion received was 'Put on lifejacket. Do not inflate. Remain seated. Inflate on exit'. This seems a reasonable suggestion, although it may be difficult to coordinate the command between cabin crew members without causing confusion. A number of operators reported in Phase I that they did use commands similar to this, with 'Lifejackets under seat', 'Fit lifejackets' and 'Do not inflate yet'. The key issue appears to be communicating to passengers that they should not inflate the lifejacket until they actually evacuate.

The commands reported for leaving all luggage behind in Phase I were similar, although again there was some variation. Operator commands included ‘Leave everything behind’, ‘Leave all hand baggage behind’ and ‘No baggage’. Passengers stated in Phase II of the research that commands to leave luggage behind should emphasise the dangers of not doing so: ‘Basically, they need to emphasise the importance of leaving these things by giving the potential danger description’. Some passengers suggested that the life/luggage trade-off could be made explicit in the command, such as ‘Save your life before your luggage’, and/or ‘Taking luggage will cost lives’. Further, as it can be extremely difficult for cabin crew to take any action once passengers have reached the exit with luggage, the instruction should also be included within the pre-flight safety briefing. The commands used in an actual evacuation situation should be consistent with the terminology used in the pre-flight safety briefing.

The introduction to the pre-flight safety briefing was also an issue explored in the current work. In Phase I, operators were asked whether they used an introductory statement to attract passengers’ attention to the pre-flight safety briefing. Phrases such as ‘It is important that you are familiar’ and ‘We ask for your full attention’ were cited by several operators. However, passengers reported that the introduction to the safety briefing should be more explicit. Examples included stating that to reduce the risk of injury or death in an accident, it was important for passengers to pay full attention, or that listening to the briefing could save lives. It is accepted that operators may be reluctant to use such frank phrasing in safety briefings, due to concerns that it may alarm passengers or cause those with a fear of flying to become unduly anxious. However, passengers themselves report that they would prefer to have the critical nature of the information emphasised, and hence operators should ideally seek to strike a better balance between a frank introduction and the euphemistic phrasing currently used. As one passenger put it ‘Perhaps drop the “comfort” – it’s for safety so just say so!’.

As well as exploring passenger expectations of cabin crew commands, Phase II included experimental evacuation trials to evaluate crew commands and procedures. Trials were conducted in both the Boeing 737 and the Large Cabin Evacuation Simulator at Cranfield University. In the Boeing 737, two experimental variables were selected for research. Firstly, the pre-flight safety briefing was either active or passive. In the active safety briefing, cabin crew actively engaged passengers in the briefing, requiring them to point out exits, count seat rows to the nearest exits forward and behind their seats, and adopt the brace position. The second variable of interest was the provision of additional, situation-specific commands from the cabin crew during the evacuation. With regard to additional commands, these are likely to have most benefit in situations where evacuating is particularly difficult, such as where visibility is poor. Hence, all trials in the Boeing 737 cabin took place in conditions of low visibility, where only limited floor proximity lighting was available.

It was not anticipated that there would be a large effect on evacuation times, because the cabin crew were acting in an assertive manner throughout all evacuations. Hence, any observed differences in evacuation times were likely to be small. However, there were some interesting effects of the active safety briefing. Firstly, participants rated this as significantly more helpful than the passive safety briefing. Participants who received the active safety briefing also stated that it would be significantly more helpful in a genuine emergency situation. With regard to the performance of the evacuation itself, passengers in the active safety briefing conditions reported finding it significantly easier to find an exit. There was also a significant interaction here; passengers given additional tactile commands from the cabin crew reported greater ease in finding an exit, but only when they had also received an

active briefing. The active safety briefing also resulted in passengers finding it significantly easier to move through the exit itself, and to use the evacuation slide. Passengers reported significantly lower levels of confidence in evacuating the cabin if they had received the passive briefing. Hence, while the active safety briefing did not significantly reduce evacuation times, it was generally associated with a significantly easier evacuation process.

It must be noted that the active briefing used here contained much the same information as the passive briefing. The difference was in the level of interaction generated during the briefing. In the active safety briefing conditions, cabin crew engaged with the passengers, encouraging full participation in the tasks (which included pointing out the exits, counting the number of seat rows forward and aft to the nearest exit, and adopting the brace position). This level of activity did not require the tasks to be practised as such, but it did seem to simulate the requirements of a practice session, in that participants presumably had to verbalise what was required, and mentally rehearse this, as well as physically pointing or carrying out the requirements. The cognitive psychology literature would suggest that this deeper level of engagement with the briefing, and the simulated practice, would provide for superior storage of the information in memory, and better retrieval in an emergency situation. While it may not be possible to have cabin crew encourage the level of engagement trialled within this experiment, operators would nevertheless be well advised to make safety briefings as active, and as interactive, as possible. This should be combined with a frank introduction, clearly stating the importance of the safety information.

Trials in the Large Cabin Evacuation Simulator also investigated two independent variables. These were the effect of dual-lane flow commands on evacuations, and also the level of visibility through the bulkheads at Type A exits. To take each in turn, dual-lane flow commands are often used in wide-bodied aircraft evacuations, to achieve the double flow of 70 passengers per lane per minute on escape slides (FAA, 1990). The second independent variable of interest was the level of visibility at the bulkhead. The bulkheads were either at half height (high visibility, since participants could then see the cabin crew at the exits), or full height (low visibility, since the view of the cabin crew at the exits was obscured). These trials included an exit redirection, to allow for the independent variables to be tested under a more demanding evacuation protocol.

The results showed that participants evacuating in trials with dual-lane flow commands were significantly slower than participants evacuating in trials without dual-lane flow commands. This result was not expected, since dual-lane flows have been shown to increase evacuation rates in other settings (for example, Full Scale Evacuation Demonstrations of the Boeing 777, Damski & Richardson, 1997). Closer inspection of the video tapes revealed that the dual-lane flow commands were difficult for passengers to follow, as there was not sufficient space in the main aisles. The cabin crew did not instruct passengers to come forward and queue along the wider cross aisle, and hence there was little scope for passengers to comply with the commands. In addition, evacuations from the LCES were on to platforms, rather than escape slides. Hence, it was possible for passengers to mass through the exits in a disorganised fashion when they were not in dual-lane flows – this would not have been possible had slides been used. The cabin crew in the current trials reported that the passengers did seem to be more organised with the dual-lane flow commands, and were generally more manageable. It is worth noting that the current trials involved only 40 passengers evacuating from the upper deck – with a larger group of passengers, the disorganisation evident in non dual-lane flow evacuation would have been more pronounced.

There was no significant effect of visibility on evacuation times. However, there were some interesting effects evident within the post-evacuation questionnaire data. For example, participants in the high-visibility conditions (that is, with the half-height bulkhead), reported finding it significantly easier to move out of their seat, and to move down the main aisle to reach an exit. It is possible that participants rated these tasks as significantly easier because they could actually see the cabin crew and see the exits – hence they had somewhere to aim for as they began their evacuation. This is supported by the fact that participants in the high-visibility condition reported cabin crew gestures as being significantly more useful. This may have been the case because of the situation – the exit redirection required crew to use additional gestures to point to the usable exit. However, it is more likely that even without the exit direction this would have been the case, and hence the result can be generalised. This is because non-verbal communication, such as eye contact and physical gestures, is a significant component in effective communication. These components of the message are lost to passengers when cabin crew are screened behind bulkheads.

Overall, both the best practice forum and the experimental trials have provided extremely useful information on passenger management issues, in both evacuations and other safety-related situations. There is a wide range of commands in use for optimal passenger management, and this is likely to remain the case. However, this research has shown there are a number of factors that could improve passenger responses to emergency situations. Further, cabin crew who are equipped with procedures and commands, which have been designed to take into account these passenger factors, are more likely to be able to deal with these situations optimally.

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APPENDIX A: PHASE I QUESTIONNAIRE

Cranfield UNIVERSITY

CRANFIELD UNIVERSITY & VIRGIN BLUE

EVACUATION COMMANDS FOR OPTIMAL PASSENGER MANAGEMENT

Cranfield University and Virgin Blue have been awarded a research grant by the Australian Transport Safety Board to investigate strategies for optimal passenger management in evacuation situations. The researchers hope to be able to provide some guidelines on best practice in evacuation commands and techniques, and the results of the research will be fed back to operators via the Asia Pacific Cabin Safety Working Group.

