VERRES CONSORTIUM

V E R R E S

VLTA EMERGENCY REQUIREMENTS RESEARCH EVACUATION STUDY

Work Package 3

Task 3.1 report – Test Plan for Evacuation Trials

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GLOSSARY

AIRBUS	AIRBUS Deutschland
CON	Contribution Report
CU	Cranfield University
D	Deliverable
DD	Draft Report
DG TREN	Directorate General Transport & Energy
ETF	ETF/SNPNC
FDD	Final Draft Report
JAA	Joint Aviation Authority
PDP	Project Documentation Plan
PMP	Project Management Plan
SOF	Sofréavia
SRG	CAA/SRG
UOG	University of Greenwich
VAA	Virgin Atlantic Airways
VERRES	VLTA Emergency Requirements Research Evacuation Study
VLTA	Very Large Transport Aircraft
WP	Work-Package

EXECUTIVE SUMMARY

The VERRES programme is an European Commission/DG Tren funded project to examine some of the evacuation issues relevant to evacuation from next generation very large transport aircraft. The consortium includes Sofréavia, CAA/SRG, JAA, Airbus, University of Greenwich, Cranfield University, Virgin Atlantic Airways and SNPNC

The VERRES technical annex details the proposal for the VERRES study. The study was initiated as 'the development of Very Large Transport Aircraft (VLTA) is of utmost importance to face the forecast increase in air traffic. The VLTA is a challenge for aircraft manufacturers and the certification authorities for emergency evacuation in case of major incident/accident or survivable crash. Indeed, the transition to more than two aisles and full double deck with a significant number of passengers to deal with may raise concerns. This poses problems not only for industry, which is looking for a rapid return on RTD investment, but also for the certification authorities who are faced with the approval of a product within a very short time scale. The VERRES project will investigate the problem for different scenarios' (p1 VERRES_TAO2_2.doc).

The technical annex notes that 'this study is general in nature and will provide information for the future generation of very large transport aircraft and it is intended that some of the recommendations may have immediate applicability to aircraft of this size that are shortly to be developed in Europe and elsewhere' (p1 VERRES_TAO2_2.doc).

Three major domains are studied within the project: the configurational aspects, the use of analysis supported by relevant small-scale evacuation tests and evacuation modelling software and the human aspects via cabin crew co-ordination and training and the mental representation layout of the aircraft for the passenger.

Members of the VERRES consortium have determined the evacuation test programme. Cranfield University are responsible for the management of the evacuation tests and have translated the consortium's design into a test plan for this report to fulfil task 3.1.

Cranfield University has been performing tests into the factors that influence passenger evacuation since 1986. The University houses two cabin simulators which are used for this work. This test plan contains general information on the protocols for evacuation work which is undertaken at Cranfield University, information on the proposed test facility, and also documents the deliverables associated with the programme.

1. INTRODUCTION

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Cranfield University has a long history of successful applied research. From its origin as the College of Aeronautics, the high level research has always emphasised finding practical solutions to real-life problems. The university's mission is "to transform world class science, technology and management expertise into viable, practical, environmentally desirable solutions that enhance economic development and the quality of life".

The Human Factors Group is staffed by professional psychologists whose main focus is the application of psychological methods to the understanding and enhancement of human performance. It is the only university based department in the UK specialising in aviation human factors. The Group enjoys a global reputation for its work within the aerospace industry, although its research covers all sectors where sophisticated technology and automation interface with human activity. Human performance and decision making in complex and stressful environments is an area of particular interest.

Since 1985, the Human Factors Group has become the focus for European cabin safety research. The expertise and experience which has been developed in factors influencing safety and survival is such that, since 1993, research programmes have received support from the Federal Aviation Administration, the Civil Aviation Authority, and Transport Canada. In addition to support from the regulatory authorities, research sponsored by manufacturers, operators and suppliers is also regularly undertaken.

Early research involved the use of a Trident airframe parked on the university airfield. This has now been superseded by two cabin simulators, a Boeing 737 and a large cabin evacuation simulator. Both research facilities are equipped with control systems for manipulating experimental variables such as smoke, lighting, sound and so on. A range of infra-red sensitive and thermal imaging cameras located internally and/or externally allow data to be collected in a range of conditions, including in darkness and in smoke.

One of the difficulties associated with conducting research into the survival of aircraft accidents is the introduction of sufficient realism, without putting participants at serious risk of physical of psychological harm. The Cranfield approach has been to maximise fidelity, by using realistic cabin simulators, trained and uniformed members of cabin crew, safety cards and passenger safety demonstrations. Members of the public who are recruited to take part in emergency evacuations are given a pre-flight safety briefing, they hear the sounds of engine noises, and are finally briefed to evacuate the aircraft.

