



CRANFIELD UNIVERSITY

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**AN INVESTIGATION OF THE FACTORS
INFLUENCING PASSENGERS' ABILITY TO OPERATE
EXITS ON CIVIL AIRCRAFT**

**COLLEGE OF AERONAUTICS
HUMAN FACTORS**

PhD THESIS

ABSTRACT

Type III exits are a useful means of escape and they exist on a large proportion of the airline fleet. Evidence from aircraft accidents and previous research indicates that many passengers experience great difficulty in operating and evacuating through an overwing exit. There are two different approaches to improving passenger operating performance; these being improvement and simplification of the task itself or provision of clear instruction or practice for the passenger seated next to the exit.

The first experiment investigated the impact of improvement to the Type III exit mechanism and practice on participant operation speed and accuracy. The results of a four-way Analysis of Variance indicated that both speed and accuracy of operation improved as a result of the exit redesign. A Repeated Measures Analysis of Variance also showed that the provision of practice led to a significant reduction in operation times. However, practising the operation of the current design of the Type III exit failed to improve participant speed of operation to the level achieved by participants when operating the modified exit for the first time.

The results from the second study which investigated the impact of variations in safety briefings on participants' speed and accuracy of operation of the traditional Type III exit clearly indicated the benefits of providing some form of instruction. Allowing participants to watch a 'fellow passenger' on a video performing the task led to quicker and more accurate exit operation. Variations in pre-flight briefing card design were also shown to improve operation accuracy.

The implications of these results for the future development of self help exits, provision of training and design of briefing material are discussed.

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CONTENTS

	Page
1 INTRODUCTION TO THESIS	
1.1 Objectives Of Thesis	1
1.2 Plan of Thesis	1
2 FACTORS INFLUENCING SURVIVAL	2
2.1 Accident Classification	3
2.2 Factors Influencing Evacuation Success	3
2.3 Type III Exits	5
2.4 Mandatory Action	8
2.5 Research Into Passenger Access And Operation Of Type III Exits	9
2.6 Passenger Behaviour And Reactions To Life Threatening Situations	12
2.6.1 Flight-fight response	14
2.6.2 Anxiety	14
2.6.3 Affiliative behaviour	16
2.6.4 Depersonalisation	16
2.6.5 Panic	17
2.6.6 Behavioural inaction	18
2.6.7 Strategic or planned behaviour	20
2.6.8 Evaluation of the classification of behaviour	20
2.7 Methods of reducing passenger maladaptive behaviour and increasing the occurrence of adaptive behaviours	21
2.8 Approaches to solving Type III exit operation problems	22
3 DESIGNING THE TASK FOR THE MAN: IMPROVEMENT OF EQUIPMENT	23
3.1 Biomechanic Considerations	23
3.2 Type III exit improvement	24
3.3 Concept generation and selection	25
4 IMPROVING THE MAN FOR THE TASK	29
4.1 Introduction	29
4.2 Safety briefing legislation	29
4.3 Safety information and passenger attention	32
4.4 Instruction and training	35
4.4.1 Telling the passenger how to operate the exit	35
4.4.2 Showing the passenger how to operate the exit	36
4.4.2.1 Safety briefing cards	36
4.4.2.2 Video safety briefings	39

4.4.3	Practice	41
4.4.3.1	Airport safety centres	41
4.5	Retention of procedural tasks	43
4.6	Transfer of training	44
5	RATIONALE FOR THE THESIS	46
5.1	Experiment One: Exit Redesign And Practice	46
5.1.1	Objectives	47
5.2	Experiment Two: Mode Of Instruction	47
5.2.1	Objectives	48
6	EXPERIMENT ONE: EXIT REDESIGN AND THE INFLUENCE OF PRACTICE	50
6.1	Research Design	50
6.1.1	Ethical considerations	51
6.1.2	Methodological considerations	51
6.1.3	Equipment	52
6.1.3.1	The Cabin Mock-Up	52
6.1.3.2	The Type III Exits	53
6.1.4	Data Acquisition	54
6.1.5	Participants	55
6.1.6	Procedure	55
6.2	Results	58
6.2.1	Individual characteristics of the participants	58
6.2.1.1	Modified Type III exit	58
6.2.1.2	Traditional Type III exit	58
6.2.2	The operation of the Type III exit	60
6.2.3	The influence of the Type III exit operation mechanism	60
6.2.4	The influence of seating condition	63
6.2.5	The influence of participants gender on the operation of the Type III exit	64
6.2.6	The influence of participants handedness on the operation of the Type III exit	65
6.2.7	The influence of practice on the operation of the Type III exit	65
6.2.8	Placement of exit and the effect of practice	68
6.2.9	Participants perceived ease of operation and the effect of practice	70
6.2.10	Problems experienced by participants in operating the Type III exit and the effects of practice	70
6.3	Discussion	73
6.3.1	Evaluation of test methodologies	73
6.3.2	The influence of the Type III exit operation mechanism	74
6.3.3	The influence of seating configuration on the operation of the Type III exit	74
6.3.4	The influence of participants gender on the operation of the Type III exit	75

6.3.5	The influence of participants handedness on the operation of the Type III exit	75
6.3.6	The influence of practice on the operation of the Type III exit	75
6.3.7	Placement of exit and the effect of practice	76
6.3.8	Participants perceived ease of operation and the effect of practice	77
6.3.9	Problems experienced by participants in operating the Type III exit and the effects of practice	78
6.4	Conclusions	79
7	EXPERIMENT TWO: MODE OF INSTRUCTION	81
7.1	Research Design	81
7.1.1	Ethical considerations	82
7.1.2	Methodological considerations	82
7.1.3	Equipment	82
7.1.3.1	The Cabin Mock-Up	82
7.1.3.2	The Type III Exits	83
7.1.4	Data Acquisition	83
7.1.5	Participants	83
7.1.6	Procedure	84
7.2	Results	86
7.2.1	Individual characteristics of the participants	86
7.2.2	Donning of the lifejacket	86
7.2.3	The operation of the Type III exit	87
7.2.4	Position of operation	92
7.2.5	Disposal of the Type III exit	93
7.2.6	Questionnaire information	95
7.2.6.1	Pre-flight safety briefing	95
7.2.6.2	Additional safety briefing	95
7.2.6.3	Safety card	95
7.2.6.4	Exit diagram	96
7.2.6.5	Verbal instructions	97
7.2.6.6	Video	97
7.2.6.7	Most preferred method of presentation of information	97
7.2.6.8	Operation of the exit	99
7.2.6.9	Exit operating difficulties	102
7.2.6.10	Perceived weight of the exit and time to operate the exit	102
7.2.6.11	Attitudes towards safety	103
7.2.6.12	Preferred briefing card	106
7.3	Discussion	108
7.3.1	Donning of the lifejacket	108
7.3.2.1	Speed of operation	108
7.3.2.2	Accuracy of operation	108
7.3.2.3	Position of operation	111
7.3.3	Questionnaire information	112
7.3.3.1	Difficulty of operation and clarity of instruction	112

**PAGE
NUMBERING
AS ORIGINAL**

LIST OF FIGURES

Figure 1	Some Factors Influencing Survival in Emergency Evacuations
Figure 2	Type III Exit dimensions
Figure 3	Type III Exit operation
Figure 4	Number of Type III exits opened and used for evacuation by passengers in thirteen emergencies during the period 1970-1980
Figure 5	Factors contributing to the uniqueness of the situation in an aircraft cabin
Figure 6	The relationship between levels of anxiety and performance for both simple and difficult tasks
Figure 7	Proposed Improved Type III exit concept
Figure 8	Alternative handle/handhold configurations tested in preliminary operation trials
Figure 9	The cabin simulator
Figure 10	Graphical representation of mean times (in seconds) taken by participants from hand on handle to exit and evacuate onto the wing TEST ONE.
Figure 11	Graphical Representation of mean times (in seconds) to operate the exit and evacuate onto the wing. All Tests
Figure 12	Correct disposal of the Type III exit and the effects of practice
Figure 13	Graphical depiction of Mean times (in seconds) taken by those participants <i>correctly disposing of the exit</i> - exit available.
Figure 14	Graphical representation of the Mean times (in seconds) taken by those participants <i>correctly disposing of the exit</i> - hand on handle to exiting onto the wing.
Figure 15	Number of participants correctly disposing of the exit
Figure 16	Placement of the exit
Figure 17	Number of participants who felt that the exit diagram on the briefing card was helpful
Figure 18	Most preferred method of presentation of information
Figure 19	Average difficulty rating of opening , disposing and exiting on to the wing
Figure 20	Average rating of the clarity of the opening and disposing instructions
Figure 21	Perceived weight of the exit and time to operate the exit.
Figure 22	Participants perceived chance of survival in an aircraft accident
Figure 23	Attitudes towards safety information on board aircraft
Figure 24	Percentage of participants who watch the pre-flight safety briefings on board aircraft
Figure 25	Preferred briefing card

LIST OF TABLES

Table 1	Individual capacity of lift (kilograms)
Table 2	Proposed methods for conveying instructional information
Table 3	The numbers of participants in each of the experimental test conditions
Table 4	Fiftieth percentile height and weight for males and females
Table 5	An independent t-test summary table for participant age across the two exit types
Table 6	An independent t-test summary table for participant height across the two exit types
Table 7	An independent t-test summary table for participant weight across the two exit types
Table 8	An independent t-test summary table for participant frequency of strenuous exercise across the two exit types
Table 9	Mean times (in seconds) taken by participants from hand on handle to exit and evacuate onto the wing.
Table 10	Analysis of Variance summary table; the influence of door type, seating condition, participant handedness and sex on exit operation time (test one).
Table 11	An independent t-test summary table for participant speed of exit operation across the two AN79 seating configurations
Table 12	An independent t-test summary table for participant speed of exit operation with and without a simulated incapacitated passenger
Table 13	Mean times (in seconds) taken by participants from hand on handle to exit and evacuate onto the wing, indicating the effect of handedness of the participants (standard deviations are shown in parentheses). Test one
Table 14	Mean times (in seconds) taken by participants from hand on handle to operate the exit and evacuate onto the wing. ALL TESTS
Table 15	A Repeated Measures Analysis of Variance Summary Table for Between-subjects and Within-subjects effect of practice, on the times taken by volunteers to operate the Type III exit and evacuate onto the wing.
Table 16	Univariate t-tests seating condition by practice, test one versus two
Table 17	Univariate t-tests seating condition by practice, tests one and two versus three
Table 18	Placement of hatch by participants using the traditional Type III exit in Trials One, Two and Three
Table 19	Problems experienced by participants in operating the modified Type III exit mechanism during the three trials
Table 20	Problems experienced by participants in operating the traditional Type III exit during the three trials
Table 21	The experimental test conditions
Table 22	Mean times (in seconds) taken by <i>all</i> participants to make the exit available and from hand on handle to exit and evacuate onto the wing.

Table 23	Mean times (in seconds) taken by those participants <i>correctly disposing of the exit</i> - exit available
Table 24	One-way Anova Summary table - Time to make exit available by briefing condition
Table 25	Mean times (in seconds) taken by those participants <i>correctly disposing of the exit</i> - hand on handle to exiting onto the wing.
Table 26	One-way Anova Summary table - Time to operate the exit and evacuate onto the wing
Table 27	Position of participants during operation of the Type III exit
Table 28	How did the Pre-flight safety briefing aid your escape?
Table 29	How did the safety card aid your escape?
Table 30	One-way Anova Summary table - Mean difficulty of opening rating by briefing condition
Table 31	One-way Anova Summary table - Mean difficulty of disposal by briefing condition
Table 32	One-way Anova Summary table - Mean difficulty of exiting through the exit by briefing condition
Table 33	One-way Anova Summary table - Mean clarity of operating instructions by briefing condition
Table 34	One-way Anova Summary table - mean clarity of disposal instructions by briefing condition
Table 35	Participants report problems when operating the Type III exit

1 INTRODUCTION TO THESIS

In an emergency, the main exits of a civil aircraft are normally expected to be operated by a member of the cabin crew. The Type III exits, which are smaller and usually located over the aircraft wing, must be opened by passengers.

The objective of this thesis was to investigate the human factors associated with the operation of the Type III Exit. The difficulties which passengers encounter when trying to operate such exits have been well documented and the aim of the two experimental studies was to investigate methods of improving passengers ability to operate these exits in a timely and correct manner.

The introduction to the thesis begins with a review of factors influencing passengers performance of safety procedures and the specific difficulties encountered with the Type III Exit. In the following chapters the methods which may be used to improve passenger operation of the Type III exit by either improving the operator through better instruction and practice or improving the design of the equipment so that it is easier for the operator to use are considered. Each of the experiments are reported in separate chapters including a discussion of the results. The final chapter of the thesis provides conclusions from the research programme and recommendations for further research are discussed.

2 FACTORS INFLUENCING SURVIVAL

Over the last three decades, air travel has become an increasingly popular means of transportation. A large proportion of the population of the United Kingdom now assume that their primary mode of transport to reach their holiday destination will be by aircraft. The market for business travel is one of the major growth areas for airlines, becoming increasingly competitive. Whilst air travel is considered to be relatively safe, unfortunately accidents do occur. In 1997 the world-wide fleet of commercial airliners were involved in 152 accidents of which 51 were classified as survivable (Flight International, 21 January, 1998).

The aviation industry has made remarkable progress in reducing the rate of aircraft accidents. Statistics quoted by Hart (1996), indicate that had accident rates not improved since 1960, due to the volumes of flights today, the industry would suffer more than 10,000 fatalities a year world-wide. He goes further to suggest that due to this dramatic decline in accident rates, the industry actually suffers on average less than 800 fatalities. This figure relates to accidents involving aircraft from the worldwide commercial jet fleet and is supported by data presented by Russell (1996).

Whilst primary safety has dramatically improved over the last few decades with measures being taken to prevent major accidents occurring, the statistics would seem to indicate that secondary measures which are introduced to protect the public in the event of an accident occurring, have not led to a similar reduction in the fatality rate on board survivable aircraft (Boeing Commercial Airplanes, 1989; Taylor, 1996). For this reason not only the issues concerned with the prevention of the occurrence of accidents, but also issues related to improving survival rates in the event of an accident, will be of major importance in the years to come.

2.1 *Accident classification*

Accidents may be classified into three categories; 'non survivable', 'survivable', and 'technically survivable'. Accidents are classified as non survivable when crash forces for example are so severe that none of the passengers or crew survive (for example Pan Am 747 in 1988 at Lockerbie). Survivable accidents, are those accidents when all of the passengers and crew survive (for example KAL Airbus A-300, 1994). Technically survivable accidents, include those where some of the passengers or crew survive. This grouping includes accidents such as the British Airtours Boeing 737 at Manchester, 1985.

In the majority of accidents the deceleration forces imposed on the aircraft occupants and their immediate environment during the crash sequence, are such that the passengers are not exposed to unacceptable 'g' tolerances. On such occasions, an emergency evacuation maybe instigated by the cabin crew with the aim to facilitate the rapid movement of passengers from a potentially hazardous environment to the outside world. The success of such rapid evacuation of those on board is dependent upon a number of extrinsic factors. These include the number and location of exits; any help received from crew and other passengers; whether any exits are blocked by fire or smoke and if all available exits have been operated. Survival may also depend upon intrinsic factors, those attributes which are held by individual passengers. The physical and mental attributes held by each individual may facilitate an individual's evacuation in the short time available; conversely these may also hinder the individual.

2.2 *Factors Influencing Evacuation Success*

The Probability of survival in a survivable aircraft accident depends on several factors. These can be broadly categorised into four groups: Configurational; Procedural; Environmental; and Behavioural (Snow, Carrole and Allgood, 1970). These are shown in Figure 1 with a brief description of each of the factors.

Figure 1. Some Factors Influencing Survival in Emergency Evacuations

(Amended from Snow et al, 1970).

	Description	Examples
Configurational	Standard features of the occupant environment controlling access to exits and evacuation flow rates	Seating density, aisle width, size, number and location of exits, slides, physical exit cues
Procedural	Regulatory and training of crew and other non-passenger rescue personnel which influence evacuation procedures	Experience and training of crew.
Environmental	Features of the occupant space and outside the aircraft which control the evacuation time	Heat and toxic by-products of combustion, secondary explosion, outside light and weather
Behavioural	Psychological, biological and cultural attributes of individual passengers which influence agility and behaviour	Sex, age, knowledge and physical condition of passengers

Included among these factors, is the passenger’s knowledge of the emergency evacuation equipment, procedures and the location of exits. It has become apparent from aircraft accident investigations, that passengers’ behaviour and ability to operate emergency equipment and procedures are important survival factors. Barthelmess (1984) suggested that pre-planning and safety knowledge were the most important factors in the survival of those onboard the DC9 at Cincinatti (June 1983).

Research and development of mandatory requirements by the aviation authorities has to date concentrated primarily on the configurational and procedural factors. The

aims of which have been to improve and maintain air safety and aid passenger egress during emergency situations. In order to ensure that emergency evacuations are as expeditious as possible the timely operation of all exits which are available is imperative. In most instances crew members will be stationed next to the main aircraft exits, however on many types of aircraft passengers without the assistance of crew members, will be required to operate self help exits such as Type III and IV exits.

2.3 Type III Exits

Type III exits are used on a large range of sizes and types of civil aircraft. There are currently 532 aircraft registered in the United Kingdom aircraft fleet with Type III exits (JAP World Airline fleets, 1998). Type III exits differ from airframe main doors by not being supported or having their motion constrained by a mechanism. The dimensions of these exits and restrictions are given in Figure 2 and a simplified representation of their operation is shown in Figure 3. Figure 3 is one example of a Type III exit operation diagram, others will be considered in Chapter 7.

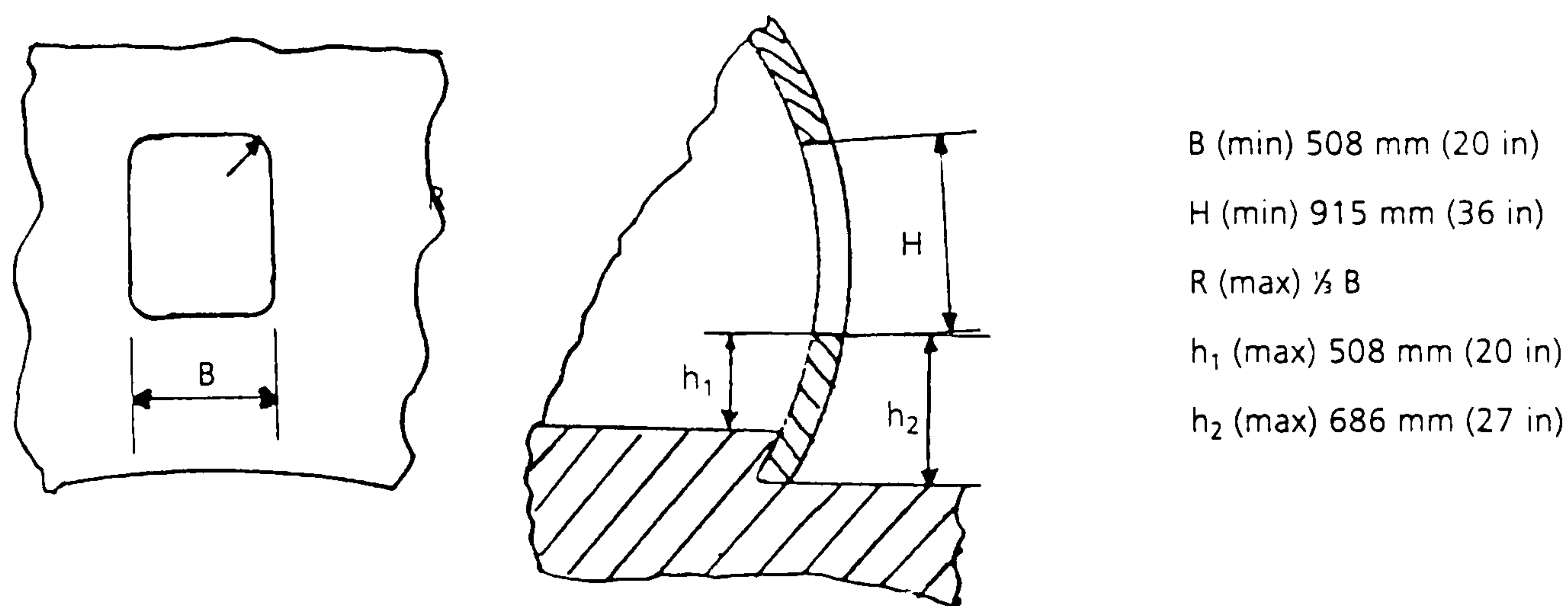


Figure 2: Type III exit dimensions



Figure 3: Type III exit operation

Once released from the aperture, the mass of the hatch must be supported by the operator who should then rotate the exit and jettison it through the opening. This method of operation has a number of possible disadvantages in an emergency situation. Firstly the hatch can be very heavy weighing up to 30.4kg (67 lbs) on some A320's (Appendix A provides details on aircraft specific Type III exit hatch weights). Added to this there is limited space between seats and other obstructions, contrary to the impression given by Figure 3. The situation is potentially made worse, for the operator of the exit, by passengers crowding into the space available, in their attempt to rapidly escape through the opening. Finally, the design of the exit is not common in everyday life, unlike most exits and doors passengers encounter on a daily basis, the exit is not hinged and does not open outwards. As Johnson (1984) observed the operator is usually a passenger, not a member of the cabin crew, as would normally be the case for larger exits, and has not had the benefit of training prior to boarding the aircraft.

The evidence from aircraft accidents indicates that many passengers were unfamiliar with the method of operation of the Type III overwing exit and as a consequence

experienced great difficulty operating a Type III exit and evacuating through the exit onto the wing. For example in the accidents which occurred at King Salmon, Alaska in 1982 and Manchester in 1985, passengers seated adjacent to these exits were confused and unclear about the method of operation. In Alaska the overwing exit did not become operational until the passengers were assisted by the Aircraft Commander. At Manchester a passenger initially attempted to operate the exit by using the armrest on the hatch, subsequently the person sat next to her operated the release handle trapping the person seated adjacent to the exit under the exit hatch. The man behind her had to then remove the hatch and place it on a seat in his row. These delays led to the exit not being fully operational until 45 seconds after the aircraft came to a halt.

CAP 360, part 1, Chapter 6 page 6/19 Paragraph 3.1 requires that for Type III exit seat rows 'the seats which form the access route from the cabin aisle to the exit are only to allocated to passengers who appear capable of operating and/or assisting with the operation of the exit'. According to this requirement, passengers may not occupy these seats if they are handicapped, children or infants, frail, elderly or obese, deportees or prisoners in custody, as they may in an emergency evacuation cause a delay or obstruction. Unfortunately, these requirements do not guarantee the speedy operation of these exits, passengers may fail to make the exit available quickly due to incapacitation from physical injuries or as a result of psychological trauma.

Despite passenger difficulties in operation of these type of exits are still an important means of escape particularly as accident data shows that exits in the middle of an aircraft tend to be more usable than exits at either end (Chandler, George and Pollard, 1987). Figure 4 indicates the important role these type of exits can have in an emergency exit.

Figure 4: Number of Type III exits opened and used for evacuation, by passengers in thirteen emergencies during the period 1970-1980*

	Aircraft accidents												
	1	2	3	4	5	6	7	8	9	10	11	12	13
No. of exits opened by passengers	1	2	1	3	4	1	4	2	2	2	3	2	2
No. of passengers using exit(s)	31	?	1	?	11	9	?	?	46	?	?	12	8

Source: Data from Johnson, 1984.
 * These data do not represent all the aircraft accidents that occurred in the period 1970-1980.

2.4 *Mandatory action*

In the accident which occurred at Manchester Airport in the UK in 1985 the evacuation of passengers was impeded by blockages at the Type III exit and at the aperture between the bulkheads at the front of the cabin. At the time, the configuration of the seat row which forms the access to the overwing exit was not required by the CAA to have any specific dimensions. The only constraint at the time was that the location of the seats relative to the exit did not cause any obstruction in the opening of the exit itself (FAR/JAR 25, part .813). As a result of the accident at Manchester, in 1986 the CAA introduced minimum standard requirements for seating configurations and exit operating instructions, in order to improve the opening and access to the Type III exits. The Airworthiness notice No.79 1989 (AN79, 1989) defined two new alternative seating arrangements which the CAA believed would make the opening of the exit easier:

‘Where all forward facing or all aft facing seats are arranged such that there is a single access route between seat rows from the aisle to a Type III exit, the access shall be of sufficient width and be located fore and aft so that no part of

any seat which is beneath the exit extends beyond the exit centre line and the access width between seat rows vertically projected, shall not be less than half the exit hatch width including any trim, or 10 inches, whichever is greater.’

and

‘Seats may only be located beyond the centre line of a Type III exit provided there is space immediately adjacent to the exit which projects inboard from the exit a distance no less than the width of a passenger seat and the seats are so arranged as to provide two access routes between seat rows from the cabin aisle to the exit’.

In addition to changes to the seating configuration the AN 79 1989 (paragraph 2.5) required Type III operating instructions, comparable to those on the Cabin Safety Leaflet to be displayed on the back of the seats, on the seat row immediately forward of the exits.

2.5 Research Into Passenger Access And Operation Of Type III Exits

The Manchester air disaster in 1985 thus precipitated a considerable amount of research into the conditions in which passengers are best able to evacuate an aircraft through its overwing exits. Much of this research has been conducted in order to determine whether the configurational changes outlined in AN79 have actually had any impact on passenger access to and opening of the Type III exits.

Early research conducted by Rasmussen and Chittum (1986), investigated configurational changes adjacent to emergency exits. They found that by increasing the seat pitch, or removing the outboard seat adjacent to an overwing exit, the rate of egress could be significantly increased. This research however, was conducted with passengers evacuating in a rapid and orderly manner in conditions similar to those in

the airworthiness certification tests, and therefore it could be argued that no account was taken of the situation when passengers are all pushing to try and get out of the exit at the same time.

Muir and Marrison (1989) conducted a programme of research into passenger behaviour in aircraft emergency evacuations. In order to increase the individual motivation of volunteers to evacuate rapidly from a stationary aircraft, bonus payments were introduced. Their study investigated the influence of several seating configurations of the seat rows which form the access to the Type III exit, including the two alternate minimum seating requirements specified in AN 79 and the seating configuration prior to 1986. The research indicated that evacuation rates through the overwing exit were significantly faster for the seating configurations specified in AN 79, as compared to that prior to 1986. However when the outboard seat was removed, two escape routes were available, one along the rows bounding the exit and one by means of the row to the aft of the exit. This led to a situation in which double the number of people had access to the Type III exit at one time, leading at some points, to a complete blockage. This congestion led on two occasions to the evacuation being halted before all of the volunteers had escaped and as a result this configuration should be treated with caution.

During each of the evacuations a member of the research team operated the Type III exit in order to remove any interaction between the method of opening the exit and the seat configuration on egress rate. As a result of this methodology, the study did not provide an insight into the difficulties that untrained personnel might encounter when attempting to operate such an exit. Interestingly the trained individuals who operated the exit during this research programme reported that some seating configurations made the task of opening the exit more difficult than others. The highest rating of difficulty was given to the outboard seat removed seating configuration followed closely by the Pre AN79 seating configuration. This result suggests that ease of exit operation is in fact a facet of the success of an emergency evacuation.

More recent work carried out by Fennell & Muir (1993) investigating the influence of hatch weight and seating configuration on the operation of a Type III exit, illustrated the difficulties that members of the public can experience when operating this type of exit. Indeed some participants in this experiment took over 50 seconds to operate the exit and evacuate onto the wing. This research also highlighted the difficulty some passengers experience with the correct disposal of the exit (many participants left it inside the aircraft, thus causing an obstruction). The authors suggested that the problems experienced by the volunteers during the tests indicated that the Type III exit hatch operating instructions illustrated on safety cards were ambiguous to some passengers. The result of this ambiguity was to slow down exit operation and cause indecision about exit disposal. The study however failed to make any suggestions about how the exit operation diagrams could be improved in such a way any ambiguity could be removed. It also failed to suggest any possible alternatives to instruction format or delivery that may aid and/or improve passengers ability to operate such exits.

The results from this test programme did however clearly indicate the benefit which could be gained from a reduction to the weight of the hatch from 25kg to 12.5kg on the time taken to operate the exit hatch. Reductions of this degree have proved difficult on large transport aircraft although there have been some redesigns e.g. Boeing 737 exit hatch mass has been reduced to 17kg, A320 exit hatch mass has been reduced to 14.5 kg. However in Fennel and Muir's study such a reduction in weight did not lead to a significant reduction in exit operation times.

Research to date has successfully highlighted methods to improve passengers egress to and through the Type III exit. The programme of work carried out by Muir and Marrison (1989) showed that configurational changes to seating in this area detailed in AN79 (1989), could significantly increase passengers speed of egress. This research also indicated that ease of exit operation is in fact a facet of the success of an emergency evacuation. Whilst the reduction in weight of these exits has been shown to significantly aid the operator, in reality these improvements have been difficult to

achieve to date. This study also indicated that many participants were failing to comprehend the operating instructions finding the diagrams ambiguous and unclear. In order to insure that in the event of an emergency, exits operated by untrained passengers are made available as quickly and correctly as possible further research is required.

2.6 Passenger Behaviour And Reactions To Life Threatening Situations

When assessing possible changes to equipment or procedures to be used by passengers, it is imperative that the way in which passengers may behave in an emergency be considered. It is well known that in some aircraft accidents everyone files out of the aircraft in an orderly manner, for example in the evacuation of the British Airways Boeing 747 at Los Angeles in 1987 as a result of a bomb scare. However, in other accidents, the orderly process breaks down and confusion in the cabin can lead to blockages in the aisles and at exits resulting in loss of life.

With comprehensive understanding of behaviour in highly stressful and disorientating conditions steps can be taken to improve the probability of increasing passenger accuracy and speed when performing safety procedures.

Behavioural responses of survivors to aircraft accidents can be gathered from two sources. Firstly via survivors' accounts and accident reports and secondly from experimental work. Until recently very few accounts of passenger behaviour have been published and conducting truly realistic experiments has been limited due to the ethical constraints imposed on such work. As a result of these constraints information has been supplemented from a variety of emergency situations and natural disasters. While the inclusion of such data has proved essential it is important to keep in mind the uniqueness of the aircraft accident. This uniqueness is apparent when one

considers the five factors, proposed by Robson (1973), constituting differences between passengers in an aircraft accident and other high stress situations.

Figure 5: Factors contributing to the uniqueness of the situation in an aircraft cabin

1. The passengers form a fairly large amorphous group, with no fixed hierarchy.
2. The passengers have usually never met before
3. The passengers are in what to the majority of them is a strange environment.
4. The cabin is a cramped environment.
5. There are essentially only two levels of group structure in the cabin - the crew and passengers.

(Taken from Robson, 1973)

In an aircraft situation all five factors apply, however in other settings only some may be present. Robson (1973) provides several examples to highlight this point, for example in a mine disaster only factor four is applicable however in a theatre fire factors one, two and five are applicable. Despite the limitations of information from such sources its inclusion supplements the available information from aircraft accidents allowing a more in depth picture to be constructed relating to the types of behaviours exhibited by passengers particularly in smoked filled environments.

There are many different ways in which individual passengers respond to an emergency situation. These may be influenced by their familiarity with the environment, the time available for preparation, the perceived time available for escape, whether they are alone or accompanied, their previous experiences, the type of emergency and demographic characteristics.

2.6.1 Flight/Flight Response

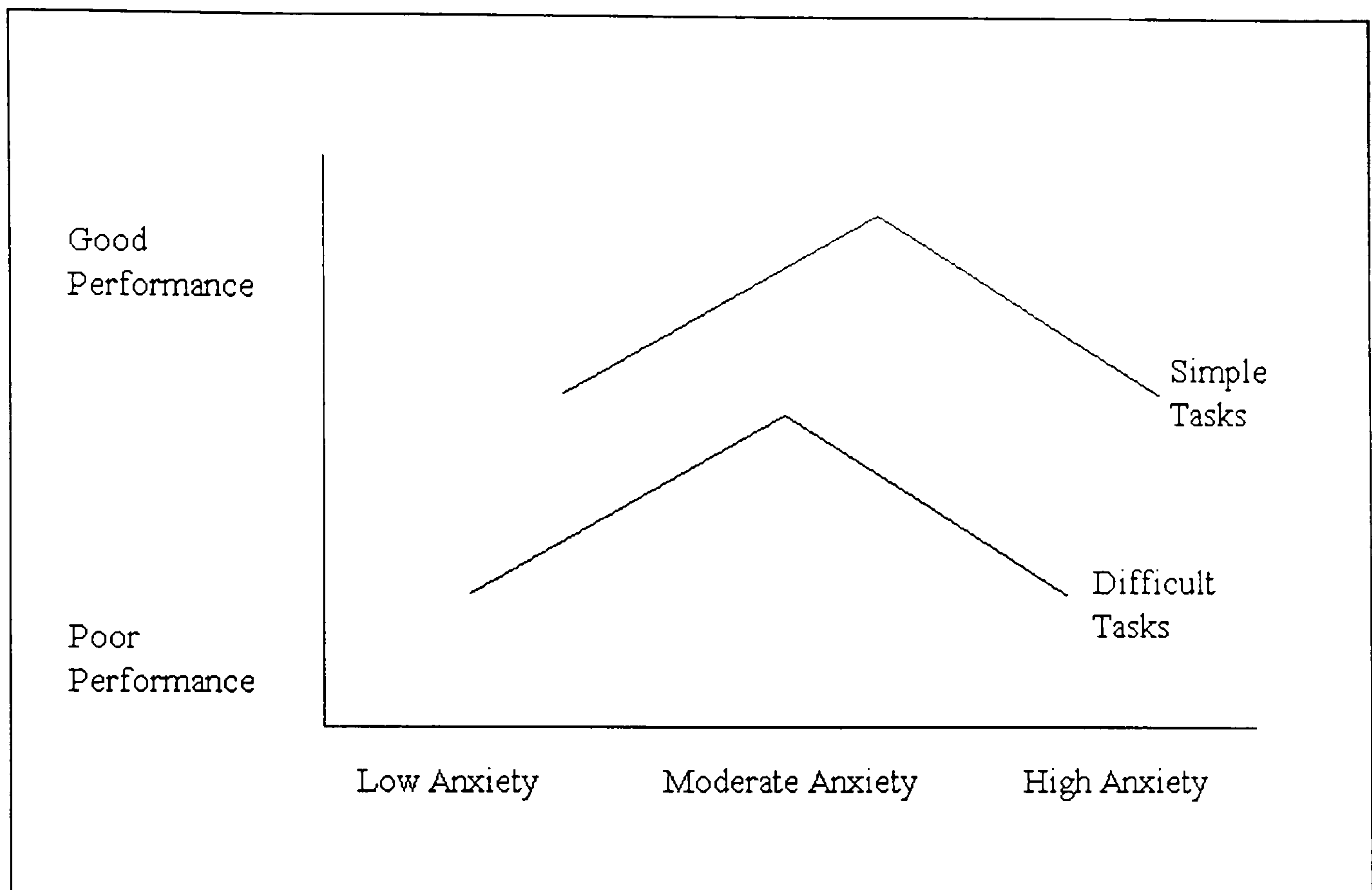
Fear, is the dominant emotion when survival is threatened and underlies all the behavioural responses to an aircraft emergency. Lazarus (1966) purported that once a threat is perceived a person may react in three ways: ‘strengthen his resources’, ‘flight’ from the area, in other words escape, or ‘fight’ i.e. attack the agent of harm, perhaps a cabin fire in this instance and finally an individual may remain inactive and ‘do nothing’.

The degree and magnitude of the flight/flight response is strongly linked to the degree of perceived threat. Flight may in the case of a small fire involve evacuating a specific part of the cabin; however, should the perceived threat be greater, this may lead to individuals even trying to evacuate before the aircraft has come to a stand still and against the advice of cabin crew as in the case of the aircraft accident quoted by LeRoy (1967).

2.6.2 Anxiety

In an emergency situation which is potentially life threatening and anxiety provoking, passengers are expected to make a series of novel and difficult responses. In view of the relationship now known to exist between individuals’ ability to perform and their level of anxiety, it is no wonder that an individuals ability to carry out the required actions and safety tasks does not reach its optimum level (see Figure 6).

Figure 6: The relationship between levels of anxiety and performance for both simple and difficult tasks (Yerkes-Dobson Law, 1906)



As Figure 6 demonstrates, during levels of high stress interference with memory and learning processes reduces one's ability to perform even the most simple tasks. This suggests that the information in the pre-flight safety briefing and on the safety card may not be well remembered. Similarly, safety demonstrations given to passengers shortly before an anticipated emergency may not be fully comprehended. An individual in an emergency situation has to quickly respond to the cues he receives. This response will also be affected by how familiar the behavioural response is to that particular situation (Becker, 1973). It has been shown that passengers' ability to perform simple tasks such as the operation of an oxygen mask and seat belt can be detrimentally affected by high levels of stress (Johnson, 1984). A useful theory for understanding and predicting the performance of passengers in emergencies is the 'habit hierarchy' (Spence, 1960). When a person experiences fear they are more likely to display a habit that is high in their hierarchy. An action will be high in the

hierarchy if it has been well practised and has become 'overlearned'. As a result an individual is more likely to perform a more familiar response in a highly stressful situation; this is known as affiliative behaviour. For example, many passengers revert to operating the aircraft lap belts as one would an ordinary car seat belt. If passengers are familiar with safety procedures then these actions will be high in the habit hierarchy and more likely to be exhibited in an emergency.

2.6.3 Affiliative behaviour

Research by Sime (1985, a) has suggested that behaviour of people trying to escape building fires is characterised by movement towards the familiar. In other words, that the direction of movement will be related to not only the location of the threat but, also the location and degree of familiarity of the individual with attachment objects (i.e. person and place affiliation). This escape behaviour has been observed in both emergency evacuations from buildings and aircraft as individuals try to escape through the doors through which they had entered the building or boarded the aircraft often by-passing useable alternative exits (Sime, 1985, b and Marrison and Muir, 1989). Recent research (Galea, 1998) has suggested that such behaviour is not as common as first thought, in fact the majority of passengers do indeed use their nearest exit.

2.6.4 Depersonalisation

Individuals involved in life threatening events often recount feelings of time slowing coupled with an increased mental activity (Noyes and Kletti, 1977). Such feelings of detachment appear to occur instantly as the individual realises they are in extreme danger and disappear when the threat is past. Individuals become 'observers' of the situation, detaching themselves from reality. By doing this it seems to allow them to be able to think and respond more effectively.

2.6.5 Panic

Panic may be defined as uncontrollable and irrational behaviour. The behaviour is characterised by self-preservation at all costs and irrational animalistic behaviour, involving the breakdown of group ties (i.e. ‘non-social’ behaviour: ignoring of group members; or ‘asocial’ behaviour: kicking, trampling) (Sime, 1985).

Panic only arises when something which is highly valued is threatened and when there is no obvious relenting by the threat (Cantril, 1958; Quarentelli, 1954). Interestingly Quarentelli noted that there appears to be little evidence of panic occurring when people have been trapped with no possibility of escape.

Sime (1993) highlights how ‘panic’ can be seen as a description of behaviour that occurs in disasters, created and used by the media to add ‘spice’ to disaster reports. The two examples below show how the same crowd behaviour may be interpreted very differently.

“Panic in an assembly audience results in a crowd jamming the exits and causing injuries quite apart from injury by fire. In the type of building now being considered, individuals as well as groups may become panic-stricken. Lives may be lost, for example through fear of using staircases in which there is smoke but which would actually give safe passage out of a building” (The ministry of Works, 1952 cited in Sime, 1993).

The same pattern of behaviour is interpreted somewhat differently below.

“When people, attempting to escape from a burning building pile up at a single exit, their behaviour appears highly irrational to someone who learns after the panic that other exits were available. To the actor in the situation who does not recognise the existence of these alternatives, attempting to fight his way to the exit available may seem a very logical

choice as opposed to burning to death”. (Turner and Killian, 1957 cited in Sime, 1993).

The second quote suggests that behaviour which may be seen as ‘irrational’ in respect to others, is in fact ‘rational’ from the perspective of those involved in the incident. It is suggested that the intentions and resultant behaviour of the individuals are in fact well thought out given the information available to them at the given time (Breux, Canter and Sime, 1976; Turner and Killan, 1957).

Whilst panic is often considered to be the most typical or expected response to an emergency the actual incidence of such behaviour is actually quite rare (Quarentelli 1954 , Fritz and Marks 1954, Innes 1975, Marrison and Muir, 1989). As Robson (1973) showed in his study following a emergency warning cabin crew members reported that only approximately 1% of individuals demonstrated panic behaviour.

2.6.6 Behavioural Inaction

Behavioural inaction is classified as a stunned and bewildered response to a disaster situation, a pattern of response described by Johnson (1984), as ‘negative panic’. Individuals behave as if they are dazed or immobile, behaviour which is totally inappropriate in an aircraft emergency, especially when fire and smoke is present in the cabin and typically individuals have less than two minutes when conditions are survivable in the cabin.

Allerton (1964), in his behavioural analysis of four disasters reported that 10 to 25% of people behaved in a “confused, anxiety-ridden, somewhat immobile manner”. Evidence from aircraft accidents suggests that this mode of behaviour is more likely to occur than panic. Survivors of the accident at Tenerife in 1977, when two Boeing 747s collided claimed to have witnessed fellow passengers remaining in their seats

while others did little to escape from the burning aircraft. Other survivors of this incident also stated that they had experienced this phenomenon but overcame it, by commanding themselves or being ordered by others to escape (Johnson, 1984). Equally, two fatalities of the DC-9 at Cincinnati (1983), were found sitting with their seat belts fastened, although both were sitting at a considerable distance from the source of the smoke and toxic fumes. Such individuals must have remained inactive until the fire and smoke overcame them.

Such a response to an aircraft accident is not surprising, passengers are expected to perform tasks which are novel and often complex. Such tasks include the location and operation of emergency exits, in an environment which may be physically threatening and confusing, due to smoke, fire, damage to the fuselage and the behaviour of fellow passengers.

Lazarus (1966) defines two cognitive states which are thought to manifest themselves in a behavioural response of inaction. The first state is that of a conflict of impulses. In the situation where an individual perceives a threat to their life the natural response is one of avoidance and immediate escape. However, such behaviour may be inhibited as a result of certain situational constraints equalling or exceeding the strength of the original threat.

The second state is that of no action impulse. Lazarus suggests that one of three conditions will lead to an individual taking no action after a threat has been identified. The first condition is where the individual is resigned to the conclusion that there is no way of preventing harm. The second condition resulting in an individual taking no action occurs when as a defence mechanism an incorrect reappraisal of the situation causes the individual to conclude that no danger exists. The final condition and possibly the most plausible explanation for behavioural inaction is that as a result of high stress the individual is uncertain of the correct response or action he/she should take.

2.6.7 Strategic or planned behaviour

Some behaviours observed in an emergency are not negative. There is considerable evidence to suggest that many individuals are capable of planning an appropriate strategy prior to an emergency and are able to retain their cognitive abilities in order to implement their chosen strategy (Barthelmess, 1984). Evidence from accidents suggests that those individuals who are well informed and mentally plan a strategy for escape have a greater chance of survival (Barthelmess, 1984; Johnson, 1984).