The aim of this questionnaire is to ask for some background information on the evacuation training and safety policies/procedures within your airline. We are interested in learning about the specific commands and instructions your cabin crew are trained to use in land evacuations or a ditching. We would also be interested in any recent evacuation incidents within your airline, especially if these provided an opportunity to test current commands and procedures! For example, you may be aware of instances where the cabin crew had to use their initiative and judgement to manage passengers more effectively.

We do intend to thank all contributors by name within the report, however, if you would prefer that your airline remained un-named, simply tick the appropriate box on the last page of the questionnaire. Please be assured that the information you provide will only be used for research to improve aviation safety. Even if you provide your name and/or the name of your company, we will ensure that specific airlines are not identified in the results. The results of this questionnaire survey will be used to design an evacuation experiment to be conducted at Cranfield University in the United Kingdom. The contribution you make could help to improve passenger management in emergency situations.

If you have any questions or queries about this research, please do not hesitate to contact one of the researchers, Lauren Thomas or Sophie O'Ferrall. Our contact details are provided below.

Many thanks for your assistance with this important research.

Sophie O'Ferrall

Cabin Standards Officer

Virgin Blue Airlines, Australia

Lauren Thomas

Human Factors Group

Cranfield University, England

Section A: Cabin crew training

Initial Training

1. Please provide an indication of the topics included in the **classroom facilitation** of **land/ditching** evacuations during **initial training**, including planned and unplanned evacuations. Please tick **all** that apply.

a.	Preparing the cabin for an emergency landing	☐
b.	Preparing the passengers for an emergency landing & evacuation	☐
c.	Identifying and briefing Able Bodied Passengers for assistance	☐
d.	Location of emergency & evacuation equipment	☐
e.	Making safety related announcements	☐
f.	Safety demonstrations (e.g. seat belts, brace position, lifejackets)	☐
g.	Initiating the evacuation (e.g. who, how, when)	☐
h.	Door operations	☐
i.	Slide packs and manual operation in case of failure	☐
j.	Managing passenger behaviour in emergency situations	☐
k.	Cabin crew stations/locations	☐
l.	Cabin crew responsibilities	☐
m.	Personal safety & survivability	☐
n.	CRM Skills (e.g. communication, assertion, leadership)	☐
o.	Cabin crew commands to use for brace & evacuation	☐
p.	Use of slides/slide rafts/life rafts	☐
q.	Managing passengers after evacuation (land & water)	☐

2. Please provide an estimate of the classroom time spent on **land/ditching** evacuations for **initial training** of cabin crew.

_____

3. Please provide an indication of practical activities which cabin crew practise **in a trainer or cabin simulator** during **initial training**. The list of activities includes **land/ditching** evacuations for both planned and unplanned evacuations. Please tick **all** that apply.

a.	Securing all equipment/items within the cabin	☐
b.	Briefing passengers for a planned evacuation	☐
c.	Identifying and briefing Able Bodied Passengers for assistance	☐
d.	Accessing emergency & evacuation equipment from stowage	☐
e.	Demonstrating the use of seat belts	☐
f.	Demonstrating the brace position	☐
g.	Demonstrating the use of lifejackets	☐
g.	Operating the exit/slide	☐
h.	Preparing concerned/difficult passengers (e.g. role-play)	☐
i.	Role-play evacuation (e.g. assertive commands, passenger flow)	☐
j.	Evacuations in presence of non-toxic smoke	☐
k.	Using slide rafts/life rafts (e.g. launch, securing cover etc)	☐
l.	Use of an evacuation slide	☐
m.	CRM Skills (e.g. communication, assertion, leadership)	☐

4. Please provide an estimate of the time spent in a cabin trainer/simulator practising **land/ditching** evacuations for the **initial training** of cabin crew.

_____

Recurrent Training

5. Please provide an indication of the topics included in the **classroom facilitation** of **land/ditching** evacuations during **recurrent training**, including planned and unplanned evacuations. Please tick **all** that apply.

a.	Preparing the cabin for an emergency landing	☐
b.	Preparing the passengers for an emergency landing & evacuation	☐
c.	Identifying and briefing Able Bodied Passengers for assistance	☐
d.	Location of emergency & evacuation equipment	☐
e.	Making safety related announcements	☐
f.	Safety demonstrations (e.g. seat belts, brace position, lifejackets)	☐
g.	Initiating the evacuation (e.g. who, how, when)	☐
h.	Door operation	☐
i.	Slide packs and manual operation in case of failure	☐
j.	Managing passenger behaviour in emergency situations	☐
k.	Cabin crew stations/locations	☐
l.	Cabin crew responsibilities	☐
m.	Personal safety & survivability	☐
n.	CRM Skills (e.g. communication, assertion, leadership)	☐
o.	Cabin crew commands to use for brace & evacuation	☐
p.	Use of slides/slide rafts/life rafts	☐
q.	Managing passengers after evacuation (land & water)	☐

6. Please provide an estimate of the classroom time spent on **land/ditching** evacuations for **recurrent training** of cabin crew.

_____

7. Please provide an indication of practical activities which cabin crew practise in a **trainer or cabin simulator** during **recurrent training**. The list of activities includes **land/ditching** evacuations for both planned and unplanned evacuations. Please tick **all** that apply.

a.	Securing all equipment/items within the cabin	☐
b.	Briefing the passengers for a planned evacuation	☐
c.	Identifying and briefing Able Bodied Passengers for assistance	☐
d.	Accessing emergency & evacuation equipment from stowage	☐
e.	Demonstrating the use of seat belts	☐
f.	Demonstrating the brace position	☐
g.	Demonstrating the use of lifejackets	☐
g.	Operating the exit/slide	☐
h.	Preparing concerned/difficult passengers (e.g. role-play)	☐
i.	Role-play evacuation (e.g. assertive commands, passenger flow)	☐
j.	Evacuations in presence of non-toxic smoke	☐
k.	Using slide rafts/life rafts (e.g. launch, securing cover etc)	☐
l.	CRM Skills (e.g. communication, assertion, leadership)	☐

8. Please provide an estimate of the time spent in a cabin trainer/simulator practising **land/ditching** evacuations for **recurrent training** of cabin crew.

_____

Section B: Passenger evacuation procedures and policies

9. Do your company policies or operating procedures require the passenger pre-flight safety briefing to include a statement about **why** passengers need to pay attention? If so, please provide that statement here.

_____
_____
_____

10. Do your company policies or operating procedures require any of the following for passengers seated in the Type III exit rows? Please tick **all** that apply.

a.	Not applicable - company does not operate aircraft with Type III (over-wing) exits	
b.	Company requires check-in staff to screen exit row passengers for physical suitability to sit at an emergency exit	
c.	Company requires check-in staff to inform passengers that they are seated in an emergency exit row	
d.	Check-in staff are required to inform the passenger that they may be required to operate the emergency exit and confirm they are comfortable to do so	
e.	Company requires cabin crew to check that exit row passengers are physically suitable to sit in an emergency exit row	
f.	Cabin crew are required to instruct passengers to stow baggage in lockers and not beneath the seats in the exit row	
g.	Cabin crew are required to instruct passengers that they are seated in an exit row and may have to operate the exit	
h.	Cabin crew are required to warn passengers to check for fire/obstructions before operating the Type III exit	
i.	Cabin crew are required to instruct passengers to read the seat back placard and/or safety instruction card regarding exit operation	
j.	Cabin crew are required to outline the operation of the exit to passengers, including the location of handles and manual/automated hatch disposal	
k.	Cabin crew are required to advise passengers that they will exit onto the wing, and will need to use the slide or jump to the ground	

11. Do your company policies or operating procedures require any of the following for passengers in Type III exit rows for aircraft with **conventional (manual) disposal**? Please tick **all** that apply.

a.	Not applicable - no aircraft with Type III hatches, or all aircraft with Type III exits have automatic hatch disposal	
b.	Cabin crew are required to inform passengers that the hatch is not hinged, and is separate from the airframe	
c.	Cabin crew are required to inform passengers of the weight of the hatch in pounds/kilograms.	
d.	Cabin crew are required to inform passengers of the weight of the hatch in terms of similarity, eg weighs as much as a heavy suitcase	

12. Do your company policies or operating procedures require cabin crew to do any of the following, **during boarding**? Please tick **all** that apply.

a.	Cabin crew are required to identify passengers who may be suitable for helping in emergency situations	☐
b.	Cabin crew are required to note the seat locations of passengers who may require additional emergency assistance in an emergency (e.g. passengers with disabilities and unaccompanied minors)	☐
c.	Identify and offload any hand luggage that does not meet the company requirements	☐