Passenger motivation to escape may also be manipulated by payment of cash bonuses to the first 50 or 75% of people to evacuate the airframe. The degree of realism produced by these techniques has enabled many of the behaviours and problems known to occur in accidents to be reproduced. The results from Cranfield University data have been used by the industry to determine what changes need to be made to improve the probability of passengers surviving aircraft accidents.

Although the Cranfield methodology can be potentially hazardous for volunteers, over 7,000 members of the public have taken part without sustaining any serious injuries. This level of safety has been achieved by having clearly defined selection criteria, detailed medicals and briefings, and clearly defined safety procedures and organisational reviews. All research undertaken within the Group is subjected to independent scrutiny by the Human Factors Group Ethics Committee. It is also recognised that, in view of the possibility of litigation, experiments of this kind may be more practicable in the UK than elsewhere.

Major cabin safety projects completed at Cranfield University include:

- Investigations into the effect of cabin bulkhead width and over-wing exit seating configurations on passenger evacuation behaviour in clear air and in smoke.

- Experimental studies to assess a range of factors influencing passenger ability to operate a Type III over-wing exit hatch. These have included changes to the weight of the hatch, a new design for the operating mechanism, changes to the seating configuration, and provision of passenger briefing information.

- Projects have been undertaken to assess the potential benefits of auditory signals for attracting passengers to exit locations during evacuations in smoke, and to explore the advantages and disadvantages of cabin water sprays operating during the evacuation.

- A major CAA/FAA investigation involved examining the influence of cabin crew behaviour on passenger evacuation performance.

The team was founded and is led by Professor Helen Muir. For her work in this field, she has received many awards and commendations. These have included the B.W.O. Townsend Award from the Royal Aeronautical Society in 1992, the Grand Master's Commendation from the Guild of Airline Pilots and Navigators in 1993, the Order of the British Empire from Her Majesty the Queen in 1993, the Award of Excellence in Cabin Safety from the California Safety Institute in 1998, and the Whittle Safety Award from the International Federation of Airworthiness in 1999. The citation for the latter was "in recognition of her contribution to improved airline cabin safety through the application of human factors in the field of passenger behaviour in emergencies".

The experimental trials for the Verres project will be managed by Professor Helen Muir, supported by a team of researchers who are members of the Human Factors Group.

2. TEST PROTOCOL

2.1. Research issues

As a starting point for the development of the experimental design, a discussion was held with all consortium members. From this discussion a number of potential research areas were noted and classified into two categories – either high or low priority, based on the specification of the Verres project. The research issues are shown in table 1.

Table 1: Classification of research issues.

High priority	Low priority
Staircase size	Width of aisles
Staircase configuration	Width of bulkheads
Staircase flow management	Redirecting passengers
Slides upper deck	Visibility of exits
Crew co-ordination	

2.2. Experimental design

Cranfield University, with the assistance of the University of Greenwich, used the ideas generated during this discussion to propose to the Verres consortium, an experimental design that ensured methodological rigour. When proposing this design, the data requirements as stated within the work package 3 management plan were considered. It is stated that the data analysis of the experimentation will be divided into three sets of analytical work: statistical data, quantitative analysis and qualitative analysis. This design was presented in the report titled VERRES_CU_WP3_Draft_Task 3.1_v0.1. This design was based on 100 participants on each test day, due to experimental resources at the time of submitting the proposal, although the design could have been altered to accommodate more passengers, if resources became available.

The design of an experiment is directly related to the confidence that may be placed in the results. In any study intended to assess evacuation issues, when a robust research design is employed, the regulators may be confident that the results are purely due to the factors that were included and controlled within the study. If this is not the case, then the results may be erroneous, and may not be interpreted with confidence. This is because the experimental findings are then subject to interpretation by other factors, such as chance, learning and practise, or a confounding variable.

Although the experimentation resources within the Verres project only permitted two days of testing, each with four trials, the design in version 1 allowed each condition to be tested twice, with counterbalancing present as far as possible in an attempt to control for effects of practice and learning. It was anticipated that this design would provide data amendable to inferential statistical analyses, although it was noted that the results would be preliminary findings. It is noted that Cranfield University and the University of Greenwich have extensive experience in the field of aircraft evacuation research and when presenting the design proposed in version 1, were drawing on existing knowledge and understanding. This was done as it was felt that the issues raised by the Verres project, built on existing knowledge of passenger behaviour during aircraft evacuation but with a novel configuration – i.e. height of upper deck and an internal staircase. It is noted that other partners within the consortium, although having experience in other fields, were not experienced in conducting experimental evacuation tests.