In the emergency at Cincinnati involving an in-flight fire (1983) cabin crew instructed five passengers in emergency procedures prior to landing. These five passengers were instructed to move towards specific exits as quickly as possible, open them and get out (Barthelmess, 1984). Four of these five passengers survived and all the crew compared with only 18 out of 41 of the remaining passengers. Barthelmess suggested that passengers given specific evacuation instructions had a 'mental game plan' or strategy.

2.6.8 Evaluation of the classification of behaviour

The evidence presented suggests that people can behave in a variety of ways when placed in a highly stressful and possibly life threatening situation. The idea that all people panic and behave in an irrational manner is a misplaced notion. An individual's response will be a reflection of the knowledge of the physical environment and his/her perception of the circumstances in which he/she finds him/herself. As a result there are a variety of behavioural responses that may be seen within one emergency.

2.7 *Methods of reducing passenger maladaptive behaviour and increasing the occurrence of adaptive behaviours.*

It has become apparent that stress is a major influence on behaviour, and may adversely affect passenger performance of novel or complex safety procedures.

Research by McDonnell Douglas (1977) proposed three methods by which maladaptive behaviours, such as behavioural inaction can be overcome increasing the chances that passengers correctly perform safety procedures. These are trial and error, training or instruction and crew member situation leadership.

An example of trial and error would be repeated attempts by a naive passenger to activate the flow of oxygen to their mask until they succeed. Such a strategy is the least effective method of overcoming maladaptive behaviours and not appropriate when time-critical responses are necessary. Unfortunately it is still the most frequently employed strategy. In light of this evidence in order to reduce the impact of high stress and optimise passenger performance when using such a strategy it is imperative that safety procedures are as simple as possible.

The likelihood of passengers eliciting maladaptive behaviours can be reduced by providing passengers with information about what to do in an emergency. The information might be given prior to aircraft departure. This strategy relies on passengers paying attention and retaining the information which is not always the case. Alternatively, the information might be delivered when an emergency is imminent although in the majority of accidents reviewed between the years of 1959 and 1985 only in 15% of cases was there time for cabin staff to inform the passengers of the imminent danger (Boeing Commercial Airplane Company, 1986). If passengers are to utilise information given to them during an emergency it must be clear and unambiguous enabling passengers to make rational and informed decisions about the appropriate course of action. If information was ambiguous this would

serve to increase passengers' already high stress levels reducing their ability to comprehend and carry out instructions effectively.

Providing passengers with training can increase the probability that safety information will, first be attended to and, secondly, carried out quickly and correctly. Pronko and Leith (1956) demonstrated that, when confronted by a confusing environment and the threat of physical harm for incorrect actions, participants who had practised the task performed best. Receiving leadership throughout the test was also of some benefit. Participants who received neither practice nor leadership, were the only experimental condition to exhibit behavioural inaction.

The third method of strong leadership can overcome behavioural inaction and prevent panic. Assigning passengers with roles and responsibilities can reduce the incidence of panic. For example, a passenger could be instructed to operate the Type III exit and others asked to take responsibility for the welfare of less able bodied passengers. Douglas found that crew member leadership combined with passenger information is more effective than either of the two methods alone.

2.8 *Approaches to solving Type III exit operation problems*

In the case of operational difficulties of the Type III exit there are two different approaches to minimising maladaptive behaviours whilst optimising passengers ability to operate the Type III exit in a timely and accurate manner. These are either “fitting the person to the task” or “fitting the task to the person”. In this instance the provision of safety information and training is concerned with the former and human centred design of equipment is concerned with the latter. Each of these will be dealt with in turn in two separate chapters.

3 **DESIGNING THE TASK FOR THE MAN**

3.1 *Biomechanic Considerations*

In general, biomechanics determines what a person can physically do. Research in the area of lifting tasks and manual handling of heavy loads invariably deals with repetitive tasks in the workplace suggesting acceptable weights and methods of reducing work related injuries.

Ayoub et al. (1987) quote the Information sheet published by the International Labor Organization which stated limits for occasional lifting as Table 1 shows the maximum acceptable weight for men aged between 20 - 35 is less than many of the designs of Type III exits. Other guidelines such as the National Institute for Occupational Safety and Health (NIOSH, 1981) and job severity index (JSI) (Ayoub et al. 1978) can be used to establish acceptable lifting recommendations.

Table 1 Individual capacity of lift (kilograms)

Age (years)	Men	Women
14-16	14.6	9.8
16-18	18.5	11.7
18-20	22.6	13.6
20-35	24.5	14.6
35-50	20.6	12.7
Over 50	15.6	9.8

As table one indicates strength tends to increase until about thirty years of age; then it levels off in middle age and decreases with old age (Hafez et al., 1982). However, the amount of decrease with age can be reduced by regular exercise. On average the strength of women is about two-thirds that of men. Suggesting that women should find more difficulty in the operation of the Type III exit.

The current method of Type III exit operation requires the operator to make unusual twisting movements to manoeuvre a large, heavy object in a restricted space. As table one indicates the lift capacity for many individuals will actually be less than that require for many of the current designs of exits. Whilst the chances of injury are greatly reduced as the operator is required to operate the exit only once, the unusual body movements and strength required to manoeuvre the exit may lead to delays and even failure in operation of even the fittest operator.

3.2 *Type III exit improvement*

As section 2.5 described work has been carried out by Fennell and Muir (1993) investigating the influence of weight changes to the existing Type III exit on the ease of passenger operation. The reductions in weight suggested as a result of this work have proved difficult to employ. So in order to aid passenger ability to operate these exits it is necessary to redesign the way in which the exit operates making it simpler and easier for passengers to use.

The following sections describe a study carried out by the Air Vehicles Design Group in the College of Aeronautics, Cranfield (Jones, 1995) which aimed to define and design an improved Type III exit so that its operation is simplified and more intuitive to untrained operators. The Yerkes-Dodson law described in section 2.6.2 indicates that that less complex the task, the more likely an individual will still be able to perform it successfully when suffering high levels of anxiety. Thus a reduction in complexity in the operation of the Type III exit, would therefore reduce the demands placed upon an individual completing this task.

3.3 *Concept generation and selection*

There are a number of ways in which present doors, exits and hatches are supported and actuated on aircraft. A sensible step in any design process is consideration of designs for the same or similar applications which already exist therefore, present methods of motion and support of exits on aircraft were surveyed. In practice these are quite limited, if consideration is restricted to exits that must be available in emergency situations for egress. However, other doors on aircraft, such as those for cargo and baggage, use further methods of support, motion and latching which are acceptable due to their not being required to be made available during emergencies.

In addition to reviewing current exit mechanisms a whole range of concepts for the basic motion(s) of the Type III exit were generated, beginning with the simplest translations/rotations and progressing through combinations of these to novel or unusual concepts. By considering the basic advantages and disadvantages of each and their ability to meet selection criteria below, as required by CAA, it was possible to select a short list of concepts for motion of the exit. The selection criteria were as follows:-

- a) Must meet all current regulations in particular FAR/JAR 25.783, 25.809 as well as all relevant ACJs (Acceptable Means of Compliance and Interpretation - Joint) and AMJs (Advisory Material - Joint).
- b) Must not result in reduction of the number of passenger seats in the aircraft.
- c) Must not become an internal loose item when opened.
- d) Must meet crashworthiness requirements (JAR 25.783).
- e) Operation must not be affected by icing.
- f) Must be simple and obvious to operate.
- g) Operation must be achieved with a minimum of effort.
- h) Ideally, the exit should only have one possible method of operation.
- i) Must be operable from both inside and outside the aircraft.
- j) There must be an indication of the latch state.

- k) There must be potential for easy retrofit to existing aircraft.

It was also stressed that the exit hatch must be positively closed by internal cabin pressure, requiring a 'plug' type closure with the first motion inwards and not relying on latches to withstand pressure loads. This was to maintain the integrity of current exits design, allowing retrofit.

In addition, other factors to be taken into account were;

- i) Complexity of support, sealing and actuation,
- ii) Alterations to exit hatch and/or aperture structure
- iii) Requirement for maintenance
- iv) Any increase in drag through external excrescence's
- v) Needs for stored energy devices
- vi) Possibility of retaining a window in the exit hatch
- vii) Possibility of use of exit in non-emergency situations e.g. during on-going maintenance

Concepts were short-listed for more detailed consideration in terms of consequences of their application to the Type III exit locations in versions of the Boeing 767. This aircraft was chosen due to the large mass of the present exit 30.4 kg (67 lbs), the number of passengers on the aircraft and therefore affected, and the close proximity of Cranfield to an operator of such aircraft. Using this approach final selection of a single concept was made and following evaluation on an AUTOCAD system developed into an experimental prototype.

Figure 7 below shows the chosen concept. The inward then upward sliding exit is in fact one that is used on the main doors of wide bodied aircraft such as the Boeing 767 and even older aircraft such as the Hawker Siddley Trident. Due to the need to raise the doors, power and/or counterbalancing is required and this can be provided by a range of methods from bungee to electric or hydraulic motors.

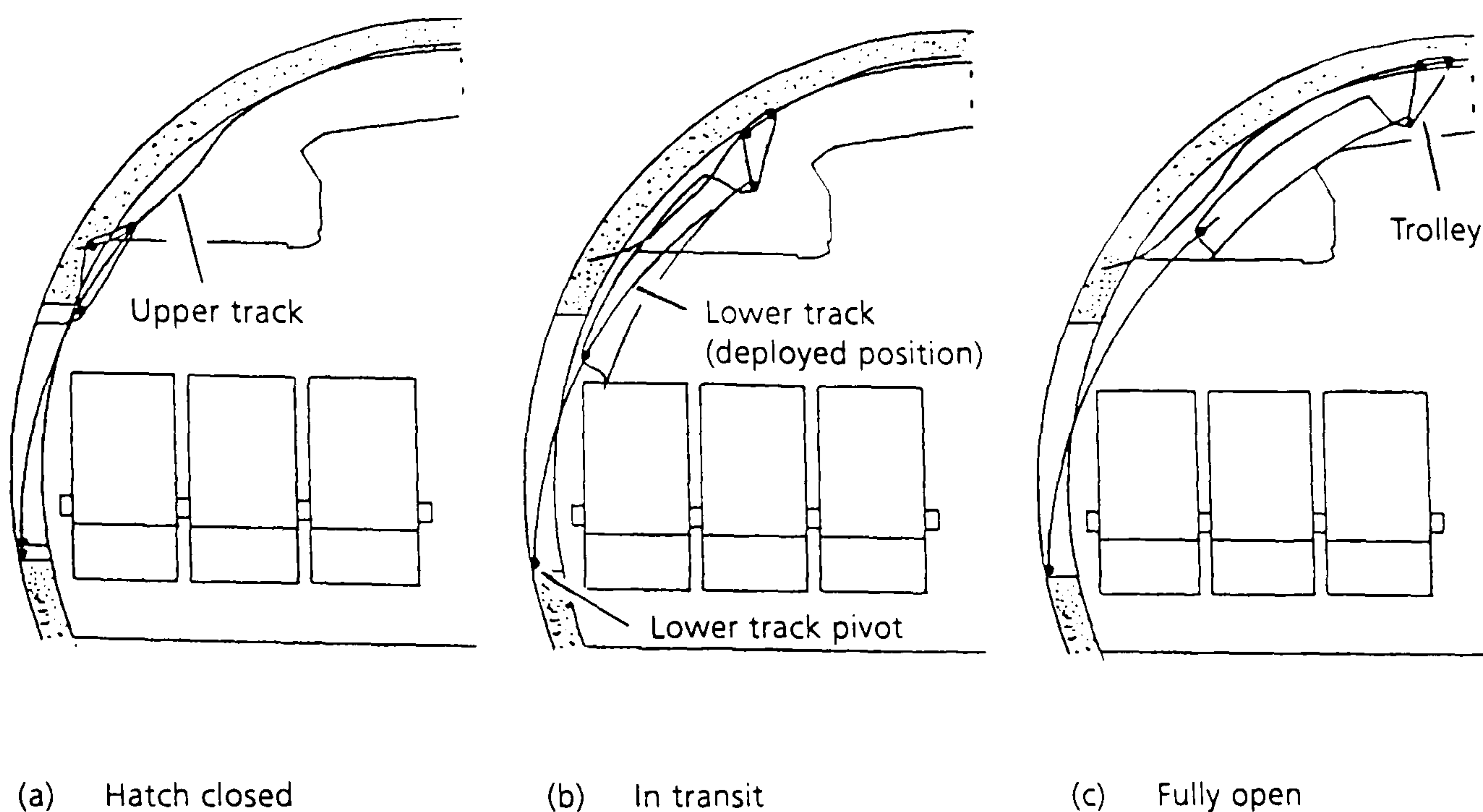


Figure 7 Proposed Improved Type III exit concept

The proposed design causes no interference with seats because the exit hatch in a Type III application would only initially need to move inwards at the top before sliding up into the overhead region. However, the concept does imply some loss of overhead bin space for the exit hatch and tracking to pass through the area.

The experimental prototype was produced in a very cost effective fashion and did not attempt to use techniques suitable for a true aircraft installation. The prototype was produced by using the cabin simulator's original Type III exit hatch, and with the addition of trim, tracks, rollers, upper support trolley and an assistance device based on a Tensator spring it weighed the same as the current traditional exit.

A more difficult design decision concerned the placement of the release handle. Two handle positions, as shown in Figure 8, were assessed in preliminary operation trials (Sibley, 1995). Whilst there appeared to be little difference in operation times, subjects found the option with release handle below the window easier to use.

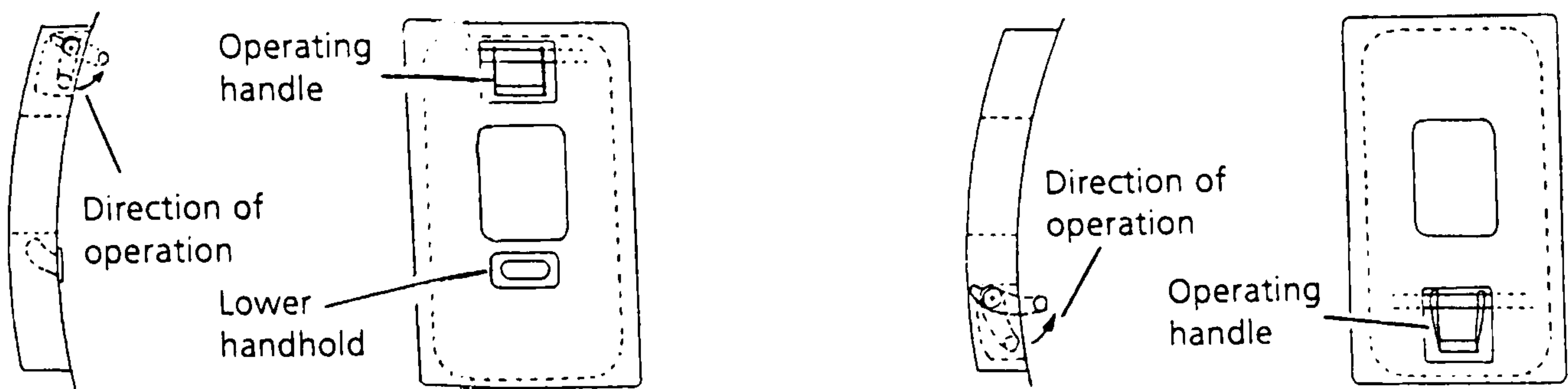


Figure 8 Alternative handle/handhold configurations tested in preliminary operation trials

4 IMPROVING THE MAN FOR THE TASK; Information, training and practice

4.1 *Introduction*

The redesign of the Type III exit, making it a simpler and easier piece of equipment for passengers to operate would be the ideal solution to operation problems. However, as section 2.3 showed there are currently a large number of aircraft registered in the United Kingdom with Type III exits and the retrofit of a new design of exit would be difficult and costly and resisted by the industry. The alternative to “fitting the task to the operators’ capabilities” is to improve the operator by selecting the correct person for the task and by providing suitable instruction and/or practice.

In the following chapter the current methods of informing the flying public of safety related information, the difficulties associated with these and possible solutions drawn from the training literature are discussed.

4.2 *Safety briefing legislation*

The 1990 amendment to Article 36 of the 1989 Air Navigation Order (ANO) specifies:

“The commander of an aircraft registered in the United Kingdom shall take steps to ensure -

- (a) before the aircraft takes off on any flight, that all passengers are made familiar with the position and method of use emergency exits, safety belts (with diagonal shoulder strap where required to be carried), safety harnesses and (where required to be carried) oxygen equipment, lifejackets and the floor path lighting system and

all other devices required by or under this Order and intended for use by passengers individually in the case of an emergency occurring to the aircraft; and

- (b) that in an emergency during flight, all passengers are instructed in emergency action which they should take.”

In addition, it is a requirement of the 1990 amended article 13 (5) of the 1989 ANO that:

“The position of equipment provided for emergency use shall be indicated by clear markings in or on the aircraft. In particular every public transport aircraft registered in the United Kingdom there shall be -

- (a) provided for each passenger; or
- (b) if the Authority permits in writing, exhibited in a prominent position in every passenger compartment -

a notice relevant to the aircraft in question containing pictorial:

- (I) instructions on the brace position to be adopted in the event of an emergency landing;
- (ii) instructions on the method of use of the safety belts and safety harnesses as appropriate;
- (iii) information as to where emergency exits are to be found and instructions as to how they are to be used;
- (iv) information as to where the lifejackets, escape slides, liferafts and oxygen masks, if required to be provided by paragraph (2) of this article, are to be found and instructions as to how they are to be used.

The legislation as it stands, states the minimum requirements regarding safety on board a passenger aircraft. The form most commonly taken by a pre-flight briefing is a verbal narrative containing instructions and demonstrations regarding emergency procedures, normally presented by a member of cabin staff although more recently, particularly on new aircraft, video presentations of pre-flight briefings are used.

As the ANO states the passenger safety briefing must be supplemented with a pictorial safety notice better known as a passenger safety card. The Air Operators' Certificates CAP360, chapter 6/22. November 1992 states that:

“Photographs, drawings, diagrams and words can be used to depict equipment and operating methods; use of words should be kept to a minimum and consideration be given to producing a multi-lingual card for use on overseas routes. Internationally recognised symbols should be used.”

As with all regulations this allows for a great variation in how the information is displayed. although in the United Kingdom a copy of each card currently in use must be lodged with the Flight operations Inspectorate.

Passengers' attention during the pre-flight briefings is drawn to the location of the emergency exits. In some of the video presentations a demonstration is given of the operation of Type I floor level exits however these videos do not currently show how to operate the Type III exits. Within the United Kingdom there is a recommendation (CAP 360, part one, chapter 6, page 6/21, para 13) that airlines should inform their passengers that they are seated next to a Type III exit and bring to their attention the operating instructions on the safety cards and the placards on the seat backs.

The success of the Pan Am 747, San Francisco 1971 and American DC10, Detroit, 1972 evacuations supports the premise that the more safety information available to passengers, the better chance of successful evacuation. During these accidents there was

the chance to pre-brief passengers about the impending emergency landings and evacuations. Since during most accidents there is little opportunity to predict them and therefore provide additional briefings, the pre-take off safety information must be presented to passengers so that it is easily understood and likely to be retained. More recently some airlines flying transatlantic routes have started to repeat the pre-flight safety briefing prior to landing and requesting that passengers familiarise themselves again with the safety card as a strategy to aid passengers' performance of safety procedures.

Given the typical behavioural response of passengers to emergency situations discussed in section 2.6, it is evident that the content of the briefing material must be clarified to the greatest extent possible, so that passengers know what is expected of them in an emergency. Passengers in an emergency may often be expected to perform novel responses, such as operating emergency exits in a confusing and possibly threatening environment. They must respond in conditions of extreme stress which can reduce performance, inhibit memory and increase the likelihood of maladaptive passenger behaviour.

4.3 *Safety information and passenger attention*

Despite these efforts to adequately inform passengers of the relevant safety information, it has been reported that many passengers over estimate their knowledge of these safety procedures, and fail to pay attention to either safety briefings or cards (Johnson, 1979, Fennell et al, 1988). In a survey carried out by the Flight Safety Foundation (1970) less than 10% of passengers looked at the briefing card. In Fennell et al. survey, high self reports of attention to safety briefings (79.9%) and reading of safety cards (59.7%) on most flights were observed.

Evidence from accidents and incidents clearly indicates the failure of passengers to refer to safety information and the impact that this can have on their chances of survival. Robson (1973) highlights an example where during a warning period of an impending emergency landing only 20% of passengers referred to the emergency evacuation leaflets. In an incident when a B707 crashed short of the runway at Pago Pago, American Samoa in 1974, "Passenger inattentiveness to the pre-takeoff briefing and passenger information pamphlet" was cited by the National Transportation Safety Board as one of the three major post-crash survival problems.

Lack of attention to safety briefings has been attributed by Fennell and Muir (1992) as a result of familiarity with pre-flight briefings and cards which can vary little between operators. This, they contend may lead to a feeling of boredom with the briefings, allowing regular passengers to feel they already know all of the relevant safety information. Passengers interviewed following aircraft accidents, frequently admit that they did not read the safety information card, and usually explain that they had read the cards previously and that all cards contained the same information (NTSB, 1974). Another more subtle reason is that safety cards must compete with other reading material within the cabin.

Fennell (1992) suggests that novice or infrequent passengers who do not wish to appear unknowledgeable about flying may also choose not to attend to the safety briefings. Somewhat more concerning is the suggestion of Beck and Emery (1985) that nervous passengers fail to attend to safety information as a means of denial in an attempt to reduce their anxiety about a flight by denying the likelihood of risk.

Becker (1973) suggested that passengers failed to attend to safety information as a result of feeling of powerlessness. The author maintains that the whole attitude and manner of delivery of emergency briefings tends to play down the significance of the information being presented. As a result, the passenger gets the feeling that he/she has no control over the environment and thus, ignores the information being presented.

Some passengers' perceptions of the role of the cabin crew may have an impact on their attention to safety information. Cabin Crew's primary role under the Air navigation Order (1990) is the safety of passengers. They are highly trained individuals and it is the belief of many passengers that cabin crew are responsible for their safety and will help them in an emergency (Fennell & Muir, 1992). It is very unlikely that in the event of an emergency that cabin crew members would be able to help all those passengers onboard so it is particularly important that passengers need to assume some responsibility for themselves, particularly those seated next to self help exits such as the Type III exit.

Some passengers may perceive that their chances of survival should they be unfortunate to be involved in an aircraft emergency as minimal and as such there is little that they could do to save themselves or alternatively that 'it wouldn't happen to me' (Johnson, 1979).

Johnson (1979) suggested that non-attenders were more likely to be frequent flyers, business passengers and those who fly alone. Fennell, et al. (1988) confirmed many of Johnson's findings. Interestingly in their study business and frequent flyers who reported that they paid less frequent attention to safety briefings and cards had higher levels of knowledge of safety procedures. This finding implies that many non attenders pay less attention to the briefings because they have more not less knowledge of safety information. Fennell et al. (1988) concluded that it is more important to gain the attention of those with limited safety knowledge and those passengers that may be most in need of knowing the safety procedures such as older passengers, females, inexperienced passengers and those flying mainly for pleasure.

Research into methods of increasing passengers' motivation to pay attention to the briefing has included altering the introduction to the pre-flight briefing to place greater emphasis on its importance (Fennell, 1992). Fishbein & Ajzen (1975) suggest two strategies by which peoples underlying beliefs and attitudes may be changed; these being

participation and persuasive communication. If passengers lack of attention to briefings is as a result of a belief that they are unimportant or unnecessary the utilisation of practical safety training as advocated by Green (1986) or education in the media about safety related issues (Graber, 1989) may be beneficial in increasing passenger attention to safety information.

4.4 *Instruction and training*

Instruction and training techniques used to instruct trainees generally fall into three categories; telling the learner what to do, showing the learner what to do, by demonstration or guidance or having the learner practice what to do.

4.4.1 Telling the passenger how to operate the exit

Most training programmes start with a verbal explanation of what the learner is required to do. Holding (1987) described verbal instructions as useful for defining the goals of training, the rules which must be applied in order to execute the task and verbal feedback (useful in improving motivation of trainees). Whilst efficient and economical, verbal instructions should be treated with caution for a number of reasons. Firstly they can convey a vast amount of information which may overload the working memory of trainees (Sweller, 1988). Secondly the teaching of perceptual-motor activities through verbal instructions is difficult because trainees find translating the verbal instructions into the perceptual-motor activity difficult. Holding also notes that verbal instructions can be interpreted differently by trainers and trainees, which can reduce their effectiveness.

The pre-flight passenger safety briefing consists of predominately verbal instructions and incorporates an element of demonstration of some of the emergency equipment. During the briefing, a large amount of information is presented in a relatively short time. This is likely to exceed the memory capacity of many of the passengers particularly those who

are inexperienced passengers with little or no previous knowledge of safety procedures and equipment.

4.4.2 Showing the passenger how to operate the exit

Showing the learner what to do can be an effective method of teaching behaviours, providing the learner with important visual feedback, and reducing the likelihood of errors (Holding, 1987). Demonstration as defined by Patrick (1992), typically provides the trainee with some form of guidance, which shows the trainee what has to be achieved either directly or indirectly through some symbolic coding. Such a strategy may be useful in the earlier stages of learning, since it narrows down the range of alternative actions, but it should be supplemented by direct practice (Holding, 1987), allowing the trainee to imitate the actions of the trainer.

Whilst the pre-flight briefing is usually accompanied by demonstration, currently passengers have no opportunity to imitate the actions required. As a result passengers may under estimate the complexity of some of the procedures and never have the opportunity to test whether they would be able to accurately remember and replicate the actions demonstrated to them.

4.4.2.1 Safety briefing cards

Illustrations can be useful as a method of showing the trainee what to do. According to Johnson (1980), the concepts about which information is to be conveyed can range from simple to complex. Instructions for simple concepts are given to perform a single action about which the why and when are obvious. A complex concept is one where multiple actions are required and multiple results can ensue. The when and why an action is to be performed may not be obvious. Johnson goes further to make the point that the concepts in question can range from concrete (such as an emergency door) to abstract (with no

physical referent, such as the general notion of danger). Table 2 below shows his proposed methods for conveying instructional methods.

Table 2 Proposed methods for conveying instructional information

	Concrete data	Abstract data
Simple	Use pictures/words	Use symbols/words
Complex	Use pictograms/words	Use words

According to Paivio (1978), any given stimulus can be encoded in our memory verbally or visually or both verbally and visually. The type of encoding is dependent upon the nature of the task and the information presented. Paivio’s theory, the dual-trace hypothesis, argues that pictures are better remembered than words. The theory states that words are coded verbally, whereas pictures are coded both verbally and visually. The ability to react to and understand information is greatly expanded when the information is presented through both visual and auditory means (Berger, 1970; Bashman and Treadwell, 1995; Stone and Glock, 1991)

In the NTSB safety study (1985) concern was raised that whilst some airlines have used firms to develop safety cards using an iterative design process whereby naive subjects are shown prototype cards and then asked to explained their interpretation or understanding of the information, many still continue to develop their own cards “which contain confusing and incomplete information”.

Some research was carried out by Douglas aircraft company in the 1970’s to identify the best means of presenting safety information on briefing cards. Altman et al. (1970) carried out a study investigating participants of the studies “most -to least” preferred style of presentation. The study examined twenty-one safety briefing cards used by domestic and international airlines. In general, the presentation style preferred by most judges was

that of simple sequential action, graphic displays of information with a minimum of keyword descriptors. Altman et al's. study can be criticised and the results taken with some caution as all of the participants in the study were English speaking and their results are based on participants preferences not their understanding or ability to perform the safety actions.

The NTSB safety study (1985) refers to research evaluating pictorial safety cards. The research evaluated the use of colour and photographs and found no statistical difference between colour photographs and diagrams and both were more effective than if they had been black and white. Colour was found to be particularly useful in highlighting important procedural actions such as the direction an emergency handle turned. Further work carried out by Douglas referenced in the NTSB study showed that passengers donning lifejackets had slightly more understanding of illustrations than photographs because the illustrations were able to highlight certain features which was not possible with photographs.

Johnson et al. (1973) carried out four large scale evacuation demonstrations during which they evaluated the benefit of different briefing card information on the jumper/sitter ratio on the evacuation slides. The four test groups were passengers who did not have a briefing card to look at (simulating those who do not attend), two slightly different cards with additional written instructions next to the diagrams showing how to use the slides to "jump" and a final group who were given cards with written instructions to "jump, don't sit". The results indicated that the use of written instructions on the briefing cards could be useful as significantly fewer people sat when reading cards with the written information than those who were given no briefing card. Significantly more passengers who were told to "jump - don't sit" jumped onto the slide than those who were told to "jump". This work again failed to provide a true comparison group as none of the passengers were given a briefing card without additional wording, so the true benefit of additional written instructions could not be evaluated.

Boher (1975) however, carried out a study investigating the benefit of words and pictures displayed together and found words or short statements with pictures was the most efficient in communicating procedural information. A further study by Barnard and Marcel (1984) indicated that such a method of presentation was particularly good for novel information. Whilst the international aviation language is English, the major concern with the introduction of language on briefing cards is the impact that this might have on those individuals who do not speak or understand English.

4.4.2.2 Video safety briefings

The use of multimedia systems such as video presentations and multi-media computers utilising a mix of audio and visual channels for communication can have a dramatic effect on learning and long-term retention. Bayard-white (1990) claimed that we remember about:

- 10% of what we read
- 20% of what we hear
- 30% of what we see
- 50% of what we see and hear
- 80% of what we say
- 90% of what we say and do at the same time.

The integration of experiences from different senses has been shown to be more resistant to forgetting and is used as the basis for many devices to aid memory (Hunter, 1964; Yates, 1966). Stoneman and Brody (1983) have shown that the presence of moving images can serve to enhance comprehension and learning of spoken material.

The use of safety briefing videos is slowly becoming more widespread in the industry. Several studies have attempted to show the benefits of presenting safety related information in video format. A study by Johnson (1973) showed that video instructions for the donning of life vests were 40 percent more effective in reducing the time to don life jackets than either safety briefings cards or cabin crew oral instructions accompanying a demonstration. This method of briefing still resulted in 29% of the viewers not being able to perform the simplest and essential steps of the donning. Johnson suggested that this was possibly due to the complexity of the life-jacket itself.

Johnson et al. (1973) investigated the benefits of video briefings further by presenting black and white videotaped safety information to potential aircraft passengers in three domains:

1. What they should do (DO)
2. What they should not do (DONT)
3. The reason why (WHY)

Information covered 11 content areas relevant to an overland flight, including the brace position. Seven groups were presented with different combinations of DO, DONT and WHY on each content area.

The videotape presentation resulted in significant improvements in knowledge of appropriate knowledge related behaviours. The DO and DONT information when combined produced significantly better results than when presented individually. The WHY information had no significant effect on increasing the participants' knowledge of which behaviours should or should not be performed.

Whilst videos may provide a simple, time effective method of display the use of safety equipment, including some that is otherwise only displayed on the safety cards (exit operation) a major problem with such a strategy is that the timing of the material is

inflexible. The viewer has no control over the rate at which the information is presented, and unlike the reader of text, cannot refer back or check previous information.

4.4.3 Practice

According to Patrick (1992) the most powerful method of training is to allow the trainee to perform the task themselves providing them with feedback on the correctness of their action. This knowledge of results can come from either the task itself, or from the trainer. The provision of such feedback allows trainees to amend their actions making them more accurate and automatic. This strategy applies to any type of learning, including the learning of facts, concepts procedures, motor skills and cognitive strategies.

The efficiency of practice not only depends on participants' knowledge of results but on its spacing and content. Practising is likely to be fatiguing unless adequate rest pauses are given, however the practicalities of training provision often determine the schedule of training.

In order that the full benefits of practise are realised it is sometimes necessary to provide part task learning. Some tasks are so simple that they can be taught in their entirety, however others are so complex that it is not possible to learn a skill from the beginning in one practice session. In this instance the entire task is broken down into sub-units which are practised separately. If this strategy is used it is important that practice follows a logical sequence allowing trainees to build on their knowledge and experience.

4.4.3.1 Airport Safety Centres

The implementation of safety centres in airport departure lounges has been proposed as a low stress environment where passengers could practise using emergency equipment (Blythe, 1986 and Green, 1986). Trained staff would be able to provide information.

guidance and feedback about performance of these novel procedures. It is argued that such safety centres could be used to educate passengers about safety issues and encourage them to take the responsibility for their own safety. Green (1986) went further to suggest that check-in-staff assigning passengers to the seat next to the overwing exit could ask them to visit the centre to practise operating the exit. He also pointed out that by giving these passengers a task to perform in an emergency would increase the likelihood of them performing quickly and correctly.

There are difficulties associated with the possible introduction of safety centres. Firstly, who should pay to equip, maintain and staff the centres. Historically there has been negative feedback from some airlines who resist the introduction of safety centres due to their costs and possible liability should a passenger be injured in a centre or were incorrectly taught or wrongly interpreted the safety procedures (Fennell, 1992).

Green pointed out that such centres may have problems due to the reaction of the general public - it is possible that no-one would visit them or they may be totally overwhelmed by the number of interested passengers. Another practical problem with the introduction of safety centres is the lack of standardisation of safety equipment onboard aircraft which may lead problems in transfer of training if passengers have become familiar with one type of equipment in a safety centre only to encounter a different type onboard their aircraft.

Mitchell (1992) clearly showed the benefits of allowing passengers to practice using emergency equipment. Participants in her study not only took less time, but were more accurate in their performance of tasks. During the debrief of participants it became apparent that the majority were in favour of some form of training to be made available to passengers in departure lounges.

One of the main arguments against safety centres is the problem of non standardisation of safety equipment. Parkinson (1994) however, showed that passengers who had been

trained on one type of life-jacket only to encounter another type in a simulated emergency where able to don their lifejacket as quickly as their counterparts who had received training on an identical lifejacket to the one in the simulated emergency. However, whilst they were not as accurate in their performance they were superior to those who had received no training at all.

4.6 *Retention of procedural tasks*

Procedural tasks such as the operation of safety equipment usually involve a set of individual, discrete motor responses which must be performed in a particular order. Unlike continuous tasks (such as tracking) which are relatively well retained over time procedural tasks appear to be highly susceptible to the effects of forgetting (Schendel and Hagman, 1982).

Skills that are infrequently practised such as emergency or safety functions often show deterioration to the point of being problematic (Hagman and Rose, 1983), even after relatively short intervals of no practice (Johnson, 1981). In a study by Shields et al. (1979) evaluating the retention of 20 common soldier tasks, the best predictor of forgetting rate was found to be the number of performance steps required by the task.

The main determinant of procedural skill retention is the level of original learning of a task. The positive effects of overtraining on retention have been well established (Atwater, 1953; Gagne and Foster, 1949). Overtraining allows trainees to practise tasks beyond the achievement of correct performance. Whilst initial overtraining may defer forgetting, it cannot prevent it and refresher training is required.

4.7 *Transfer of training*

Transfer of training to the work situation is paramount. Transfer of training occurs when the effects of prior learning influence the performance of a later activity (Holding, 1991). An example of transfer of training is carrying over the effects of practice with the right hand bouncing a ball to bouncing a ball with the left hand. Positive transfer has occurred if learning a new task improves performance of a second task. It sometimes happens that learning a new task hinders the acquisition of a second task and this is termed negative transfer (Holding, 1977).

The two major viewpoints that describe the conditions necessary for transfer are the identical-elements and the transfer-through-principle theories. Identical-elements theory proposed by Thorndike and Woodworth (1901) predicted that transfer would occur as long as there were identical elements in the two situations. These identical elements included aims, methods and approaches and are defined in terms of stimulus and responses. If the tasks are identical in training and transfer, trainees are simply practising the final task during the training program and there should be high positive transfer. If, as is common to many training programs, the stimuli are somewhat different in training and transfer settings, but the responses are the same, the learner can generalise training from one environment to the other. Negative transfer is likely when the stimulus conditions are similar in the training and work environments, but the response requirements are different.

One method of increasing the similarity between the training and transfer environment, is through the use of simulators. It is quite possible that a safety centre in the airport could be designed to represent an aircraft cabin interior. However given the difficulties with variations in equipment and the problems in predicting all of the emergency situations that may arise the alternative to identical-elements, transfer through principles may be of more relevance. The principles theory suggests that training should focus on the general principles necessary to learn a task so that the learner may apply them to solve problems

in the transfer task. As a result performance is more flexible and adaptable which can be applied in a variety of circumscribed situations (McGehee and Thayer, 1961). General principles also seem to be more resistant to forgetting than procedural rules.

5. RATIONALE FOR THE THESIS

Type III exits are a useful means of escape (Johnson, 1984; Chandler, George and Polard, 1987) and they exist on a large proportion of the airline fleet. The findings of research into passenger access to and opening of the Type III exit as well as accident experience, have clearly demonstrated that many passengers still have great difficulty in operating, and evacuating through, this class of exit (e.g. Fennell and Muir, 1993). Furthermore, evidence of maladaptive behaviours exhibited by passengers and the impact of elevated levels of anxiety on individuals ability to perform even the simplest tasks (Yerkes-Dobson, 1906; Johnson, 1984) forms the rationale for the work carried out in the thesis. There are two different approaches to improving passenger performance these being improvement and simplification of the task itself or the provision of better instruction for the passenger seated next to the exit. The two experiments investigate these two design options.

5.1 Experiment One: exit redesign and practice

In order to remove the problem of requiring passengers to manoeuvre the large, heavy exit hatch in the cramped conditions of the cabin the Air vehicles Design group began work on the definition of an improved Type III exit under a Civil Aviation Contract. One of the most important design criteria was that the exit hatch was to be constrained in motion so that it did not become a loose item once opened. The chosen concept was developed into a working model which then required testing so that the impact of the new overwing exit on passenger performance and accuracy could be made. The first study aimed to compare passenger operation of the traditional Type III exit with the modified exit. The influence of the operators' sex and handedness as well as seating configuration on passenger ease of operation of the two types of exit were also made. In accordance with criteria adopted for testing by the CAA, the effect of an incapacitated passenger seated immediately adjacent to the exit on exit operation was also assessed.

Finally, this experiment aimed to explore the benefits of practice on passengers ability to operate both the traditional and modified exits.

5.1.1 Objectives

1. To investigate the influence of modifications to the design and operation of the Type III exit and the influence on passengers' speed and accuracy of operation.
2. To investigate the impact of passengers' sex and handedness on the operation of the traditional and modified exit.
3. To investigate the influence of the two seating configurations specified in AN 79 on traditional and modified exit operation times.
4. To investigate the influence of an 'incapacitated passenger' in the seat adjacent to the exit, on the ease of operation of the traditional and modified Type III exit.
5. To assess the potential benefits of training members of the public in the operation of the traditional and modified Type III exits.

5.2 Experiment Two: Method of instruction

Due to the difficulties detailed in section 4.4.3.1 and the lack of success in introducing safety centres to date the possibility of providing passengers with comprehensive training in Type III exit operation is currently not available as a result. A study of the alternative methods of briefing passengers about how to operate the exit is required.

Currently there is no regulation requiring that passengers seated next to the exit receive a specific briefing about the Type III operation, they are simply informed that they are sat next to an exit, they may be required to operate it in an emergency and that they should note the operating instructions.

The preceeding chapters have discussed possible variations in instruction and training techniques as well as research evaluating alternative methods of displaying instructions.

The second experiment compared passenger speed and accuracy when operating the Type III exit following a variety of modes of instruction. The modes of instruction were as follows:

- no briefing card. This condition simulated passengers who do not read the safety information on briefing cards.
- briefing card. Four variations of exit operation diagrams:
 - Colour photographs with operator shown
 - Colour pictures with operator shown
 - Colour pictures and words with operator shown
 - Colour picture without operator shown
- no briefing card, the cabin crew member gave the passenger sat adjacent to the exit an additional *verbal* description of how to operate the Type III exit.
- no briefing card, the passenger sat adjacent to the exit was shown a video of the Type III being operated.

5.2.1 Objectives

1. To investigate whether instruction on the operation of the Type III exit is beneficial.
2. To investigate whether showing people rather than telling them how to operate the exit results in an improvement in performance.
3. To assess any differences in accuracy and performance of Type III exit disposal as a result of variation in safety briefing card presentation and content.

4. To investigate whether the use of animated instructions improve passengers performance.

6 **EXPERIMENT ONE: EXIT REDESIGN AND THE INFLUENCE OF PRACTICE**

6.1 Research Design

Members of the public were recruited to take part in a research programme in which each participant was required to operate a Type III exit on three occasions. Half of the participants operated the exit with the traditional mechanism and half operated the exit with the modified mechanism. These two groupings were further subdivided in order to assess the influence of changes to the seating configuration adjacent to the exit. The seating configurations tested involved the two options specified in the Airworthiness Notice No 79 (1989). One involved a thirteen inch vertical projection between the seat rows adjacent to the exit and the other a six inch vertical projection between the seat rows and the removal of the outboard seat. The tests involving the thirteen inch vertical projection between the seat rows were replicated with a 50th percentile male dummy, simulating a incapacitated passenger unable to operate the exit. During the test the hatch weight was kept constant at 21.5kgs (similar to a Boeing 737 hatch).

Table Three shows the number of participants in each of the experimental conditions. A total of 96 participants took part (48 operating the modified exit and 48 operating the traditional exit) with equal numbers of left and right handed males and females in each condition.

Table 3 The numbers of participants in each of the experimental test conditions

	<i>Modified Type III exit design</i>				<i>Traditional Type III exit design</i>			
	<i>Left handed</i>		<i>Right handed</i>		<i>Left handed</i>		<i>Right handed</i>	
	<i>M</i>	<i>F</i>	<i>M</i>	<i>F</i>	<i>M</i>	<i>F</i>	<i>M</i>	<i>F</i>
13" Vertical projection	4	4	4	4	4	4	4	4
13" Vertical projection - Dummy	4	4	4	4	4	4	4	4
OSR	4	4	4	4	4	4	4	4

OSR = Outboard seat removed

6.1.1 Ethical consideration

Key issues should be considered during the initial stages of any applied research programme. These issues are covered in “The Ethical Code of Conduct”, available to all those undertaking research at Cranfield University. Prior to carrying out this investigation, an ethics proposal was submitted to the Ethics Committee. This committee deals with all of the Cranfield Department of Psychologys’ research. The normal ethical considerations of confidentiality of data, safety and welfare of participants, voluntary participation and knowledge of results were adhered to.

6.1.2 Methodological considerations

Problems arise with any investigation of emergency behaviour. As described in section 2.6, in a real emergency the stress of the situation is likely to influence the manner in which individuals behave. Even research into a sensitive issue such as an aircraft emergency may be psychologically disturbing for test participants if not handled with care. On the other hand, any attempt to identify behaviour or the problems likely to be experienced by individuals in a non-representative situation will lack validity. The use of a cabin mock-up provides the opportunity to observe passenger behaviour in a controlled environment. This would allow the ability of

participants to perform safety procedures, and any problems doing so, to be identified without involving personal risk to test participants.

The fidelity of the simulation described in this thesis, was increased by giving test participants a pre-flight safety briefing, after they were seated on board the aircraft followed by simulated emergency scenarios.