13. Do your company policies or operating procedures require cabin crew to do any of the following, **in the event of an emergency**? Please tick **all** that apply.

a.	Cabin crew are required to identify passengers who may be suitable for helping in emergency situations	☐
b.	Cabin crew are required to note the seat locations of passengers who may require additional emergency assistance in an emergency (e.g. passengers with disabilities and unaccompanied minors)	☐
c.	Cabin crew are required to place passengers with reduced mobility (e.g. passenger with leg in a plastercast) away from the exit rows and exits	☐
d.	Cabin crew are required to place infants in child seats, or parents with infants on their lap at the window, rather than seats in the main aisles	☐

14. If your company policies and procedures require cabin crew to make use of Able Bodied Passengers (ABPs) for assistance in planned emergencies, what types of tasks might an ABP be responsible for in **planned emergency situations**? Please tick **all** that apply.

a.	ABPs may be informed of the slide arming/disarming mechanism on the exits, and how to manually operate slides in case of failure	☐
b.	ABPs may be requested to assist with leading passengers onto slide rafts/life rafts, and to manage other passengers on the rafts	☐
c.	ABPs may be required to exit the aircraft first in land evacuations, to hold the base of slide to the ground and to keep the base of the slide clear	☐
d.	ABPs may be informed of the location of emergency equipment, and be expected to use it if appropriate/as required	☐

Commands

Please complete the table below

Desired Instruction to Passengers	**Command** (Please write out command)	**Are these commands mentioned in the standard safety briefing (Yes/No)?**	**Are these commands mentioned in the on the safety instruction card (Yes/No)?**	**Are these commands mentioned in the emergency safety briefing during a planned evacuation (Yes/No)?**
15. What commands are cabin crew required to use to instruct passengers to brace immediately?				
16. What commands are cabin crew required to use to instruct passengers to **reach** for their lifejackets?				
17. What commands are cabin crew required to use to instruct passengers to **don** their lifejackets (i.e place over head, don't inflate yet)?				
18. What commands are cabin crew required to use to instruct passengers to open the Type III Exits? (If not applicable write N/A)				
19. What commands are cabin crew required to use to instruct passengers to unfasten their seat belts?				
20. What commands are cabin crew required to use to instruct passengers to move towards the exits (i.e. exits being opened, slides deploying)?				

Desired Instruction to Passengers	**Command** (Please write out command)	**Are these commands mentioned in the standard safety briefing (Yes/No)?**	**Are these commands mentioned in the on the safety instruction card (Yes/No)?**	**Are these commands mentioned in the emergency safety briefing during a planned evacuation (Yes/No)?**
21. What commands are cabin crew required to use to instruct passengers to leave behind personal belongings and hand luggage?				
22. What commands are cabin crew required to use to instruct passengers to move through the exits and use the slides (i.e. remove shoes, fold arms, jump)?				
23. What commands are cabin crew required to use in an unplanned evacuation to instruct ABPs for assistance?	Land Evacuation: (e.g. Stay at the bottom, Hold slide) Ditching: (e.g. Move people to the back)			
24. What commands are cabin crew required to use to manage guests who aren't following crew commands?				

Section C: Evacuation incidents in your airline

25. If there are any comments you would like to make regarding evacuation and passenger management, please provide them here. We would be particularly interested to hear of any changes to training, policy or procedures in the light of learning from incidents.

_____
_____
_____
_____
_____
_____
_____
_____

26. If you could make available any training syllabi, cabin crew manuals, announcement scripts or safety cards for this research, it would be much appreciated. Please feel free to forward any such documents to Sophie O'Ferrall with your completed questionnaire.

Section D: Your organisation

This information is required for background information only.

27. Please indicate which aircraft types your airline operates.

a.	Boeing 737	☐
b.	Boeing 757	☐
c.	Boeing 767	☐
d.	Boeing 777	☐
e.	Boeing 747	☐
f.	Airbus A300	☐
g.	Airbus A319	☐
h.	Airbus A320	☐
i.	Airbus A321	☐
j.	Airbus A330	☐
k.	Airbus A340	☐
l.	MD11	☐
	Other (please specify)_____	☐
	Other (please specify _____	☐
	Other (please specify) _____	☐

28. In order that we know which airlines have participated, please tell us the name of the organisation you work for.

_____

If you would prefer not to be named in the acknowledgements, please tick here:_____

Thank you for participating in this research. Please ensure that the completed questionnaire, along with any documentation which you are able to make available, is returned by 20 December 2004.

APPENDIX B: CABIN SIMULATOR LAYOUTS

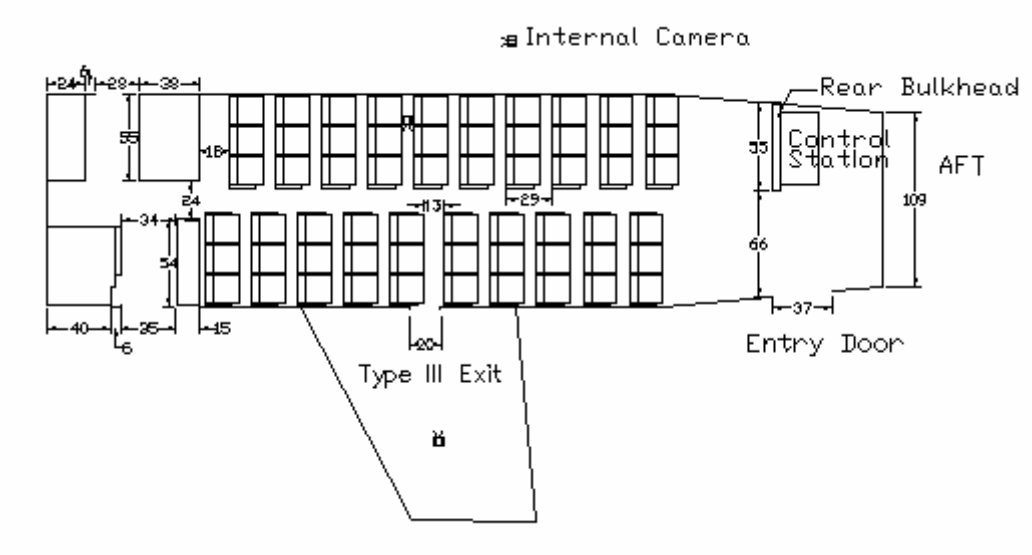


Diagram of the Boeing 737 cabin simulator; dimensions for the tests reported may vary from those shown above.

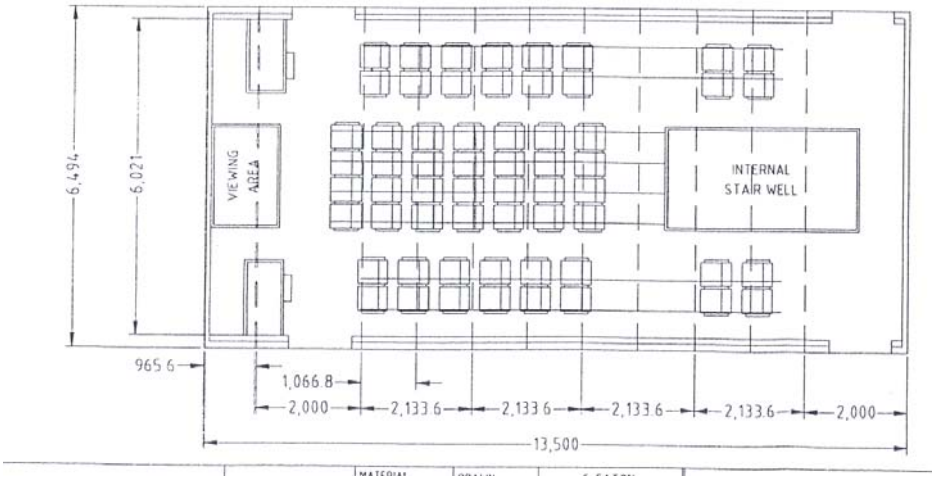


Diagram of the upper deck of the Large Cabin Evacuation Simulator; dimensions for the tests reported may vary from those shown above.

APPENDIX C: COPY OF RECRUITING ADVERT AND LETTER

Cranfield UNIVERSITY

✈ Earn £20 cash! ✈

Aircraft Cabin Evacuation Trials

The Human Factors Group at Cranfield University is recruiting volunteers to take part in a series of evacuations from an aircraft cabin simulator.