Since version 1 of the research design was submitted to consortium members, the JAA have proposed additional resources to increase the number of participants from 100 to 200 on each test day. It is anticipated that this will allow the impact of multiple decks on passenger evacuation to be studied. Currently there is limited knowledge and experience of passenger behaviour in such situations, where passengers are required to move from one deck to another to evacuate during an emergency situation. It is currently proposed for VLTA with multiple decks that each deck will be considered separate in terms of emergency evacuation, with passengers evacuating from the deck they are seated on. However, it has been raised by individuals within the industry that events may occur whereby it may be necessary for passengers on one deck to evacuate via the other deck (i.e. precautionary evacuations or unavailable exits) and therefore it has been proposed that research is conducted to assess the impact of multiple decks.

Within the idea of assessing the impact of multiple decks, the Verres consortium identified a large number of potential variables of interest, and it has become evident that it would be difficult to limit the number of independent variables. As only eight evacuation trials are available, this is insufficient to obtain adequate replications of each test condition. The consortium were unable to agree a test programme that could be conducted as a controlled experiment, instead, the evacuation trials will take the form of a series of evacuation demonstrations, which can then be used to explore possibilities for future research. As a result, there are no independent variables to be manipulated within the tests.

The final programme that has been agreed is to use the eight trials available to explore passenger movement in three types of situations. The first scenario is where there is a free choice between available exits on both decks (the free choice condition). The second type of situation is where passengers on the lower deck are required to move to the upper deck, to the only available exits (the moving upstairs condition). The third situation is where passengers on the upper deck are required to move to the lower deck, to the only available exits (the moving downstairs condition).

2.3. Trial order

Given that the trials are to be a series of evacuation demonstrations, it was decided to prioritise the situations that were perceived as more critical. Hence, within the eight tests, two will be free choice situations. There will be two tests of the moving upwards scenario. However, for the moving downwards scenario, there will be four tests. Also of interest is the presence or absence of additional cabin crew at the staircase, but this is considered to only be relevant for conditions in which participants have no free choice about where they move to available exits. Hence, one of the moving upwards tests will have two additional cabin crew, and two of the moving downwards test will have two additional cabin crew. When additional crew are available at the staircase, one will be located at the top of the staircase on the upper deck, and one will be located at the bottom of the staircase on the lower deck. Given the limited number of tests available, and the fact that the evacuations are for demonstration purposes only, no attempt at counterbalancing is made.

The University of Greenwich have expressed a preference for data obtained from naïve participants on the staircase. As the scenarios are not counterbalanced, the only manner in which such data can be obtained is to divide the passenger load into two groups. This ensures that a quantity of data is obtained from naïve participants moving both up and down the stairs. The order of each of the evacuation trials over both test days is provided in Table 2 below.

2.4. Experimental schedule

The experimental schedule is provided in Table 2. All tests will commence with one group of passengers (84) seated on the upper deck and one group of passengers (84) seated on the lower deck either side of the staircase.

Table 2: Experimental schedule for trials on 25th January 2003 and 1st Febraury2003

Trial	25 January 2003	1 February 2003
1	**Free choice** No additional crew at staircase Available exits UR1, LL2 and LR2, Group A seated on upper deck Group B seated on lower deck	**Moving Downwards** Additional crew at staircase Available exits LL2 and LR2 Group A seated on upper deck Group B seated on lower deck
2	**Moving Downwards** No additional crew at staircase Available exits LL2 and LR2 Group A seated on lower deck Group B seated on upper deck	**Moving Upwards** No additional crew at staircase Available exits UL1 and UR1 Group A seated on upper deck Group B seated on lower deck
3	**Moving Upwards** Additional crew at staircase Available exits UL1 and UR1 Group A seated on lower deck Group B seated on upper deck	**Moving Downwards** No additional crew at staircase Available exits LL2 and LR2 Group A seated on upper deck Group B seated on lower deck
4	**Moving Downwards** Additional crew at staircase Available exits LL2 and LR2 Group A seated on upper deck Group B seated on lower deck	**Free Choice** No additional crew at staircase Available exits UR1, LL2 and LR2 Group A seated on lower deck Group B seated on upper deck

2.5. Test facility

The test facility will be the large cabin evacuation simulator located at Cranfield University in the UK. This facility was commissioned and funded by the Civil Aviation Authority of the United Kingdom, and was opened by HRH The Duke of Kent in July 2001. The facility is constructed over two decks in a modular fashion, such that key configurational variables can be manipulated according to specific research aims. The aisles, seats, monuments, the staircase linking the decks, and the exit size and location have all been designed and fitted such that they can be moved or relocated as required. For this programme, the facility will be modified to provide key physical features of a generic wide bodied cabin over two decks. Both decks will be used in the current study.

2.6. Cabin configuration

The lower deck of the cabin seats up to 172 participants. Seats within the cabin will be set at a 31” pitch, equivalent to a vertical projection of 5 inches. Three exits will be fitted on the lower deck, one forward on the port side of the cabin (Lower Left 1, or LL1). An exit pair will also be located midway down the cabin at the base of the staircase, one exit on the port and one on the starboard sides. These exits will be designated Lower Left 2 and Lower Right 2 (LL2 and LR2 respectively). All lower deck exits conformed to the dimensions of Type A exits, being 42” wide by 72” high. Platforms are available outside all lower deck exits for participants to evacuate. The sill height of the lower deck platform is 5 metres above ground level.