As in previous exit operation studies test participants operated the exit on their own without any other ‘passengers’ on the aircraft. This enabled the impact of the design of the exit mechanism on operator performance to be assessed without risk to others in the cabin. However, it is recognised that the problems experienced in a real emergency, or accident, situation are likely to be worse in a simulation as they are likely to be adversely affected by other passengers crowding into this area.

6.1.3 Equipment

6.1.3.1 The cabin mock-up

The experimental tests took place on board the single aisle cabin simulator in the College of Aeronautics at Cranfield. Ten rows of triple seats were located along either side of the cabin fuselage. A fully functioning Type III exit of either the modified or traditional design was fitted half way down the side of the fuselage (see Appendix B for modified exit details). The seat rows adjacent to the Type III exit were arranged in accordance with AN79 1989, either paragraph 4.1.1 or 4.1.2 (see Appendix C for diagrams).

In the aircraft cabin simulator, when there were rows of triple seats forming the exit aisle the seats fore and aft of the Type III exit were at a seat pitch of approximately 38 inches (97 cm) with a vertical projection between the seats of 13 inches (33 cm). This vertical projection was used so the exit seat row did not extend beyond the exit centre line thus complying with paragraph 4.1.1 in AN79 (see Appendix C). When the outboard seat removed configuration was used the seats fore and aft of the Type III

exit were at a seat pitch of approximately 18 inches (45 cm) with a vertical projection of 6 inches (15 cm). The seat back of each seat which formed the boundary of the access route to the Type III exit was restricted in its movement in accordance with AN79 1989 paragraph 4.3.



Figure 9 The cabin simulator

6.1.3.2 The Type III exits

The dimensions of both the modified and traditional exit hatch in the cabin simulator were representative of those on a narrow bodied transport aircraft. The vertical step-up from the floor to the bottom of each exit inside the cabin was 13.5 inches (34.4cms), identical to that of a Boeing 737 aircraft. The step-down height from the bottom of each door onto the wing was 15 inches (38cms) which although is identical to a Boeing 737, is considerably less than the maximum 23 inches (58.5cms) allowed (Edwards and Edwards, 1990).

The handle mechanism of the traditional Type III exit operated in the standard manner. In accordance with the Type III exit operating instruction requirements, the word ‘PULL’ was written in white on this handle mechanism and at the top of the exit there was a red arrow pointing downwards on either side of the handle (JAR 25.813). The handle mechanism and operating instructions for the modified Type III exit had ‘PULL’ written in white on the operating handle and red arrows either side of the handle.

In accordance with AN79 requirements, safety placards illustrating the operating method for the traditional and modified Type III exits were located on the back of each seat in the row forming the access to the exit during all the trials. The illustration depicting the operating method of the traditional exit was based on those currently used on Boeing 737 aircraft. A new safety placard was designed for use with the modified Type III exit design (both of these can be found in Appendix D).

6.1.4 Data Acquisition

Video cameras were located inside and outside the cabin, in order to record the manner in which participants opened and disposed of the Type III exit. The cameras were fitted with a time base function and microphones to provide the information required for the data analysis.

A short questionnaire was used to identify any problems experienced by participants when opening the exit and evacuating onto the wing. In this questionnaire participants were asked to assess the ease with which they considered they were able to open the exit and evacuate from the cabin and to indicate the nature of any difficulties experienced in completing the task (see Appendix E).

As all the participants operated an exit three times, a shortened version of the questionnaire was completed by participants after the second and third time they operated the exit. In the shortened version of the questionnaire, participants were

asked if their experience in operating the exit in the first and second tests affected the manner in which they subsequently operated the exit.

6.1.5 Participants

A total of 96 participants took part in the study, 48 in each phase. Exactly equal numbers of left and right handed males and females operated each design of Type III exit. The participants were recruited by campus advertising and through the use of the Department of Applied Psychology’s participant database. In order for the participants to be representative of those individuals in the population who were expected to encounter most difficulties in completing the task, the maximum height and weight of participants recruited for these tests was decided using the criteria for fiftieth percentile UK males and females, as indicated in Table four. None of the participants had previously operated a Type III exit.

Table 4 Fiftieth percentile height and weight for males and females

	<i>50th Percentile Height</i>	<i>50th Percentile Weight</i>
<i>Males</i>	175cm	70kg
<i>Females</i>	161cm	64kg

6.1.6 Procedure

The 48 male and 48 female participants were each assigned to one of the experimental conditions, such that there were eight males and eight females in each. A member of the research team, trained and dressed as a cabin crew member, briefed each participant about the nature of the test upon his/her arrival at the College of Aeronautics. In order to maximise the realism, the participants were not told about the precise nature of the test but were forewarned that they might be required to lift a weight equivalent to that of a heavy suitcase (potential participants with health

problems were screened out during recruitment). Participants were then asked to complete a consent form indicating that they understood the general nature of the study and that they believed they were physically able to take part in the test.

In the experimental conditions when a dummy was not present, the participant was sat in the seat adjacent to the Type III exit. In the experimental conditions when the dummy was present, the dummy was positioned, with the seat belt fastened, in the seat adjacent to the Type III exit and the participant sat next to the dummy (see Appendix C).

Once seated inside the cabin, each participant was given a modified pre-flight safety briefing by a member of the research team (a transcript of this can be found in Appendix F). The safety briefing included a demonstration of the method of operation of the seat belt and oxygen mask, as well as the location of the Type III and other exits. This briefing also drew the participants attention to the safety briefing card situated in seat pocket of the seat in front of them. In accordance with recommended procedure in CAP 360, Part one, Chapter 6 Page 6/21 Paragraph 1.3 the following statement was used ‘I would like to draw your attention to the fact that you are sat by an emergency exit, should there be an emergency you would be expected to operate this exit. Instructions showing the method of operation can be found on the safety briefing card in the seat pocket in front of you and on the safety placard on the back of the seat, here’.

The member of the research team then checked that the participant’s seat belt was fastened securely and positioned him/herself at the rear of the cabin. The participants heard one of three different engine noise scenarios (see Appendix G), before being issued with the instruction to ‘*Undo your seat belt and get out*’. If the participants were hesitant in moving towards the exit (that is, if they had not begun to open the exit after five seconds) the researcher shouted the instruction ‘Overwing exit’ in order to hurry the participant. The test continued until the participant had successfully opened the exit and evacuated through the Type III exit , or had given up on the task voluntarily. After this first test had been completed each participant was asked to fill

in a short questionnaire in order to identify any problems they had experienced in carrying out the task.

The test procedure was then repeated twice more with each participant (no additional training or help was offered from the cabin crew member). On each occasion the participant was given a modified pre-flight safety briefing and seated in the same position as before. A different engine noise scenario was used with each trial in order that participants did not anticipate the call to evacuate. After completing the third test and questionnaire the participant was debriefed and thanked for taking part in the test, before being paid his/her attendance fee.

6.2 RESULTS

6.2.1 Individual characteristics of the participants

6.2.1.1 *Modified Type III exit*

The mean age of all of the participants was 33.85 years; 34.67 years for males (with ages ranging between 20 and 48 years) and 33 years for females (with ages ranging between 20 and 48 years). The male participants had a mean height and weight of 172.29cm and 69.17kgs. The female participants had a mean height and weight of 160.70cm and 59.46kgs respectively. The median frequency of exercise for males and females was once or twice a week. All but three participants had previously flown on an aircraft before and the median category on the questionnaire for total number of return flights taken by the participants was 6-10 flights.

6.2.1.2 *Traditional Type III exit.*

The mean age of all of the participants was 31.17 years; 31.08 years for males (with ages ranging between 21 and 49 years) and 31.25 years for females (with ages ranging between 20 and 48 years). The male participants had a mean height and weight of 173.58cm and 71.67kgs. The female participants had a mean height and weight of 161.83cm and 59.13kgs respectively. The median frequency of exercise for males and females was once or twice a week. All but three participants had previously flown on an aircraft before and the median category on the questionnaire for total number of return flights taken by the participants was 11-15 flights.

There were no significant differences between the age, height, weight and frequency of exercise taken by participants in the two types of exit mechanisms as tables 5 - 8 show.

Table 5 **An independent t-test summary table for participant age across the two exit types**

	N	Mean	S.D	S.E	t	df	Probability
Traditional exit	48	31.17	8.57	1.23	1.51	94	0.134
Modified exit	48	33.83	8.69	1.25			

Table 6 **An independent t-test summary table for participant height across the two exit types**

	N	Mean	S.D	S.E	t	df	Probability
Traditional exit	48	167.71	7.48	1.08	-0.83	94	0.409
Modified exit	48	166.54	6.24	0.9			

Table 7 **An independent t-test summary table for participant weight across the two exit types**

	N	Mean	S.D	S.E	t	df	Probability
Traditional exit	48	65.39	8.97	1.29	-0.67	94	0.505
Modified exit	48	64.31	6.74	0.973			

Table 8 **An independent t-test summary table for participant frequency of strenuous exercise across the two exit types**

	N	Mean	S.D	S.E	t	df	Probability
Traditional exit	48	2.37	1.12	0.162	0.09	94	0.932
Modified exit	48	2.39	1.25	1.80			

6.2.2 The operation of the Type III exit

The participant's times to evacuate were obtained from the video recordings. The camera's internal time base and audio recordings provided information on the time it took for each evacuation and the way in which the participant opened and disposed of the Type III exit. The evacuation time was calculated from the point at which the participant's hand touched the operating handle, to when he or she had put one foot onto the wing. This particular starting point was taken so that any variation in the delay of participants responding to the call to evacuate was not included in the analysis. The mean reaction time of participants to respond to the call to evacuate (from the call '*Undo your seat belt and get out*' to when their hand was on the operating handle) was 4.94 seconds for the traditional Type III exit and 4.14 seconds for the modified exit.

6.2.3 The influence of the Type III exit operation mechanism

The mean times taken by participants to open the modified and traditional Type III exits in the first test conducted by each participant in the three seating configurations are shown in Table 9. This is graphically represented in Figure 10. The raw data giving demographic details for each participant and the times taken by each participant to operate the Type III exit in each of the three tests they performed can be found in Appendix H. The data from the previous Type III exit operation research

carried out at Cranfield University (Fennell and Muir, 1993) involving the traditional Type III exit is also included in Table 9.

The mean times taken by participants to operate the Type III exit, in all of the conditions in the recent research were consistently quicker than those recorded in the previous testing. A number of factors could have contributed to these differences, they include improved Type III exit operation diagrams, alterations in the cabin simulator improving realism and a reduction in the weight of the exit hatch from 25kgs to 21.5kgs.

Table 9 Mean times (in seconds) taken by participants from hand on handle to exit and evacuate onto the wing (standard deviations are shown in parentheses).

TEST ONE.

	Outboard seat removed		13” Vertical Projection No Dummy Present		13” Vertical Projection Dummy Present	
	Female	Male	Female	Male	Female	Male
Modified Type III	4.17 (0.97)	3.76 (1.43)	4.47 (1.83)	3.90 (1.00)	7.73 (3.74)	6.61 (2.93)
Traditional Type III	10.76 (4.28)	9.45 (3.32)	13.15 (4.78)	8.78 (1.28)	18.04 (7.33)	13.26 (7.79)
Previous testing ¹	N/T	N/T	19.63 (7.12)	9.96 (2.10)	31.87 (14.11)	21.95 (11.48)

N/T - Configuration Not tested

It can be seen from Table 9 that the mean times for each experimental condition in test one of the recent research ranged from 3.76 seconds for males operating the modified Type III exit with the outboard seat removed, to 18.04 seconds for females operating the traditional Type III exit with the dummy present. The data from the previous test programme will not be included in the subsequent analyses. A four-way analysis of variance was performed using SPSS for windows, allowing the influence of the door mechanism, seating configuration, participant handedness and sex on exit

¹ Previous testing data for a traditional Type III exit weight 25kgs (Fennell and Muir, 1993)

operation speed and accuracy, during test one, to be assessed. All of the subjects data was entered as none of the trials had to be halted and all subjects managed to evacuate on to the wing. Table 10 shows the ANOVA summary table.

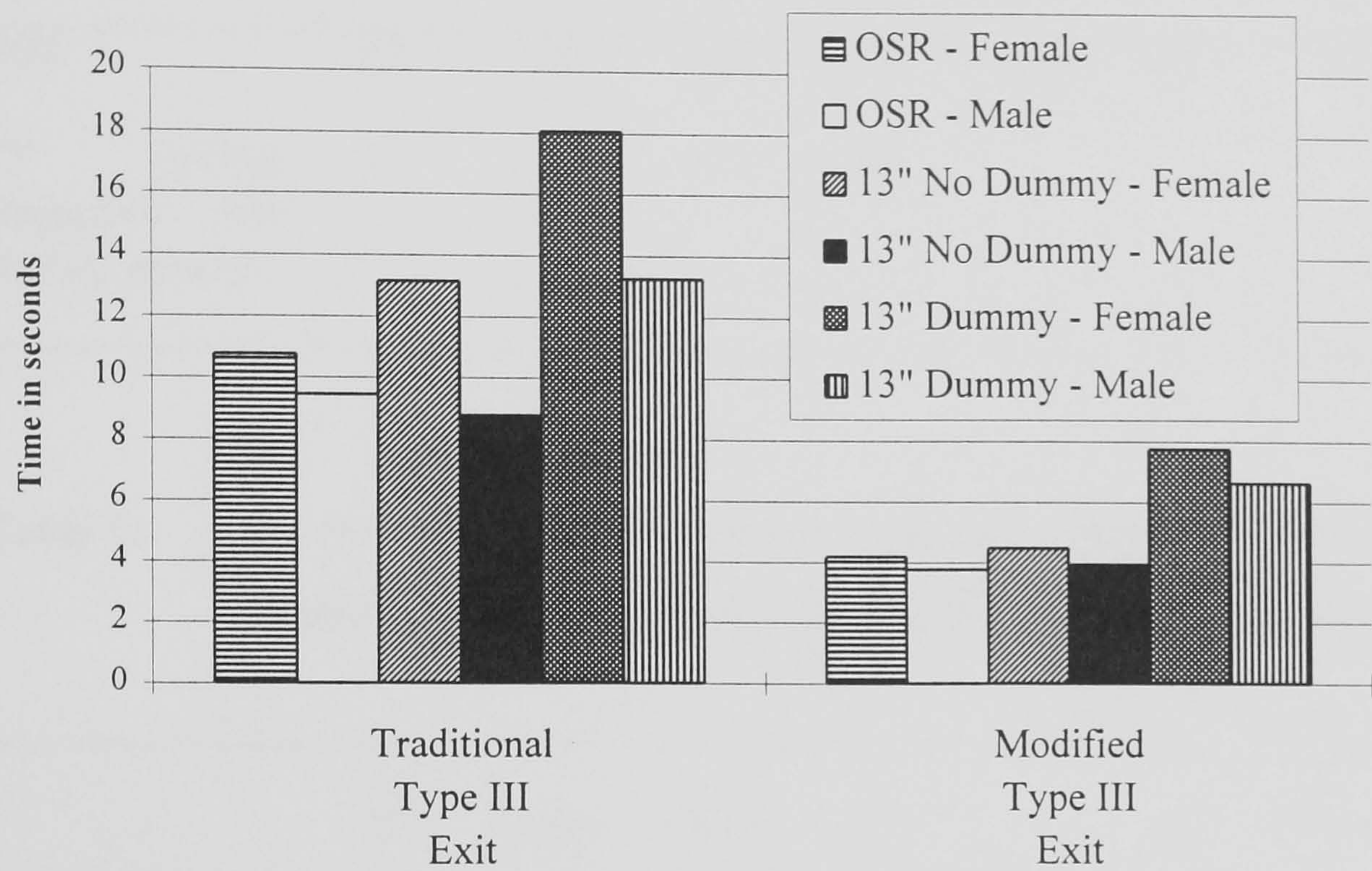
Table 10 Analysis of Variance summary table; the influence of door type, seating condition, participant handedness and sex on exit operation time (test one).

	Sums of squares	DF	Mean square	F	Sig. of F
Main Effects	1714.95	5	342.99	22.11	0.0001
Door type	1220.51	1	1220.51	78.69	0.0001
Seating condition	364.15	2	182.08	11.74	0.0001
Handedness	25.15	1	25.15	1.62	0.207
Sex	105.13	1	105.13	6.78	0.011
2-way Interaction	191.02	9	21.23	1.37	0.219
Door type S. condition	23.36	2	11.68	0.75	0.475
Door type Handedness	20.00	1	20.00	1.29	0.260
Door type Sex	46.62	1	46.62	3.01	0.087
S. condition Handedness	80.77	2	40.39	2.60	0.81
S. condition Sex	19.19	2	9.59	0.62	0.793
Handedness Sex	1.07	1	1.07	0.07	0.793
3-way interactions	118.97	7	16.99	1.09	0.375
Door type S. condition Handedness	91.88	2	45.94	2.96	0.58
Door type S. condition Sex	10.844	2	5.42	0.35	0.706
Door type Handedness Sex	3.38	1	3.38	0.22	0.642
S. condition Handedness Sex	12.87	2	6.44	0.42	0.662
4-way Interactions	35.939	2	17.97	1.16	0.320
Door type S. condition Handedness Sex	35.939	2	17.97	1.16	0.320
Explained	2060.88	23	89.603	5.77	0.0001
Residual	1116.74	72	15.51		
Total	3177.62	95	33.449		

The mean time of 12.24 seconds for all participants operating the traditional Type III exit regardless of seating configuration was significantly slower than the time of 5.11 seconds for the modified Type III exit ($F_{1,72} = 78.69, p=0.0001$). This data is graphically represented in Figure 10.

Figure 10 Graphical representation of mean times (in seconds) taken by participants from hand on handle to exit and evacuate onto the wing

TEST ONE.



6.2.4 The influence of seating condition

Seating condition was found to have a significant effect of the time taken by participants to operate the Type III exit ($F_{2,72} = 11.74, p=0.0001$). The mean exit operation times shown in table nine and independent t-tests suggest that in the situation with an able bodied passenger seated adjacent to the exit for both the traditional and modified Type III exit, changes to the seating configuration adjacent to the exit did not significantly influence the time taken for participants to operate the exit and evacuate onto the wing (Table 11). However, when an incapacitated passenger was seated adjacent to the exit for both the traditional and modified exit mechanisms, there was a significant increase in the time taken by participants to operate the exit and evacuate onto the wing in comparison to when participants were sat in the seat adjacent to the exit (Table 12).

Table 11 **An independent t-test summary table for participant speed of exit operation across the two AN79 seating configurations**

	N	Mean	S.D	S.E	t	df	Probability
OSR	32	7.03	4.16	0.736	-0.49	62	0.623
13” vertical projection. No dummy present	32	7.57	4.57	0.807			

Table 12 **An independent t-test summary table for participant speed of exit operation with and without a simulated incapacitated passenger**

	N	Mean	S.D	S.E	t	df	Probability
13” vertical projection. No dummy present	32	7.57	4.57	0.807	-2.53	62	0.01
13” vertical projection. Dummy present	32	11.41	7.25	1.282			

6.2.5 The influence of participants gender on operation of the Type III exit

The mean operation time of 7.63 seconds (standard deviation 4.89) for male participants was significantly faster than the time of 9.72 seconds (standard deviation 6.44) for female participants indicating that women found the operation of a Type III exit regardless of the type of mechanism more difficult ($F_{1,72} = 6.78$ $p=0.011$). The mean times shown in Table 8 suggested that the differences between the operating

times for males and females were reduced for the modified Type III exit. However this difference failed to reach significance ($F_{1,72} = 3.01$ $p=0.087$).

6.2.6 The influence of participants handedness on the operation of the Type III exit

Table 13 below, clearly indicates that mean times for participants to operate either exit type, were not effected by an individuals handedness. Statistical treatment of the data supported this as the effect of handedness was found to have a non-significant result ($F_{1,72} = 1.62$ $p=0.207$).

Table 13 Mean times (in seconds) taken by participants from hand on handle to exit and evacuate onto the wing, indicating the effect of handedness of the participants (standard deviations are shown in parentheses).

TEST ONE

	Outboard Seat Removed		13" Vertical Projection No Dummy Present		13" Vertical Projection Dummy Present	
	Right	Left	Right	Left	Right	Left
Modified Type III	3.93 (1.31)	3.99 (1.12)	4.04 (1.32)	4.34 (1.65)	7.19 (3.14)	7.15 (3.65)
Traditional Type III	10.06 (3.53)	10.15 (4.24)	11.71 (4.98)	10.21 (3.06)	12.04 (6.53)	19.26 (7.42)

6.2.7 The influence of practice on the operation of the Type III exit.

Table 14 below, shows the mean evacuation times for all three tests by each participant and the data can be seen graphically represented in Figure 11.

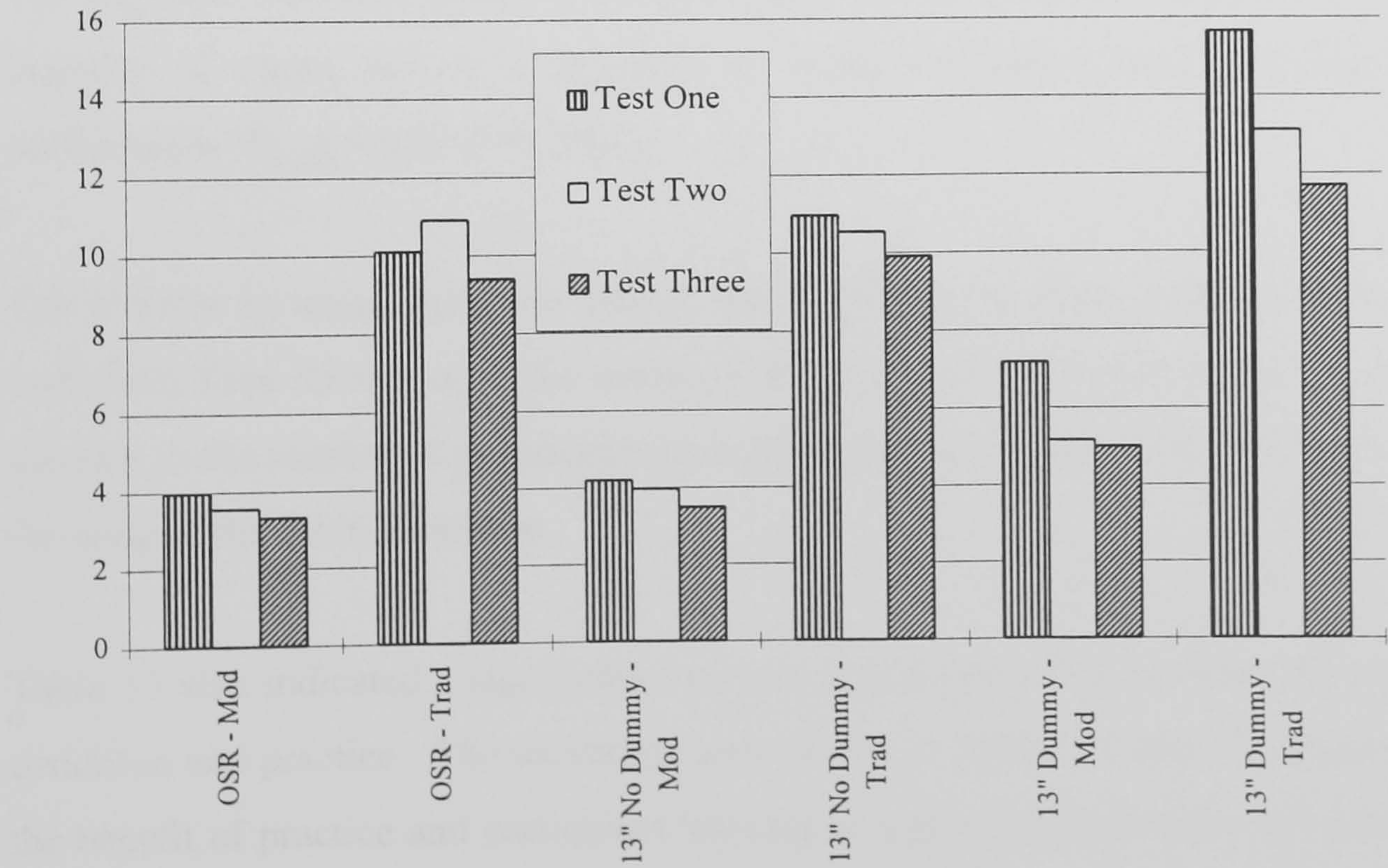
Table 14 Mean times (in seconds) taken by participants from hand on handle to operate the exit and evacuate onto the wing (standard deviations are shown in parentheses).

ALL TESTS

	Outboard Seat removed		13" Vertical Projection No Dummy		13" Vertical Projection Dummy Present	
	Mod. Type III	Trad. Type III	Mod. Type III	Trad. Type III	Mod. Type III	Trad. Type III
Test One	3.96 (1.2)	10.11 (3.77)	4.19 (1.45)	10.96 (4.07)	7.17 (3.29)	15.65 (7.71)
Test Two	3.54 (0.74)	10.91 (5.38)	3.95 (1.27)	10.54 (3.23)	5.14 (1.91)	13.09 (5.71)
Test Three	3.31 (0.68)	9.41 (2.83)	3.48 (1.00)	9.92 (3.44)	4.99 (2.02)	11.67 (5.64)

Figure 11 Graphical Representation of mean times (in seconds) to operate the exit and evacuate onto the wing.

All Tests



Mod. - Modified Type III exit
Trad. - Traditional Type III exit

A Repeated Measures Analysis of Variance was performed as this allowed the influence of practice on trial times to be assessed. Again, the main effect of door mechanism and seating configuration found in the analysis of participant operation times across all of the tests was significant.

Table 15 A Repeated Measures Analysis of Variance Summary Table for Between-subjects and Within-subject effect of practice, on the times taken by volunteers to operate the Type III exit and evacuate onto the wing.

	Sum of squares	df	Mean squares	F	Probability
Seating condition	435.36	2	217.63	7.67	0.001
Door type	3474.31	1	3474.31	122.5	0.0001
S. condition by door type	20.71	2	10.35	0.37	0.695
Within + residual error	2552.38	90	28.36		
Practice	114.34	2	57.17	9.87	0.0001
Seating condition by practice	75.25	4	18.81	3.25	0.013
Door type by practice	10.88	2	5.44	0.94	0.393
S. condition by door type by practice	11.50	4	2.87	0.50	0.738
Within + residual error	1042.60	180	5.79		

The repeated measures ANOVA indicated that overall the effect of practice, in the majority of cases, led to a decrease in mean evacuation time and improved performance ($F_{2,180} = 9.87$ $P=0.0001$).

The increase in mean operation time in test two taken by participants operating the traditional Type III exit when the outboard seat was removed can be explained by the increase in the number of participants trying to correctly dispose of the exit hatch onto the wing of the cabin simulator.

Table 15 also indicated a significant two-way interaction effect between the seating condition and practice. The univariate tests shown in Tables 16 and 17 indicate that the benefit of practice and participant learning is highest between tests one and two. The benefit of practice is highest for those individuals who were required to operate the exit in the presence of an incapacitated person or dummy.

Table 16 Univariate t-tests seating condition by practice, test one versus two

	coefficient	Standard error	t	probability
OSR Vs 13" no dummy	0.37	0.62	0.59	0.55
13" no dummy Vs 13" dummy	-1.39	0.62	-2.26	0.026

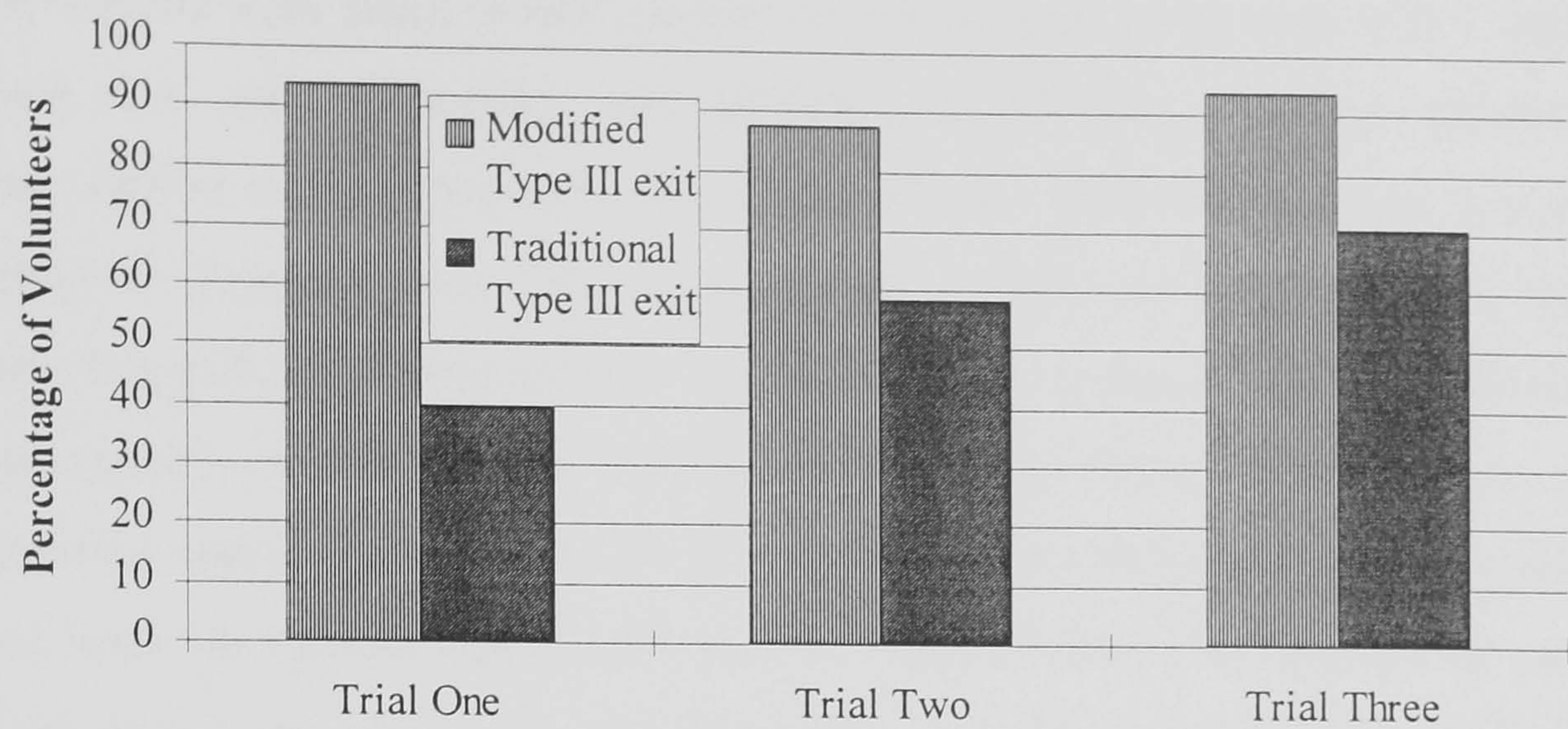
**Table 17 Univariate t-tests seating condition by practice, tests one and two
 versus three**

	coefficient	Standard error	t	probability
OSR Vs 13" no dummy	-0.48	0.59	-0.08	0.93
13" no dummy Vs 13" dummy	-0.99	0.59	-1.69	0.09

6.2.8 Placement of exit and the effect of practice

Figure 12 below shows the number of participants correctly disposing of the exit hatch for both designs of Type III exit mechanism. In order for the exit hatch to have been ‘correctly disposed’ the traditional exit hatch had to be placed out onto the wing and the modified exit hatch had to be pushed fully up into the fuselage. Figure 12 clearly shows that the numbers of participants correctly disposing of the exit hatch in the first test, were greater with the modified exit (94% as opposed to 40% with the traditional exit). The number of participants correctly disposing of the traditional exit hatch did increase in tests two and three, however 29% were still leaving the exit inside the aircraft in test three. Between each of the tests participants were NOT provided with information about the correct disposal of the exit from the cabin crew.

Figure 12 **Correct disposal of the Type III exit and the effects of practice**



All of the participants in the modified Type III exit group who failed to dispose of the exit correctly, had not gained enough momentum to push the exit fully up into the fuselage. This however, did not pose a problem for them when they evacuated onto the wing. Table 18 below shows where the participants using the traditional Type III exit left the exit hatch inside the aircraft cabin, when failing to jettison it through the exit aperture.

Table 18 **Placement of hatch by participants using the traditional Type III exit in Trials One, Two and Three (figures indicate the number of participants placing hatch in each location)**

	Trial One	Trial Two	Trial Three
On floor in exit row	8	3	2
On seat in exit row	5	4	4
Across Dummy’s lap	5	4	3
Where the outboard seat had been removed	8	5	2
On the floor behind the exit row (in OSR condition)	3	4	3
Correct disposal onto wing	19	28	34

OSR - Outboard seat removed

6.2.9 Participants perceived ease of operation and the effect of practice

Participants were asked to rate subjectively (on a seven point scale with 1 indicating ‘very easy’ and 7 indicating ‘very difficult’) the difficulty of various actions which were related to the operation of the Type III exit. Statistical analysis was used to assess the degree to which the perceived level of difficulty changed during the three trials that participants carried out. Regardless of the design of the exit, with practice, participant’s ratings for the ease of using the operating handle, clarity of exit operating instructions, opening the exit and clarity of instructions for disposing of the exit hatch all became significantly lower. This indicates that participants perceived these to become easier over the three trials ($F=3.48$ df 2,178 $P=0.033$, $F=6.90$ df 2,178 $p=0.001$, $F=3.09$ df 2,178 $p=0.048$ and $F=24.95$ df 2,178 $p=0.0001$ respectively). Participants ratings for the weight and size of the exit and exiting on to the wing did not change significantly during the three trials.

6.2.10 Problems experienced by participants in operating the type III exit and the effects of practice

The percentage of participants reporting difficulties in operating the Type III exit was far greater with the traditional exit mechanism than with the modified exit mechanism. During trial one, 31% of those participants operating the modified exit experienced some difficulties in comparison to 88% of those participants operating the traditional Type III exit. Tables 19 and 20 below show the difficulties experienced by participants during the three trials for the modified and traditional Type III exits respectively.

Table 19 Problems experienced by participants in operating the modified Type III exit mechanism during the three trials (figures indicate percentage of participants experiencing each difficulty)

	Trial One	Trial Two	Trial Three
Size of Type III exit aperture	25	25	23
Stepping over exit ledge	8.3	8.3	8.3
Hit head on exit	2.1	4.2	2.1
Unsure where to put exit	8.3	2.1	-
Exit didn't retract all the way into fuselage	2.1	4.2	6.25
Dummy obstructed participant in some way*	6.25	12.5	12.5
Seats were in the way	-	-	2.1

*percentage refers only to 16 participants in the 'dummy present' trials

Table 19 shows the frequency with which problems were occurring with the modified exit mechanism. Problems such as the size of the exit aperture and stepping over the exit ledge onto the wing, remained stable with practice and did not effect the initial operation or disposal of the exit itself. During the three trials the number of participants reporting that they did not translate the exit fully in to the fuselage increased. The participants explained that due to the ease of the first operation they had not opened the exit with the same amount of force in the subsequent trials, this led to their difficulties in movement of the exit hatch into the fuselage.

Table 20 Problems experienced by participants in operating the traditional Type III exit during the three trials (figures indicate percentage of participants experiencing each difficulty)

	Trial One	Trial Two	Trial Three
Size of exit hatch and therefore the disposal	37.5	58.3	58.3
Unsure where to put exit hatch	16.6	10.42	2.1
Seats were in the way	8.3	4.2	12.5
Surprise of weight and exit hatch coming free	16.6	6.25	-
Stepping over exit ledge	2.1	-	2.1
Exit hatch hit their head	2.1	2.1	2.1
Dummy obstructed participant in some way*	12.5		18.75

*percentage refers only to 16 participants with the dummy present

Table 20 clearly shows the problem participants experienced with the size of the exit hatch and consequently its disposal. The frequency of this problem increased as participants practised opening the traditional Type III exit. This increase was accompanied by a decrease in the number of participants who were unsure where to

put the exit hatch. Figure 12 above, clearly shows that as participants practised opening the exit there was an increase in the probability of a correct disposal of the traditional Type III exit and therefore a similar increase in those participants encountering difficulty in trying to place the exit hatch onto the wing.

6.3 *Discussion*

6.3.1 Evaluation of test methodologies

The research programme illustrated many of the difficulties that members of the public can have in operating Type III exits. The participants were not briefed about the exact nature of the test prior to taking part, so the experimental situation simulated the ambiguity which may occur in an emergency.

The differences in the mean operation and evacuation times from previous Type III exit tests may have been due to such factors as improvements to the Type III exit operation diagrams or improved realism in the aircraft cabin simulator.

The participants were also advised that passenger safety briefing cards in the seat pockets and safety placards on the seat backs in front of them detailed how the exit operated. This instruction may have led to an increased awareness on the part of participants leading them to study the safety card and/or placard in more detail. However, this result should not be taken to indicate that all passengers would be equally prepared in an aircraft emergency, indeed a few participants during the research programme initially started to move towards the exits at the rear of the cabin as they believed that cabin crew would be stationed there and that these exits would be easier to evacuate from, thus disregarded the instructions given to them in the pre-flight briefing.

As a result of methodological considerations all of the tests were carried out on an individual basis without the pressure from other passengers trying to escape. In this event it is hypothesised that the manoeuvre of the traditional exit may indeed be made even more difficult than the results indicated.

6.3.2 The influence of the Type III exit operation mechanism

The mean evacuation time for each participant on the first test, regardless of seating configuration, clearly indicated that the modifications to the Type III exit operating mechanism significantly increased the speed at which participants could open the exit and evacuate onto the wing of the simulator. The difficulties participants found in manoeuvring and disposing of the exit due to its size and weight were removed or lessened when operating the modified exit mechanism. This finding demonstrates the benefits which could be gained from the adoption of the modified Type III exit mechanism, particular during evacuations when passengers are pushing to escape.

6.3.3 The influence of seating configuration on the operation of the Type III exit

The evacuation times from both types of exit mechanisms showed that the seating configuration did not affect the speed at which participants opened the exit and evacuated onto the wing. Due to methodological considerations the test did not involve other participants competing to escape and as a result, operation difficulties reported with the outboard seat configuration could not be assessed.

Exit operation times were significantly slower when a dummy representing an incapacitated passenger was present. Participants found that their access to the exit was restricted and therefore the operation of the exit more difficult. The restricted space caused by the presence of the dummy was a particular hindrance when participants were trying to dispose of the traditional Type III exit. In some cases as the participant tried to manoeuvre the exit through the exit aperture it became wedged against the dummy and seat row in front. Due to the weight and size of the exit hatch they decided to leave the exit lying across the dummy's lap rather than continuing in their efforts to place the exit onto the wing.

6.3.4 The influence of participants gender on the operation of the Type III exit

Male participants operated the Type III exit significantly quicker than female participants. Women found the operation of both Type III exit mechanisms more difficult than male participants, although the mean evacuation times suggested that these differences were reduced when participants were operating the modified exit mechanism. It appeared that the female participants who found the size and weight of the traditional exit particularly difficult to manage were not at such a disadvantage when operating the modified exit mechanism. This mechanism did not require them to support and manoeuvre the heavy exit, a task which the female participants had found particularly difficult. The results of changes in exit mechanism on male and female participants ability to operate a Type III exit suggest that the benefits of adopting the modified design of Type III mechanism would be greater for female passengers.

The adoption of the modified exit mechanism would ease the problems that check in staff face when deciding on who should be seated in this area. Whilst they have strict rules about individuals who should not be seated next to the exit it can be a very subjective assessment of whether an individual is ‘capable’ of operating the exit. The adoption of the modified type III exit mechanism would ensure that a greater range of passengers really are ‘capable’ of successfully operating such a class of exits.

6.3.5 The influence of participants handedness on the operation of the Type III exit

The mean times taken to operate both exit mechanisms showed that an individual's handedness did not affect their ability to operate a Type III exit.

6.3.6 The influence of practice on the operation of the Type III exit

Practising the task three times significantly reduced the times taken by the participants to operate the exit and evacuate onto the wing. The effects of practice

between the two exit mechanisms were not found to be significantly different. however the benefits of reduction in evacuation times appeared to be greater with the traditional exit mechanism. This result indicates quite clearly the benefits that passengers could gain from being provided with the opportunity to use equipment in a safety centre. Their performance improved through practice even without any training input from the researcher. It is suggested that correct disposal of the traditional Type III hatch would have been even greater after trial three had instruction been provided between each attempt.

Although practising the operation of the traditional Type III exit mechanism improved participants ability to operate the exit, it failed to the increase it to the speed of operation of the modified exit mechanism. This result suggests that if such modifications to these exits were introduced onto current aircraft they could reduce the need for hands on training in safety centres

The reduction in operating time and benefits due to practice were greatest when the dummy was present. This demonstrates the effect an incapacitated person could have on an evacuation of this type and the importance of including this configuration in future testing.

6.3.7 Placement of exit and the effect of practice

The number of participants correctly disposing of the Type III exit was greater in all three trials when participants were operating the modified exit mechanism in comparison to the tradition exit mechanism. In the first test only 40% participants correctly disposed of the traditional exit correctly where as 94% participants fully pushed the modified exit up into the fuselage. The numbers of participants correctly disposing of the traditional Type III exit did increase in tests two and three, however 29% were still leaving the exit inside the aircraft in test three.

The participants who failed to dispose of the traditional Type III exit onto the wing did so because they found that either the size and weight of the exit was too difficult to manoeuvre or because they failed to understand the diagrams on the passenger safety briefing cards and placards. Many of the participants felt that improvements could be made to the diagrams indicating the operation of the traditional Type III exit for example they felt that the pictures could be clarified, showing exactly where to place the exit. They also commented that it would be useful to give an indication of the weight of the exit and to verbally explain how to use the exit.

This result demonstrates the difficulty that participants can experience when operating the Traditional Type III exit. The failure to correctly dispose of the traditional Type III exit could lead to it becoming an obstruction to passengers in their attempt to evacuate from an exit of this type. As the testing showed, the modified exit removed the problem of passengers leaving the exit inside the aircraft and therefore creating any subsequent obstruction. Even when participants had failed to read or were not clear about the operating instructions for the modified exit, when they released the operating handle, the movement of the exit encouraged them to correctly push it up into the fuselage.

6.3.8 Participants perceived ease of operation and the effect of practice

Participants subjective ratings indicated that regardless of type III exit operation mechanism, with practice they felt that the ease of using the operating handle, clarity of exit instructions, opening the exit and clarity for disposing the exit all became easier. This suggests that the diagrams used in this study became easier to understand with practice and the information they impart could in fact be clarified and improved. The participants subjective ratings for the weight and size of the exit and exiting on to the wing did not change significantly during the three trials, indicating that the difficulty of these factors remained constant.

6.3.9 Problems experienced by participants in operating the Type III exit and the effect of practice

The percentage of participants reporting difficulties in operating the Type III exit was far greater with the traditional Type III exit mechanism than with the modified exit mechanism. The type of difficulties encountered by participants were dependent on the exit mechanism being used. In the traditional Type III exit trials more participants reported difficulties pertaining to the operation and disposal of the exit. In comparison, difficulties reported in the modified Type III exit trials were linked to the size of the exit aperture and height of the exit ledge, which caused problems when participants were evacuating onto the wing.