Volunteers will be required on *one* occasion for approximately 3½ hours, and will undertake 4 evacuations. Some of the evacuations may be conducted in

low level lighting, and may include the use of a small emergency slide.

An attendance payment of £20 will be given to all those who participate. Volunteers must be aged 20 - 50. Volunteers must also be normally fit and healthy as some people could find the trials physically demanding.

There are several dates available: the evenings of 19 April, 21 April,

26 April and 28 April. All sessions will start between 6.00-6.30pm.

For further information, or to book a seat, please contact the Human Factors Group at Cranfield University on 01234 750 111

Cranfield,

Bedfordshire.

MK43 0AL.

Telephone: 01234 750 111

Dear

Thank you for volunteering to take part in the cabin evacuation trials which are to take place on the evening of 19 April 2005. To ensure that the trials run smoothly, it is essential that you arrive at Hangar 3 (Building 83, School of Engineering), between 6.00 and 6.30pm.

All volunteers must be between the ages of 20 and 50, be normally fit and healthy, and not excessively overweight. The trials may be physically demanding, so please do not take part if you have any history of the following illnesses: heart disease, high blood pressure, fainting or blackouts, diabetes, epilepsy or fits, deafness, chronic back pain, ankle swelling, depression, anxiety, other nervous/psychiatric illnesses, fear of enclosed spaces, fear of heights, fear of flying, brittle bones, asthma, bronchitis, breathlessness, chest trouble, allergy, lumbago sciatica, or any other serious illness. Additionally, women who are pregnant, or who think they may be pregnant, should not take part. Prior to the evacuation you will be asked to complete a medical questionnaire. You may be asked to see the doctor or nurse for a brief medical examination if you have had a recent leg or ankle injury, recent surgery, or are currently receiving medical treatment.

We will require you to take part in four evacuations during the evening. Some evacuations may take place in low level lighting, and you may also be required to use an emergency slide. All volunteers will be paid £20 for attending the session.

Your safety is of the utmost importance. Please ensure that you **wear trousers, long sleeve tops and trainers or flat pumps and socks.** Please do not wear earrings which may come loose, or which may get caught on clothing. It is not advisable to wear spectacles during the actual evacuations. Coats and bags will not be allowed on the aircraft, although we will provide a secure, supervised area in which they may be left.

Please ensure that you have read and completely understand this information, as you will be asked to sign a form to confirm your agreement to participate in the trials. Please do not hesitate to contact us if you have any queries about the information which has been supplied. Also, **we would be most grateful if you could let us know if you are no longer able to participate**.

Again, thank you for volunteering. We look forward to seeing you on 19 April at 6.00pm.

Human Factors Group

APPENDIX D: VOLUNTEER INFORMATION SHEET

It is essential that you read this document carefully, and fully understand its contents before completing the Volunteer Consent and Medical Clearance form. If you feel after reading this document that you do not wish to take part, then please do not feel obliged to do so.

1) Health and medical

a) Volunteers must have no history of the following: Heart disease, high blood pressure, fainting or blackouts, diabetes, epilepsy or fits, deafness, chronic back pain, ankle swelling, depression, anxiety, other nervous/psychiatric illnesses, fear of enclosed spaces, fear of heights, fear of flying, brittle bones, asthma, bronchitis, breathlessness, chest trouble, allergy, lumbago sciatica, or any other serious illness.

b) Because the trials may involve use of the evacuation slide(s), volunteers who have had a leg or ankle injury in the last six months must make this known to the nurse. Similarly, all volunteers who are undergoing any medical treatment or who have recently undergone surgery should consult with the nurse before agreeing to participate.

c) Women who are pregnant, or who think they may be pregnant, should not take part.

2) Safety

To ensure the safety of all volunteers, a number of precautions have been taken.

a) If an evacuation of the aircraft is necessary, you may be required to use the emergency slide. In order to ensure your safety while using this slide, it is essential that you are wearing jeans or trousers made from natural fibres, socks and flat fastened shoes or trainers, and a long sleeved top or sweatshirt.

b) The evacuation slide has been fitted with a speed resistant surface to slow passengers down on descent. Support nets have been placed beneath and around the slide. Padded mats have been placed at the bottom of the slide, to ensure that injury is minimised in the event of an accident.

c) To evacuate the aircraft using the slide, you must fold your arms on your chest in front of your body. Move forwards to the sill, and step onto the slide. You must land on the slide on your bottom, keeping your legs straight and out in front of your body. Keep your arms folded on your chest, so that your hands stay clear of the slide. Cabin crew will be available at the exits/slides to instruct and physically assist if necessary. Stewards will be available to assist you in moving away from the base of the slides. When moving through exits, please follow the directions provided by the cabin crew and stewards at all times.

At least two members of the Cranfield research team will be present on the aircraft at all times. Researchers and medical personnel carry alarms, and if you hear an alarm, this is a signal to HALT. This indicates that a problem has occurred, and that the trial has therefore been stopped. If a trial is stopped, you must stop immediately and wait for instructions from the research team.

d) A doctor and/or nurse is on hand, as is a first aider. If you feel the need to consult one of these individuals, please do not hesitate to do so.

3) Payment

Today we will require you to take part in four evacuations. All volunteers will be paid £20 for attending. There are no bonus payments for being the first participants to exit the aircraft. However, it is important that you exit the aircraft as quickly as possible, since there is a need to complete the evacuation in as short a time as possible.

4) Insurance

You are advised that the tests are undertaken at your own risk. The University has arranged personal accident insurance which provides benefit in the event of you sustaining accidental bodily harm. No further claims are admissible, nor shall the University be held liable in the event of any accidental injury or damage outside these benefits.

Scope of Insurance Cover: Accidental Bodily Injury

Temporary Total Disablement, per week	£150
Temporary Total Disablement, where not otherwise gainfully employed, per week	£25
(Maximum 104 weeks)	
Permanent Total Disablement	£100,000
(Other than loss of sight of one or both eyes or loss of one or more limbs)	
Loss of one or more limbs	£100,000
Permanent Total Loss of Sight of One or Two Eyes	£100,000
Death	£100,000

5) Personal Information

a) All personal information that you provide will be treated with the strictest confidence. You have been provided with a volunteer number to ensure that all information you provide remains anonymous. This means that although the information you provide will be used by Cranfield University for research purposes, you will not be personally identifiable by name, age or other personal characteristic.

b) These trials will be video recorded by Cranfield University. The video footage will be used in research to investigate the factors which influence survival in the event of an aircraft emergency. Some of this footage may also be used for promotional purposes. If you take part in these trials, you consent to your image being used in this manner, although any other personal details you provide will of course remain confidential.

c) You are free to withdraw from these trials at any stage during the session. If you wish to do so, then simply inform a member of the research team or the doctor or nurse.

After reading this document carefully, you will be called by Cranfield research staff to be weighed and measured. You should also complete the Volunteer Consent and Medical Clearance form. This will be signed by the doctor or nurse, and you may also have a brief medical.

APPENDIX E: MEDICAL QUESTIONNAIRE AND CONSENT FORM

Volunteer number: _____

Age: _____

Sex: _____

Part A: To be completed by the Cranfield Research Team

Volunteer height: _____ Volunteer Weight:_____

Part B: Your Medical History

It is essential that you answer these questions truthfully and completely. The answers you provide to these questions will be treated with the strictest confidence. However, it may be necessary for you to have a brief medical with a doctor or nurse in order to obtain medical clearance to take part in these trials. To answer, place a tick in the appropriate box.

1. Have you ever experienced any of the following:	**Please tick: No**	**Yes**
a. *Heart disease*		
b. *High blood pressure*		
c. *Fainting or blackouts*		
d. *Diabetes*		
e. *Epilepsy or fits*		
f. *Deafness*		
g. *Chronic back pain*		
h. *Ankle swelling*		
i. *Depression*		
j. *Anxiety*		
k. *Nervous/psychiatric illness*		
l. *Fear of enclosed spaces*		
m. *Fear of heights*		
n. *Fear of flying*		

Have you ever experienced any of the following (cont.)	Please tick: No	Yes
o. *Brittle bones*		
p. *Asthma*		
q. *Bronchitis*		
r. *Breathlessness*		
s. *Chest trouble*		
t. *Allergy*		
u. *Lumbago sciatica*		
v. *Any other serious illness*		
2. Have you experienced an ankle or leg injury in the last six months?		
3. Are you currently receiving medical treatment?		
4. Have you undergone surgery within the last six months?		
5. Is there any possibility that you may be pregnant?		