On the upper deck, 88 seats are available, also at 31” pitch. Two exits are fitted to the upper deck, one forward on the port side (Upper Left 1, or UL1), and one forward on the starboard side (Upper Right 1, or UR1). All upper deck exits conformed to the dimensions of Type A exits, being 42” wide by 72” high. UL1 has a platform outside for evacuating passengers, at 8 metres above ground level. UR1 is fitted with a dual-lane evacuation slide, again 8 metres above ground. The slide is 16 metres long and was capable of carrying upwards of 140 passengers per minute (70 per lane, in accordance with the FAA Emergency Evacuation Slides Technical Order[1].

The simulator will be fitted with battery operated exit identifiers at each exit, and a floor proximity emergency escape path marking system will be available. For safety precautions, additional lighting will be placed on the staircase. Infra-red cameras will be located outside each exit and inside the cabin to obtain views of the evacuation. The exact locations of the cameras will be discussed with consortium members in an attempt to collect the data required by all members.

[1] FAA (1990) *Emergency Evacuation Slides, Ramps, Ramp/slides and Slides/rafts*. Technical Standard Order C69c. Department of Transport, 18 August 1990.

Diagrams showing the configurations of the lower and upper deck cabins are provided in figures 1 and 2.

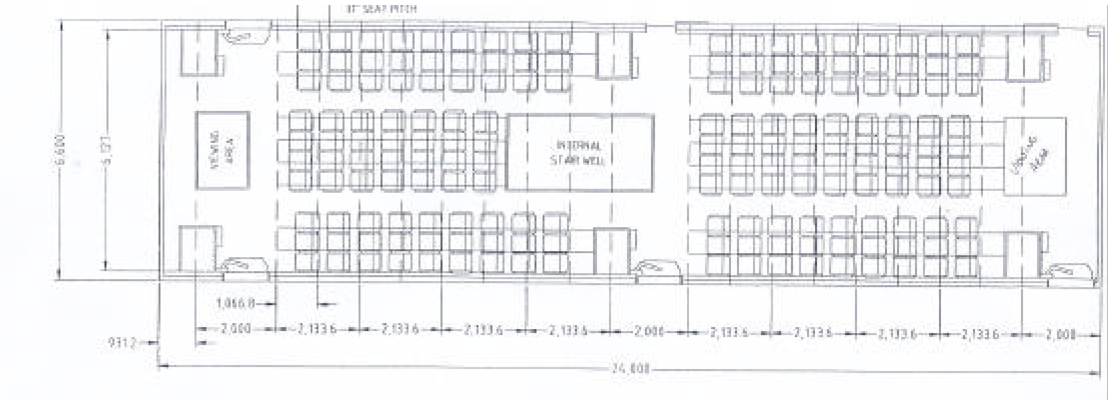

Figure 1: The lower deck of the Cranfield University Large Evacuation Simulator

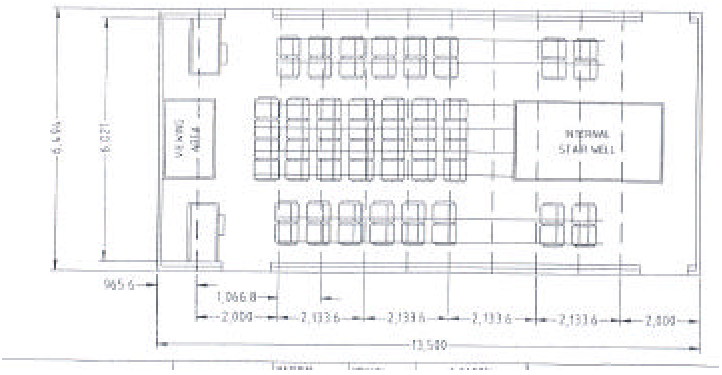

Figure 2: The upper deck of the Cranfield University Large Evacuation Simulator

2.7. Experimental participants

A group of up to 168 participants will be recruited to take part in each of two test sessions. Each test session will comprise four evacuations. The participants will be assigned to one of two groups, each group will be seated on the lower deck for two evacuation trials and on the upper deck for two evacuation trials. The participants will be seated throughout the upper deck and located either side of the internal staircase on the lower deck.

Participants will be recruited via local and regional advertising. In order to minimise the risk of injury, volunteers will be required to be aged between 20 and 50 and relatively fit. Participants who have experienced any of the following medical conditions will be excluding from taking part:

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, bronchitis, breathlessness, chest trouble, allergy, lumbago sciatica, or any other serious illness.