6.4 *Conclusions*

1. The present Type III exits provided on current aircraft have a number of short-comings, including weight and manoeuvrability which have led to problems in the operation of the exit.
2. The short-comings of the traditional Type III exit may be best overcome by provision of a system of support and constraint which aids the operation of removing the hatch from the aperture in the limited space around it.
3. The modified exit uses the same motion principles as the main doors on a number of aircraft. This concept provides a relatively simple scheme which does not require substantial fuselage modification or loss of seating capacity.
4. The time taken by participants to operate a Type III exit and evacuate onto the wing of a simulator was significantly quicker when using the modified Type III exit mechanism. This Indicates need to simplify equipment to be used by untrained operators.
5. The two seating configurations specified in AN79 paragraphs 4.1.1 and 4.1.2 1989, did not significantly influence the time taken by participants to operate either type of Type III exit mechanism and evacuate onto the wing. Further research is required to assess the impact on ease of operation of the presence of other passengers, particularly with the outboard seat removed.
6. The presence of the simulated incapacitated person seated adjacent to the Type III exit significantly increased the time taken by participants to make the exit available and evacuate onto the wing.
7. Female participants found the operation of both types of Type III exit mechanism more difficult than male participants. The benefits of adopting the

modified Type III mechanism would be greater for females than for males and would ease the difficulties of those individuals who are responsible for ensuring passengers seated next to the exit really are 'capable' of successfully operating these exits.

8. Participants handedness did not affect participants ability to operate either Type III exit mechanism.
9. Providing participants with the opportunity to practice the task three times led to a reduction in the times taken to operate both types of Type III exit mechanisms and evacuate onto the wing. The greatest learning occurred between test one and two. This result indicates the benefits passengers could gain from visiting safety centres.
10. Practising the operation of the traditional Type III exit failed to improve participants speed of operation to the speed achieved by participants when operating the modified Type III exit without practice. The introduction of such modifications to these exits onto current aircraft could reduce the need for hands on training of Type III exit operation in safety centres.
11. The effect of practice was greatest in conditions with the dummy present.
12. Practice provided participants with the opportunity to find more effective methods of opening and manoeuvring the traditional Type III exit. Practice also led to a greater number of participants correctly disposing of the traditional Type III exit.
13. The difficulties that naive participants encountered in trying to understand the exit operating instructions of the traditional Type III exit indicated the need to clearly indicate the method of operation and disposal of such exits.

7 **EXPERIMENT TWO: MODE OF INSTRUCTION**

7.1 *Research Design*

The tests were conducted on a B-737 simulator configured to the current regulations. Each test involved an individual participant performing a safety related task (donning life jacket) before operating a Type III exit and evacuating on to the wing of the cabin simulator. The use of this safety task was done so to provide a blocking task between the safety information and exit operation. The Type III exit hatch weighed 21.5 kg and all of the trials were conducted with a triple row of seats with a 13” vertical projection (see Appendix C).

In total, 56 volunteers operated a Type III exit, 8 volunteers in each of the seven safety information conditions. In each of the conditions participants were given a pre flight safety briefing followed by an additional safety briefing (Appendix I) informing them that they were sat next to an emergency exit and may have to operate it in the event of an emergency. Participants were then either directed to look at the briefing card (Appendix J), given a verbal description of how to operate the exit (Appendix K) or shown a video (Appendix L), depending on the experimental condition they were in. Table 21 shows the experimental conditions and volunteers utilised.

Table 21 The experimental test conditions

Condition	Male	Female
1) no briefing card	4	4
2i) colour pictures with operator (Pic operator)	4	4
2ii) colour picture without operator (Pic)	4	4
2iii) colour photograph with operator (Photo)	4	4
2iv) colour picture and words (words)	4	4
3) verbal description no briefing card (verbal)	4	4
4) video no briefing card (video)	4	4

7.1.1 *Ethical considerations*

The research design was submitted to the Cranfield Ethics committee. As with study one the ethical considerations of confidentiality of data, safety and welfare of participants, voluntary participation and knowledge of results were adhered to in this research programme.

7.1.2 *Methodological considerations*

As with study one there is a need to balance the need for realism with the safety of the participants. The Type III operation trials involved individual participants for several reasons; firstly it was felt that the risk of injury to other participants precluded group trials. secondly, in order to produce pressure in the exit area a large number of participants or confederates would be required, over the course of the experimental programme the cost and practicalities negated such a design. Thirdly and more importantly, the study aimed to make an assessment of the impact that briefing material alone had on exit operator performance. Should other passengers or confederates been present during the tests the operator may have relied upon them to help them. Such behaviour has been reported in earlier testing (Sibley, 1995) when passengers attempted to evacuate from the main exits because cabin crew members were stationed there rather than assuming responsibility for the operation of the Type III exit.

7.1.3 *Equipment*

7.1.3.1 *The cabin mock-up*

The experimental tests took place in the same simulator used during experiment one. Ten rows of triple seats were located along either side of the cabin fuselage. A fully functioning Type III exit was fitted half way down the side of the fuselage. The triple seat configuration forming the exit aisle the seats fore and aft of the Type III exit were

at a seat pitch of approximately 38 inches (97 cm) with a vertical projection between the seats of 13 inches (33 cm). This vertical projection was used so the exit seat row did not extend beyond the exit centre line thus complying with paragraph 4.1.1 in AN79 (see Appendix B).

7.1.3.2 Type III Exits

The dimensions of exit hatch in the cabin simulator were representative of those on a narrow bodied transport aircraft and the same used for the ‘traditional’ exit in experiment one.

7.1.4 Data Acquisition

Video cameras were located inside and outside the cabin, in order to record the manner in which participants opened and disposed of the Type III exit. The cameras were fitted with a time base function and microphones to provide the information required for the data analysis.

A questionnaire was used to identify any problems experienced by participants when opening the exit and evacuating onto the wing. In this questionnaire participants were asked to assess the ease with which they considered they were able to open the exit and evacuate from the cabin and to indicate the nature of any difficulties experienced in completing the task (see Appendix K).

7.1.5 Participants

The volunteers were recruited by local advertising and use of the Human Factors Group’s data base. In order for the volunteers to be representative of those who were expected to encounter most difficulties in completing the task, the same maximum height and weight criteria used for recruitment during experiment one were employed during experiment two.

Volunteers who had taken part in previous Type III tests were not eligible to take part in the test programme. The volunteers were only allowed to take part on one occasion.

7.1.6 Test Procedure

The volunteers were randomly assigned to one of the seven experimental conditions. A member of the research team, trained and dressed as a cabin crew member briefed each participant about the nature of the test upon his/her arrival at the College of Aeronautics. In order to maximise realism the participants were not briefed about the precise nature of the test but were forewarned that they would be carrying out various safety procedures and they might have to lift a weight equivalent to that of a heavy suitcase (potential volunteers with health problems were screened out during recruitment). Participants were asked to complete a consent form indicating that they understood the general nature of the study and that they believed they were physically able to take part in the test.

Once seated inside the cabin, each participant was given a pre-flight safety briefing which included a demonstration of the method of operation of the seat belt, oxygen mask, life jacket as well as the location of the Type III and other exits (see appendix I). Following the participant was informed that they were sat next to an emergency exit and that should there be a need to evacuate the aircraft that they may have to operate the exit. This additional briefing was followed by one of the experimental conditions.

The cabin crew member then checked that the participants' seat belt was fastened securely and positioned herself at the front of the cabin. The participant then heard a sound recording of an aircraft starting up, taxiing to a runway and taking off before being issued with the instruction to don his/her life jacket before being instructed to 'Open the exit and get out'. The test continued until the participant successfully opened the exit hatch (and disposed of it) and evacuated onto the. After the test the

participant completed a questionnaire commenting on various aspects of the safety briefing, their evacuation and their attitudes to aircraft safety briefings etc. (see Appendix K).

Before leaving Cranfield each participant was given a debriefing in which they were reminded of the safety of air travel and advised that they should get back in touch with Cranfield if they experienced any physical or emotional problems as a result of participating in the tests.

7.2 RESULTS

7.2.1 Individual characteristics of the participants

The mean age of all of the participants was 27.25 years (the youngest being 20, the oldest 44 years old). The male participants had a mean height and weight of 173 cm and 69.25kg. The female participants had a mean height and weight of 163 cm and 60.5kg respectively. The average frequency of exercise taken by participants was one or two times a week. All but one participant had flown before and the average number of flights taken was 11-15 return flights. Eighty three percent of the participants had flown within the last year.

7.2.2 Donning of the Lifejacket

All of the participants were given a pre-flight briefing which included a demonstration by the cabin crew showing how to don the lifejacket. The time taken to don the lifejacket was taken from the instruction “put on your life-jacket” (time 0.00) to when the participant had finished their attempt to put on the life jacket.

A total of 9 participants had to be given extra information about the stowage of the life-jacket which was located beneath their seat. The average time taken by participants to don their life-jacket was 49.12 seconds (10.76 SD). The shortest time taken to don a life-jacket was 29.60 seconds the longest was 76.47. Seventy one percent of participants correctly donned their life-jacket, those that did not, had tied the tapes across the life-jacket itself making inflation difficult.

Twenty three percent of participants undid their seat belt to put on their life-jacket, even after specific instructions to remain seated with their seatbelt on. A further four percent stood up while putting on their life-jacket. Several participants commented that whilst they had been shown how to put on their life-jacket, the demonstration was given by the cabin crew member whilst standing. Consequently when they were

asked to put on their life-jacket they were unclear whether they should initially stand and then found that the demonstration they had seen was in fact of little help.

7.2.3 The operation of the Type III exit

Table 22 shows the mean times (in seconds) by all of the participants to make the exit available. This time was calculated from the point at which their hand was on the operating handle to when the exit was available i.e. the exit was on the wing or had been deposited in the cabin. Table 22 also includes the time taken by participants to operate the exit and evacuate onto the wing. This time was taken from the point at which their hand was on the operating handle to when they had one foot on the wing.

As Table 22 shows participants who were shown the video made the exit available quicker and exited on to the wing more quickly than any of the other groups.

Table 22 Mean times (in seconds) taken by *all* participants to make the exit available and from hand on handle to exit and evacuate onto the wing (standard deviations are shown in parentheses).

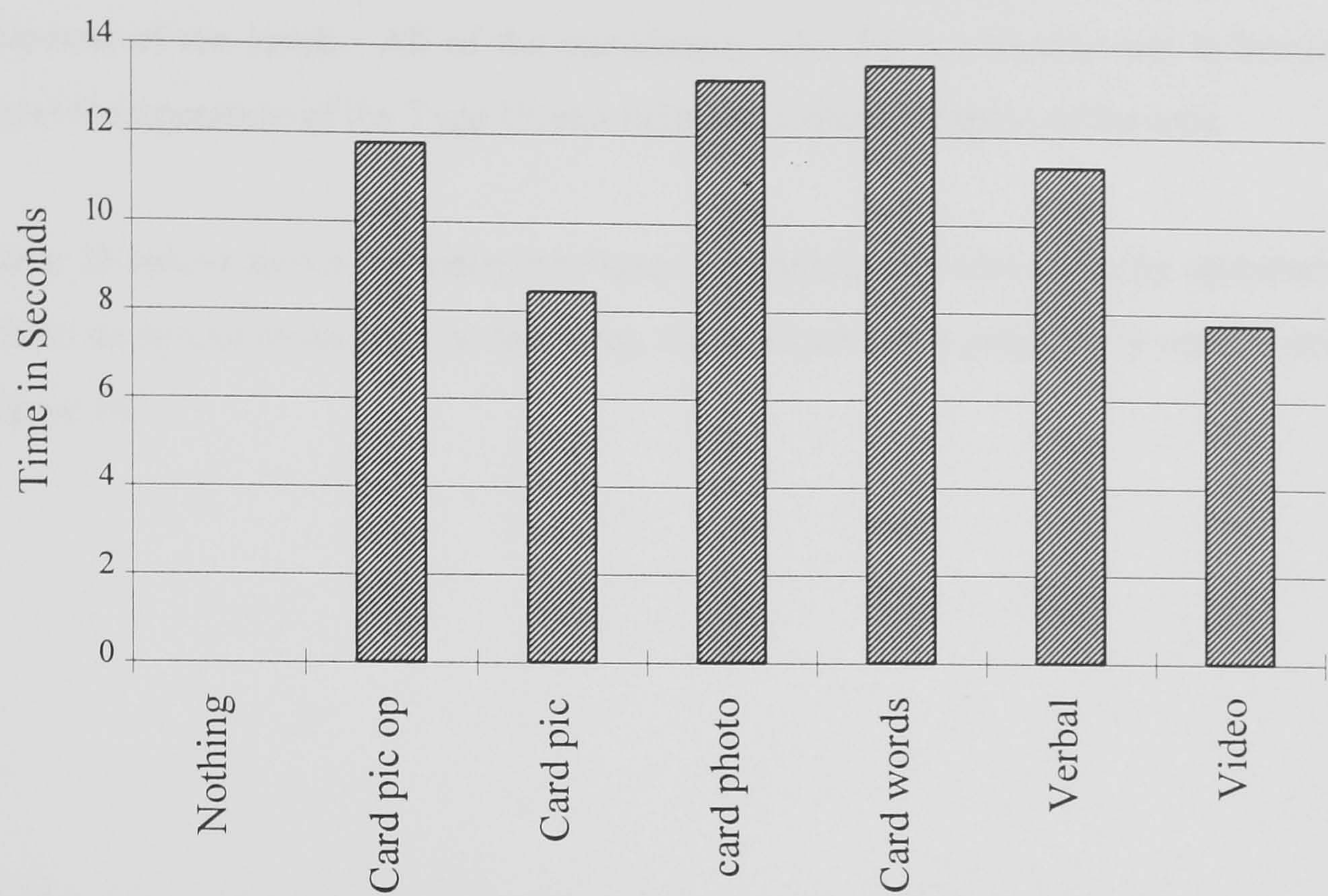
	Time in seconds to make the exit available	Time in seconds from hand on handle to exit onto the wing
Nothing	10.76 (6.12)	14.21 (6.03)
B/Card Pic operator	10.89 (3.45)	14.76 (5.00)
B/Card Pic	9.90 (2.99)	12.49 (3.54)
B/Card Photo	13.97 (10.86)	17.50 (10.45)
B/Card Words	12.57 (4.46)	16.33 (3.92)
Verbal Description	11.52 (4.91)	15.51 (6.94)
Video	7.75 (3.28)	11.82 (5.65)

Due to differences in the numbers of participants correctly disposing of the exit onto the wing Table 23 shows the mean times taken by participants who correctly disposed of the exit. Figure 13 graphically represents this information.

Table 23 **Mean times (in seconds) taken by those participants *correctly disposing of the exit* - exit available (standard deviations are shown in parentheses).**

	Time in seconds	Number of paxs correctly disposing of exit
Nothing	-	0
B/Card Pic operator	11.76 (3.90)	4
B/Card Pic	8.44 (2.74)	5
B/Card Photo	13.26 (0.00)	1
B/Card Words	13.62 (4.32)	5
Verbal Description	11.31 (3.26)	6
Video	7.75 (3.28)	8

Figure 13 Graphical depiction of Mean times (in seconds) taken by those participants *correctly disposing of the exit* - exit available.



There was no significant difference in the time taken by participants to make the exit available as a result of the exit operation information they were given, the one-way ANOVA summary is shown in Table 24.

Table 24 **One-way Anova Summary table - Time to make exit available by briefing condition**

	D.F	Sums of squares	Mean squares	F	Probability
Between Groups	5	147.85	29.57	2.44	0.065
Within Groups	23	278.52	12.10		
Total	28	426.37			

As Table 23 shows the quickest times were recorded by those participants who had been shown the video presentation. All of these participants correctly disposed of the exit. The simplified briefing card without an operator also led to quick operating times however fewer participants correctly disposed of the exit. The slowest times

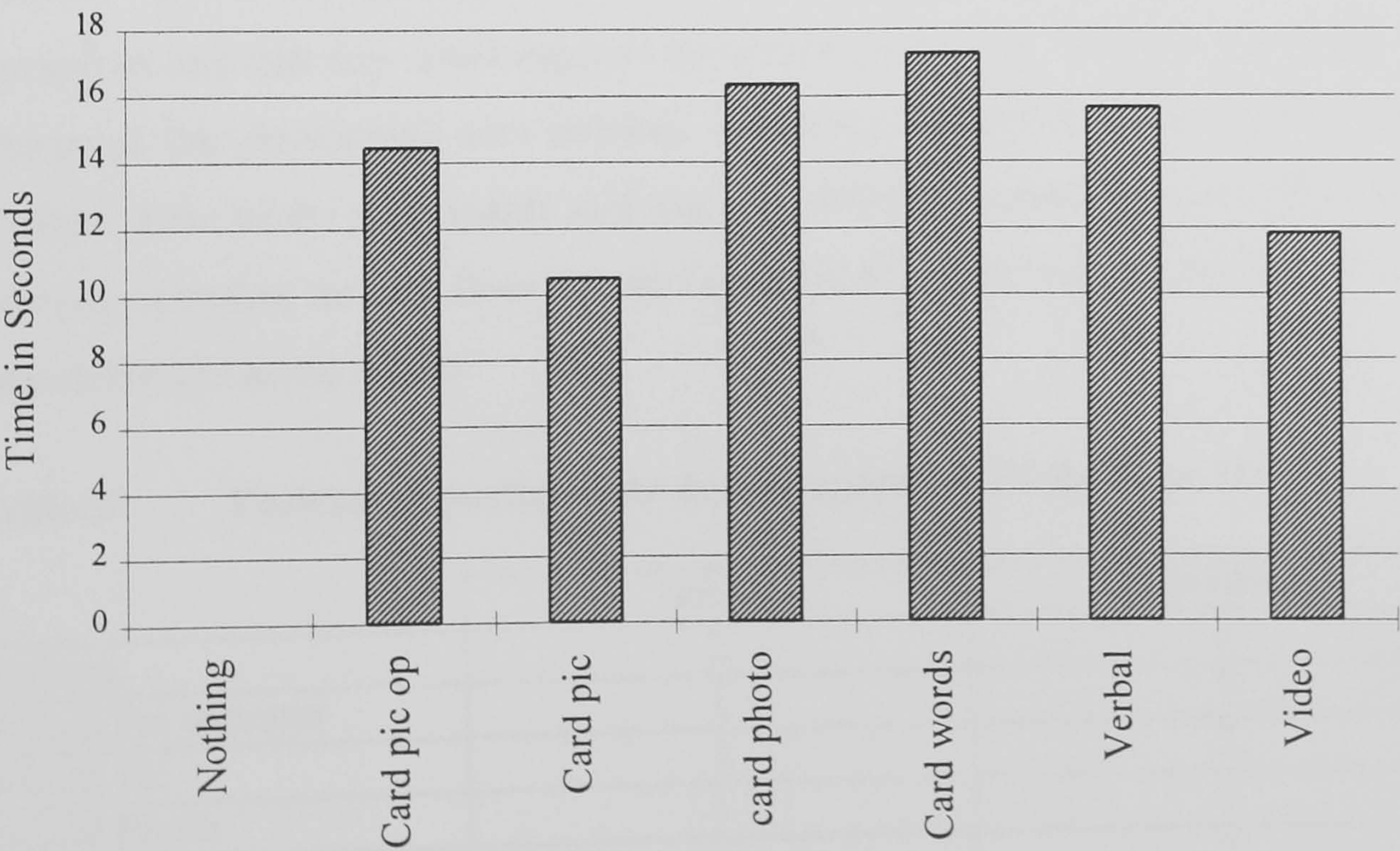
were recorded by participants who had been shown the photograph and pictures with additional words briefing cards. The briefing card with safety information depicted in photographs not only led to slow operation times, but only one participant correctly disposed of the hatch. All of the participants who did not receive any information about the operation of the Type III exit failed to correctly dispose of the exit.

Table 25 below shows the mean time taken by participants who correctly operated the exit to do so and evacuate onto the wing, this information is graphically represented in Figure 14.

Table 25 Mean times (in seconds) taken by those participants *correctly disposing of the exit* - hand on handle to exiting onto the wing (standard deviations are shown in parentheses).

	Time in seconds	Number of paxs correctly disposing of exit
Nothing	-	0
B/Card Pic operator	14.46 (5.75)	4
B/Card Pic	10.48 (2.83)	5
B/Card Photo	16.34 (0)	1
B/Card Words	17.28 (4.34)	5
Verbal Description	15.65 (5.98)	6
Video	11.82 (5.65)	8

Figure 14 Graphical representation of the Mean times (in seconds) taken by those participants *correctly disposing of the exit* - hand on handle to exiting onto the wing.



As Table 26 indicates there were no significant differences in the times taken to operate and evacuate onto the wing between the groups. Again the quickest times were recorded by those individuals in the simplified exit diagrams without an operator and video groups. The slowest times were recorded by those individuals who were shown exit operation information presented in pictures with additional words.

Table 26 One-way Anova Summary table - Time to operate the exit and evacuate onto the wing

	D.F	Sums of squares	Mean squares	F	Probability
Between Groups	5	175.51	35.10	1.32	0.288
Within Groups	23	608.54	26.45		
Total	28	784.04			

7.2.4 Position of operation

Table 27 below shows the position participants operated the Type III exit. As the table indicates the majority of the participants operated the exit from a standing position. The reason they gave for doing this was because they felt it was more appropriate and that they could support the weight of the exit. However, seventy five percent of the participants who watched the video operated the exit from a seated position. Four of the participants said that they did this because the video had shown a person operating the exit from a seated position the other two felt that it was more appropriate to remain seated.

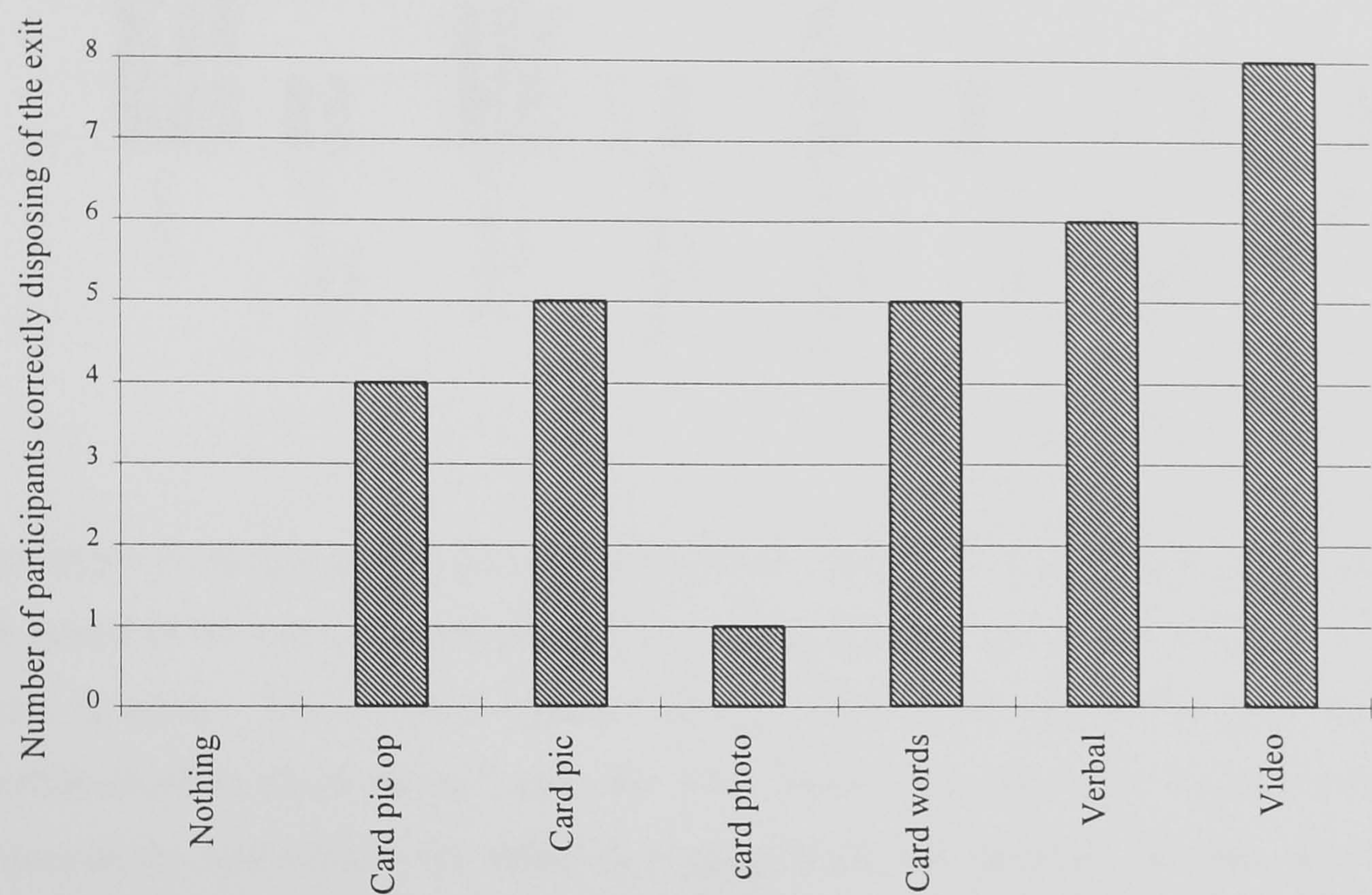
Table 27 Position of participants during operation of the Type III exit

	Seated	Standing
Nothing	2	6
B/Card Pic operator	1	7
B/Card Pic	1	7
B/Card Photo	1	7
B/Card Words	1	7
Verbal Description	1	7
Video	6	2

7.2.5 Disposal of the Type III exit

In total fifty two percent of the participants disposed of the Type III exit correctly onto the wing. Figure 15 below shows the number of participants in each condition who correctly disposed of the exit.

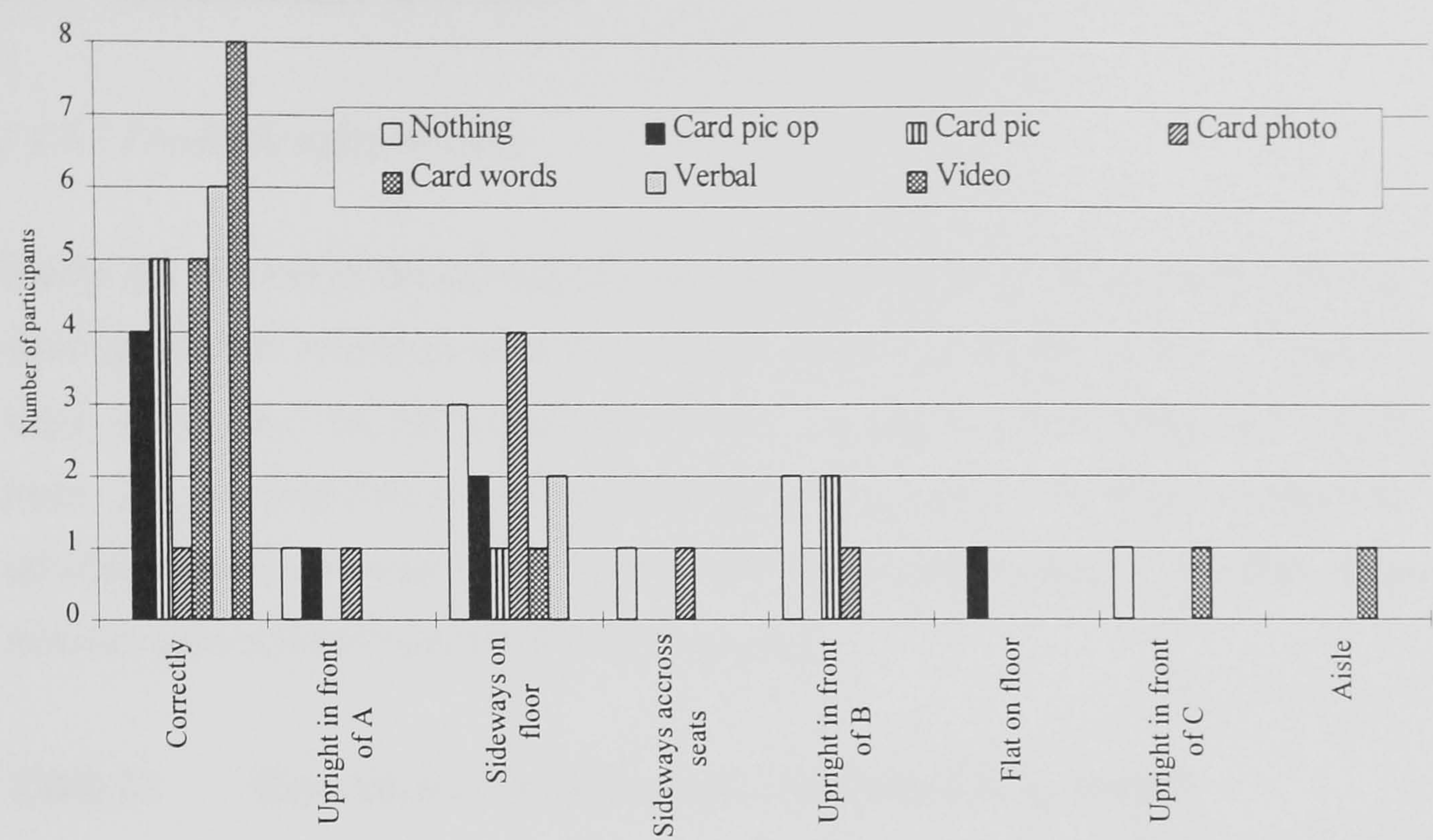
Figure 15 Number of participants correctly disposing of the exit



Statistical analysis showed that mode of information presentation had a significant effect on the number of participants correctly disposing of the exit ($\chi^2_5 = 23.45$, $p < 0.0006$). As figure 15 shows when participants received no instructions about operating the exit and did not have a briefing card none of them correctly disposed of the exit. The photographic exit diagrams appear to be particularly poor in conveying to participants where they should dispose of the exit. All of the participants who were shown the video correctly disposed of the exit.

Figure 16 shows where participants disposed of the exit.

Figure 16 Placement of the exit



As figure 16 clearly shows, all of the participants who were shown the video correctly disposed of the exit. Six participants who received verbal instruction disposed of the exit correctly. These results indicate that by showing participants or specifically telling them to place the exit onto the wing correct disposal of the exit increases. Most of the individuals who failed to dispose of the exit correctly operated the exit handle and simply let the exit drop to the floor on its side. A few individuals didn't realise that the exit had to be placed on the wing and placed it upright against the seats in front.

7.2.6 Questionnaire information

7.2.6.1 Pre-flight safety briefing

Ninety one percent of the participants paid attention to the Pre-flight safety briefing. when asked if it helped them in their escape all but two felt that it had. Table 28 below shows how the participants felt that the pre-flight safety briefing had helped them. The two participants who felt that the information in the Pre-flight briefing was unhelpful did so because the life-jacket demonstration had shown the cabin crew member putting the life-jacket on whilst standing.

Table 28 How did the Pre-flight safety briefing aid your escape?

	Percentage
Showed how to put on your life-jacket	54
Knew exactly what to do	25
Knew how to operate the emergency exit	14
Knew where the exits were	7

7.2.6.2 Additional safety briefing

Ninety six percent of the participants listened to the additional safety briefing advising them that they were sat next to the emergency exit. Seventy five percent of these participants felt that the additional safety briefing had been helpful because they knew it was their responsibility to operate the exit and as a consequence paid attention to any additional exit information..

7.2.6.3 Safety Card

Of the thirty two participants who had a briefing card seventy five percent carefully looked at the card. Table 29 below shows how the participants felt that the briefing cards had been helpful. Only one of the participants felt that the card had been

unhelpful; reporting that felt that the pictorial briefing card without an operator wasn't clear in showing where the door should go.

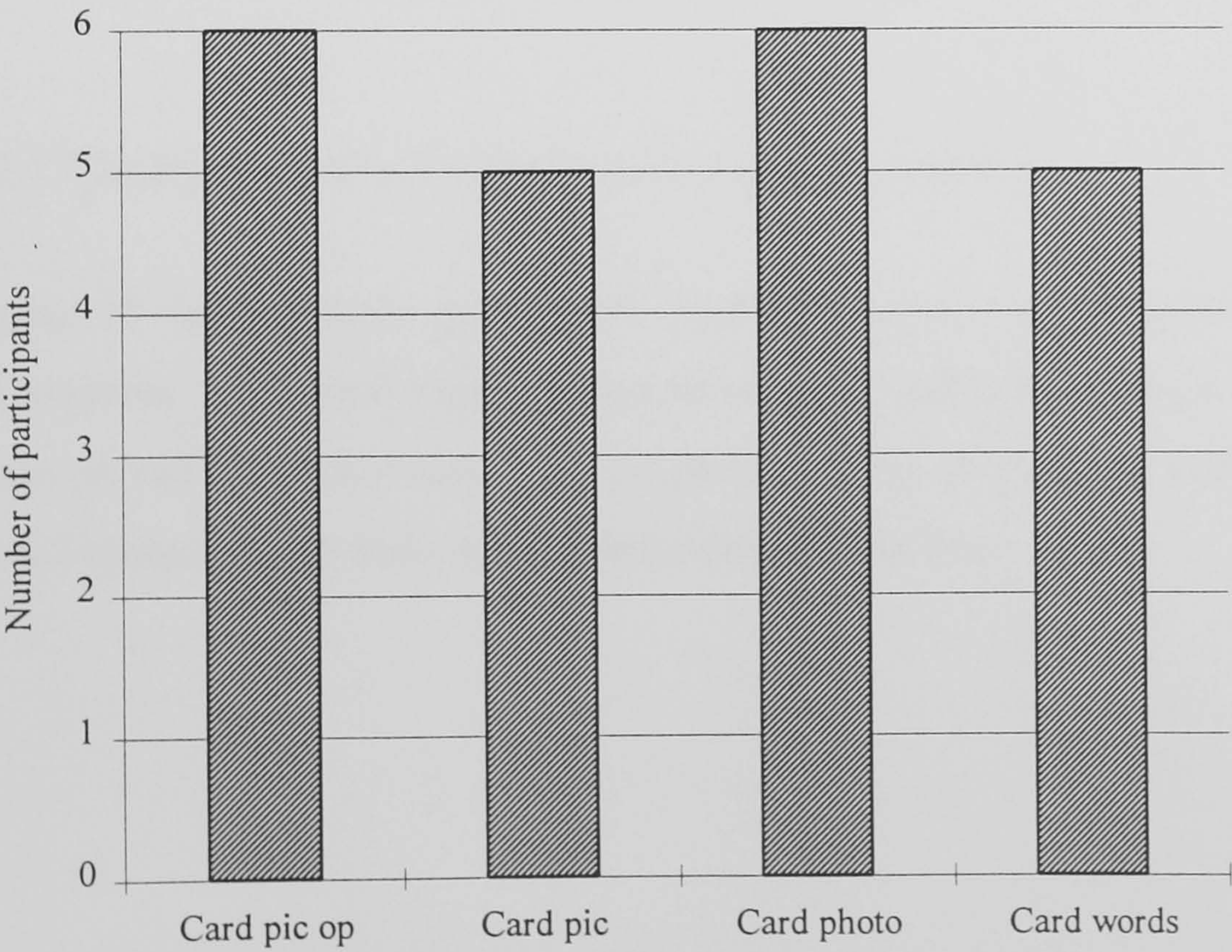
Table 29 How did the safety card aid your escape?

	Percent
Showed how to open the exit	82
Provided more information on the life-jacket	12
I knew to put the life jacket on seated	6

7.2.6.4 Exit diagram

The majority of participants who had a briefing card read the exit operation instructions carefully (92%). Figure 17 below shows the number of individuals who felt that the diagrams had helped them in their operation of the exit.

Figure 17 Number of participants who felt that the exit diagram on the briefing card was helpful



7.2.6.5 Verbal instructions

Those individuals who were given verbal instructions detailing how to operate the exit all felt that this had been helpful and aided them in the operation of the Type III exit. When they were asked how the instructions had helped, the majority of the participants (6) said that they knew exactly how to open and dispose of the exit . The two participants who felt that the verbal briefing had not prepared them to operate the exit said that it provided them with information however they were still unclear about the operation of the exit.

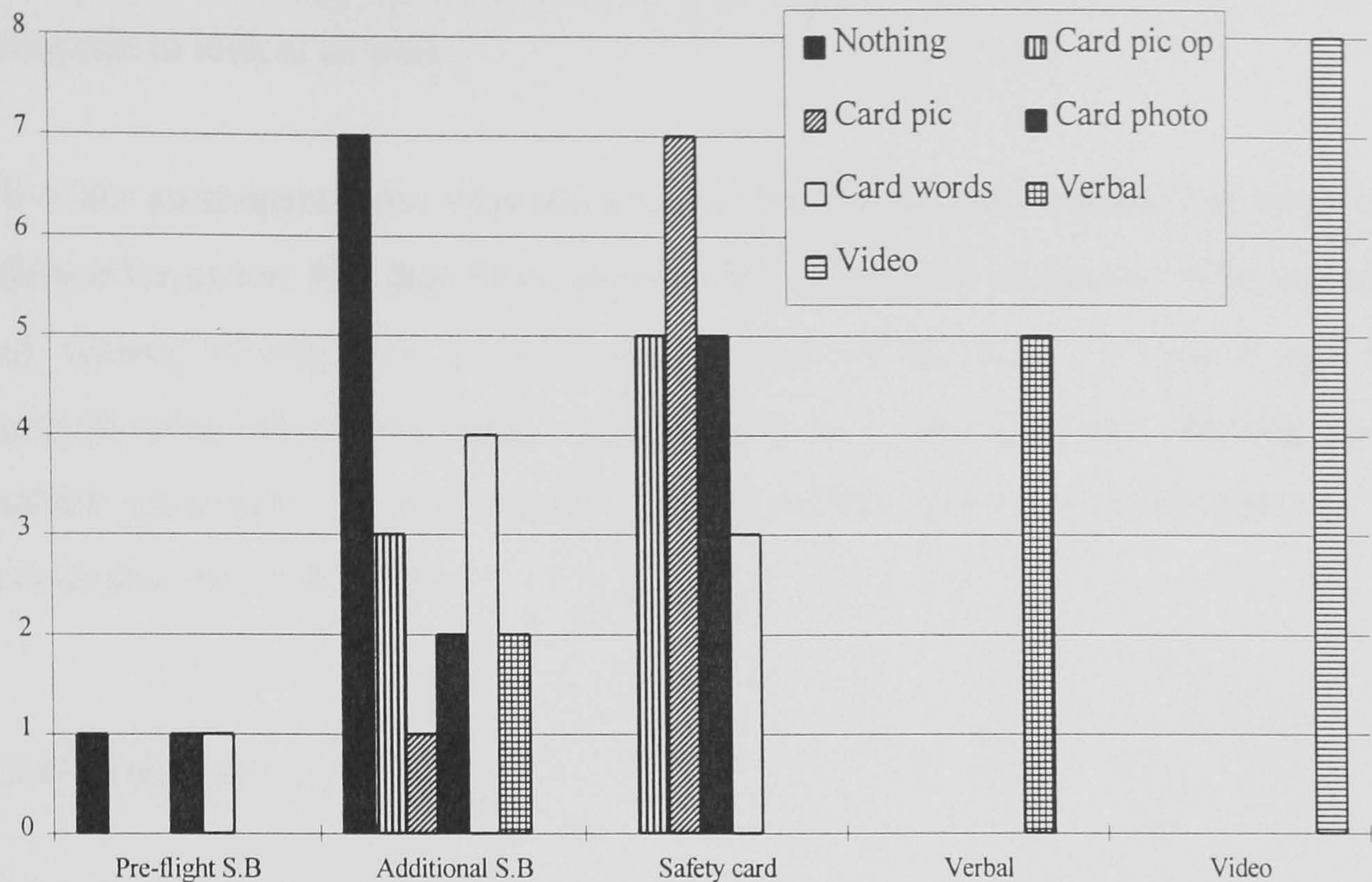
7.2.6.6 Video

The participants who were shown the video detailing how to operate the exit all said that it had aided their escape. They all stated that the video had clearly shown the exact steps necessary to operate and dispose of the exit.

7.2.6.7 Most preferred method of presentation of information

Figure 18 below shows participants preferred method of presentation of safety information. ‘Preferred’ simply means which of the safety information they had been given proved to be most useful in the operation of the exit and as a consequence they would choose to help them in their performance of the task.

Figure 18 Most preferred method of presentation of information



Participants who had received no exit information felt that the additional safety briefing informing them that they were seated next to an exit and that it was their responsibility to operate it had been more useful than the pre-flight safety briefing. This was because it had captured their attention as it was very personal.

Those participants who had a briefing card to look at, predominantly felt that this had provided them with the best information as it provided them with a visual depiction of how to operate the exit and showed what to pull and where to hold the exit. Those participants who felt that the additional safety briefing had been the most beneficial commented again that this had been very personal and they had listened carefully to the instructions they were given, once they realised that it was their responsibility to operate the exit they then read the briefing card carefully.

All of the participants who received verbal instructions and responded to this question felt that it was indeed these instructions which had provided them with the most useful information. Again as it was a one to one presentation so as a result they felt compelled to listen to the verbal description. A couple of participants commented

after the test that they had felt it hard to visualise exactly what they had to do without a diagram to look at as well.

All of the participants who were shown the video felt that this was the best method of safety information that they were given. They stated that it captured their attention and showed clearly how to open and dispose of the exit. It was a real life demonstration which was better than pictures as it was dynamic. Having watch another 'passenger' operate the exit they were then able to mentally rehearse the actions that they had to take.

7.2.6.8 Operation of the exit

Participants were asked to rate various aspects of the operation of the exit on a seven point scale; 1 indicating very easy, 7 indicating very difficult. Eighty percent of the participants rated the location of the exit in relation to their seat as very easy. Eighty two percent felt that finding the operating handle had also been very easy. There were no significant differences between mode of presentation group and participants ratings of opening, disposing and exiting onto the wing. However, as figure 19 shows those participants who were shown the video, on average rated opening and disposing the exit as easier than all of the other groups.