Part C: Volunteer Consent Declaration

I, _____ (please print your name in block capitals) confirm that I have read and completely and fully understand the "Volunteer Information" provided. I have completed my Medical History details fully and truthfully. I believe my health and fitness are good enough for me to cope with the work involved in the aircraft safety trials which are to take place today. I therefore give my consent to taking part in this research.

Signature_____ Date_____

Part D: Medical Clearance

Evacuation Nurse: _____ Date_____

or

Doctor: _____ Date_____

APPENDIX F: BACKGROUND INFORMATION QUESTIONNAIRE

Volunteer Number: _____

This information will provide us with some background information about you. Please complete as much of this questionnaire as possible – your answers may help to save lives someday!

1. Please could you tell us your date of birth? _____ day/date, _____ month, _____ year.

2. Are you: (please circle one)

a) Male
b) Female

3. What is your highest level educational qualification? (please circle one)

a) None
b) GCSE Grade D/ CSE Grade 2 or below, or equivalent
c) GCSE or O Level Grade C or above or equivalent
d) 'A' Levels or equivalent
e) Higher National Certificate or Diploma, or equivalent
f) Bachelor degree
g) Post-graduate degree

4. Have you participated in an aircraft evacuation test in the last six months? (please circle one)

a) Yes
b) No

5. How often have you ever flown in a commercial aircraft? (please circle one)

a) Never
b) 1-3 return trips
c) 4-7 return trips
d) 8 + return trips

6. How frequently have you made a return trip by commercial aircraft in the last 12 months? (please circle one)

a) Not within the last 12 months
b) 1 - 3 times within the last 12 months
c) 4 - 7 times within the last 12 months
d) 8+ times in the last 12 months

7. If you have flown in a commercial aircraft, have you had to perform an emergency evacuation from the aircraft? (please circle one)

a) Yes
b) No

8. Are you? (please circle one)

a) Left handed
b) Right handed
c) Ambidextrous

9. Do you have corrected vision? (please circle one)

a) No
b) Yes, for seeing things close up (such reading)
c) For seeing things at a distance (such as driving)
d) I have corrected vision for both close and distant work.

10. If you have flown on a commercial aircraft within the last twelve months, did you pay attention to the safety information? (please circle one)

a) Yes, all of it
b) More than half of it
c) Less than half of it
d) None of it

11. If you answered b, c, or d to question 10, why did you not pay attention to the full safety briefing? (please circle one)

a) I was with family or friends, and talking to them
b) I didn't want to look like I hadn't flown before
c) I fly regularly and had seen it before
d) The safety information wouldn't be of any use in a real accident
e) It was all basic knowledge
f) It went on for too long
g) Other (please specify)……..

12. What distance are you able to swim with confidence? (please circle one)

a) I can't swim - I don't like water
b) I can't swim - I have a fear of water
c) I can't swim - I didn't have the opportunities to learn
d) I can confidently swim up to 10 metres (approximately 30 metres)
d) I can confidently swim between 11-20 metres (approximately 31-60 feet)
e) I can confidently swim between 21-40 metres (approximately 61-120 feet)
f) I can confidently swim over 41 metres (approximately 121 feet or more)

13. Airlines use safety briefings to tell passengers important safety information. However, sometimes these safety briefings are not very effective. Please tell us how you would explain the following information to members of the public, using phrases that they would be likely to understand. Remember, this is about the words that you think other people would understand best, and not what you personally would expect to hear in a safety briefing.

a) To encourage passengers to pay attention to the safety information, some airlines use an introductory statement such “For your personal comfort and safety, it is in your own best interests to pay attention to this safety briefing”. What statement do you think the cabin crew could use so that people would understand that it is important to pay attention to the safety briefing?

……

……

……..

b) In a decompression, oxygen masks normally fall automatically from the units above passengers’ seats. Passengers need to put these masks on quickly, and to put on their own mask before assisting other people, because otherwise they may become unconscious. What instructions do you think the cabin crew could include in the safety briefing, so that people would understand this?

……

……

……..

14. Cabin crew are legally required on board an aircraft to manage passengers in an emergency situation. Airlines train cabin crew to use short, positive and assertive commands with passengers. This is because there is not much time to explain things in detail, and cabin crew need to get passengers to respond very quickly. Please think about the commands that you think members of the public would understand in the following emergency situations. Remember, this is about the instructions that you think other people would understand best, not what you would understand.

a) In an emergency landing on water, passengers need to put on their lifejackets before the landing. However, passengers need to stay in their seats, with their seat belts fastened, until the aircraft has landed. Lifejackets should only be inflated as passengers leave the aircraft, because otherwise it may slow down the evacuation. What commands do you think cabin crew could give to members of the public preparing for an emergency landing, so that passengers would understand?

……

……

……..

b) In an emergency landing, passengers may be required to brace themselves for impact to protect themselves against injury. The brace position is normally illustrated on the safety card. What commands could cabin crew use during the emergency landing to make passengers understand that they need to get into, and stay in, the brace position?

……

……

……..

c) In an evacuation, passengers have to leave all hand luggage, duty free purchases, and personal belongings behind. These items can slow down the evacuation and damage the escape slides. What short commands do you think the cabin crew could use in an evacuation to make people leave these items behind?

……

……

……..

d) When evacuating onto slides, passengers wearing high-heeled shoes should take them off to avoid damaging the escape chutes. What short commands do you think the cabin crew could use in an evacuation to make people understand they have to do this?

……

……

……..

e) In some evacuations, certain aircraft doors cannot be used. This is usually because of damage to the door or to the escape slide. What short commands do you think cabin crew should use during an evacuation when a door is not available, to make passengers understand that they will need to find another emergency exit?

……

……

……..

f) Sometimes, evacuations take place in the dark, or in smoke. What short commands could cabin crew use during an evacuation to help passengers find their way to an emergency exit?

……

……

……..

APPENDIX G: PARTICIPANT BRIEFING

Well, OK, this has taken a little bit of time. Can I start by saying thank you very much for coming and helping us, I hope you will enjoy taking part, most people usually do. If for any reason you have any concerns or worries, come and talk to us. Incidentally there are lots of us from the Cranfield team around. Lauren is here, this is her experiment. Tricia, who helped you check in, and we have stewards or marshals all around. The people in the white T-shirts are marshals, and are part of the Cranfield team. We also have two cabin crew, just there, in the Cranfield airways uniforms. If you've got any queries about anything please come and ask one of us. Jackie, the nurse, will be here all the time if you see that you've bumped yourself or whatever, come and ask. What we're going to do is just go through our procedures, so if you could try and do just as we direct you, that would be a great help.

I know this experiment you are taking part in is about aircraft emergencies, but in the event this building had the fire alarm go off, that would not be a fake, that would be a real emergency. So depending on where you are, you will be directed by the Cranfield team where to go to get out of the building. When you get there, if you could organise yourselves into a line, with number 1 at the start of the queue, going through your participant numbers to the back, that way we can quickly check that we have everyone out of the building. Does that make sense?

OK. Now what I want you to do is two things. Firstly, let me tell you a little bit about the background to the work which you are going to take part in, and then I can tell you what is going to happen blow by blow for the rest of the evening.

The background to this is that at Cranfield we have been helping the aircraft industry to improve the probability of passengers surviving accidents for over 20 years. We've done numerous experiments, we have had, I worked out one day, over 12,000 people through tests here. We are actually quite proud of our safety record in that we have only had two relatively minor injuries, and we don't want any tonight. So please don't do anything that you think would put yourself or anyone else at risk. That said, what we are trying to do is work out how we can change things, so that in the event of an aircraft having an accident passengers are more likely to survive.

Accidents occur for all sorts of reasons. In aircraft accidents, loss of life usually occurs if there has been a fire. If there is a fire, there are usually just two minutes between the first spark, and the point where conditions in the cabin becoming unsurvivable. So, you've got to get out fast, and the industry has to enable you to get out fast. What we are doing in these tests is to see what else we can do to help people to get out more quickly. Now, I don't want to tell you now exactly what we are looking at, because that would influence what you might do - you would know what we are looking for. So we'll tell you that afterwards if you are interested! But we can look at all sorts of things, like how we layout the cabin, which way you are able to go, how dark or light it is, all sorts of things. You will find that each of these evacuations it is a bit different.