Participants who are pregnant, or who think they may be pregnant, will be excluded from taking part, as will participants who have recently received medical treatment or who have recently undergone surgery will be required to obtain medical clearance from the medical officer present for the trials.

All volunteers will be required to weigh no more than around 15 stones (95.25 kg), should not be excessively overweight, and should be normally fit and healthy.

Participants will be sent a booking confirmation letter, which will also advise of them of the appropriate clothing to wear for the trials. A copy will be presented in the analysis report. In addition, all participants will be required to complete a medical questionnaire and consent form prior to taking part in the trials. This form will be checked and signed by the medical practitioner or one of the nurses present for the trials. If there is any doubt about an individual's fitness to participate, the medical practitioner will provide final clearance to take part in the session.

2.8. Procedure

On arrival, members of the research team will greet participants. Participants will be provided with a bib detailing their participant number, and a badge detailing the seats that they are to occupy for each of the four trials. Participants will also be provided with a clipboard containing the Volunteer Information sheet which details the health and safety requirements, insurance cover, payment details and confidentiality. The clipboard will also contain the Volunteer Consent and Medical Clearance Form. Members of the research team will measure and document the height and weight of all participants, and this form will be screened by the doctor or one of the nurses present. Participants will also sign this form to indicate that they have provided full and informed consent. The clipboard will also contain a Background Information questionnaire and a Cranfield University post-evacuation questionnaire for each trial, to supplement the descriptive analyses. Sofreavia are also designing a passenger post evacuation questionnaire. To ensure that participants do not receive advance information regarding the nature of the tests, Cranfield University strongly recommend that identical questions are asked each trial. All participant correspondence will be provided in the analysis report.

Once the check-in process is complete, Professor Muir will brief all participants about the nature of the trials. The briefing is intended to encourage participants to behave in a motivated manner, although there will not be any financial incentives for rapid evacuation. Participants will also be informed of the correct way to use the evacuation slide. In order to establish rapport, Professor Muir will not deliver the briefing verbatim. A sample briefing from similar trials is provided below, and a transcript of the trial briefing will be provided in the final report.

2.8.1. Sample participant briefing

Good morning ladies and gentlemen, thanks very much for coming along and agreeing to help us today. I would now like to spend a few minutes doing two things. Firstly, I want to give you a little bit of background about what these tests are about, how we come to be doing them here, and what we are trying to find out, and then, secondly, what in reality is going to happen when you go and board our aircraft.

Why are we doing these studies? Some of you may have been to help us before but for those of you who haven't, since 1987 Cranfield have been helping the regulatory bodies, in other words the officers that make the safety regulations, to determine what they can do to increase the chance of people surviving an aircraft accident.

Aircraft accidents are very infrequent but when they do happen, if a fire occurs, there can be loss of life. Typically once the fire has started there are only usually two minutes in which the conditions in the cabin remain survivable, so we have to make sure that we can get everybody out in less than two minutes. I am sure you can appreciate that in some of the large aircraft on which you fly that can be quite a challenge.

At Cranfield we are carrying out testing work to see whether if we change something, it will help people to get out more quickly. For example, what happens if we change part of the cabin interior or the behaviour of the cabin staff? What can we change to try and improve the situation? What can we learn about what is stopping people getting out in difficult situations? This is the purpose of this programme, and I will tell you more details about the purpose of today's tests at the end of the session. I should advise you that as accidents do not happen during daylight hours you may find some of the tests occur in night conditions!

Today we will be doing a total of four evacuations from the aeroplane. The arrangement that we have made is that we will pay you £25 each for coming along here today. What is very, very important is that each time, you try to get out as quickly as you can. Obviously, we will not be setting the cabin on fire, but it is important that you try to get yourself out in the shortest possible time, and are really motivated to be one of the first few out. We won't tell you have quickly you have to do it, so you just all have to try and get out as quickly as you can.

You may have been wondering why we have been measuring you and taking all this detailed questionnaire information. It is because in addition to the overall time it takes to get people out we are interested in what sort of people are able to get out quickly. Can big people get out faster than smaller people; can younger people get out faster than older people? All of this information is used to help us understand how to make getting out of an aircraft as fast as possible for everyone. This is why we are collecting all of the information.

When we have finished talking here, I will ask you to leave your clipboards here and your coats and so on. It is very important that you remember where your clipboard is, so that you can find it again later. Make sure you are wearing the numbered bib you have been given, and make sure that you have tied it securely. Then we will take you up into our cabin simulator. The cabin is quite large, as I suppose you might have guessed from the number of people here today, so to make all of this easier we will be asking you to board in groups, just like on a real flight.

Our cabin staff here will call you to board a few rows at a time. The cabin crew will then show you to your seats, the seat you sit in for the first evacuation is the first seat number on the badge and on the front of the clipboard that you have been given. Please make sure your badge with the seat numbers on, is securely stuck to you, so we know what seat you are to sit in for each evacuation once up in the cabin.