Figure 19 **Average difficulty rating of opening , disposing and exiting on to the wing**

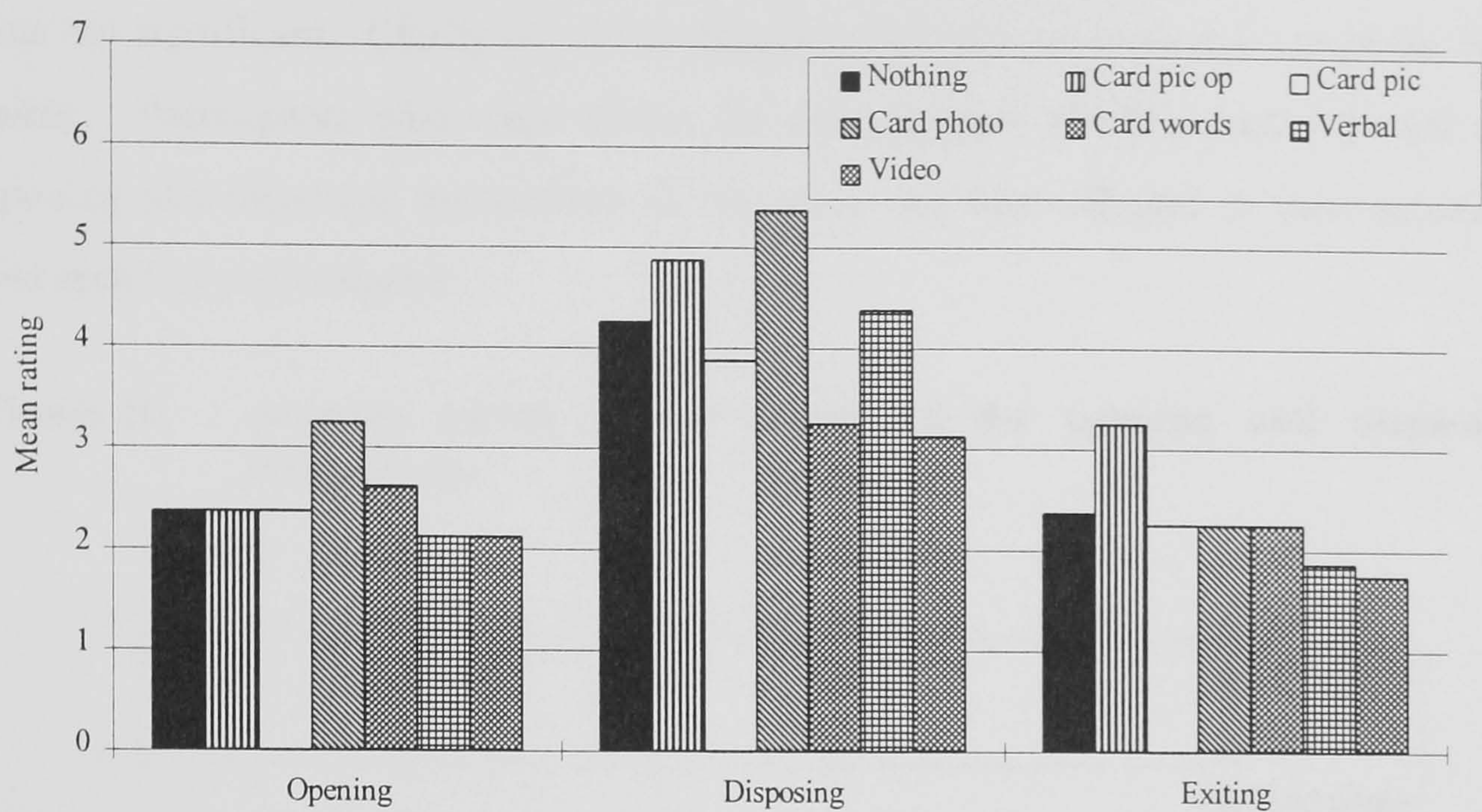


Table 30 **One-way Anova Summary table - Mean difficulty of opening rating by briefing condition**

	D.F	Sums of squares	Mean squares	F	Probability
Between Groups	6	7.17	1.19	0.76	0.61
Within Groups	49	76.75	1.56		
Total	55	83.92			

Table 31 **One-way Anova Summary table - Mean difficulty of disposal by briefing condition**

	D.F	Sums of squares	Mean squares	F	Probability
Between Groups	6	32.17	5.36	2.09	0.07
Within Groups	49	125.37	2.55		
Total	55	157.55			

Table 32 **One-way Anova Summary table - Mean difficulty of exiting through the exit by briefing condition**

	D.F	Sums of squares	Mean squares	F	Probability
Between Groups	6	11.17	1.86	1.33	0.25
Within Groups	49	68.25	1.39		
Total	55	79.42			

As Figure 20 indicates, on average participants who were shown the video gave this mode of presentation a better rating for clarity of opening instructions than those participants who were given verbal instructions or briefing cards, although this result was not significant. Clarity of video disposing instructions were also given the best rating. Participants who were shown the photographic briefing card reported the opening and disposing instructions as less clear and this reflected in their accuracy and speed of performance.

Figure 20 Average rating of the clarity of the opening and disposing instructions

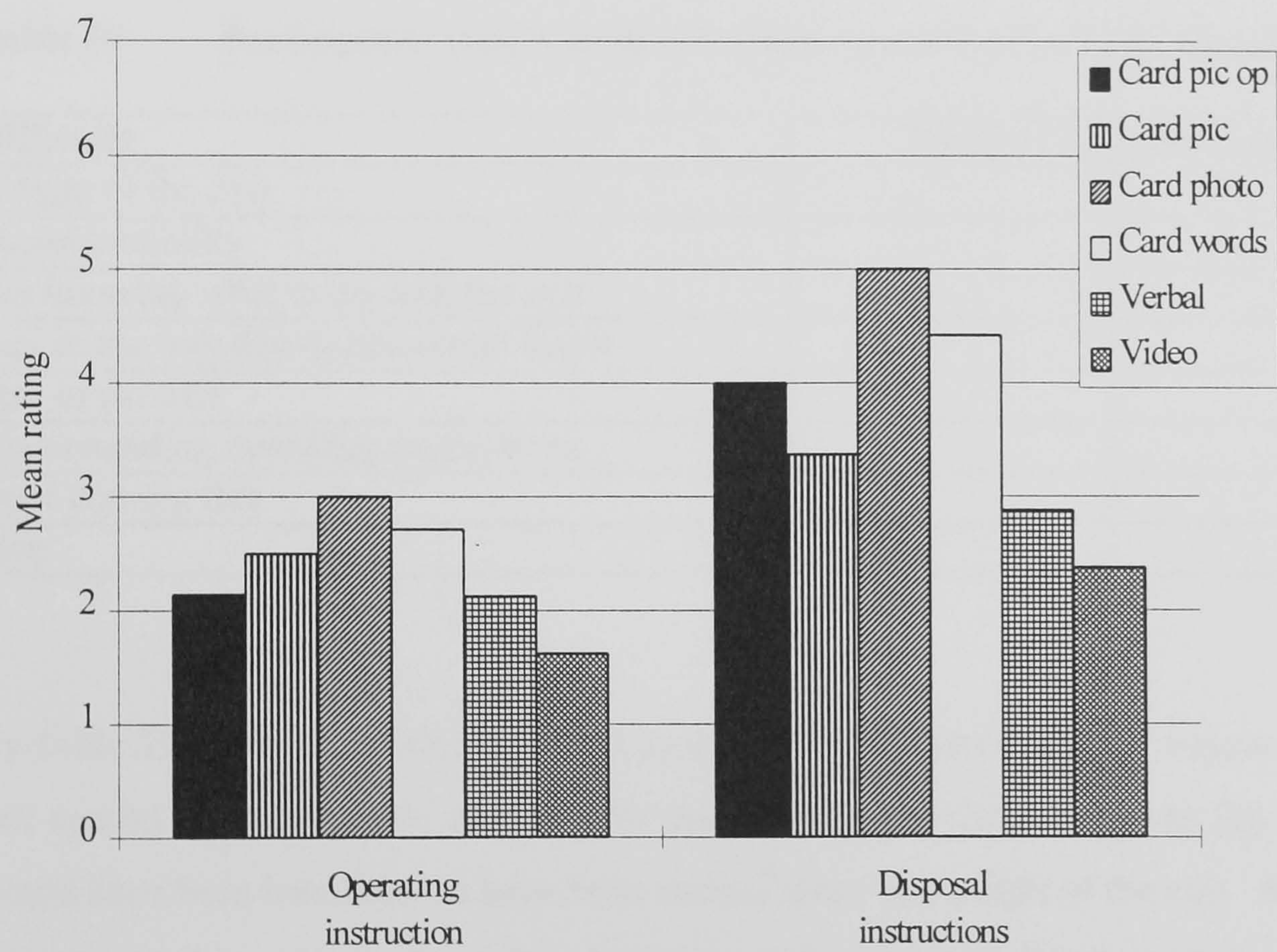


Table 33 One-way Anova Summary table - Mean clarity of operating instructions by briefing condition

	D.F	Sums of squares	Mean squares	F	Probability
Between Groups	6	9.51	1.58	0.91	0.49
Within Groups	40	69.03	1.72		
Total	46	78.55			

Table 34 One-way Anova Summary table - mean clarity of disposal instructions by briefing condition

	D.F	Sums of squares	Mean squares	F	Probability
Between Groups	6	38.26	6.37	1.22	0.31
Within Groups	42	218.83	5.21		
Total	48	257.10			

7.2.6.9 Exit operating difficulties

Table 35 shows the problems participants reported when using the overwing exit.

Table 35 Participants report problems when operating the Type III exit

Difficulty	Number of participants
Weight of the exit	17
Manoeuvrability	11
Not knowing what to do with the exit	10
Exit in the way due to placement inside	5
Size of the exit	2
Understanding operating instructions	2
Door coming free	3
Step	1

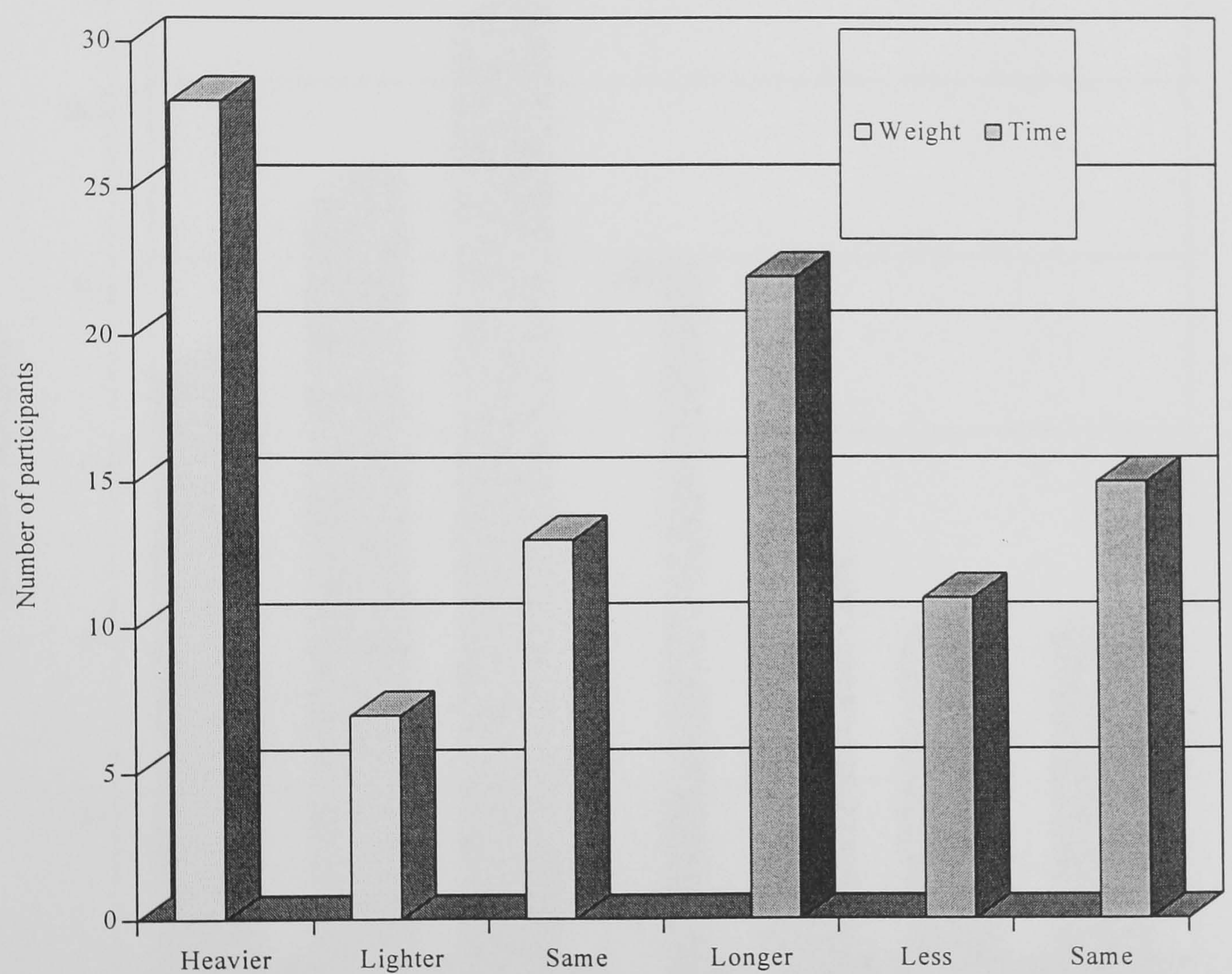
As Table 35 shows thirty six percent of participants commented that the weight of the exit caused them difficulty, twenty three percent of all of the participants felt that it would have been beneficial to have been warned about the weight of the exit. Several participants felt unclear about the placement of the exit and felt that advice about where to place it would have be beneficial.

7.2.6.10 Perceived weight of the exit and time to operate the exit

Participants were asked if the weight of the exit was heavier, less than or about the same weight as they had expected. As figure 21 below shows, the majority of participants said that the exit was indeed heavier than they expected, only fifteen

percent thought that the exit was lighter than they had expected. Forty six percent of the participants said that the operation of the Type III exit had taken them longer than they expected in comparison to twenty three percent who thought that it had taken less time than they expected.

Figure 21 Perceived weight of the exit and time to operate the exit.

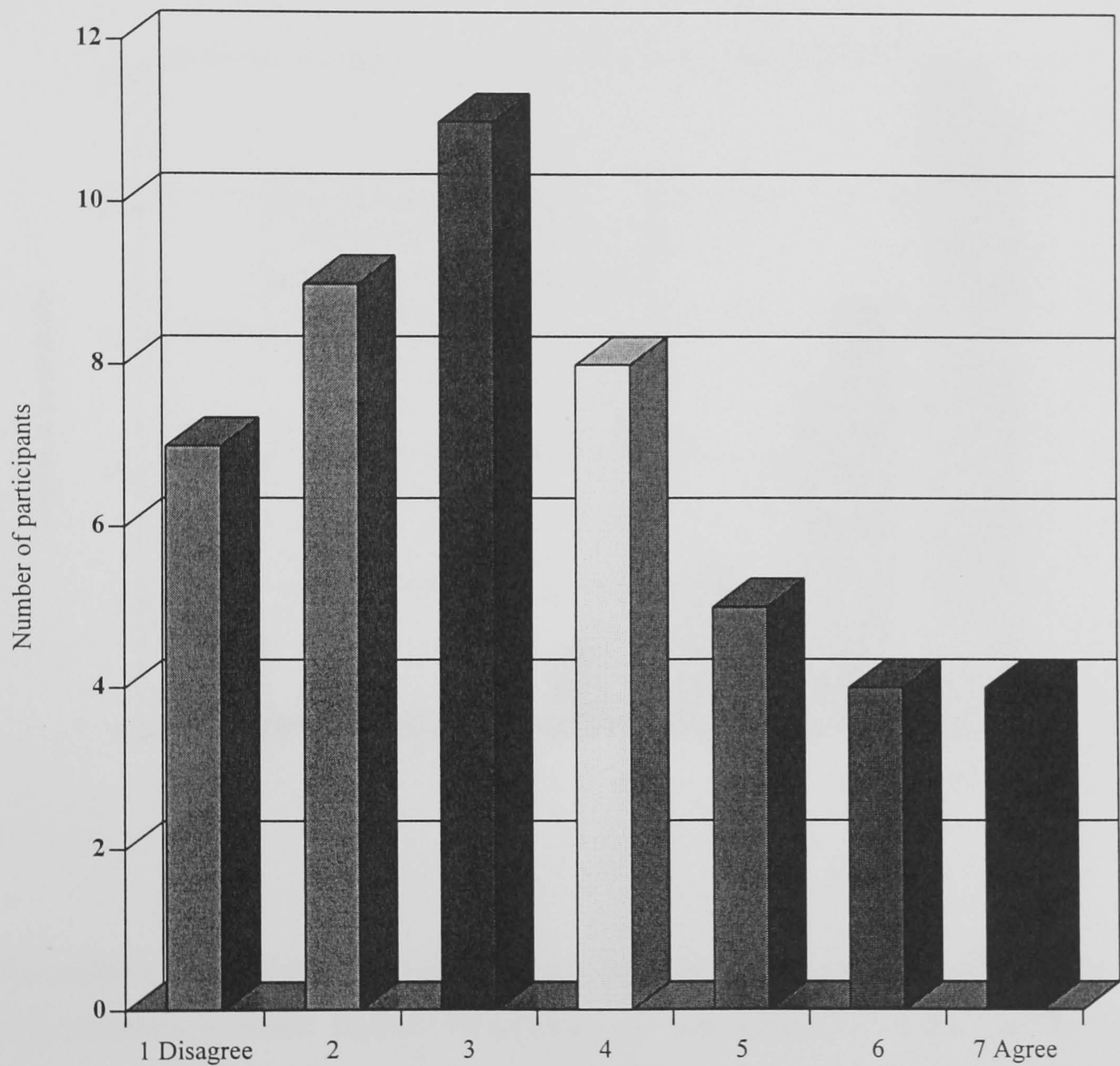


7.2.6.11 Attitudes towards safety

In order to put into context passengers perceptions of the usefulness of safety briefings and assess whether their attention could be affected by their perception of survival chances in an emergency participants were asked to indicate the extent to which they agreed or disagreed with various statements. Participants response to the

first statement “If I was unfortunate to be involved in an aircraft accident my chances of survival would be minimal” is shown in figure 22 .

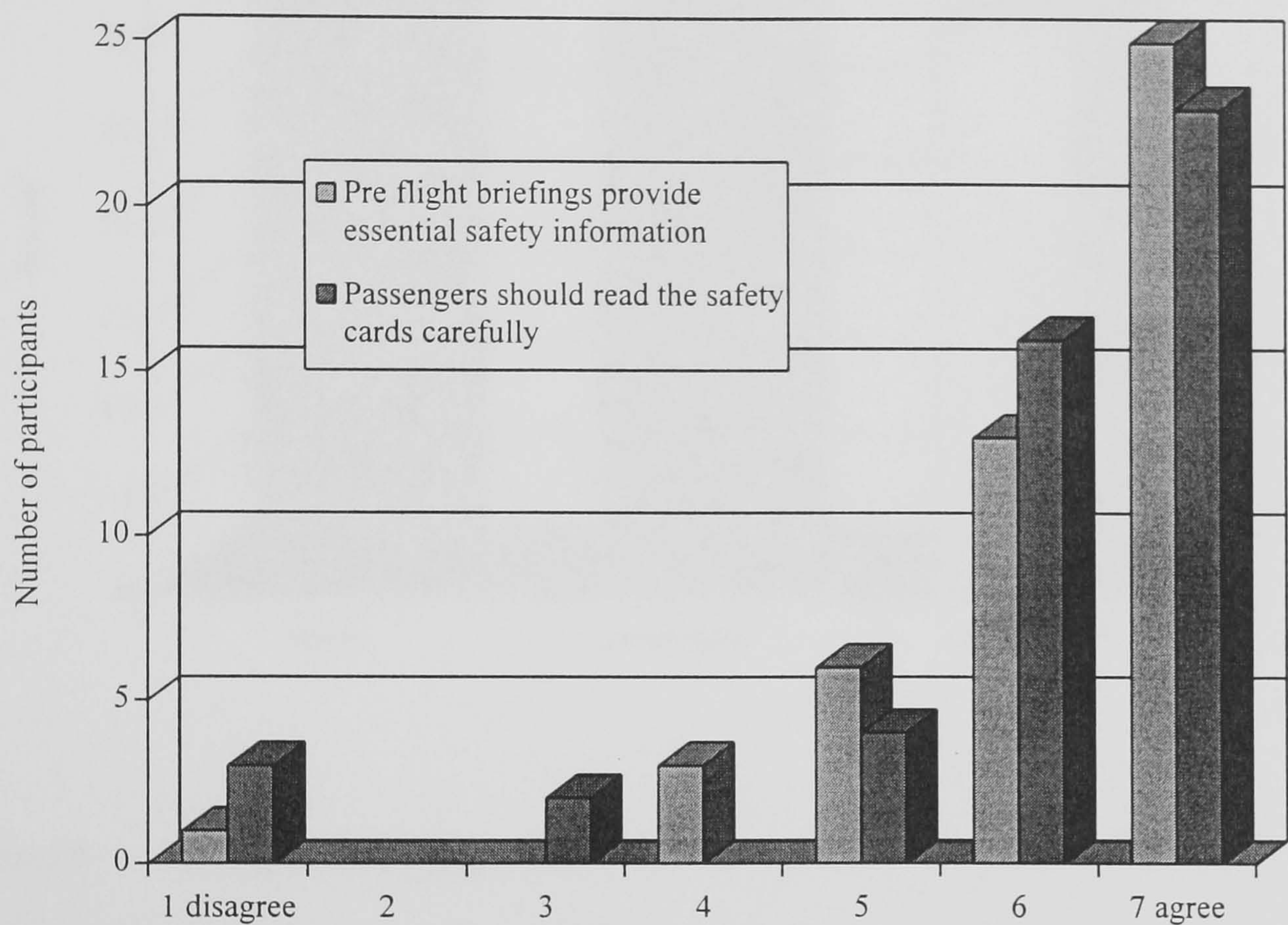
Figure 22 Participants perceived chance of survival in an aircraft accident



Fifty six percent of participants showed some level of disagreement with the statement and thought that their chances of survival were greater than just “minimal”. Seventeen percent neither agreed nor disagreed (mid point) with the statement. Twenty seven percent agreed with the statement and felt that their chances of surviving and accident would be minimal.

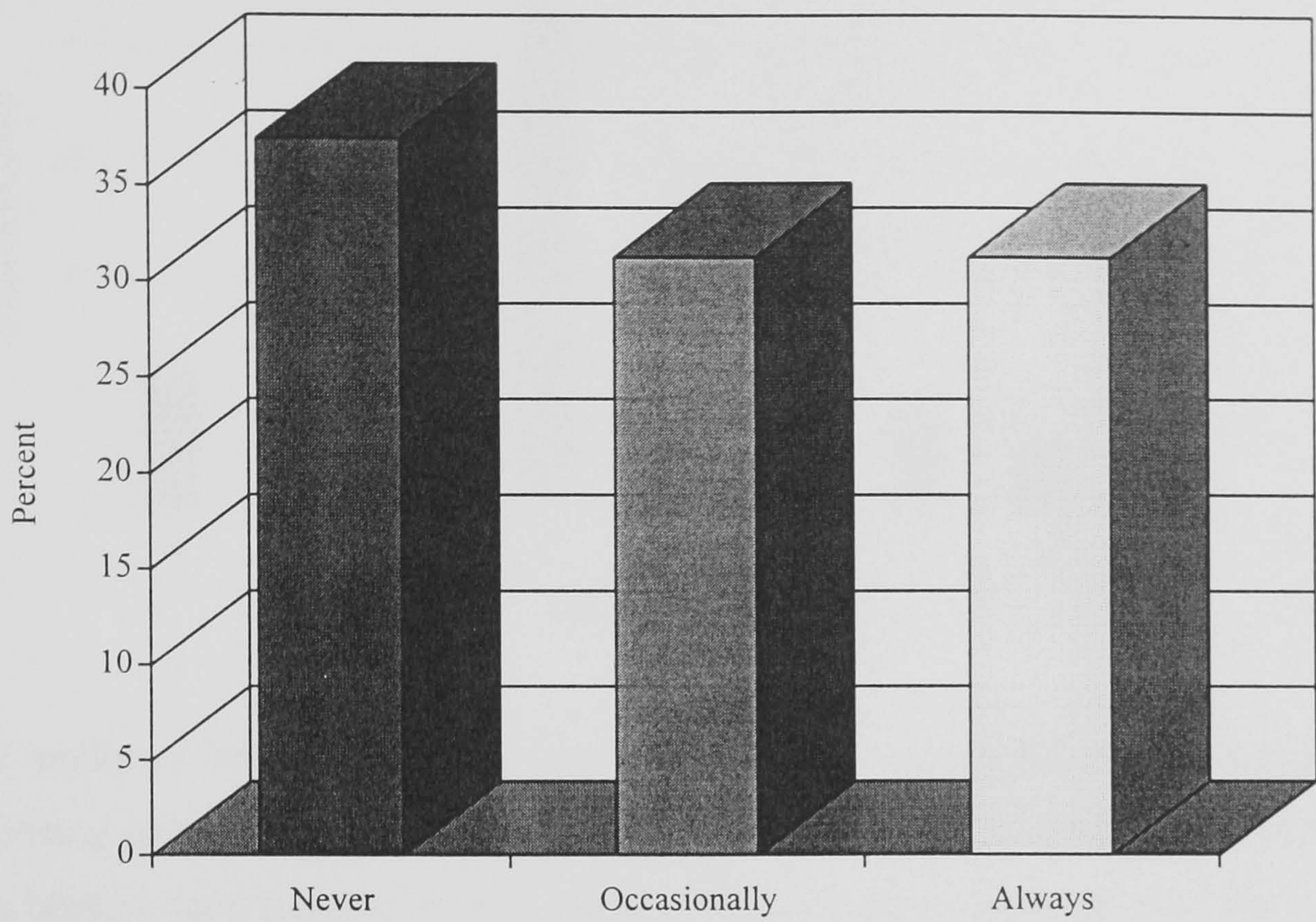
The next two statements asked the participants about their attitudes toward safety information. Again their were asked to indicate their agreement to the statement on a seven point scale. Figure 23 graphically depicts their responses.

Figure 23 Attitudes towards safety information on board aircraft



The majority of participants (90%) showed some level of agreement that pre-flight safety briefings provided essential information and that passengers should read the safety cards carefully. This response is interesting because as Figure 24 shows only thirty one percent of the participants said that they always look at the pre-flight safety briefings and read the safety cards when they fly. Many participants during the debrief said that they realised after taking part in the test how important the safety information was and that they would listen to the briefings and look at the cards in the future.

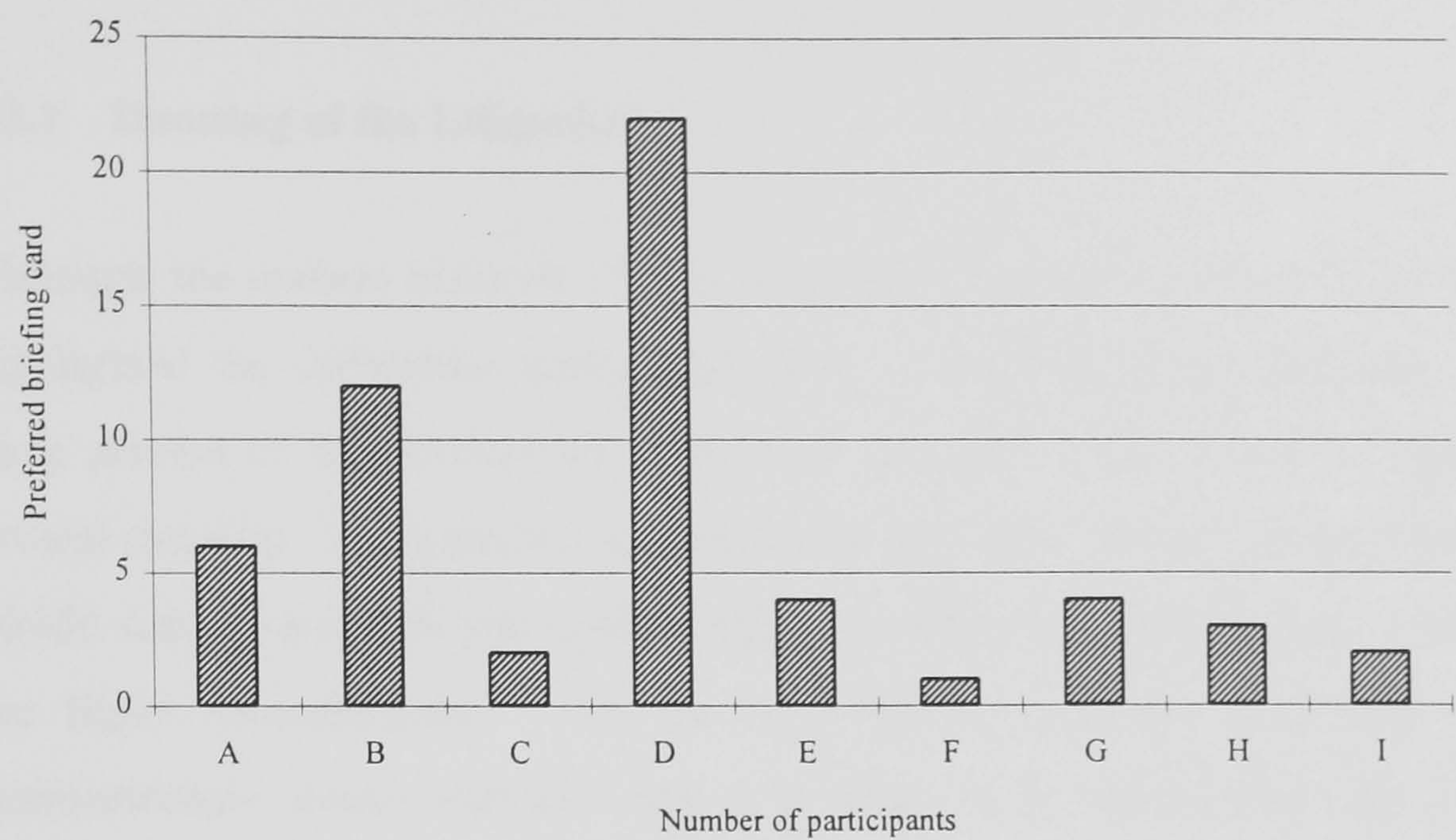
Figure 24 **Percentage of participants who watch the pre-flight safety briefings on board aircraft**



7.2.6.12 *Preferred briefing card*

Participants were shown nine different briefing cards depicting the operation of the Type III exit, these can be found in Appendix N. They were asked to chose the one that best depicted the operation of the Type III exit. Figure 25 shows the number of participants choosing each of the variations.

Figure 25 Preferred briefing card



The preferred briefing card was card D. Card D was actually the photographic operating instructions used during the test programme. The participants who chose this briefing card preferred it as it was a photograph and it depicted “real life”. As Table 21 and Figure 13 showed, participants who were shown this card took the longest to make the exit available and only one individual correctly disposed of the exit. These instructions also received the poorest ratings for clarity of opening and disposing instructions from test participants.

7.3 DISCUSSION

7.3.1 Donning of the Lifejacket

Although the current research's focus was on the operation of the Type III exit it highlighted the difficulties participants have in donning their lifejackets. Twenty three percent of the participants undid their seat belt to put on their lifejacket and several stood up. Participants commented that they were confused about whether they should stand to don their life jacket as the cabin crew members had done so during the pre flight demonstration. The use of video or computer generated pre-flight demonstrations could alleviate such a problem as it would allow the life-jacket demonstration to be shown with someone seated. Such demonstrations could also make a clear indication of where the life jacket is stowed, many of the participants during the test had to be given extra help to find their life jacket. The difficulties that passengers exhibited in donning the lifejacket further supports the introduction of some form of interactive and hands on training in safety centres.

7.3.2 The operation of the Type III exit.

As in the trials carried out in study one, the research programme illustrated further the difficulties that members of the public can have in operating Type III exits with many failing to correctly operate and dispose of the exit.

One of the difficulties when analysing a study such as this, is how much emphasis should be placed on speed of exit operation and how much on accuracy of exit operation. Passengers may make the 'exit available' quickly by pulling the operating handle and allowing the exit to fall to the floor however this 'incorrect' performance may be of hindrance to other passengers in the ensuing evacuation. Conversely, passengers may take longer to operate the exit because they correctly dispose of the hatch onto the wing, such an action may cause a delay in the start of the evacuation but the hatch itself will no longer be a hindrance to passengers inside the cabin.

The impact of mode of presentation on the speed and accuracy of passenger operation of the Type III exit will be discussed in two separate sections.

7.3.2.1 Speed of operation

There were no significant differences between operation and evacuation times between the mode of presentation groups, although the quickest times were recorded by those participants who watched a video briefing. The results indicated that the speed at which an untrained operator can operate the Type III exit can not be significantly reduced as a result of a variation in the way in which they had been briefed. This result, supported by previous testing (Fennell & Muir, 1993) and study one, indicates that the operation of the current Type III exit mechanism is an inherently difficult task. As a consequence, untrained passengers find dealing with the hatch weight and manoeuvring the exit hatch very difficult and it appears that the operating descriptions tested in this study failed to convey enough pertinent information to improve the speed at which passengers could operate this class of exit. It is also worth noting that all of the trials were carried out on an individual basis without any other passengers pushing in an attempt to evacuate, in this instance operation times could be significantly longer. This is something which is worthy of further investigation.

7.3.2.2 Accuracy of operation

Unlike the speed of exit operation, significant differences were found between the numbers of participants disposing of the exit correctly as a result of the way in which they were briefed.

The video instructions which dynamically showed the method of exit operation, better prepared participants to operate the exit. All of them correctly disposed of the exit on to the wing (8), significantly more than any other mode of presentation group. These

findings demonstrate the benefits which could be gained from showing passengers a video demonstrating the operation of the Type III exit. Passengers in this group stated that by watching the video it had clearly shown the exact steps necessary to operate and dispose of the exit, it showed “real life” and had given them a chance to mentally rehearse the procedure they had to use.

The participants who were not given any exit briefing material all failed to dispose of the exit hatch correctly. All of them pulled the handle and let the exit fall to the floor. The aim of this test group was to simulate those individuals who do not read the safety information. This result indicates the importance of highlighting to passengers seated in this area that they are responsible for the operation of the exit and that they must read the safety information, even if they have sat there on previous flights. Evidence from the participants’ questionnaires suggest that the use of such a briefing could be very successful as the majority of the participants reported that the additional exit briefing had captured their attention making them aware that in an emergency it would be their responsibility to operate the exit. The also noted that as a result of the briefing if they had a briefing card they re-read the information on the exit operation.

Only one individual in the photographic diagrams briefing group correctly disposed of the exit, it appeared that the photographs used did not adequately depict where the exit had to be placed. This result mirrors some of the findings carried out by Douglas, suggesting that pictures were better able to highlight certain features which photographs cannot. It would appear that the exit operating and disposal instructions were some how lost in the rich detailed photograph. All of the alternative briefing cards resulted in significantly more passengers correctly operating the exit and it is therefore suggested that photographs should not be used to depict procedural safety information. Interestingly, whilst this card resulted in the poorest performance of those individuals who were shown this card, it was the preferred choice of participants when asked to chose the best briefing card from nine alternatives (see discussion section 7.3.3.4).

All three alternative briefing cards led to significantly more participants correctly operating the exit than those in the photographic briefing card group. The benefits of additional wording on the safety briefing cards were not realised as there was no significant difference in exit operation accuracy between the card with wording and its equivalent without words.

7.3.2.3 Position of operation

The briefing cards showing an operator, all depicted him or her operating the exit from a standing position. The majority of passengers mimicked this action and chose to operate the exit whilst standing. The simplified pictorial diagrams which did depict an operator and as a consequence did not show the position from which to operate the exit or which hand to pull the handle also resulted in the majority of participants operating the exit from a standing position. These participants commented that the diagrams were very clear because they only had to concentrate on what the exit was doing and not on how to mimic the operator in the diagram. Interestingly, those individuals who were shown the video instructions were more likely to operate the exit from a seated position (as shown in the video).

The results clearly indicate that participants natural response was to operate the exit from a standing position, however, having watched on video another passenger operating the exit from a seated position, more participants in this group copied this behaviour. The trained operator used during Muir and Marrisons' study (1989), has reported that he found it easier to operate the exit from a seated position. Before advocating briefing material depict such a method of operation, further work is required to quantify the impact of operating position on naive participants speed and accuracy of operation. It is suggested that such experimental work should be carried out in both an individual and group evacuation scenario.

7.3.3 Questionnaire information

7.3.3.1 Difficulty of operation and clarity of instructions

Participants were asked to rate the difficulty of opening and disposing of the exit, the results indicated that there were no significant differences between the mode of presentation groups. Participants rated disposing of the exit as much harder than opening it. This result supports the suggestion in section 7.3.2.1, that the task itself is very difficult to carry out and any form of briefing instruction (apart from hands on practice) will probably fail to prepare passengers for the weight of the hatch and subsequent manoeuvrability difficulties.

When participants were asked to rate the clarity of the opening and disposing instructions there were again no significant differences between the groups. As with the difficulty ratings for the performance of the actions participants consistently rated the disposal instructions as less clear than the opening instructions. The opening instructions on the briefing cards are shown in two pictures. The first shows which handles to use and the second indicates that the hatch comes free from the fuselage. The disposal instructions however are all contained in the final diagram which indicates firstly that the exit must be turned on its side and secondly that it has to be placed out on the wing. Having the two procedures contained in one diagram somewhat simplifies the actions that need to be taken and may actually be confusing for an individual who has never operated such a exit before. It is suggested that it would be useful to evaluate alternative instructions which separate these two tasks.

Whilst the ratings were not significantly different, the video operating instructions were rated as the clearest. This is not surprising as this group had actually observed another passenger disposing of the exit onto the wing. The photographic card was rated as being the most unclear, again this supports the hypothesis that photographs are rich in detail and information, making it difficult for individuals to pick out the relevant points. Further work investigating participants eye scanning patterns and dwell times when looking at briefing cards may highlight disparities between the time

they take to look and interpret photographs in comparison to drawings. The use of eye-tracking will also provide a method of assessing any details that passengers are failing to attend to on both briefing cards and videos. It would then be possible to evaluate the way in which variations in layout, design and colour can be used to ensure the necessary safety information is extracted by passengers. Such experimentation may also be used to assess ways in which variations in briefing material can increase passenger attention.

7.3.3.2 Exit operating difficulties

Participants reported finding a number of difficulties when operating the Type III exit. The most frequently mentioned were the weight of the exit, manoeuvrability of such a large and heavy object and not knowing where to dispose of the exit. When asked about how heavy the exit was a large proportion of the participants said that they had underestimated the weight of the exit and that it took them longer than they expected to make the exit available. Twenty three percent felt that a warning about the weight of the exit would have extremely beneficial. Further work to assess the impact of warning passengers about the weight of the exit is required. Such a study would evaluate whether passengers can really be better prepared for the weight of the exit as a result of being informed of its weight, whilst at the same time assessing whether this might have any negative impact on performance.

7.3.3.3 Attitudes towards safety

When asked to agree or disagree with the statement “if I was unfortunate to be involved in an aircraft accident my chances of survival would be minimal” just over half of the participants disagreed (section 7.2.6.1). Surprisingly twenty seven percent (13) of the participants felt that their chances would be minimal. When talking to the participants after the test many felt that most aircraft accidents were non-survivable, a view that had been cultivated from publicity of recent catastrophic accidents. Many suggested that the general public should be made more aware of how safe air travel

actually is and be given more information on safety related topics. They went on further to state that if passengers realised that their chances in an accident were relatively positive that they would then be more likely to pay attention to safety information, realising that they have to take responsibility for their survival.

The majority of participants felt that pre-flight briefings provided essential information and that passengers should read safety cards carefully. These findings were interesting because only thirty one percent of the participants said that they actually watch the pre-flight safety briefings and read the safety cards when they fly. Most participants commented that having taken part in the test that they now realised the importance of the safety information and that they would pay attention to the information in the future. Again this result supports the need for some form of passenger education.

7.3.3.4 Preferred briefing card

All of the participants were shown nine alternative briefing cards and asked, from their experience, to choose the one that best depicted the operation of the Type III exit. Twenty two participants (40%) preferred the photographic card used during the testing programme. It would seem that participants preferred this card because the pictures were depicting “real life” and they thought that these were visually more appealing and clearer than many of the hand drawn instructions. However the study showed that participants who were shown this card found it difficult to understand where to dispose of the exit. So, whilst participants preferred photographs as a medium the actual photographs used during the testing appeared to lack the clarity necessary to show participants how to perform the task. This result clearly supports the need for thorough evaluation of safety material that is to be used by passengers. The material will normally be designed by an individual who is familiar with how to use the equipment and as a consequence they may fail to predict any difficulties untrained naive passengers may have in interpreting safety information. As previously

mentioned the use of eye-tracking data would be beneficial in investigating participant difficulties in interpretation of briefing cards.

7.4 *CONCLUSIONS*

1. Participants were confused about whether they should don their life jacket whilst standing as the cabin crew had demonstrated, this confusion could be over come by using a video or computer generated demonstration with the person donning the life jacket whilst seated.
2. The time taken by participants to make the exit available (operate and dispose of exit) was quicker when the exit information had been presented in the form of a video. Although this result was not significant.
3. Providing participants with information relating to the operation of the Type III exit improved their performance accuracy.
4. The correct disposal of the exit was significantly influenced by the mode of presentation of the information. Significantly more participants correctly disposed of the exit when they had been shown the video.
5. Photographic diagrams for the Type III exit operation were very confusing to passengers. Performance accuracy was significantly worse in this group of participants in comparison to the other briefing cards.
6. The introduction of wording on the briefing card did not appear to improve participant exit operation performance.
7. Additional safety briefings informing passengers that they are sat next to exits are useful in capturing passengers attention, informing them of their responsibility to operate the exit and may influence the amount of attention passengers give to safety information.

8. Individuals who watched the video presentation rated the difficulty of opening and disposing of the exit as easier than individuals in the other groups.
9. Participants found the size and weight of the exit hatch difficult to manage, particularly as many had under estimated the exit's weight. Further work is necessary to assess the influence of informing passengers of the exit hatch weight prior to its operation.
10. Participants attitudes towards safety indicate that a large proportion underestimate their chances of survival. There is a great need for a passenger education campaign to inform passengers of how safe air travel is, as well as the importance of safety information.
11. Airlines must think carefully about the method in which they present safety related information. There is a great need to evaluate both pre-flight briefings and more importantly briefing cards on members of the public, prior to them entering service, to ensure that untrained passengers can really understand all of the information that is being presented.
12. Further experimental work is required to assess the impact of other passengers trying to escape on naive passengers operation speed and accuracy of the Type III exit. Such research would also allow the evaluation of the best position from which to operate the exit.

8 CONCLUSIONS OF THE RESEARCH PROGRAMME AND RECOMMENDATIONS FOR THE FUTURE

8.1 *Conclusions*

The experimental testing programme clearly confirmed and illustrated many of the difficulties that members of the public can have in operating Type III exits. The two different approaches taken to improving passenger performance, exit improvement and instruction, illustrated that both Type III exit operation speed and accuracy could be improved.

The preferred solution to passenger operation difficulties was shown to be the redesign of the Type III exit mechanism, constraining its motion so that it did not become a loose item once opened. This removed the requirement for participants to support and manoeuvre a heavy weight, significantly increasing the speed and accuracy at which they were able to operate the exit. Anecdotal evidence collected during the debrief of participants suggested that even if they had not really paid attention to the operating instructions, on release of the operating handle the exit began to move up in to the overhead locker, providing a cue as to what they were meant to do. The study has clearly indicated the benefits of simplification of equipment for use by passengers, this is of particular importance when taking into account the variety of behaviours passengers may exhibit during an emergency.

In the future any new designs of equipment should attempt to be as simple and intuitive to use as possible and it is suggested that the manufacturers as a matter of course should test new equipment with naive participants.

The provision of practice was shown to improve performance in participants operating both the traditional and modified Type III exits. Even after three attempts however, the speed at which participants could operate the traditional exit was not as quick as participants operating the modified exit for the first time. Furthermore nearly a third

of participants operating the traditional exit after three attempts were still leaving the exit inside the aircraft.