So that's a bit of background to this. Other reasons why people don't survive accidents are when there is actually a crash and the aeroplane hits the ground, because then you get impact injuries, and I suppose the other reason, more recently, is terrorism. However, there won't be any terrorism tonight, and there won't be any crash impact, but I do want you to imagine how you would feel. What would you do if you were up in an aircraft, and when they tell you to get out, you know it is on fire. I think for most of us, if you know that an aircraft is on fire, you go pretty quickly and try to get out as quickly as you can. That's what we want you to do. Just imagine you are new to this - what would you do? Do that, because that's how we learn in our research. We learn by seeing what behaviour is like when we get a fire, and seeing what we can do to help you. So, if there is an area for instance where everybody had to go through, and it was too narrow and was blocked up, that would be important for us to know. We could make the gap wider. Can you bear that in mind please?

When we do our emergencies, you are going to take part in four evacuations, but you are going to be in two

different sorts of aeroplanes. One is what we call the narrow bodied aeroplane, the sort you use to go on holiday in Europe, and one is called a wide bodied or jumbo…. Actually, we've got it looking a bit like an A380 at the moment, which is the new Airbus, the new aircraft which they are about to launch.

When I've finished explaining what is going to happen, you'll go into the aeroplane for your first evacuation. When you do that, please can you leave clipboards and all your personal effects here. They will be quite safe as Tricia will lock the room, so no one can come in while you're not here. So you will then follow the cabin crew who will lead you to the aeroplane. The seat in which you are sitting for the first evacuation is that first red number on the bottom line on the sticky label on your bibs. Next, the cabin crew will be there to show you, just like boarding a normal plane, to your seats. They'll help you with your things, you won't have any bags with you, and there aren't any duty free drinks, I'm afraid. But you will have a pre-flight briefing, just as you would on an ordinary plane. Eventually, you will hear the instructions from the captain as to what to do, you will do as you are told and you will get out as quickly as possible. You will have seat belts, you will have all the usual things, our cabins are just like the real aircraft, aren't they, Lauren? On some evacuations you may have full light, on some you may not. On some evacuations you may have to go down an escape slide, on others you'll just go onto a platform outside the aircraft.

I just want to tell you a little bit about going down the slide because that's the one area where people can easily injure themselves in real emergencies, and if they're not careful in tests as well. So, if you get to a door and there's an inflated slide, they're exactly like real ones on real aircraft, you will find the cabin crew are there to help you. What you want to do is to cross your arms, put your legs together and jump as if to sit down, like on a bouncy castle. Then you just slide to the bottom, and our marshals will be there to pick you up, and move you on. The key things are that you must cross your arms, put your legs together and jump onto the slide. Keep your legs together, because if you let them fly apart you will slow yourself down, and that's when you hurt your ankles. Keep them together, and keep your hands here, because then won't slide them down the side of the slide and then get sores and friction burns. It's very obvious, there will be people there shouting and telling you what to do. When you get to the bottom, the thing you want to do is to get away as quickly as possible, so that the person coming down behind you doesn't push their feet into your back. As I say, get up quickly, the marshals will be there to help you. Then move away from the bottom of the slide as you will be directed, so we don't end up with a stack at the bottom and we don't have a blockage. As I've said, there will be people there to help you. When everybody's out, the marshals will bring you back here, you will come back to your seats, Tricia will have unlocked the door and you'll receive your next questionnaire.

When everyone has done their questionnaires, we start it all over again. I would like to ask you that when you come back here and do your questionnaires, fill them in as much detail as you can. Please try to do them yourself, and not spend too much time chatting about the evacuations… the sooner you can do this the sooner we finish… Then the cabin staff or our marshals will take you out to wherever you're going next, and we'll repeat the exercise. We will do this four times. If at any point in this series, anyone has any queries, please just ask. Whether it's about what's happened, or if you've hurt yourself. Jackie, the nurse, will be here to help you. Or if you're just not sure about what to do next, please ask. If you find it is getting to you and you're not happy to do any more then that's fine, please just tell us. Most people like to carry on, but if it's starting to worry you, just say.

Now a couple of more general points. We want you to be desperate to get out, and get out as you would in a real emergency. In so doing, don't risk injuring yourself or anyone else, and do bear in mind that we will have videos all over inside the cabin and outside, so don't do anything you wouldn't like to see played back afterwards! The other thing is hat if we should have a situation that potentially might lead to someone being injured, for example, if somebody fell, and you couldn't see them and you were going to go over the top of them, we would have to stop the evacuation. If that happens, we will sound the emergency alarm. It is very loud… (*sounds rape alarm*)… if you hear that, stop immediately. Just wait for instructions. It's very unlikely to happen, but we do have to have some procedure because we have a lot of people. So, if there's a problem, we stop it. So if you hear this, just wait and then we'll tell you what to do. The marshals will make sure that you are safe

Please make sure you haven't got any jewellery or things on your clothes that might cause a problem. So, if

you've got dangly ear rings or things that could possibly get caught on a sharp object or trapped in the cabin, please take them out. We have some envelopes here, and if you want them looking after, you can take an envelope, put your name on the front and pop the item inside, we'll look after them and you can collect them at the end of the evening. You don't want dangly chains, dangly ear rings, big sharp rings, expensive watches, and as you will probably going down the slide at some point, don't have any keys in your back pocket as they'll make quite an impression by the time you get to the bottom of the slide!

Can I just also say that the exits on an aircraft are not always available straightaway, so we need to relay a signal to the cabin crew to them when to open the doors. This signal to the cabin crew will be to simulate the time it would take to make the exit available on a real aircraft. The signal that we are going to be using is a whistle. Please don't confuse the whistle with the emergency stop procedure. The whistle sounds like this... (*sounds whistle*)…. That will go within a few seconds after the call to evacuate. So, the whistle means go, and the rape alarm means stop…

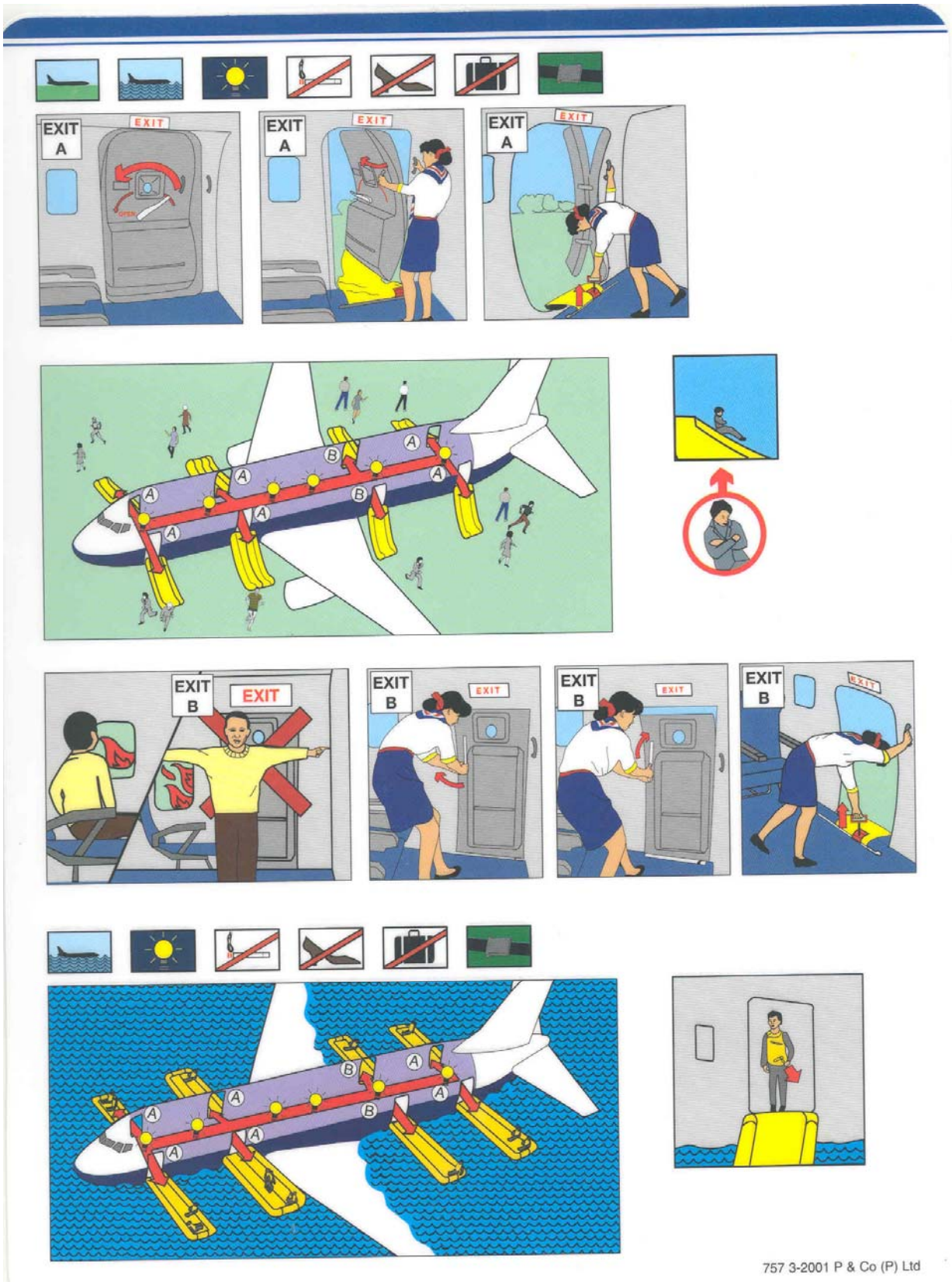
Now, has anyone got any questions? I hope we haven't put anyone off but if we have, please feel free to say. I think we're ready to board. Does anyone want envelopes? Shoelaces, can you check your shoelaces are done up, and tighten your bib strings. Please then pop your things down, and follow the crew and enjoy your flight.