Once you are all on board and everybody is seated, you will be given a typical pre-flight briefing, the sort of briefing you have when you go on a flight somewhere, demonstrating how to do the seat belts and so forth, but we are not unfortunately giving you duty free drinks on this flight I am afraid. You will then hear the sound of the engines start up and things starting to happen and eventually the instructions from the captain "Undo your seat belts and get out". When you hear that instruction, that is your cue to move and you should make your way towards whatever exits seem to be being opened and indicated to you. As I said, it is vitally important that you really think about getting out of the exit as quickly as you can, and that you try to remember we want to try and see the real urgency that would be there in a real situation.

When you get to the exit, you will find there are people outside to help you move away from the area as quickly as possible. Please try and move to wherever you are asked to go, as we have a lot of people evacuating the cabin today, and we do not want to cause any blockages outside the doors. The people outside will help you to move out of the area quickly, and tell you where to stand. Don't worry too much about this, as there will be stewards to tell you where to go. Please stay where you are told until the evacuation is over, and then we have some friendly stewards who will bring you back down here to find your seat.

When you come back down here, keep your bib on. You will need to wear that bib throughout the session. Then go back to your clipboard and fill in the first, coloured questionnaire on your clipboards. Once you have done this, we will go back on board the simulator, this time you will sit in a different seat, this is shown on your badge and clipboard, we will then start the process again, and as I have said we are doing a total of four evacuations.

I know there is a lot of questionnaire information here, but it really is important and it really is needed, so please do bear with us and fill it in as best you can, it is quite important that we have this information as accurately as we can because all the time we are trying to learn more about things we need to look at and things that might possibly lead to an improvement.

Now, we obviously hope that there won't be any problems, but should there be a problem on the aircraft, suppose somebody falls and somebody else trips over them and people are in danger of being hurt then we would obviously stop the evacuation. We don't have to do this often, but it is a sensible precaution to have a procedure for stopping the evacuation. If we have to stop the evacuation we will sound an alarm. I would like to demonstrate it to you now so that you know what to expect. It is terribly loud; you may want to protect your ears. S*ounds rape alarm.*

You will be in no doubt if you hear that noise, if you hear that noise just stop and wait for instructions, it means that a problem has occurred. You should wait exactly where you are and the cabin crew or stewards will tell you what to do. We have to say that we hope that you don't let a problem occur because if you do and we have to use the alarm, that's not much fun for anybody. So make sure we don't have to, please look after each other and be careful whilst at the same time really trying to get out as quickly as you can. Please just note that you may also hear people blowing whistles – this is a way of communicating to our cabin crew and stewards that our exits are ready for use. Don't worry that the evacuation has been halted; because this sounds very different from the rape alarm I have just demonstrated. *Sounds whistle.*

If anyone starts to become concerned and decides they want to drop out that is perfectly all right, just come and have a word with me. We'll still pay you for coming along. Not everybody enjoys doing these things, and if you find you are starting to get worried about something, just come and say and we'll arrange for you to drop out.

Regarding your personal effects, we would ask you please not to take part in these evacuations wearing very expensive watches because straps sometimes get broken and they could get trodden on. If you can possibly manage please remove your glasses. If you need them for the questionnaires, if you give them to me, or if you come to me when you are about to board the aircraft I'll show you where you can leave them and from where they can be collected afterwards.

Please don't wear any long chains or long, dangly earrings, or anything that could possibly either get damaged or injure you or somebody else. It's just a question of being practical and sensible. If you have any of these items and you are not going to take them on the aircraft, Rebecca here has some brown envelopes, when I have finished talking if you come and get a brown envelope, put your name on the envelope, put whatever items you have in the envelope, seal it up, give it back to Rebecca. We will keep them safely for the duration of the exercise and then you can pick them up at the end.

Does anyone have any questions? Has anyone decided to drop out already? No? That's good. If you need an envelope, come forward to Rebecca. If you don't, or when you are ready, we will ask the cabin crew to start boarding now.

2.8.2. Boarding process

On boarding, the cabin will be lit under normal (take off and landing) lighting conditions. It has been requested by consortium members that on completion of the safety briefing, the lighting level is lowered to night conditions. The lighting will remain at this level until the call to evacuate. At the call to evacuate, light levels will be diminished to emergency levels. Normal, night and emergency lighting levels within the cabin will be measured at key points along each main aisle, at armrest height, under test conditions, and these figures will be documented in the analysis report.

The evacuation will be controlled from an observer station on the lower deck of the simulator. This station will be used to manage all pre-flight briefings, the soundtrack including the call to evacuate, and the lighting levels, a Cranfield University, Human Factors Group technician will manage this.