This result strongly supports the suggestion of the introduction of safety centres in airport lounges. As a minimum, training for those individuals being seated next to the overwing exit should be available. It would not be entirely impossible to stamp individuals passports or log on their frequent flyer details that they have been Type III exit trained, indicating to check in staff that they could be seated next to the exit. The provision of such training would not only help to improve the speed and accuracy of passenger operation but ensure that passengers know when they should operate the exits, ensuring all available means of escape are used during an emergency evacuation.

The results of the study indicated that providing instruction either in the form of verbal instruction or visual (cards or video) could increase the speed, and more importantly significantly improve participants accuracy of operation. The most successful form of instruction was through the use of videos, which clearly showed the exact steps necessary to operate and dispose of the exit. Observing a ‘fellow passenger’ provided participants with an opportunity to mentally rehearse the procedure they had to use.

Briefing cards were also shown to aid the accuracy with which participants operated the exit. The use of photographs however, was shown to be a poor medium with which to present procedural task information, it appeared to provide a wealth of information from which participants found it difficult to extract all the relevant operation information. It is imperative that airlines think carefully about the method in which they present safety related information. They should be encouraged to trial new designs of cards or instructions for new equipment on individuals who are not familiar with the aviation industry thus ensuring that even the most infrequent flyers can easily interpret and understand the safety information.

8.2 *Recommendations for the future*

Manufacturers need to make every effort to simplify the method of operation of equipment to be used by passengers in an emergency. Equipment needs to be easy and intuitive to use, thus increasing the chances of correct operation in a highly stressful situation such as an aircraft accident.

The provision of practice which could be utilised in the introduction of safety centres was shown to be a useful way of improving passengers' ability to operate safety equipment. A study assessing airlines, airports and passenger attitudes to such a scheme should be carried out.

The results of the mode of instruction study clearly indicated that the way in which information is presented can increase or decrease passenger comprehension of safety information, as well as their willingness to pay attention. Further research is required to investigate exactly what information passengers are (or are not) attending to in safety information. The use of an eye-tracking system may prove beneficial in a further evaluation of exit operation diagrams/instructions.

None of the studies carried out evaluating mode of presentation to date has evaluated the impact of time delay on passenger ability to perform safety tasks. Further research investigating the retention of safety information over the duration of European and transatlantic flights would be beneficial and may provide support for the re briefing of passengers prior to landing (as is being carried out by some North American airlines.)

Evidence from the second study also indicated that passengers are still unaware of how high their survival chances are in an emergency, many indicated that this was one of the reasons for their lack of attention to safety information. It is suggested that the introduction of some form of passenger education could be useful to encourage passengers to not only pay attention to safety information but conform to baggage requirement, smoking restrictions etc.

The comments of many participants in the study indicated that many were surprised by the sheer weight of the exit and would have benefited from being informed of the exits exact weight, further research is required to investigate the benefits of informing passengers of the weight of the exit prior to its operation.

Careful consideration must now be given as to how to select passengers who should be seated next to the exit. Further emphasis must be placed on advising passengers of their responsibilities when seated next to the exit and as a minimum draw their attention to the current form of safety information.

All of the Type III exit operation studies to date have been carried out on an individual basis, the next step forward must be the assessment of the impact of other passengers on participants ability to operate the emergency exit. It is hypothesised that the introduction of other “passengers” will also serve to raise the level of stress and anxiety the operator may feel during the tests, further increasing the realism. The use of such an experimental methodology would also investigate further the benefits which could be accrued by the introduction of the modified Type III exit mechanism.

Currently all of the data from the exit operation trials has been made available to computer modelers who are developing evacuation models to be used by the manufacturers and aviation authorities. Data from Type III exit operation tests involving other passengers would further add to the information about time delays in exit availability and the impact that this may have on the subsequent evacuation times.

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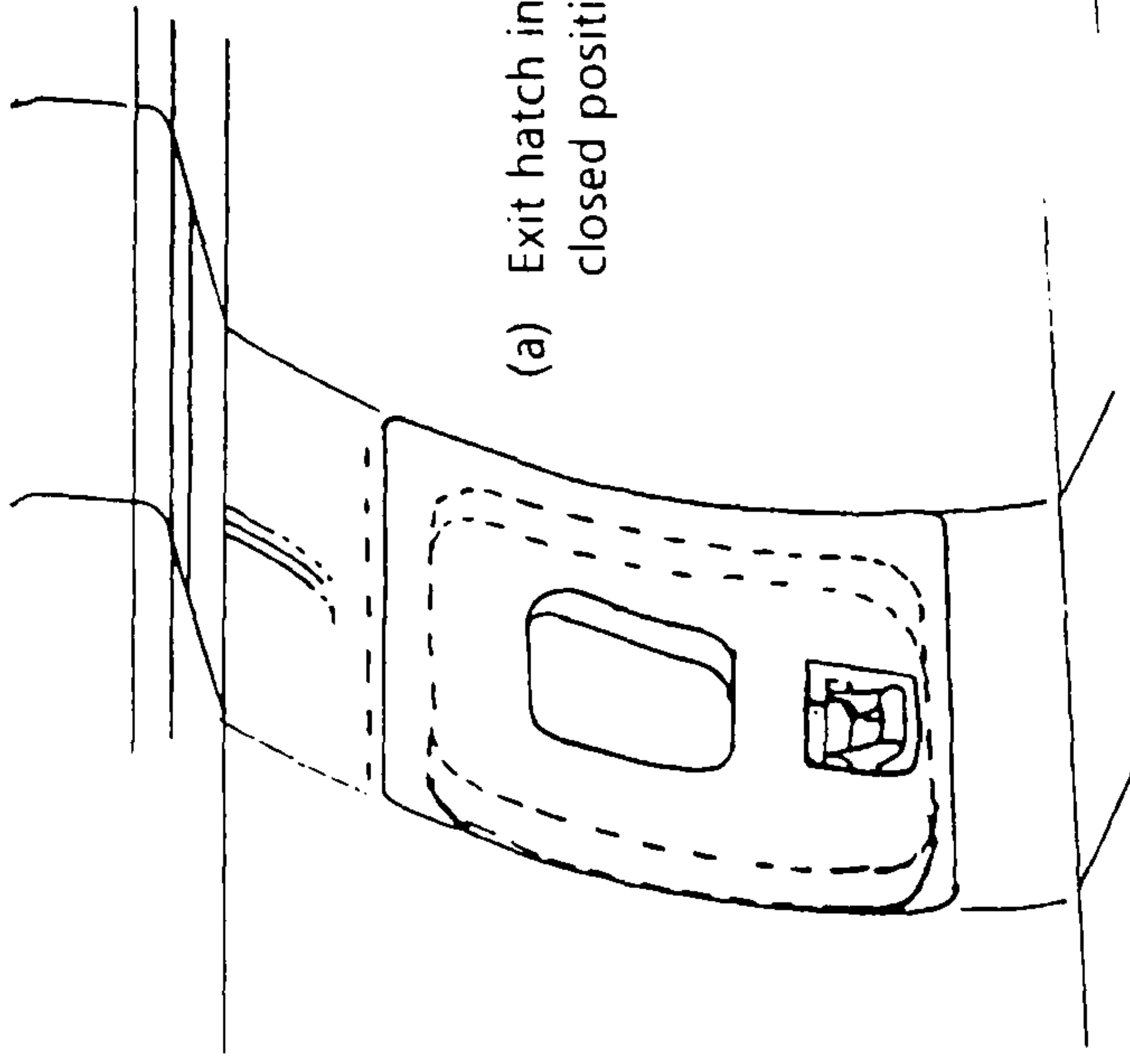
Appendices

Appendix A Type III exit hatch weights

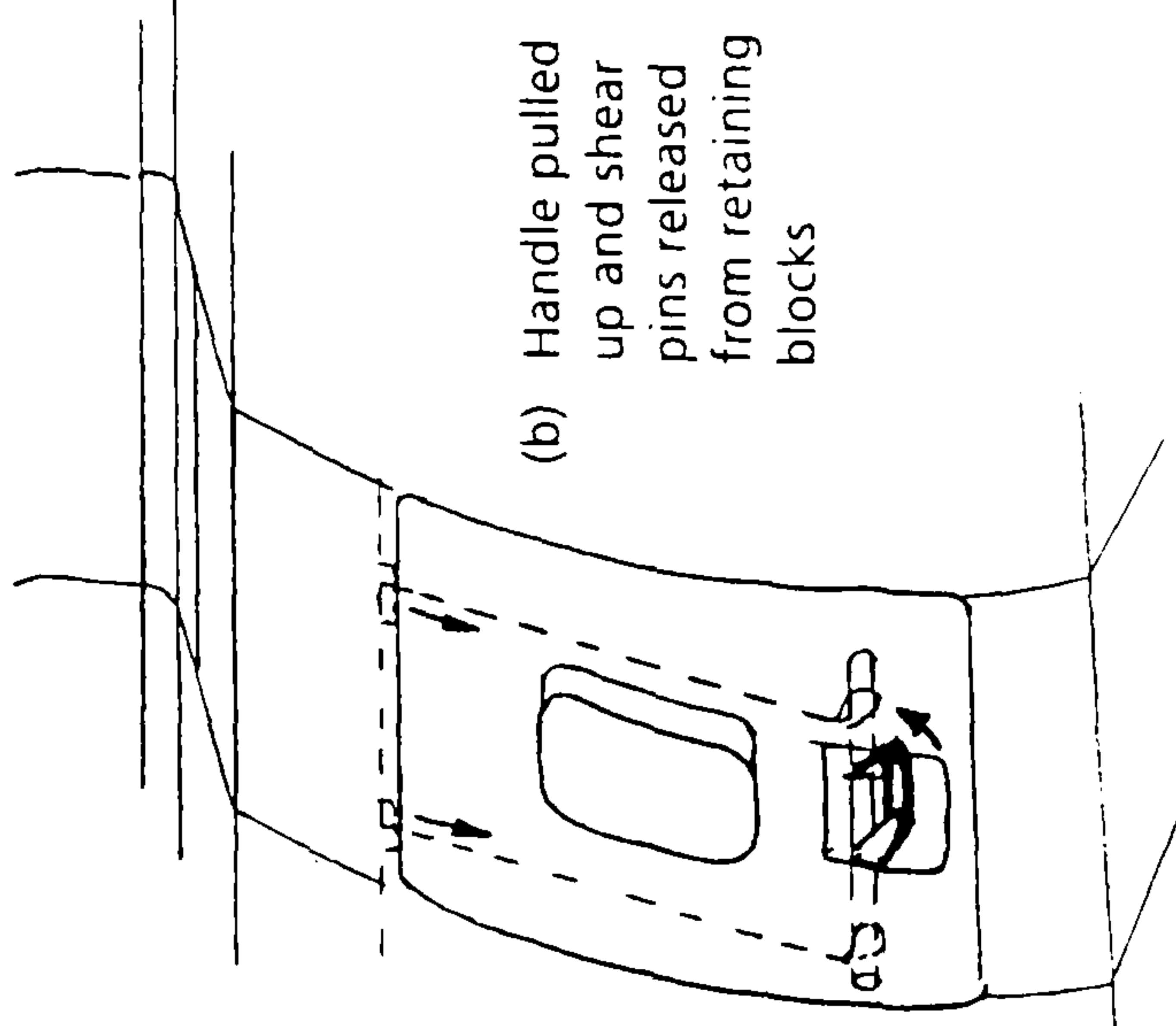
Type III exit hatch weights

Aircraft Type	Hatch weight	
	kgs	lbs
A320	14.5	32
Fokker 100	15.5	34.2
F28 MK 1000/2000/3000/4000	16	35.2
BAe 146-300	16	35.2
ATP	21	46.3
Mercure	18.9	41.7
Caravelle 10	25	55.2
Boeing 737 - 100/200/300/400/500	21	46.3
Boeing 737 - 400 lightweight	17	36
Boeing 767	30.3	67
MD 83	17.6	38.8
DC 8	25.5	56.3

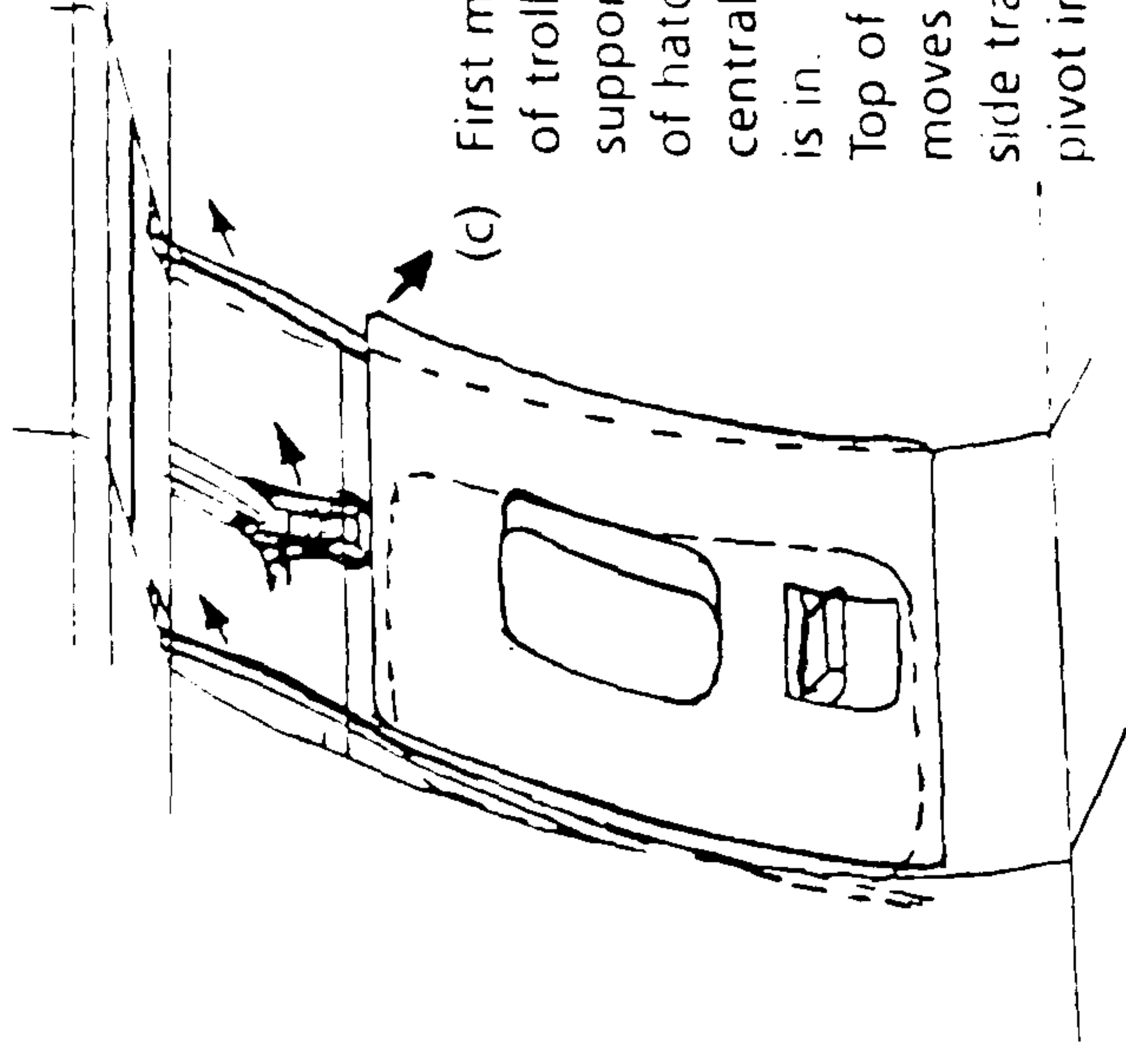
Appendix B Modified Exit Details



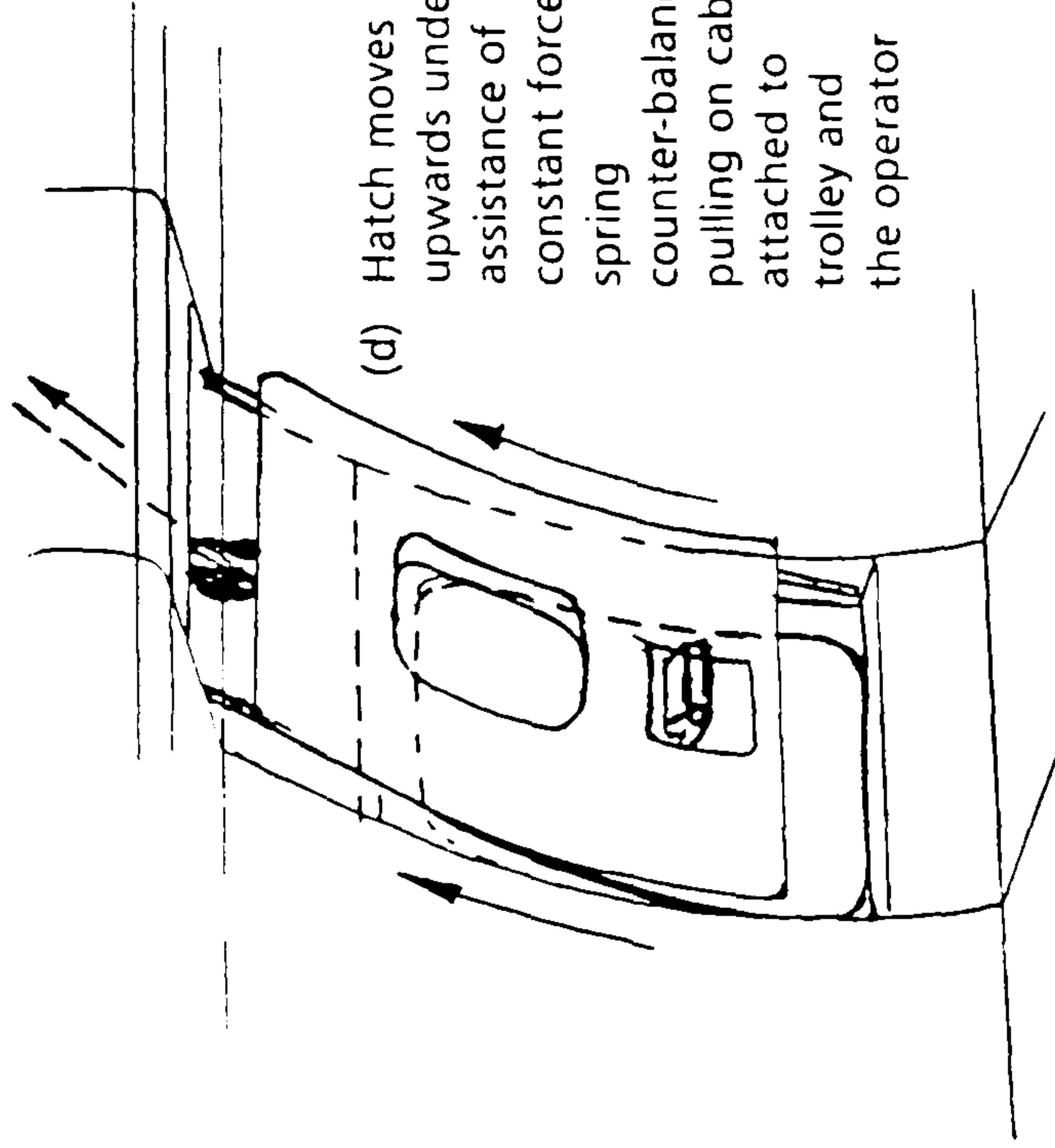
(a) Exit hatch in closed position



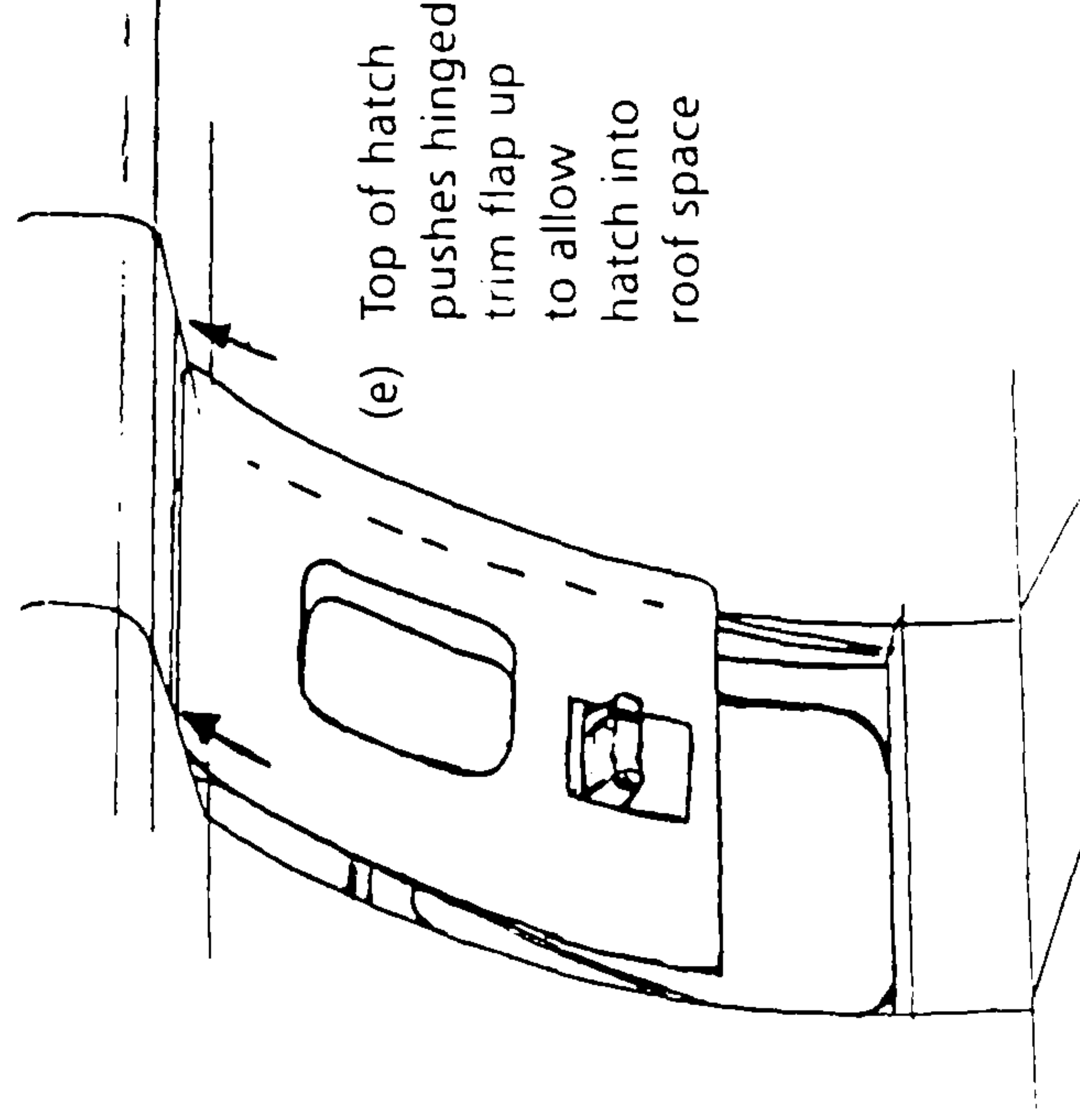
(b) Handle pulled up and shear pins released from retaining blocks



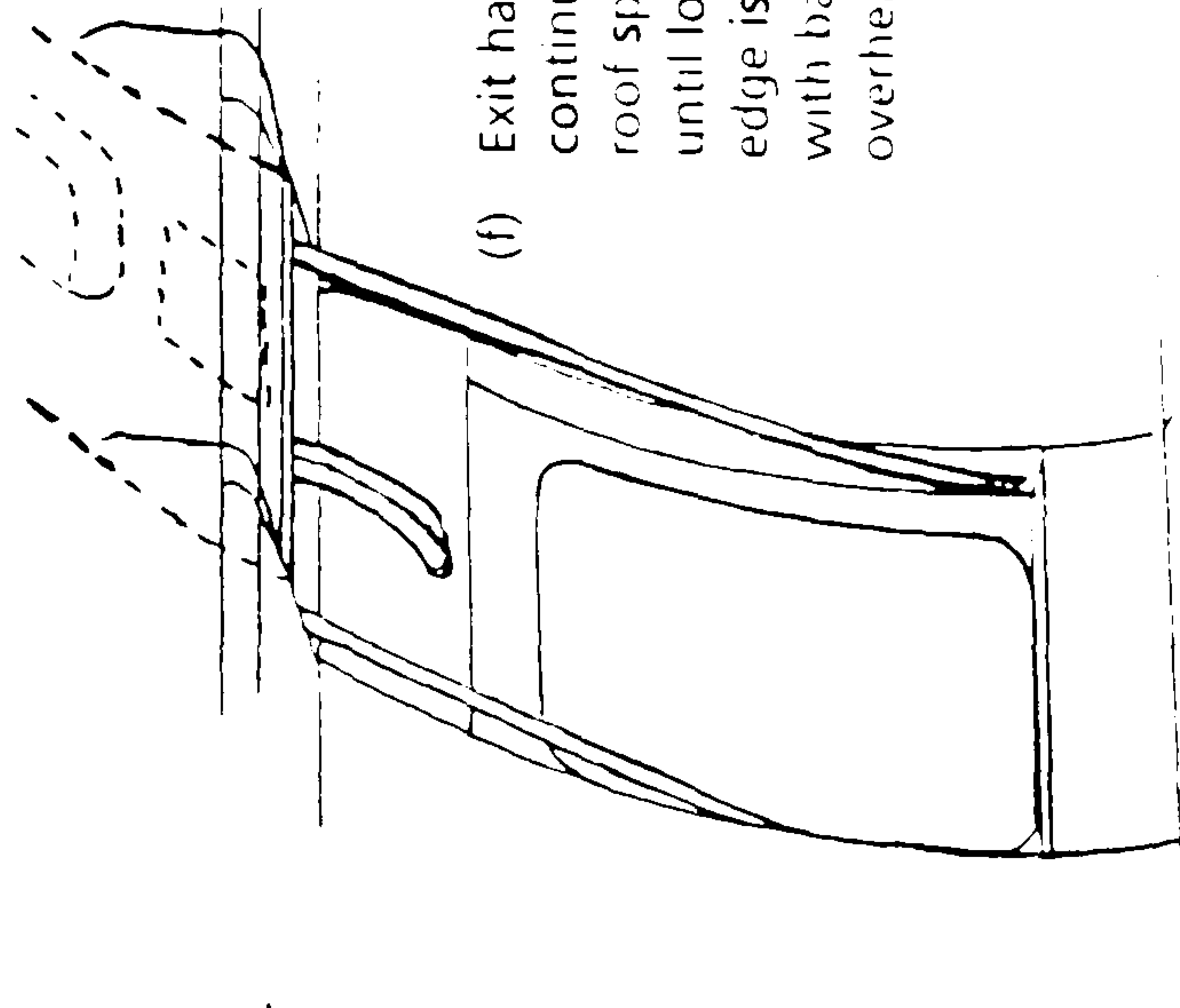
(c) First motion of trolley supporting top of hatch on central track is in. Top of hatch moves in and side tracks pivot in



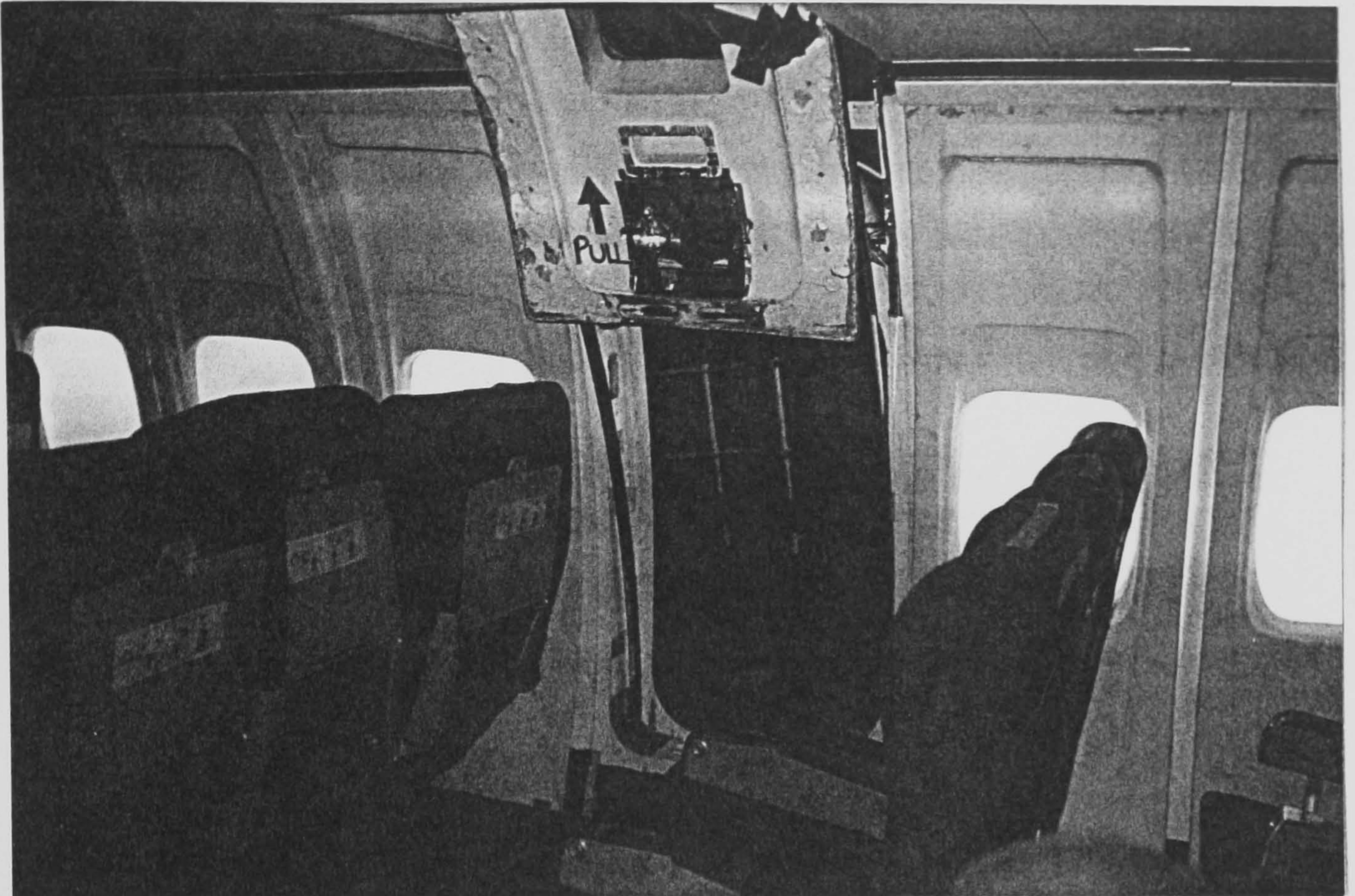
(d) Hatch moves upwards under assistance of constant force spring counter-balance pulling on cable attached to trolley and the operator



(e) Top of hatch pushes hinged trim flap up to allow hatch into roof space



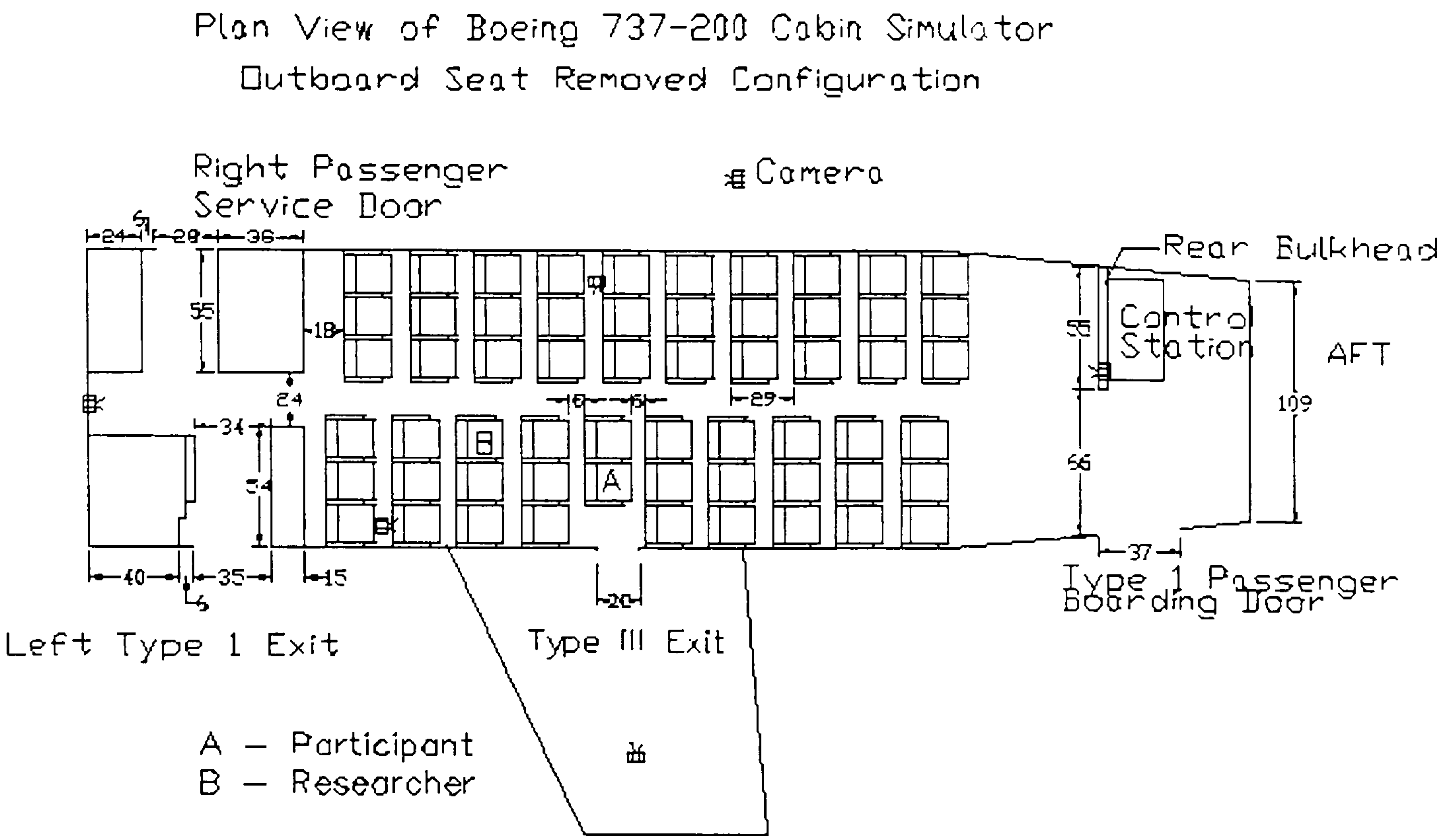
(f) Exit hatch continues into roof space until lower edge is level with base of the overhead bin



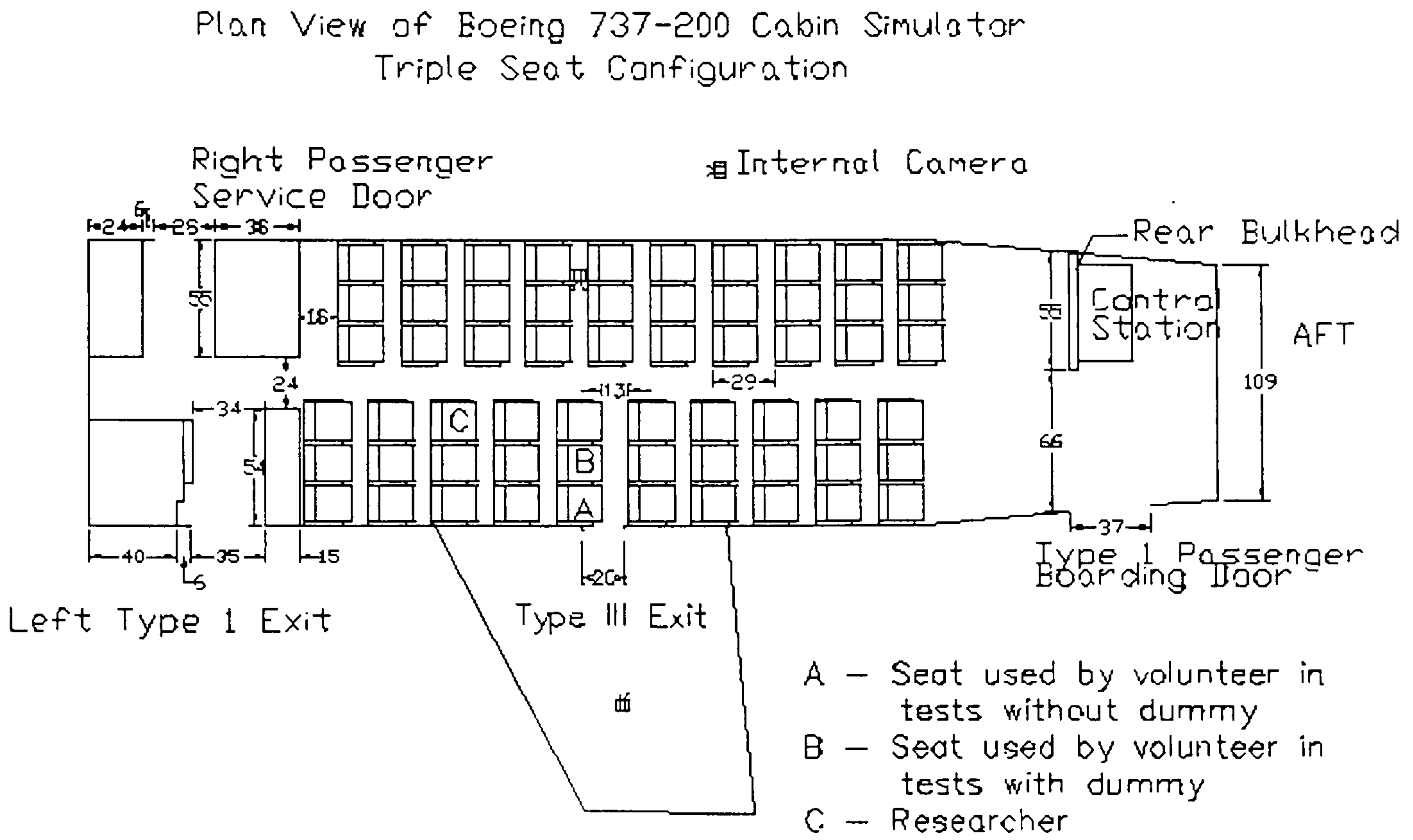
Appendix C Seating Arrangement Diagrams

- i Plan diagram of simulator - outboard seat removed tests
- ii Plan diagram of simulator - 13” vertical projection tests
- iii Outboard seat removed seating configuration diagrams
- iv 13” seating configuration diagrams without dummy dummy present
- v 13” vertical projection seating configuration diagrams with dummy present