APPENDIX H: SEATING PLAN

Participant number	First Boeing 737 trial	Second Boeing 737 trial	First LCES trial	Second LCES trial
1	5B	4B	3K	1K
2	5A	5C	6A	2K
3	4C	6C	1K	5G
4	6E	5B	5G	4B
5	4A	8E	7K	7A
6	2E	6D	6D	2H
7	3C	6B	5B	1H
8	2C	6F	6C	7K
9	5F	4E	1H	2A
10	6C	4F	7D	5D
11	5E	7D	1C	7B
12	3E	3B	7A	4A
13	5C	8A	5K	6D
14	8F	2A	3A	7D
15	3B	5A	7E	5B
16	3F	2C	4D	4K
17	3D	2B	3B	4J
18	2F	7A	2C	6H
19	4B	4C	4B	7F
20	8E	7C	5D	3B
21	6A	6E	5A	1B
22	2B	5F	6G	3A
23	2D	6A	7G	1A
24	2A	9F	1A	5J
25	6B	9A	2A	5K
26	8A	5D	4K	4D
27	7F	3E	1J	6C
28	4D	3C	2H	1C
29	7A	4A	6K	1J
30	7D	3F	4A	7G
31	8B	2F	5J	6A
32	4E	8F	4G	3K
33	6D	5E	7J	5A
34	3A	7F	1B	7J
35	7C	8B	7B	6G
36	6F	4D	2K	3J
37	4F	2D	4J	7E
38	9F	2E	7F	6K
39	9A	3A	6H	4G
40	5D	3D	3J	2C

APPENDIX I: SAFETY CARD USED IN BOEING 737 TRIALS

Note: The actual safety card used for the Boeing 737 trials was designed for a Boeing 757, and was used with the permission of the operator. The cabin interiors of both aircraft types are similar and the instructions for the use of exits and escape slides are typical of a narrow-bodied aircraft of either type

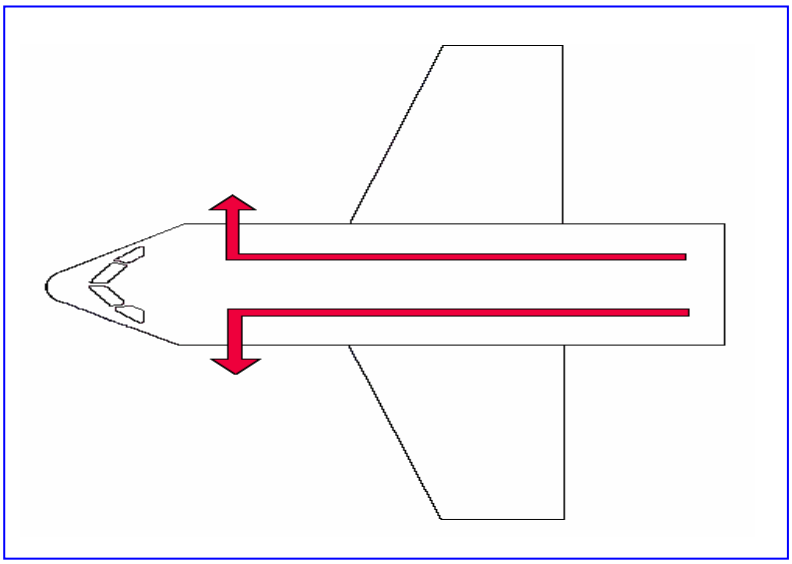


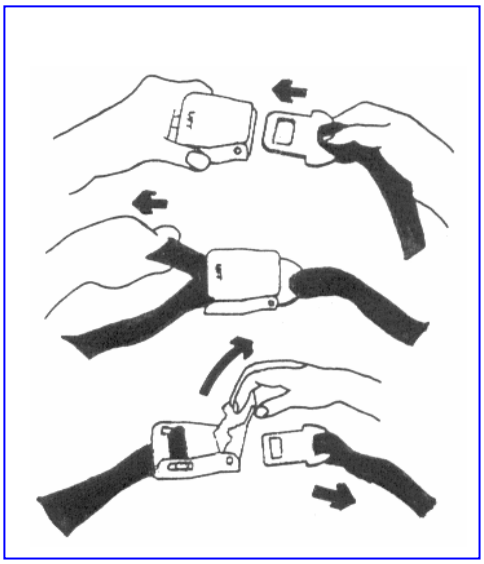
APPENDIX J: LCES SAFETY CARD (UPPER DECK)