After Professor Muir's briefing, participants will board the cabin simulator. The University of Greenwich have requested that participants are naïve about the internal staircase until the evacuation commences and therefore have requested that participants seated on the upper deck board externally rather than using the internal staircase. The upper deck passengers will be boarded first, followed by the lower deck passengers. Participants will be boarded by rows. Seats will be allocated according to a pre-defined seating plan on a random basis, with the exceptions that no participant will be allocated the same seat on the same deck twice and participants will sit twice on the upper deck and twice on the lower deck. Seating plans will be presented with the analysis. Once inside the simulator, the cabin crew will seat the passengers according to their pre-allocated seat number.

Once all participants have been boarded, an abridged pre-flight safety briefing will be played. Cabin crew will also demonstrate the key features of the safety briefing. Safety cards will be used to supplement the information provided in the safety briefing. Consortium members have provided input into the safety card and safety briefing. A sample briefing is provided below.

2.8.3. Sample Safety Briefing

Ladies & 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. 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 to demonstrate)* This contains details of the demonstration.

The emergency exits are clearly marked, and are being pointed out to you. These are the two doors at the front of the cabin… *(cabin crew to demonstrate),* the two doors in the centre of the cabin. …(*cabin crew to demonstrate),* and the two doors at the rear of the cabin *(cabin crew to demonstrate).* In the event of an emergency, floor level lighting will illuminate, showing the routes to these exits... *(cabin crew to demonstrate).*

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

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… *(cabin crew to demonstrate)* and masks like these will drop down... *(cabin crew to demonstrate).* Remain seated, pull the mask towards you, place over nose and mouth and breathe normally... *(cabin crew to demonstrate).* Adults should fit their own masks before assisting children.

Please now ensure that your seat table is folded away, your seat back is upright with the arm rest down, and your seatbelt is tightly fastened.

Thank you for your attention. We would like to wish you a pleasant flight *(cabin crew to check that passenger seatbelts are fastened).*

2.8.4. Cabin crew stations

On completion of the safety briefing the cabin crew will return to their stations at each exit or near the staircase. One member of cabin crew will be available at each of the four exits on the lower deck (LL1/LL2/LR1/LR2) and two members of cabin crew will be stationed at each upper deck door (UR1/UL1) for safety when using the slide. It is strongly felt by Cranfield University that due to the safety of both passengers and cabin crew, members of the Cranfield University research team will need to act as cabin crew at the upper deck slide door. Virgin Atlantic Airways crew will be stationed at all other exits. 10 crew are required in total, four on the lower deck (VAA), four on the upper deck (2 VAA and 2 CU) and two on the staircase when required (VAA). The crew will not be required to evacuate the simulator. Cabin crew will be stationed at the exits in this manner for all trials, in order that the presence or absence of cabin crew gives no indication to passengers of the exits that may be available on a given trial. When additional crew are to be situated at the internal staircase, they will be located at the top and bottom of the staircase to assist in managing the flow, but in a location where the passenger flow will not be disrupted. On the upper deck, the crew member will wait at the side of the staircase until the evacuation commences and on the lower deck, a seat immediately in front of the base of the staircase will be allocated. It is anticipated that the crew will position themselves in the same position for all trials.

2.8.5. Evacuation scenarios

After the safety briefing, participants will hear a pre-recorded evacuation scenario. A different evacuation scenario will be used for each test, in order that participants will be unable to anticipate precisely the call to evacuate. Each scenario will include a period of engine noise lasting for between 30 seconds and 2 minutes. Each scenario will end with the Captain's voice commanding passengers to evacuate. In addition, each scenario will include a pre-recorded signal approximately 10 seconds after the call to evacuate. This time delay represents the approximate time required for the evacuation slides to deploy. Cabin crew and stewards will be familiar with the signal, in order that all exits to be made available on a given trial can be opened simultaneously. A transcript of each evacuation scenario will be provided in the analysis report.

2.8.6. Evacuation conduct

On the call to evacuate, lighting will be dimmed to emergency levels. All cabin crew will remain stationed directly in front of their exits, and will be required to call passengers towards them, as if every exit were to be available. Cabin crew will not know in advance if their exit is available or unavailable during each trial. Cabin crew will be required to use assertive, concise, positive commands and gestures, as per the findings of Muir & Cobbett (1996)[2]. Virgin Atlantic Airways commands will be used to avoid causing any crew confusion, these are "Open seat belts and get out" "Leave everything behind" and "Come this way". It may also be required for these trials for crew to use "Wait", "Don't push" and "Form two lines". Cabin crew will be encouraged to use gestures, signals and eye contact as appropriate. Whilst issuing these commands to passengers, crew will open their exit but prevent passengers from evacuating until the whistle is heard. The only exception is at upper right, where both members of cabin crew will be Cranfield University researchers. Due to safety precautions, the upper deck slide exit will only be opened during trials when the exit is in use. Therefore both members of the crew will be aware in advance if the exit is available or unavailable, although during all trials they will on the call to evacuate, call passengers towards the exit and attempt to open the door. On the whistle signal, the crew will either step into the assist space and allow passengers to evacuate or redirect as appropriate.