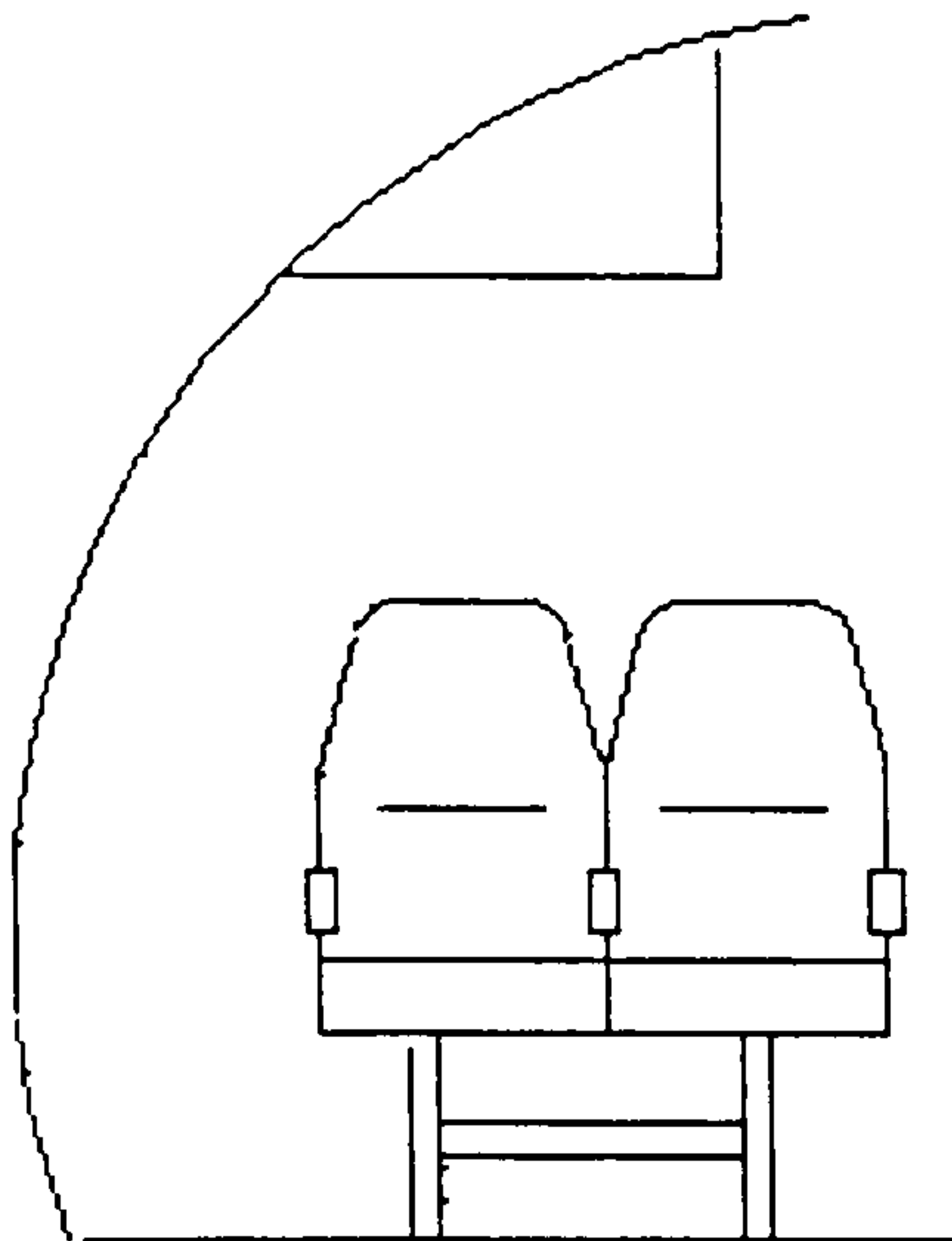
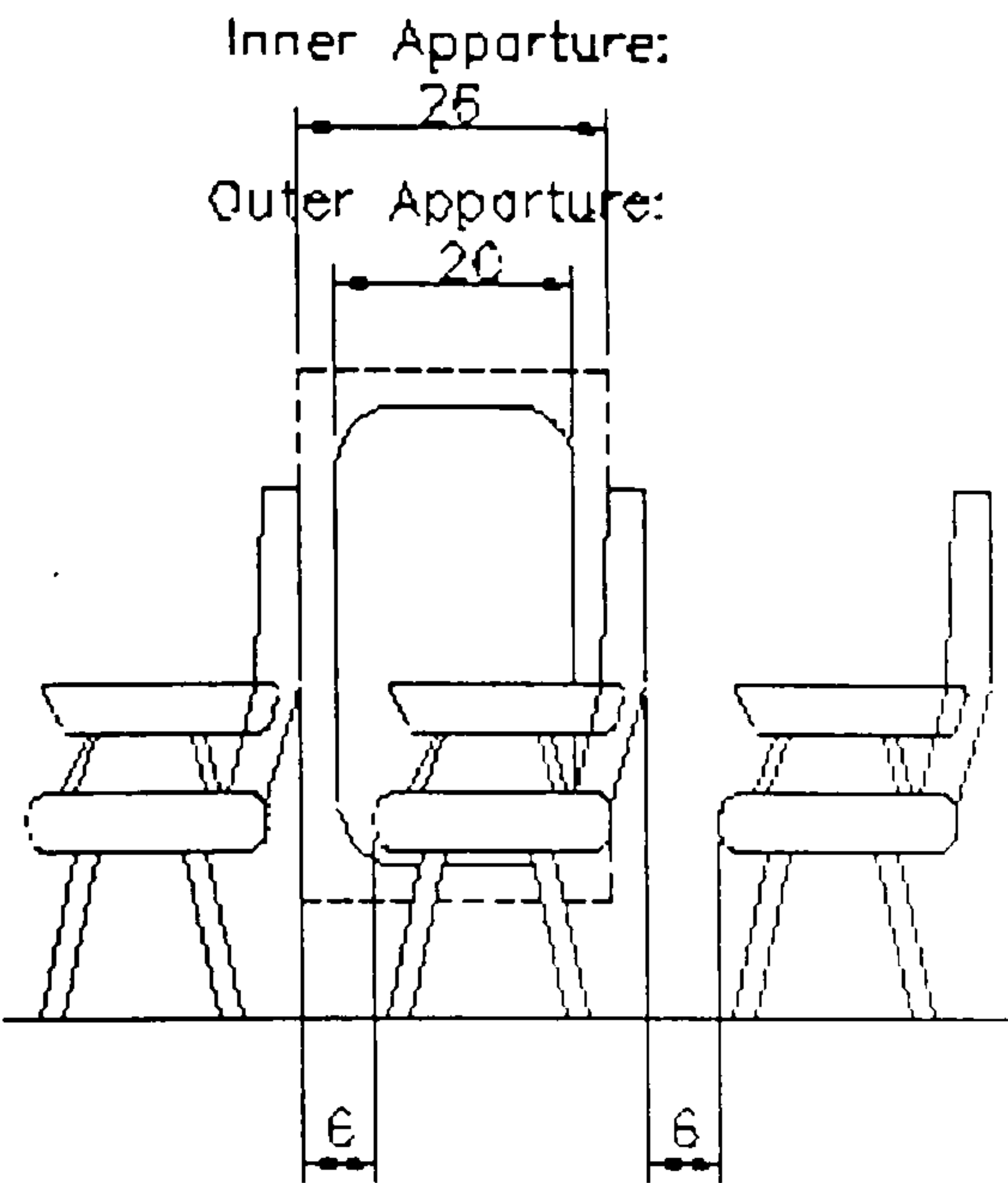
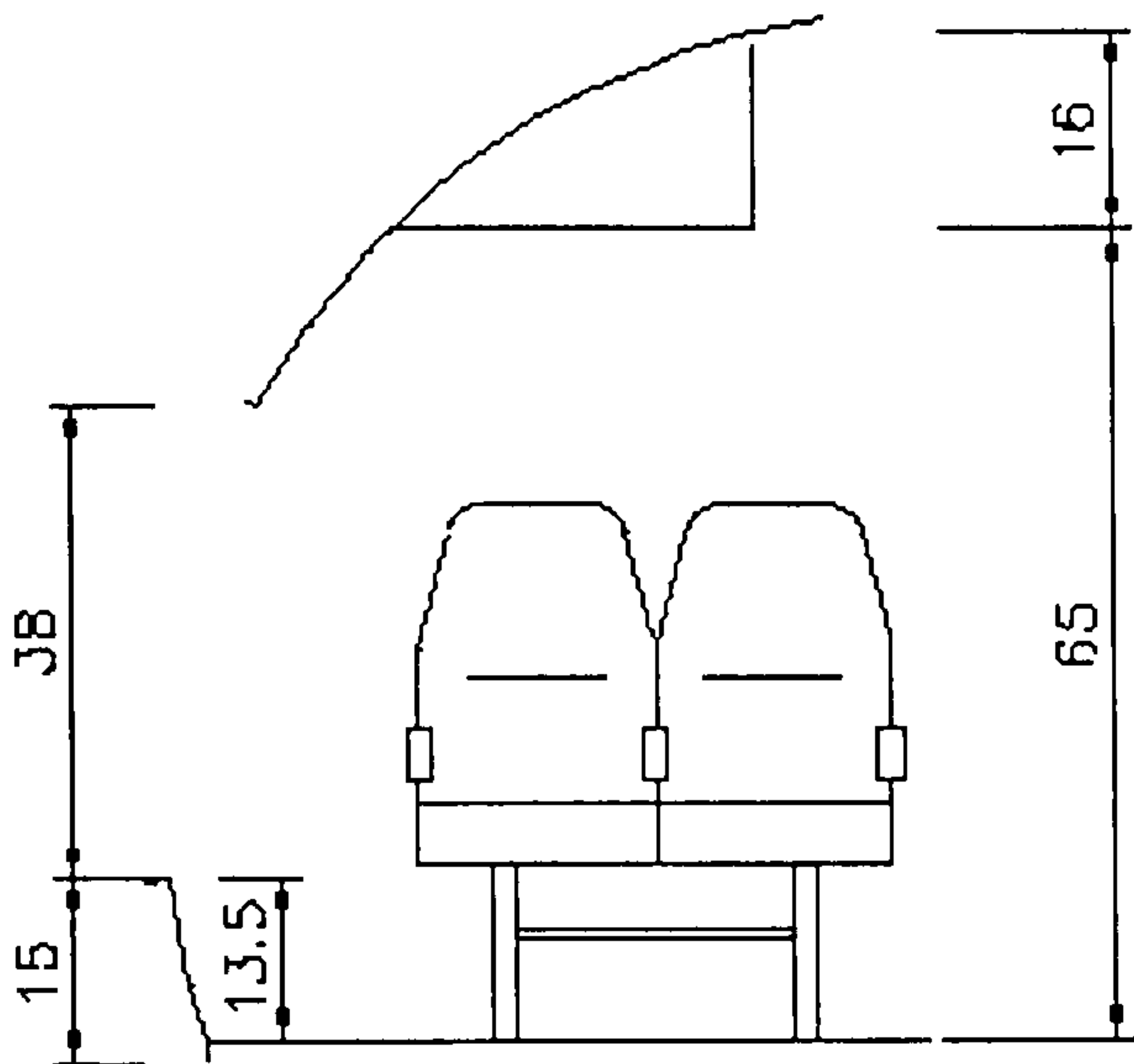
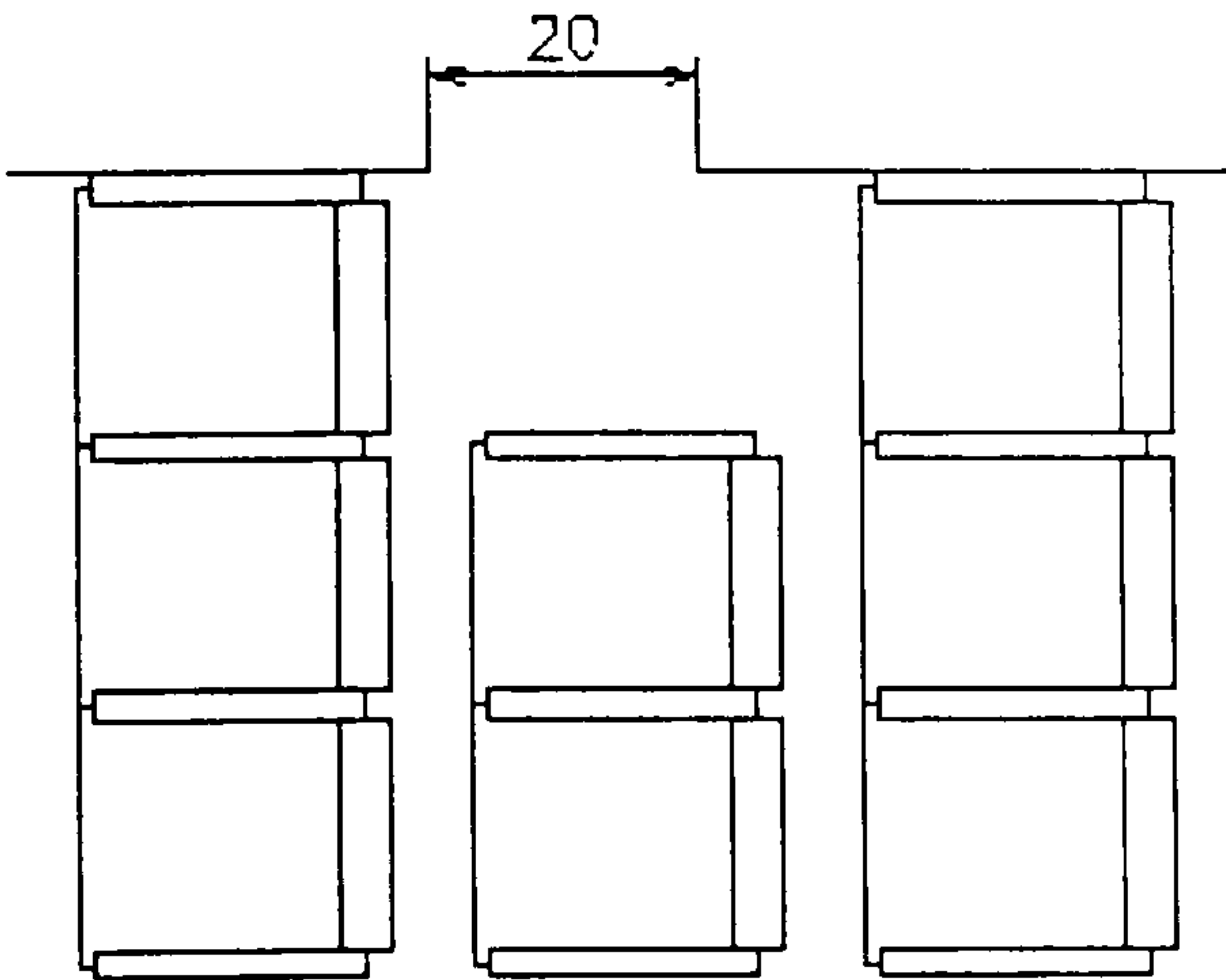
i Plan diagram of simulator - outboard seat removed tests



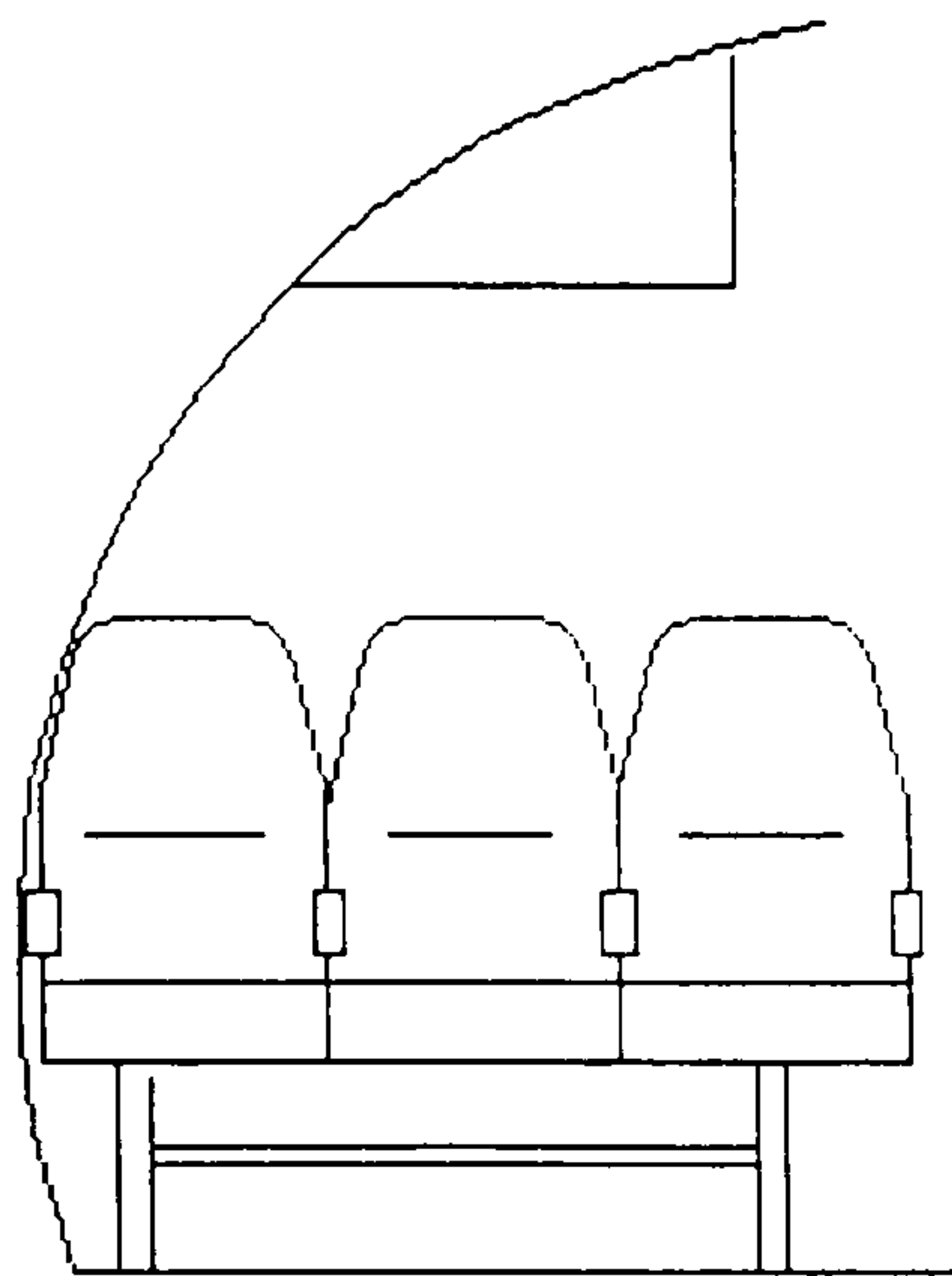
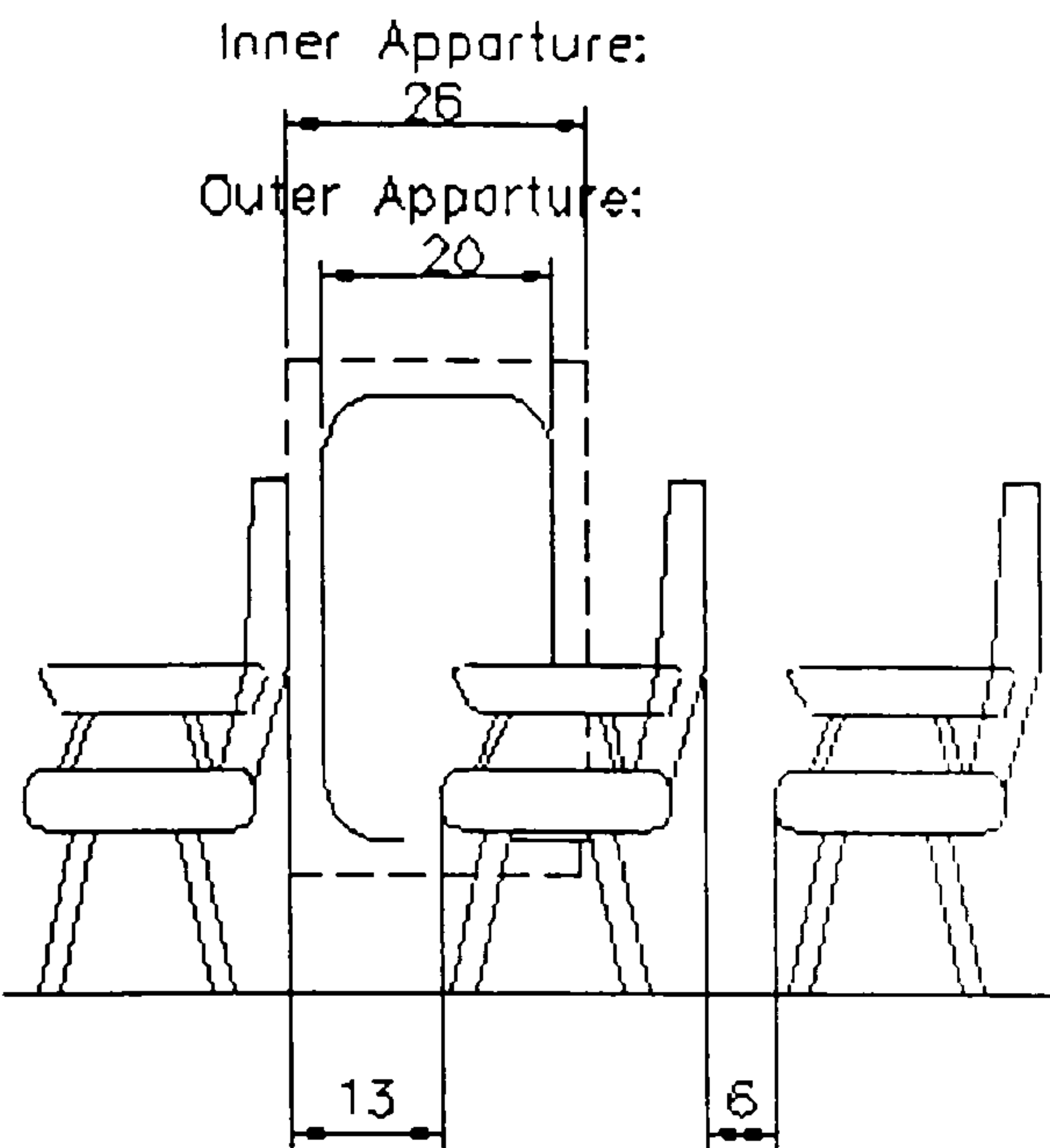
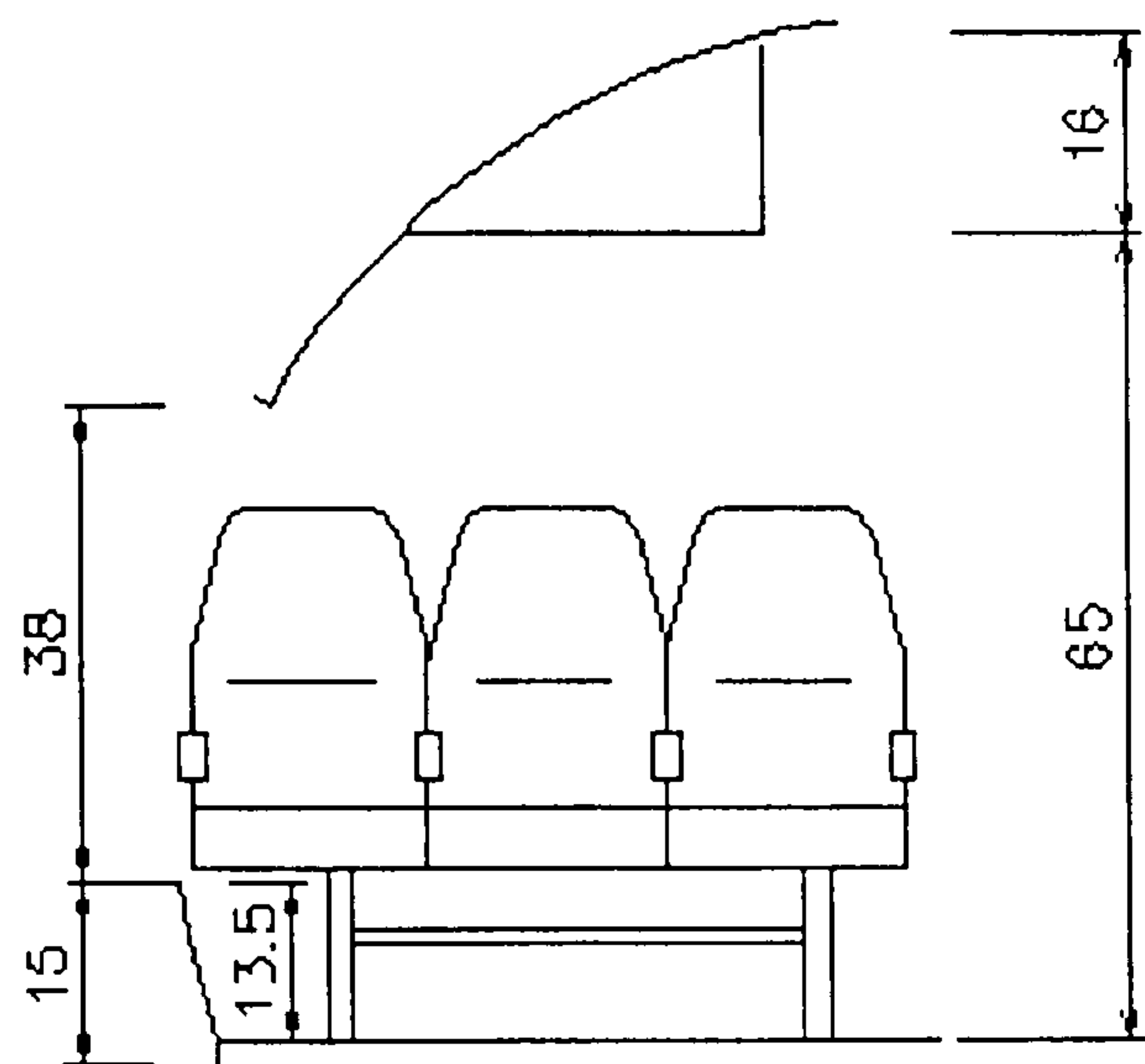
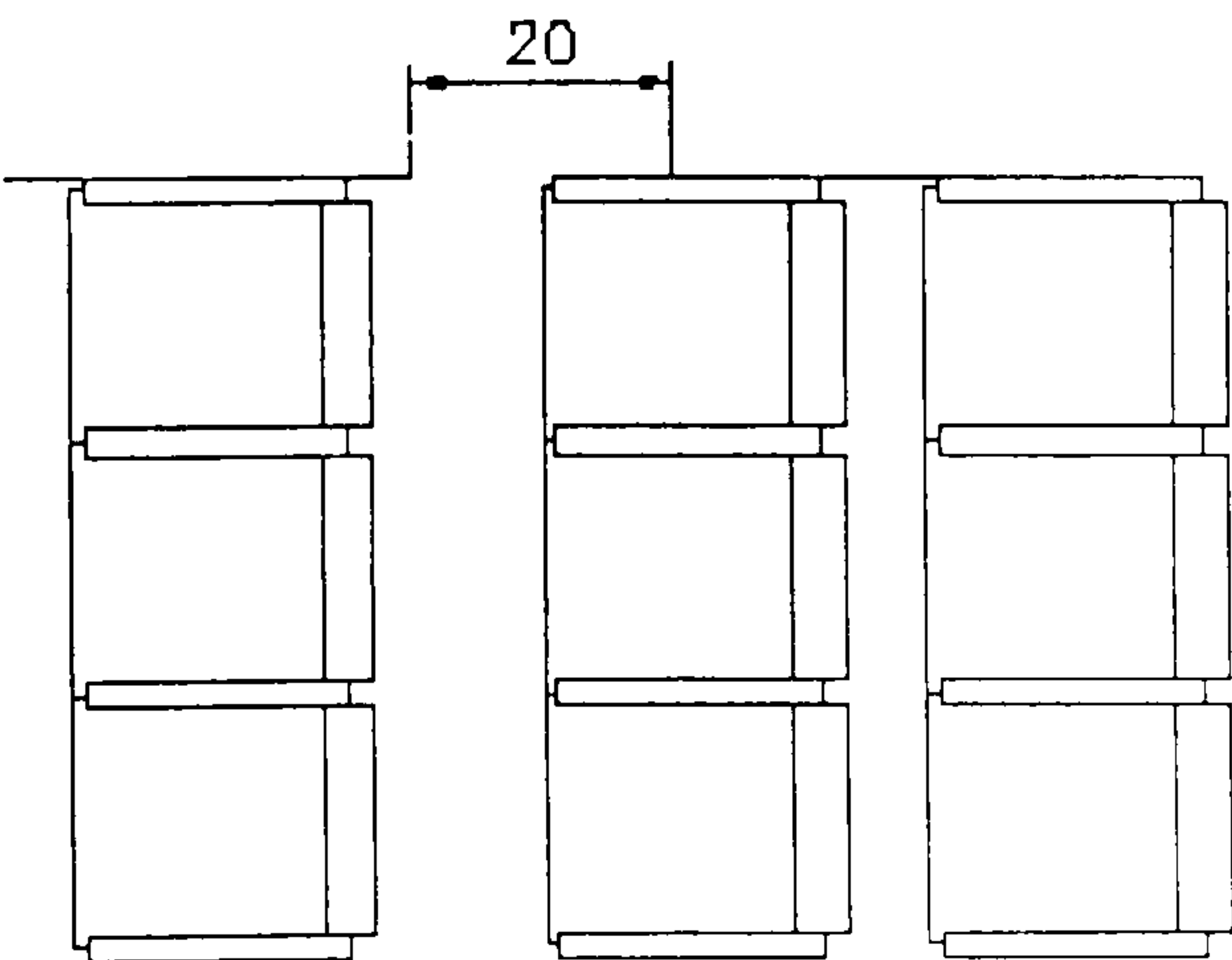
ii Plan diagram of simulator - 13" vertical projection tests



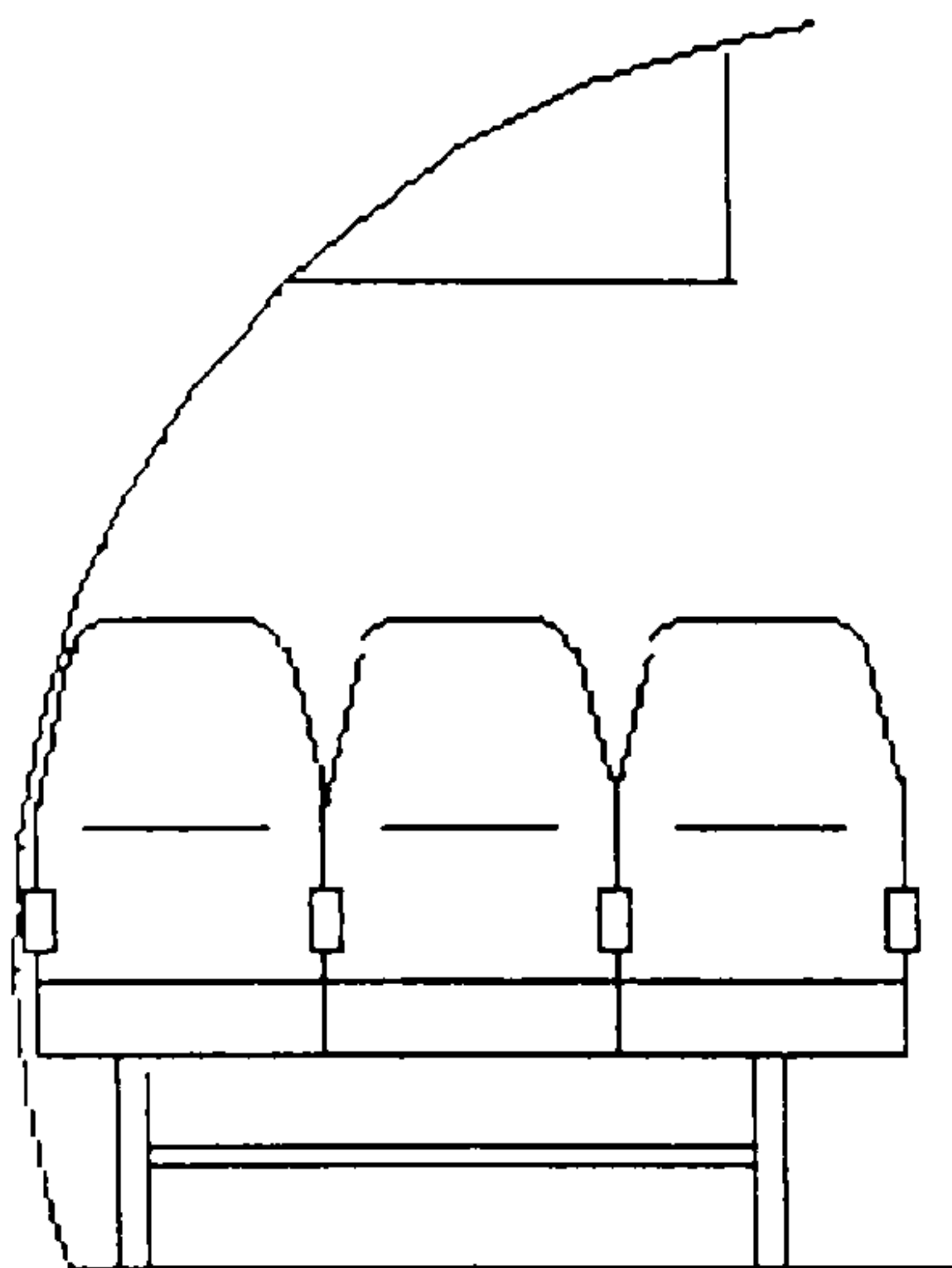
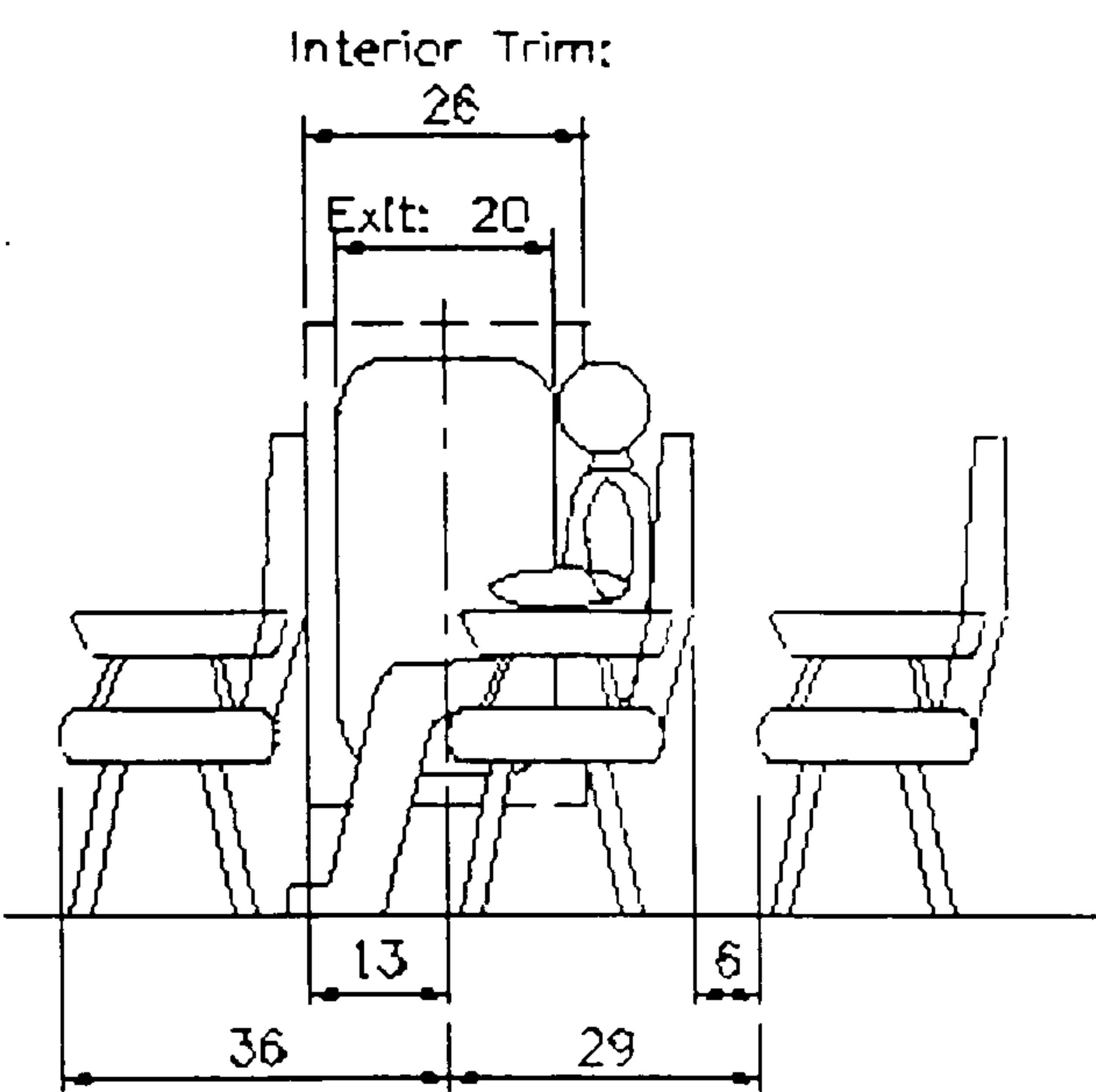
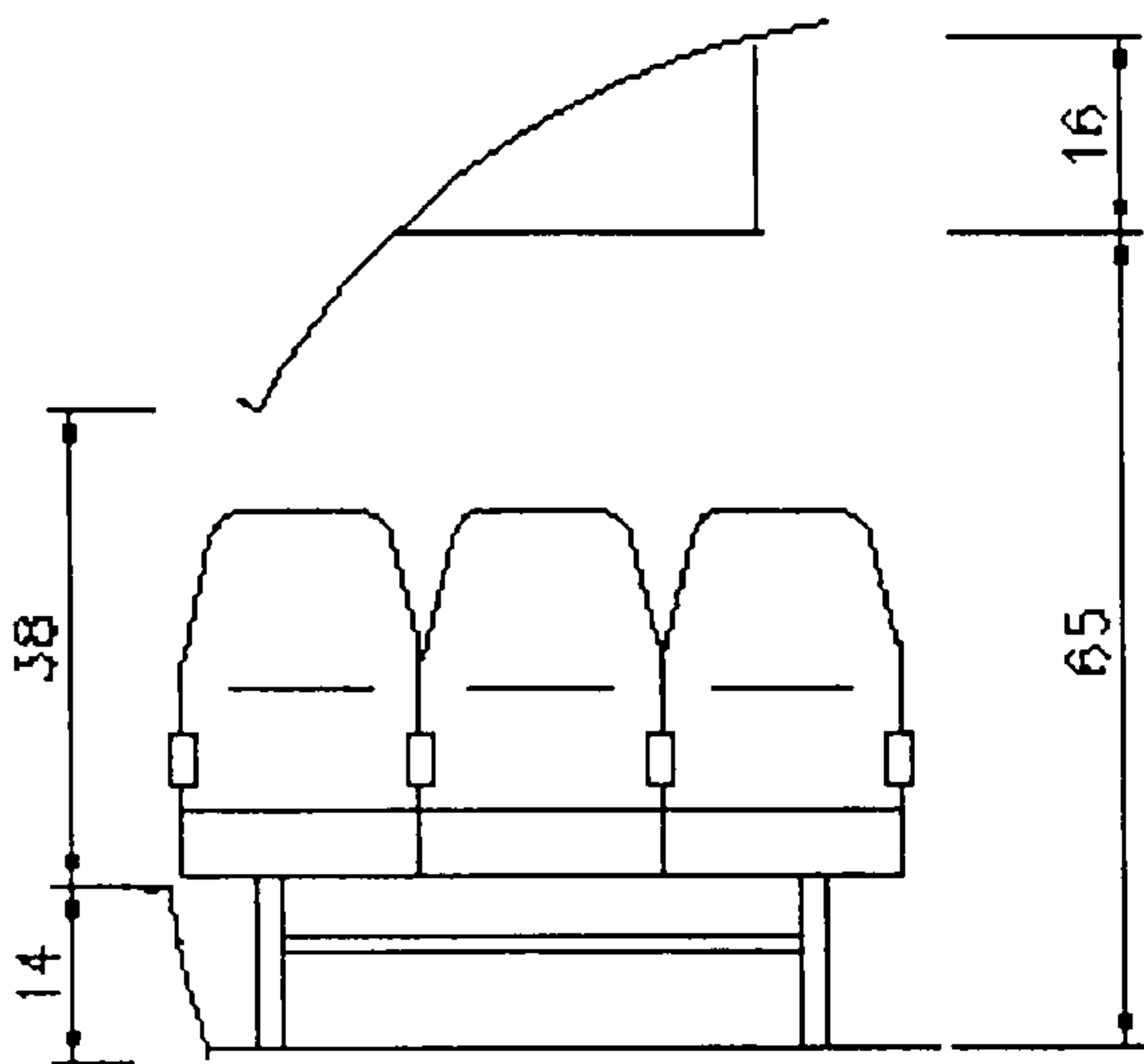
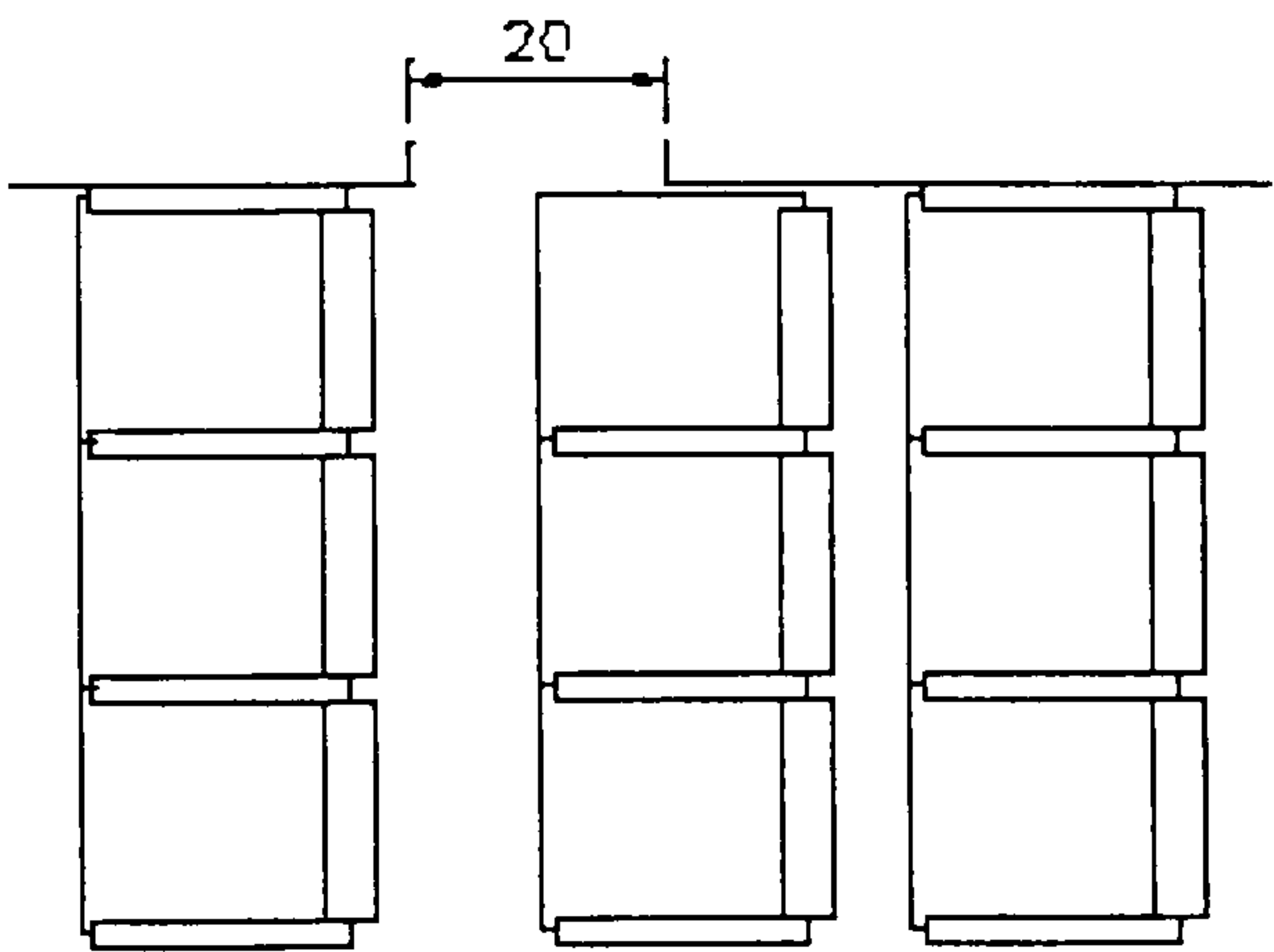
iii Outboard seat removed seating configuration diagrams



iv 13'' seating configuration diagrams without dummy dummy present



v 13" vertical projection seating configuration diagrams with dummy present



Appendix D Briefing cards - experiment one

Traditional exit briefing card

Cranfield
College of Aeronautics

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

على الطائرة لسلامتک

Please study and leave on the aircraft



Takeoff and landing
Décollage et atterrissage
Start und Landung
Decollo e atterraggio
Despegue y aterrizaje

الاقلاع والهبوط

उड़ान का आरंभ और उतराई

起飞和降落

離陸および着陸

Απογειωση και προσγειωση



Emergency landing
Atterrissage forcé
Notlandung
Atterraggio forzato
Aterrizaje forzoso

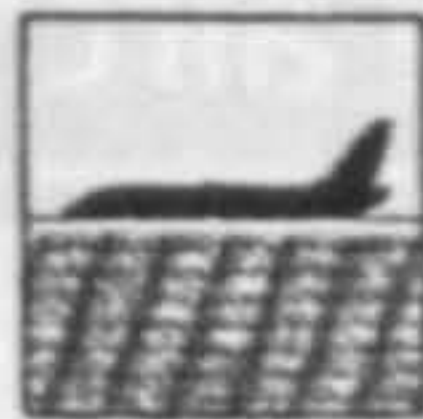
انبوط في حالة الطوارئ

दुर्घटना के समय उड़ान का उतराई

緊急降着

緊急着陸

Αναγκαστική προσγειωση



Landing on water
Amerrissage
Wasserung
Ammaraggio
Amaraje

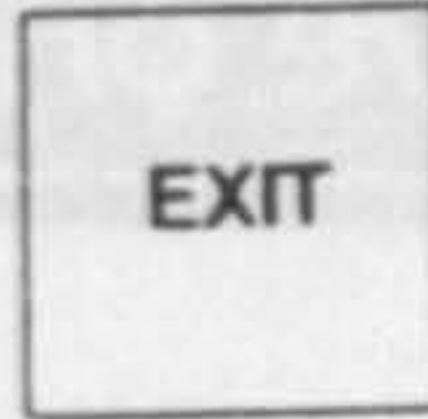
انبوط على الماء

पानी पर उड़ान का उतराई

降着水面

緊急着水

Αναγκαστική προσβαλίσσωση



EXIT

Emergency exit
Sortie de secours
Notausgang
Uscita di emergenza
Salida de urgencia