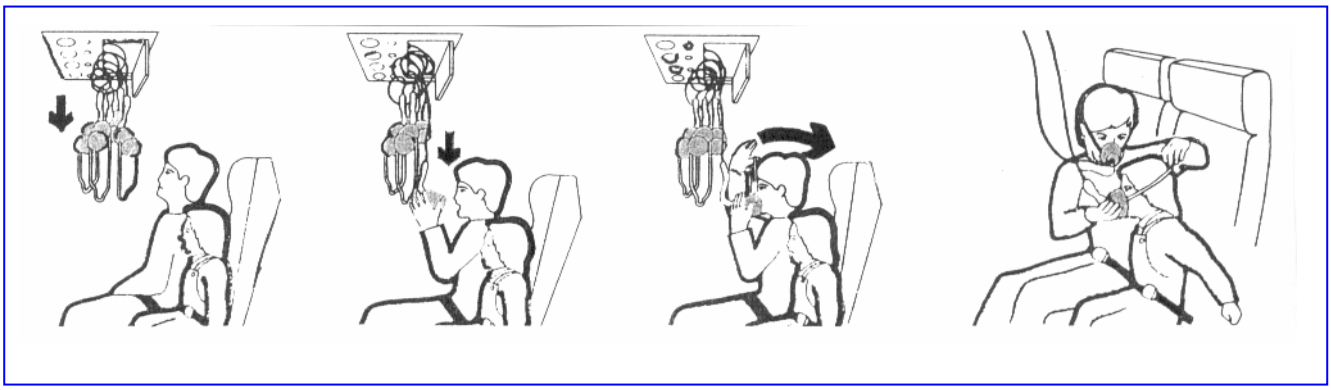
Cranfield Airways

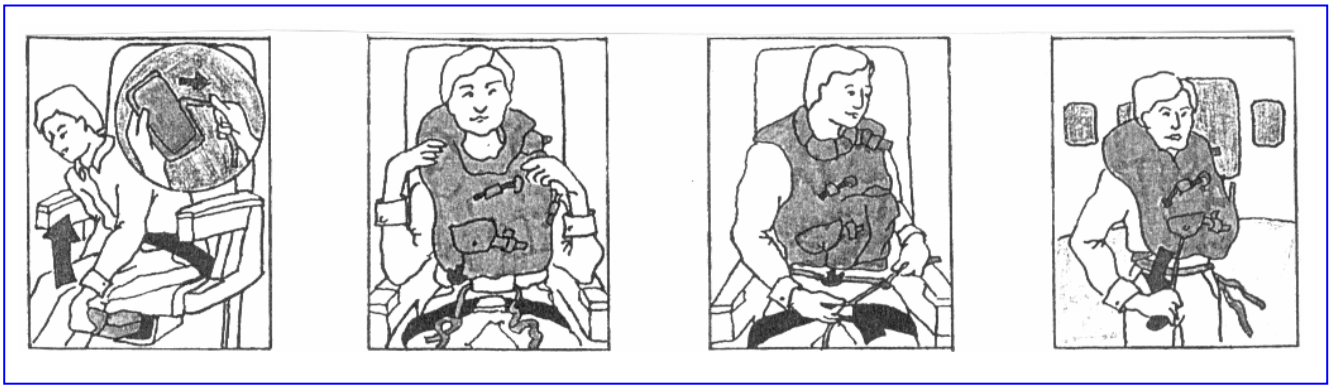
Please study and leave on the aircraft

FOR YOUR SAFETY
POUR VOTRE SÉCURITÉ
FÜR IHRE SICHERHEIT
PER LA VOSTRA SICUREZZA
PARA SU SEGURIDAD
PARA A SUA SEGURANÇA









We would like to remind you that this is a non-smoking flight

APPENDIX K: POST-EVACUATION QUESTIONNAIRE

The information we ask for in this questionnaire relates to the evacuation you just did. Please complete as much of this questionnaire as possible - your answers could help us to improve safety for airline passengers world-wide.

1. On a scale of 1 to 7, where 1 is paying full attention and 7 is paying no attention, to what extent would you say you **listened to the safety briefing** provided? Please circle **one** number only.

1	2	3	4	5	6	7
Full attention						**No attention**

2. On a scale of 1 to 7, where 1 is very helpful and 7 is not at all helpful, please indicate the extent to which the **safety briefing** assisted you in this evacuation. Please circle **one** number only.

1	2	3	4	5	6	7
Very helpful						Not at all helpful

3. On a scale of 1 to 7, where 1 is very helpful and 7 is not at all helpful, please indicate the extent to which you think the safety briefing you received would help in a real emergency. Please circle **one** number only.

1	2	3	4	5	6	7
Very helpful						Not at all helpful

4. If there are any other comments you would like to make regarding the safety briefing, particularly about how passengers can be encouraged to listen, please provide them here.

_____
_____
_____

5. Did you read the **safety card** that was in the seat pocket in front of you? Please circle **one** option only.

   a. Yes

   b. No

6. On a scale of 1 to 7, where 1 is very easy and 7 is very difficult, please indicate the difficulty in **undoing your seat belt**. Please circle **one** number only.

1	2	3	4	5	6	7
Very easy						Very difficult

7. On a scale of 1 to 7, where 1 is very easy and 7 is very difficult, please indicate the difficulty of **moving out of your seat** to reach the main aisle**.** Please circle **one** option only.

1	2	3	4	5	6	7
Very easy						Very difficult

8. On a scale of 1 to 7, where 1 is very easy and 7 is very difficult, please indicate the difficulty of **moving down the main aisle** through the cabin. Please circle **one** option only.

1	2	3	4	5	6	7
Very easy						Very difficult

9. On a scale of 1 to 7, where 1 is very easy and 7 is very difficult, please indicate the difficulty you experienced in **finding an open door**. Please circle **one** option only.

1	2	3	4	5	6	7
Very easy						Very difficult

10. On a scale of 1 to 7, where 1 is very easy and 7 is very difficult, please indicate the difficulty you experienced in **moving through the exit** itself. Please circle **one** number only.

1	2	3	4	5	6	7
Very easy						Very difficult

11. Did you use the slide in the evacuation you just completed? Please circle **one** option only.

a. Yes (go to question 12)

b. No (go to question 13)

12. On a scale of 1 to 7, where 1 is very easy and 7 is very difficult, please indicate the difficulty you experienced in **using the evacuation slide.** Please circle **one** number only.

1	2	3	4	5	6	7
Very easy						Very difficult

13. On a scale of 1 to 7, where 1 is very helpful and 7 is not at all helpful, please indicate the extent to which **what you could see** assisted you in this evacuation. Please circle **one** option only.

1	2	3	4	5	6	7
Very helpful						Not at all helpful

14. On a scale of 1 to 7, where 1 is very helpful and 7 is not at all helpful, please indicate the extent to which **what you could hear** assisted you in this evacuation. Please circle **one** option only.

1	2	3	4	5	6	7
Very helpful						Not at all helpful

15. On a scale of 1 to 7, where 1 is very helpful and 7 is not at all helpful, please indicate the extent to which **what you could touch or feel** assisted you in this evacuation. Please circle **one** option only.

1	2	3	4	5	6	7
Very helpful						Not at all helpful

16. On a scale of 1 to 7, where 1 is very helpful and 7 is not at all helpful, please indicate the extent to which the **instructions shouted by cabin crew** assisted you in this evacuation. Please circle **one** option only.

1	2	3	4	5	6	7
Very helpful						Not at all helpful

17. On a scale of 1 to 7, where 1 is very helpful and 7 is not at all helpful, please indicate the extent to which the **cabin crew gestures (e.g. pointing)** assisted you in this evacuation. Please circle **one** option only.

1	2	3	4	5	6	7
Very helpful						Not at all helpful

18. In what ways could the cabin crew have improved your evacuation?

_____
_____
_____

19. How do you think the cabin crew **aided** your evacuation? Please circle **all** that apply.

a. Directed me to the exit
b. Shouted helpful instructions
c. Shouted encouragement
d. Pushed passengers through the exit
e. Other (Please specify)
_____

20. How do you think the cabin crew **hindered** your evacuation? Please circle **all** that apply.

a. Shouted too much
b. Shouted too loud
c. Added to the confusion
d. Pushed passengers through the exit
e. Did not help passengers who needed help
f. Occupied space or got in the way
g. Distracted me from more important things
h. Other (Please specify)
_____

21. In what ways did your fellow passengers **help** your evacuation?

_____
_____
_____

22. In what ways did your fellow passengers **hinder** your evacuation?

_____
_____
_____

23. In what ways could your fellow passengers have improved your evacuation?

_____
_____
_____

24. Did anything within the cabin **help** your evacuation? Please circle **one** option only

a. No

b. Yes (Please specify what helped you, and how)

_____
_____

25. Did anything within the cabin **hinder** your evacuation? Please circle **one** option only

a. No

b. Yes (Please specify what hindered you, and how)

_____
_____

26. The cabin crew provided a safety briefing and demonstration prior to this evacuation. With hindsight, what information do you think could have been included to improve your evacuation?

_____
_____
_____
_____

27. On a scale of 1 to 7, where 1 is very confident and 7 is not at all confident, please indicate your **level of confidence** while evacuating the cabin. Please circle **one** option only.

1	2	3	4	5	6	7
Very confident						Not at all confident

28. If there are any other comments you would like to make regarding the evacuation you have just completed, please provide them here.

_____
_____
_____
_____
_____
_____

APPENDIX L: TRIAL PHOTOGRAPHS

L1: Interior photograph of Boeing 737 cabin simulator (photograph © Lauren Thomas 2005)

L2: Control station in Boeing 737 cabin simulator (photograph © Lauren Thomas 2005)

L3: Safety briefing in progress, Boeing 737 (photograph © Lauren Thomas 2005)

L4: Evacuation slide fitted to Boeing 737 Type I exit (photograph © Lauren Thomas 2005)

L5: Boeing 737 evacuation slide in use (photograph © Lauren Thomas 2005)

L6: Large Cabin Evacuation Simulator (LCES), upper deck view towards front of cabin, showing half-height bulkheads (photograph © Lauren Thomas 2005)

L7: Large Cabin Evacuation Simulator (LCES), upper deck view towards front of cabin, showing full-height bulkheads (photograph © Lauren Thomas 2005)

L8: Safety briefing in progress, Large Cabin Evacuation Simulator (LCES), showing half-height bulkheads (photograph © Lauren Thomas 2005)

L9: Safety briefing in progress, Large Cabin Evacuation Simulator (LCES), showing full-height bulkheads (photograph © Lauren Thomas 2005)

L10: Passengers evacuating, Large Cabin Evacuation Simulator (LCES) with dual-lane flow commands and half-height bulkheads (photograph © Lauren Thomas 2005)

L11: Upper L1 door, used for all LCES evacuations. Photograph also shows full-height bulkhead and the first row of seats turned to face aft, to simulate continuation of bulkhead along cross aisle (photograph © Lauren Thomas 2005)