A ten second delay will be used to simulate the time that it would take for an exit to be opened and for a slide to deploy. Following this delay, a whistle signal will be used to indicate to stewards outside the exits, and the crew inside the cabin, the moment when exits will be made available. Stewards who will be aware of the exit status, will be located outside each exit and will then signal to the cabin crew if the exit is available or unavailable.

If the exit is available the crew will move into the assist space and allow passengers to move through the exit using assertive commands such as "jump, jump," on the slide, "keep moving", "form 2 lines" and "stay on your feet". These commands will be supported by physical gestures, hand signals and eye contact as appropriate.

Cabin crew at unavailable exits will be asked to redirect passengers to the available exits. Again Virgin Atlantic Airways current commands will be used such as "Exit blocked" and "Go that way". Crew will be asked to use the information available to them to redirect passengers through the cabin using appropriate commands, physical gestures, hand signals and eye contact.

[2] Muir, H.C. & Cobbett, A.M. (1996) *The influence of cabin crew during emergency evacuations at floor level exits*. CAA Paper 95006, Civil Aviation Authority, London.

2.8.7. Platform safety

There will be a number of stewards located outside each of the exits. They will marshal evacuating passengers away from the exits. This will be done to ensure that the evacuation flow is not affected by passenger blockages outside the exits. At the bottom of the evacuation slide will be two fire persons who will assist passengers to move away from the bottom of the slide. Stewards will also be located at the bottom of the slide to move passengers away from the area. Medical personnel and research staff will be available throughout the evacuation, and will carry emergency stop alarms. If it is felt that the safety of any participant is at risk during the trial, the alarm will be sounded to halt the trial.

2.8.8. Completion of trial

Each trial will be deemed complete once all participants have evacuated the cabin simulator. Participants will then be required to complete relevant post evacuation questionnaires. One of these has been designed by Cranfield University and the other by Sofreavia. Participants will then board the cabin simulator for the next trial, and the procedure will be repeated. Sofreavia have also designed a post evacuation interview schedule with cabin crew. These will be administered after each trial.

2.8.9. Completion of session

Once all four evacuation trials have been completed, the participants will be thanked and debriefed by Professor Muir. Professor Muir will require clarification with regards to the information that can be provided in a debrief, since the project is confidential. Participants will then be paid the £25 attendance fee, and will also be provided with a thank you letter containing contact information in the event that they experience any difficulties as a result of participation in the trials. A copy of this letter will be provided in the analysis report.

3. DATA ANALYSIS

Three partners of the consortium are conducting data analysis from the trials - Cranfield University, Sofreavia and the University of Greenwich.

Due to the experimental design, Cranfield University feel that the data obtained from the proposed test plan will not be amenable to statistical analyses. Even where such analyses are feasible, the results will be difficult to interpret. Findings from such limited data are also likely to be unreliable, and hence it will not be possible to draw any firm conclusions. Therefore Cranfield University will only be conducting descriptive analyses on evacuation times and rates and selected information from the Cranfield University post evacuation questionnaire. Cranfield University will provide the qualitative responses from their questionnaire in a data supplement, but will not be conducting in depth qualitative analysis on these responses. The University of Greenwich will be conducting quantitative and qualitative analysis on staircase flow rates, passenger use of the handrail and upper deck slide hesitation. Sofreavia will be conducting qualitative analysis using information gained from the Sofreavia post evacuation passenger questionnaire and cabin crew interviews.

Cranfield University will retain all video original data and originals of the Cranfield University questionnaires. Originals of the Sofreavia post evacuation questionnaires and cabin crew interviews will be retained by Sofreavia. Cranfield University will edit and time coded all video data and distribute a copy of the footage to all partners after the trials.

4. TIMESCALES

As with all research conducted by the Human Factors Group, the approval of the Human Factors Group Ethics Committee will be sought before the tests can commence.

The data is due to be collected over two test sessions in January and February 2003. The tests will be conducted within the Large Cabin Evacuation Simulator located within Hangar 3, School of Engineering, Cranfield University. The proposed test dates and times are as follows:

- Saturday, 25 January 2003, with check in starting at 09.00
- Saturday, 1 February 2003, with check in starting at 09.00

Two pilot trials will be conducted during the week commencing the 20 January 2003. These trials are intended to provide training for the cabin crew and stewards, and to ensure that test procedures operate as planned. The dates and times of these sessions are Thursday 23rd January at 16.00 with up to 40 participants and Friday 24th January at 13.00, again with up to 40 participants Cranfield University propose that cabin crew training is held on Thursday 23rd January prior to the scheduled pilot trial.