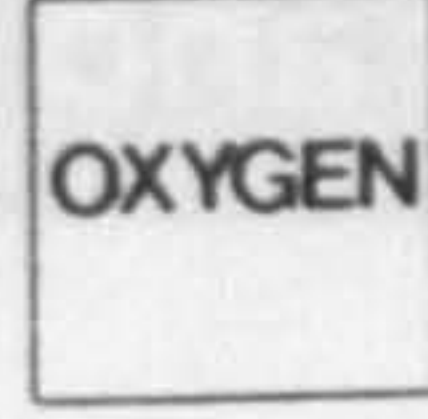
خروج في حالة الطوارئ

दुर्घटना के समय बाहर निकलने का रास्ता

大平門

非常口

Εξοδος κινδύνου



OXYGEN

Oxygen
Oxygène
Sauerstoff
Ossigeno
Oxigeno

الأكسجين

बायलीज

酸素

酸素

Οξυγόνο



No smoking
Ne pas fumer
Nicht rauchen
Non fumare
No fumar

ممنوع التدخين

शिगरेट अदि न भेदिये

शुर्क नोस्तिक

禁止吸烟

禁煙

Μη καπνίζετε



Remove high heel shoes
Enlevez les souliers à hauts talons
Schuhe mit hohem Absatz ausziehen
Togliere le scarpe contacco alto
Quítense los zapatos de tacón

انزع الأحذية ذات الكعب العالي

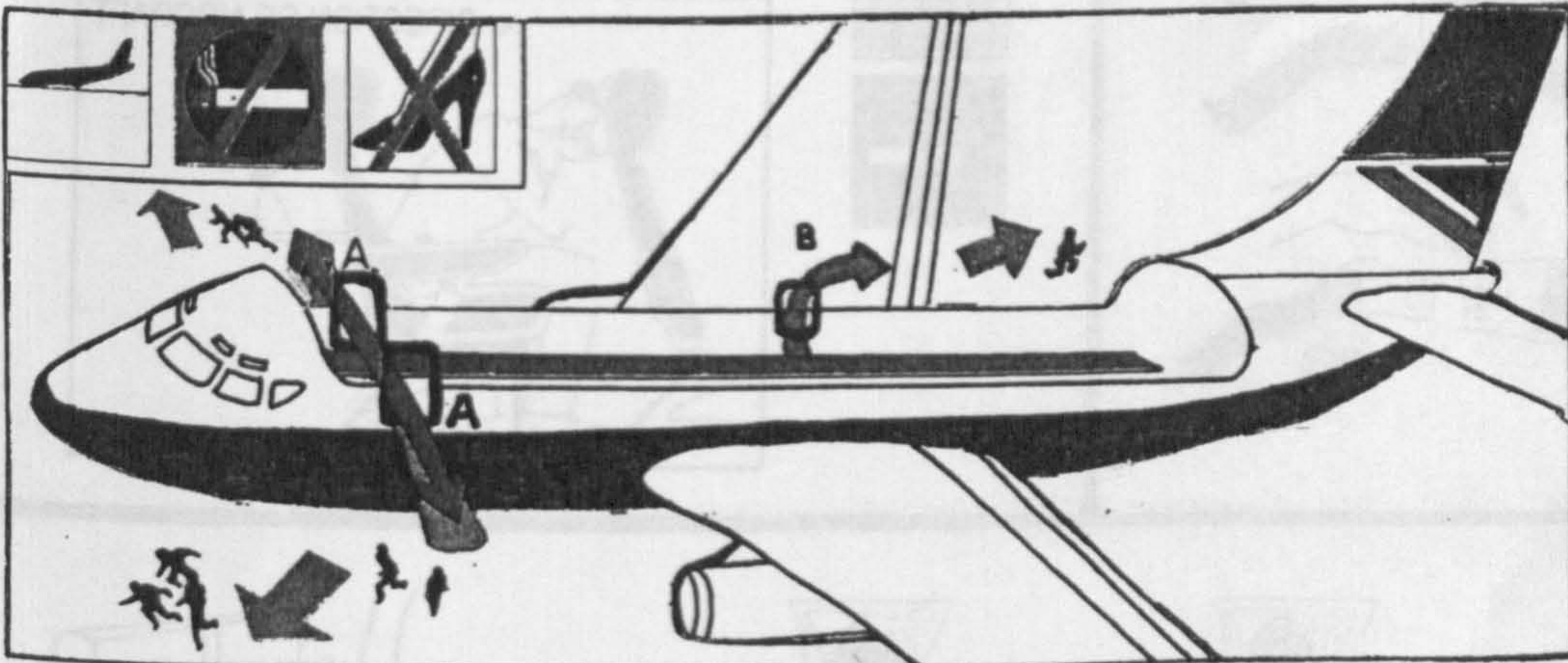
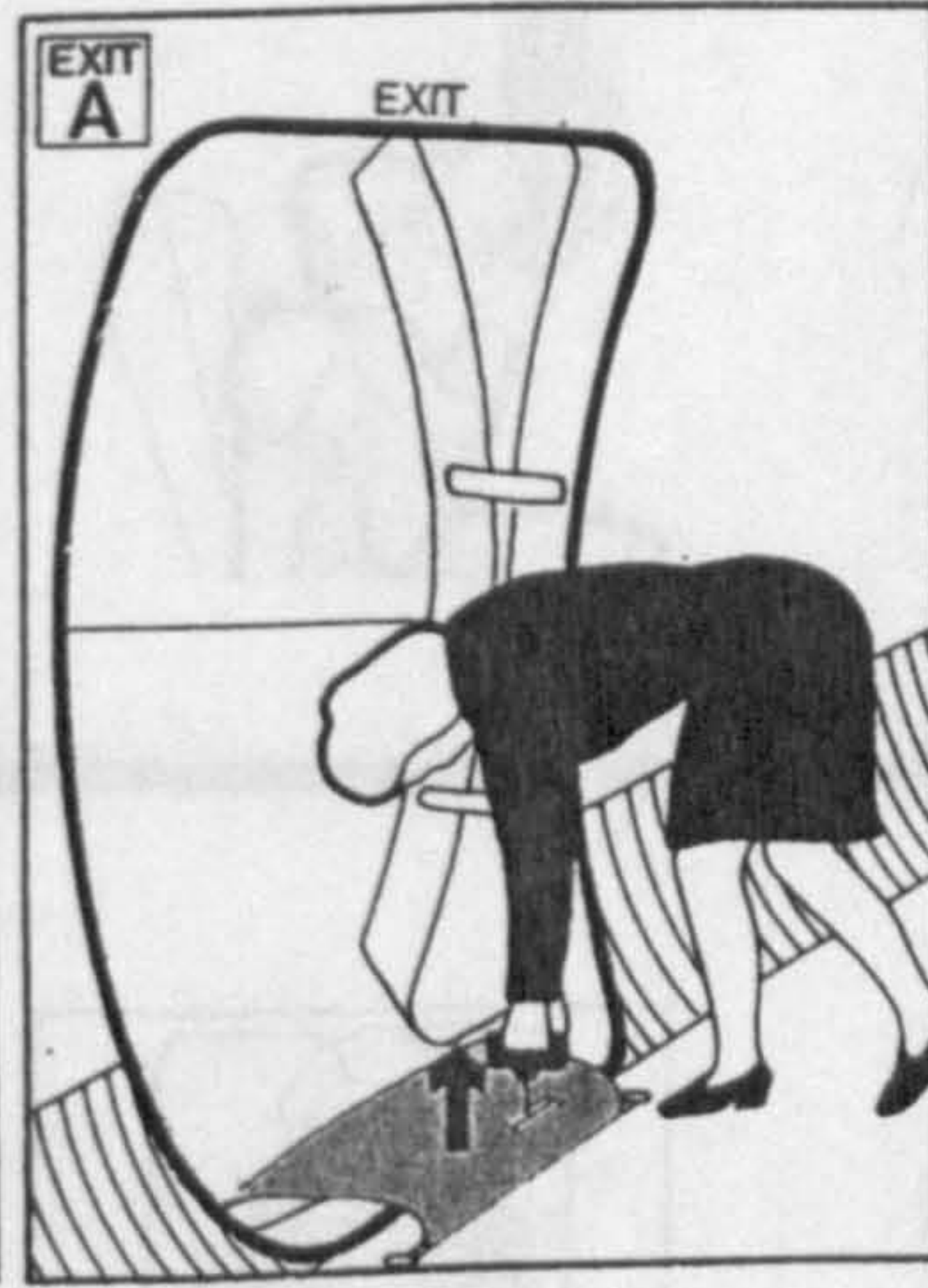
ऊची एड़ी वाले जूते उतार दें

उंची एड़ी वाले जूते उतार दें

除掉高跟鞋

ハイヒールの靴は脱ぐこと

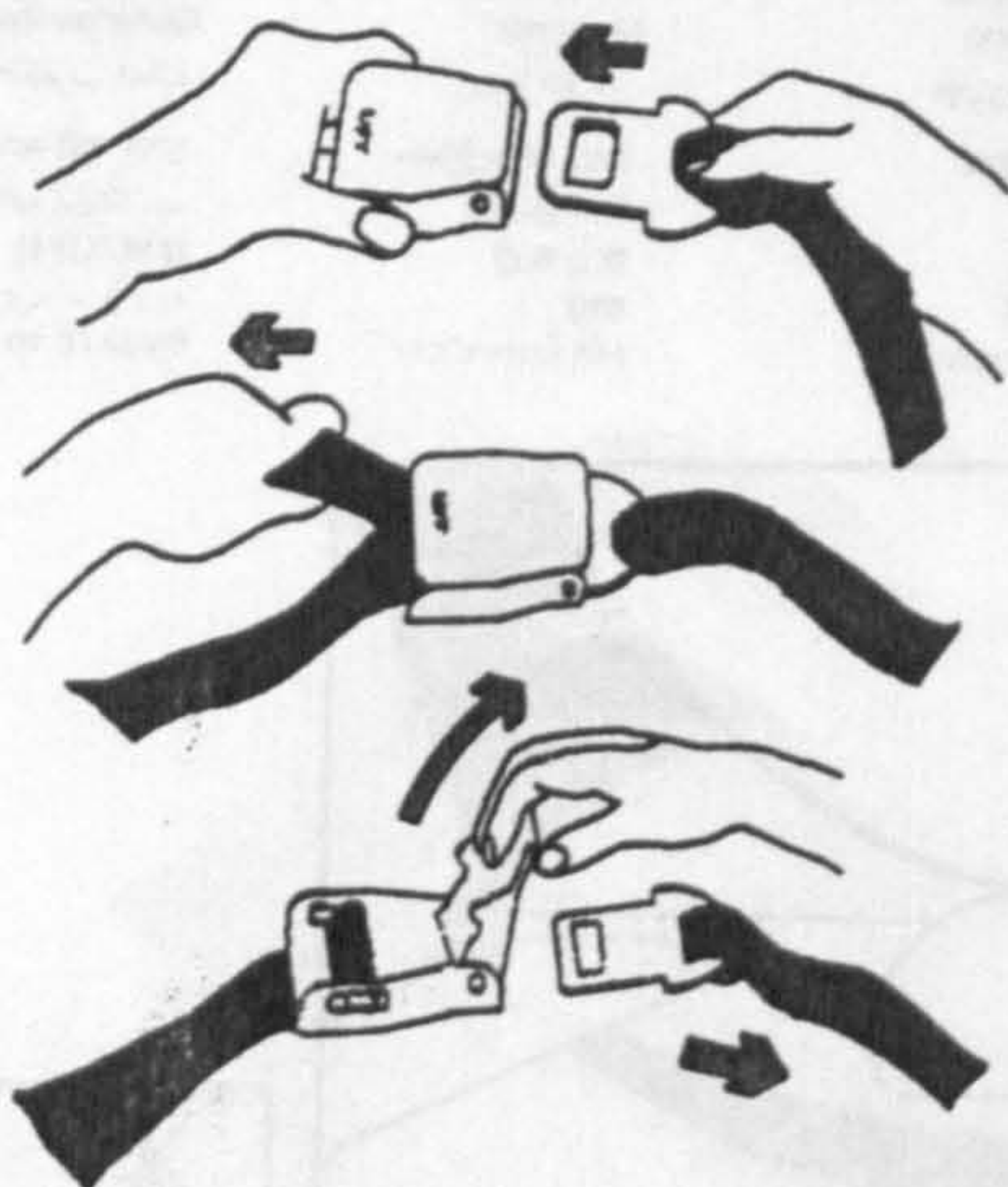
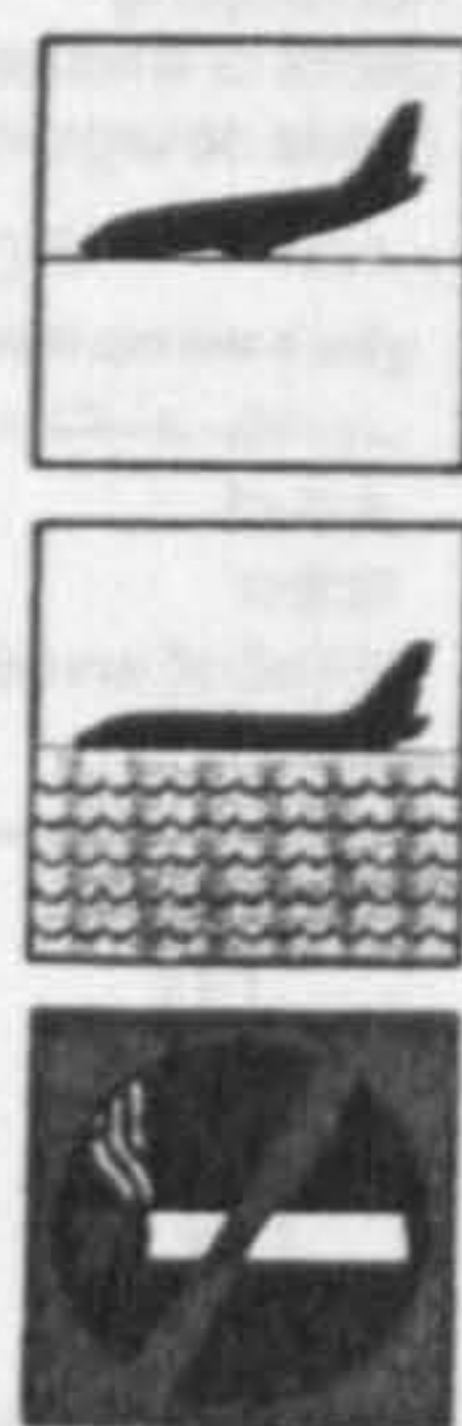
Βγάλτε τα Ψιλοτάχουνα



Cranfield
College of Aeronautics

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

Please study and leave on the aircraft



OXYGEN



Life jacket under seat



Place over head



Tie around waist
under jacket



Exit **first**, then inflate

2

Modified exit briefing card

,

1

.

1

2

3

4

5

6

7

Cranfield
College of Aeronautics

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

على الطائرة لسلك

Please study and leave on the aircraft



Takeoff and landing
Décollage et atterrissage
Start und Landung
Decollo e atterraggio
Despegue y aterrizaje
الإقلاع والهبوط
उड़ान का उड़ान और उतराई
起飛和降落
離陸および着陸
Απογείωση και προσγείωση



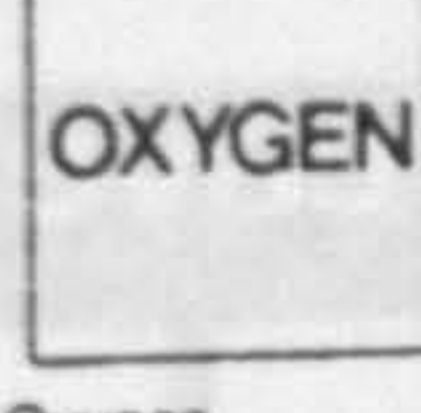
Emergency landing
Atterrissage forcé
Notlandung
Atterraggio forzato
Aterrizaje forzoso
اقطوط في حالة الطوارئ
दुर्घटना के समय उड़ान का उतराई
緊急着陸
Αναγκαστική προσγείωση



Landing on water
Amerrissage
Wasserung
Ammaraggio
Amaraje
اقطوط على الماء
पानी पर उड़ान का उतराई
緊急着水
Αναγκαστική προσβαλάνσωση



EXIT
Emergency exit
Sortie de secours
Notausgang
Uscita di emergenza
Salida de urgencia
خروج في حالة الطوارئ
दुर्घटना के समय उड़ान का उतराई
緊急出口
Εξοδος κινδύνου



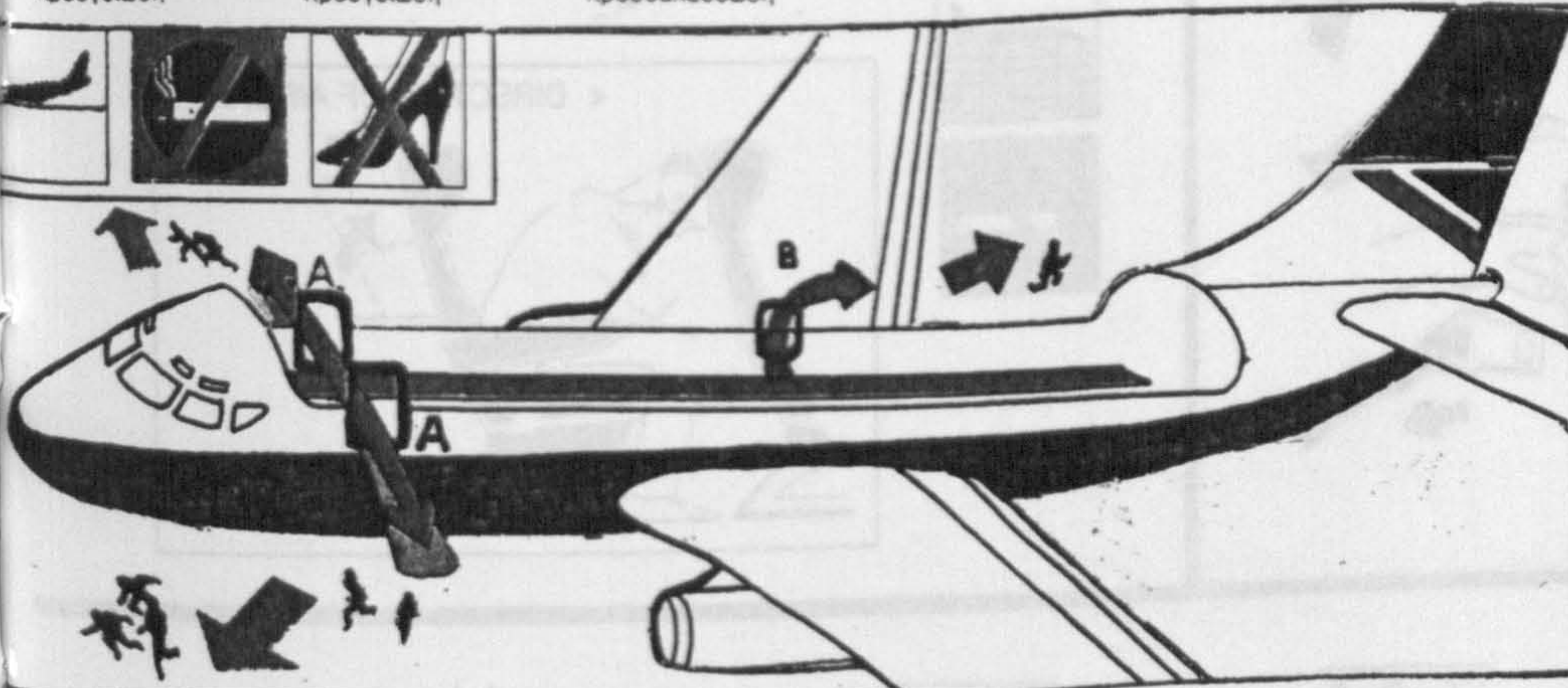
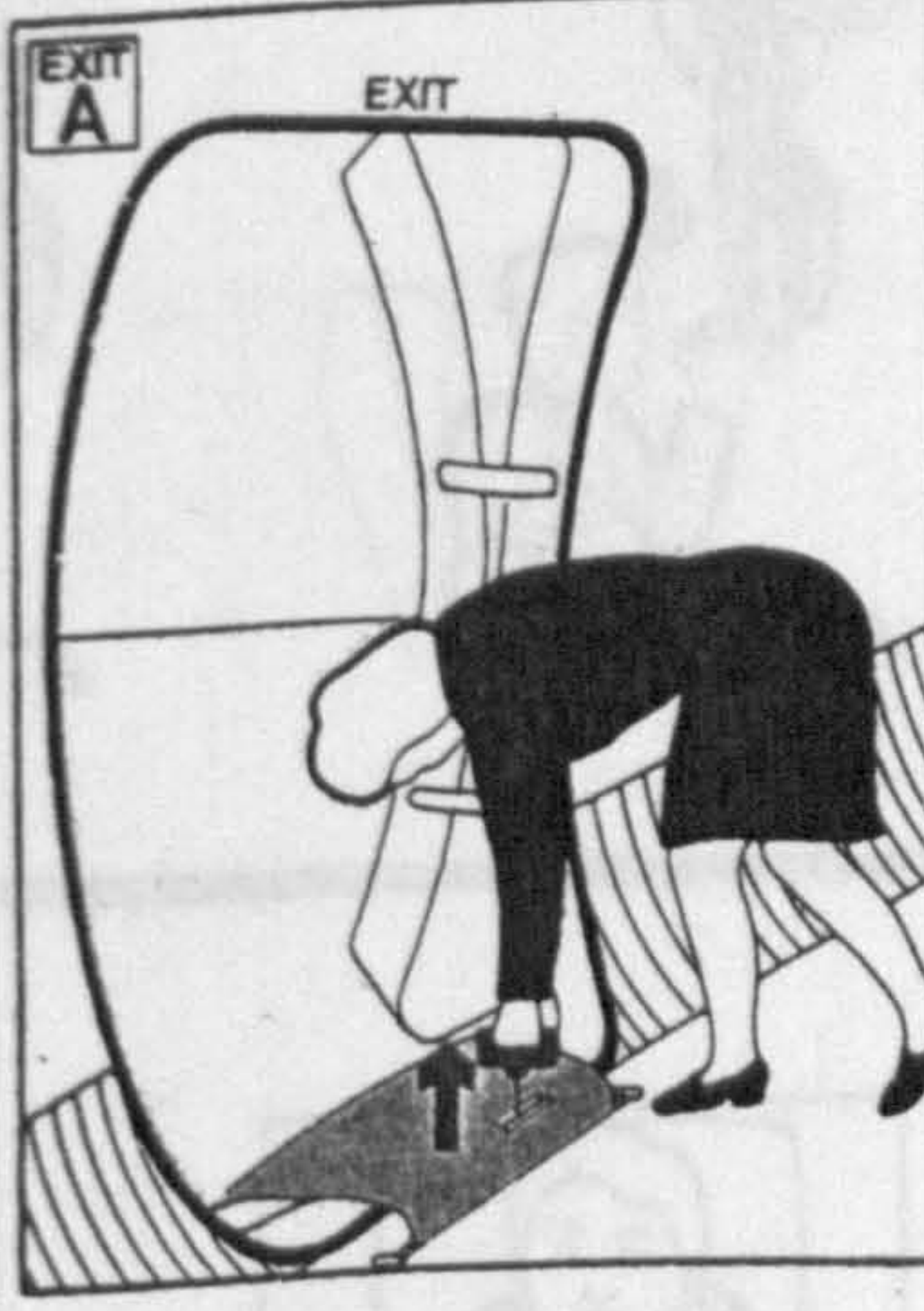
OXYGEN
Oxygen
Oxygène
Sauerstoff
Ossigeno
Oxigeno
الأكسجين
ऑक्सीजन
酸素
Οξυγόνο



No smoking
Ne pas fumer
Nicht rauchen
Non fumare
No fumar
ممنوع التدخين
विद्युत अग्नि न फैलाये
禁煙
Μη καπνίζετε



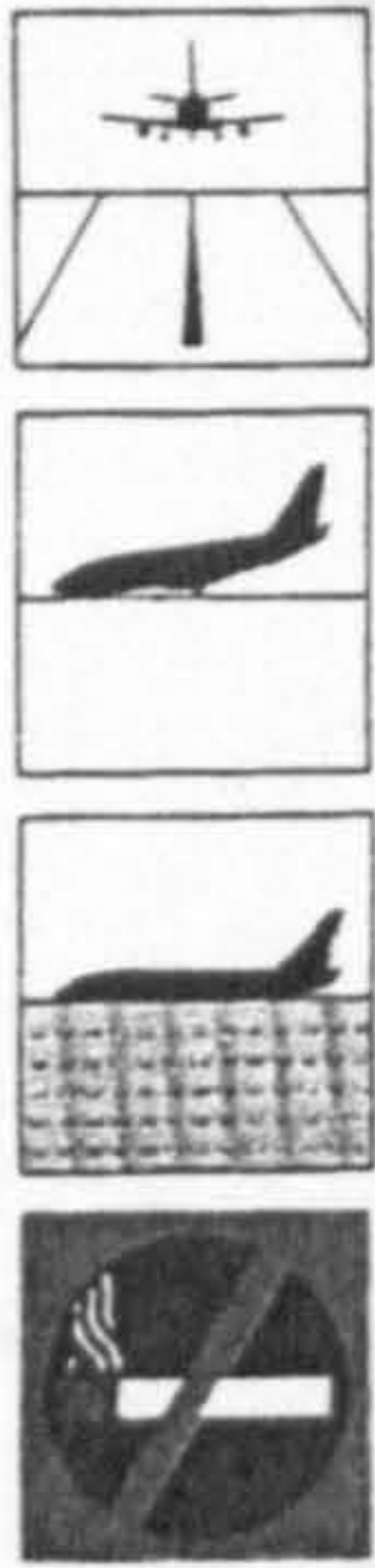
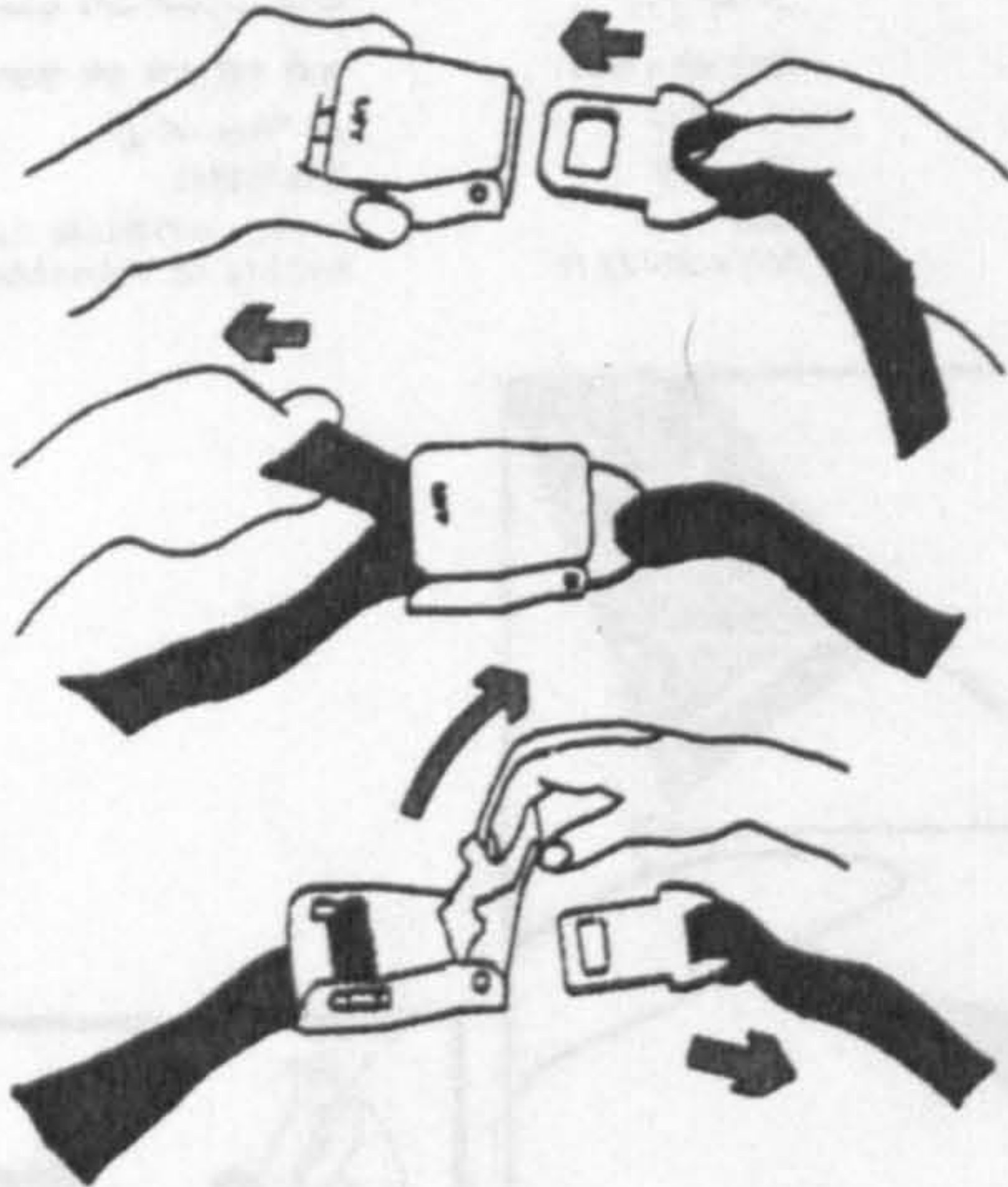
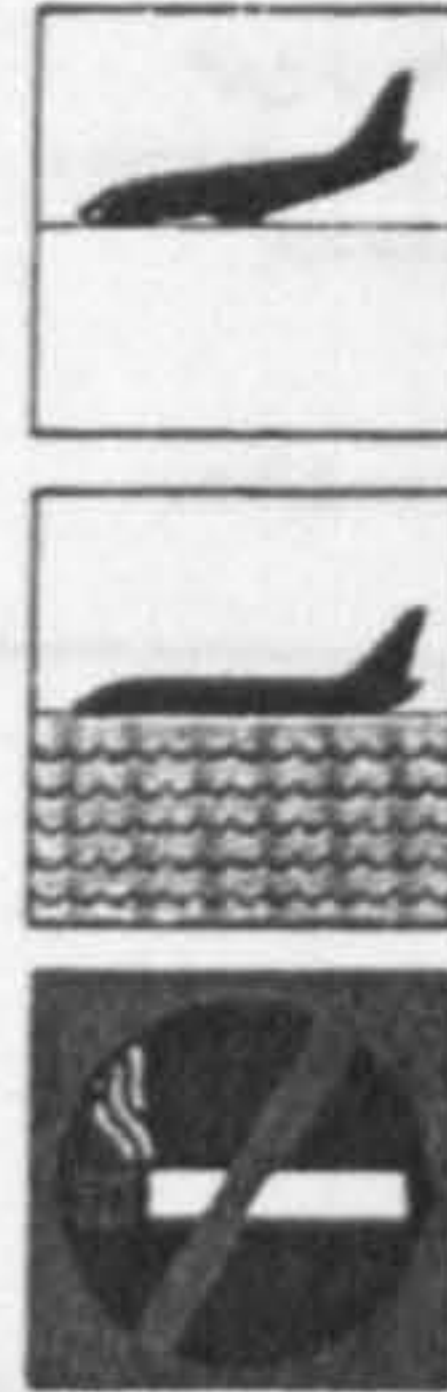
Remove high heel shoes
Enlevez les souliers à hauts talons
Schuhe mit hohem Absatz ausziehen
Togliere le scarpe con tacchi
Quitense los zapatos de tacón
تخلع الأحذية ذات الكعوب العالية
उंची पाड़ी बांधें जने उतार दें
अपनी उंची पाड़ी उतार दें
除掉高跟鞋
ハイヒールの靴は脱ぐ
Βγάλτε τα Ψιλοτάκουνα



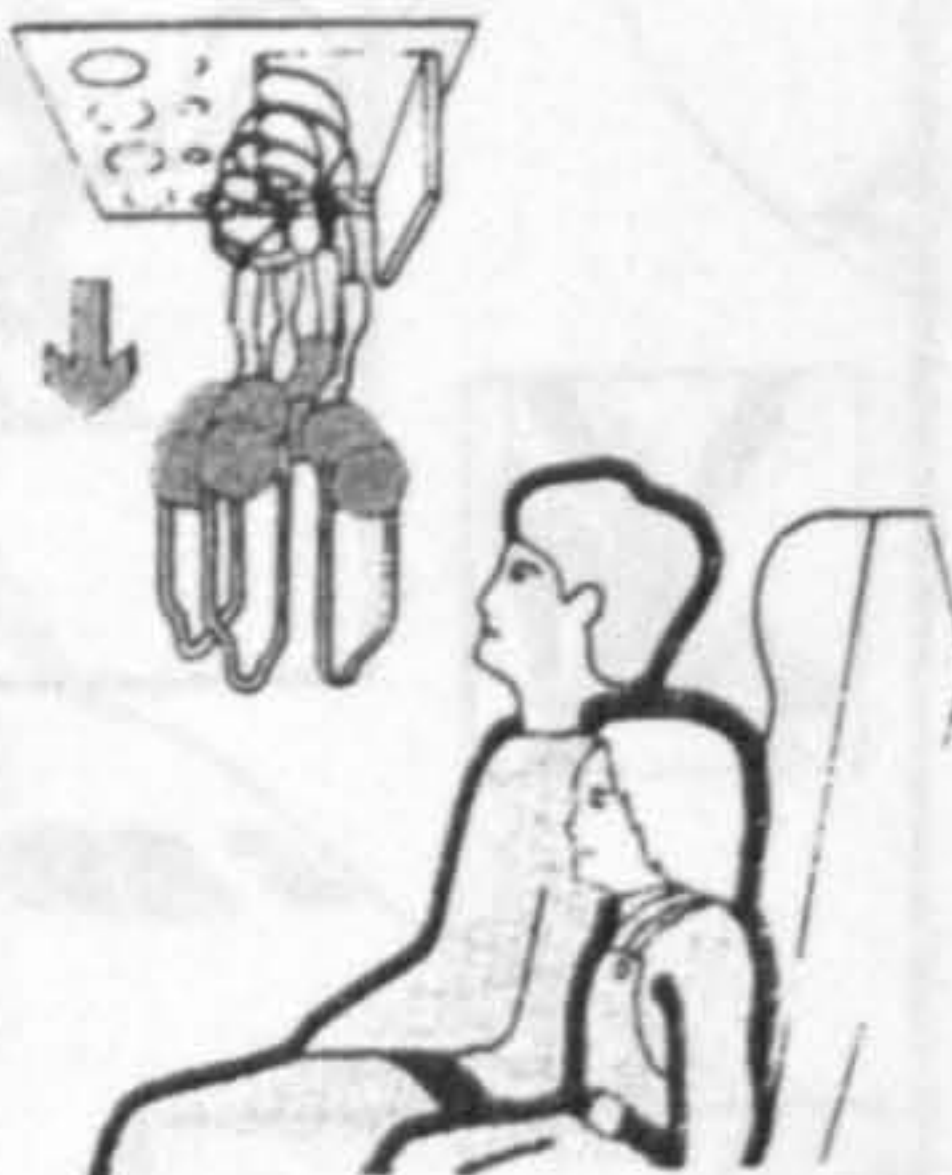
FOR YOUR SAFETY
POUR VOTRE SÉCURITÉ
FÜR IHRE SICHERHEIT
PER LA VOSTRA SICUREZZA
PARA SU SEGURIDAD
PARA A SUA SEGURANÇA

على الطائرة لسلامتكم

Please study and leave on the aircraft



BRACE POSITION



Life jacket under seat



Place over head



Tie around waist
under jacket



Exit first, then inflate

Appendix E Experiment one questionnaire

Appendix E Experiment one questionnaire

Cranfield University
Department of Applied Psychology

Questionnaire Number 1

Volunteer Number

Please complete the relevant sections of the questionnaire and return it to the researcher

☒ **Tick as applicable**

1. Did you pay close attention to the safety briefing given by the cabin crew member?

Yes ☐

No ☐ → go to Q.2

If yes, did this aid your escape?

Yes ☐

No ☐

If yes, how did it aid your escape? _____

If no, why didn't it aid your escape? _____

2. Did you pay close attention to the additional safety briefing given by the cabin crew member, indicating that you were seated next to the overwing exit and might therefore be required to operate it in an emergency situation?

Yes ☐

No ☐ → go to Q.3

If yes, did this aid your escape?

Yes ☐

No ☐

If yes, how did it aid your escape? _____

If no, why didn't it aid your escape? _____

3. Did you study the safety card in detail?

Yes ☐
No ☐ → go to Q.4

If yes, did this aid your escape?

Yes ☐
No ☐

If yes, how did it aid your escape? _____

If no, why didn't it aid your escape? _____

4. Did you study the diagrams on the safety card/placard showing the method of operating the overwing exit in detail?

Yes ☐
No ☐ → go to Q.5

If yes, did this aid your escape?

Yes ☐
No ☐

If yes, how did it aid your escape? _____

If no, why didn't it aid your escape? _____

5. If you have any suggestions of ways in which the safety briefing or card/placard could be improved, such that they increase your likelihood of escape in an emergency situation please write them in the space below:

6. Were you hinder you in your access to the exit from your seat?

Yes ☐
No ☐ → go to Q.7

If yes, what were you hindered by? _____

7. In opening the exit, please rate how easy or difficult you found the following by circling the appropriate number on the scale below:

	Very Easy	Very Difficult
The location of the exit in relation to your seat	1-----2-----3-----4-----5-----6-----7	
Finding the exit’s operating handle	1-----2-----3-----4-----5-----6-----7	
The clarity of exit operating instructions	1-----2-----3-----4-----5-----6-----7	
Using the exit’s operating handle	1-----2-----3-----4-----5-----6-----7	
Opening the exit	1-----2-----3-----4-----5-----6-----7	
The weight of the exit	1-----2-----3-----4-----5-----6-----7	
The size of the exit	1-----2-----3-----4-----5-----6-----7	
Clarity of instructions for disposing of the door	1-----2-----3-----4-----5-----6-----7	
Exiting through the exit onto the wing	1-----2-----3-----4-----5-----6-----7	

8. Please describe in detail anything about the overwing exit that caused you difficulty.

9. Did you operate the overwing exit from a seated or standing position?

Seated ☐

Standing □

For what reason did you operate the exit from this position?

10. How many times have you flown as an airline passenger before? (counting a return flight journey as one flight)

Never ☐

1-5 □

6-10 ☐

11-15 ☐16-20 ☐21-25 ☐26-30 ☐31+ ☐

11. Have you ever experienced an aircraft emergency situation?

Yes ☐

No ☐ → go to Q.7

If yes, what kind of emergency situation was it and what happened?

12. How often do you carry out strenuous physical exercise?

Once a day □

3+ times a week ☐

1-2 times a week ☐

1-2 times a month ☐

less than 1-2 times a month ☐

13. If there are any further points you would like to make please use the space provided below:

THANK-YOU

Cranfield University
Department of Applied Psychology

Questionnaire Number 2

Volunteer Number

Please complete the relevant sections of the questionnaire and return it to the researcher

☒ Tick as applicable

1. Were you hinder you in your access to the exit from your seat?

Yes ☐
No ☐ → go to Q.7

If yes, what were you hindered by? _____

2. In opening the exit, please rate how easy or difficult you found the following by circling the appropriate number on the scale below:

	Very Easy	Very Difficult
The location of the exit in relation to your seat	1-----2-----3-----4-----5-----6-----7	
Finding the exit's operating handle	1-----2-----3-----4-----5-----6-----7	
The clarity of exit operating instructions	1-----2-----3-----4-----5-----6-----7	
Using the exit's operating handle	1-----2-----3-----4-----5-----6-----7	
Opening the exit	1-----2-----3-----4-----5-----6-----7	
The weight of the exit	1-----2-----3-----4-----5-----6-----7	
The size of the exit	1-----2-----3-----4-----5-----6-----7	
Clarity of instructions for disposing of the door	1-----2-----3-----4-----5-----6-----7	
Exiting through the exit onto the wing	1-----2-----3-----4-----5-----6-----7	

3. Please describe in detail anything about the overwing exit that caused you difficulty.

4. Did you operate the overwing exit from a seated or standing position?

Seated

☐

Standing

☐

For what reason did you operate the exit from this position?

5. Did your experience at opening the overwing exit during the first safety trial lead you to do anything differently during the second trial?

Yes

☐

No

☐

→ go to Q.6

If yes, what did you do differently during the second trial?

6. Did your experience at opening the overwing exit during the first safety trial aid your escape from the aircraft during the second trial?

Yes

☐

No

☐

→ go to Q.7

If yes, how did it aid your escape?

If no, why didn't it aid your escape?

7. If there are any further points you would like to make please use the space provided below:

Cranfield University
Department of Applied Psychology

Questionnaire Number 3

Volunteer Number

Please complete the relevant sections of the questionnaire and return it to the researcher

☒ Tick as applicable

1. Were you hinder you in your access to the exit from your seat?

Yes ☐
No ☐ → go to Q.7

If yes, what were you hindered by? _____

2. In opening the exit, please rate how easy or difficult you found the following by circling the appropriate number on the scale below:

	Very Easy	Very Difficult
The location of the exit in relation to your seat	1-----2-----3-----4-----5-----6-----7	
Finding the exit’s operating handle	1-----2-----3-----4-----5-----6-----7	
The clarity of exit operating instructions	1-----2-----3-----4-----5-----6-----7	
Using the exit’s operating handle	1-----2-----3-----4-----5-----6-----7	
Opening the exit	1-----2-----3-----4-----5-----6-----7	
The weight of the exit	1-----2-----3-----4-----5-----6-----7	
The size of the exit	1-----2-----3-----4-----5-----6-----7	
Clarity of instructions for disposing of the door	1-----2-----3-----4-----5-----6-----7	
Exiting through the exit onto the wing	1-----2-----3-----4-----5-----6-----7	

3. Please describe in detail anything about the overwing exit that caused you difficulty.

4. Did you operate the overwing exit from a seated or standing position?

Seated ☐

Standing ☐

For what reason did you operate the exit from this position?

5. Did your experience at opening the overwing exit during the second safety trial lead you to do anything differently during the third trial?

Yes ☐

No ☐ → go to Q.6

If yes, what did you do differently during the third trial? _____

6. Did your experience at opening the overwing exit during the second safety trial aid your escape from the aircraft during the third trial?

Yes ☐

No ☐ → go to Q.7

If yes, how did it aid your escape? _____

If no, why didn't it aid your escape? _____

7. If there are any further points you would like to make please use the space provided below:

THANK-YOU

Passenger Safety Briefing For Type III

On passenger boarding

Ladies and gentlemen, Welcome on board. For your personal safety, any light articles which you have brought aboard the aircraft should be placed in the overhead bins or under the seat in front of you. Please ensure that hand luggage does not obstruct the aisles or any emergency exit. Passengers are asked to refrain from smoking until the no smoking signs have been switched off. Portable telephones must not be used at any time. Electronic items such as computers, tape recorders etc. may only be used when the seat belt signs are off.

Directly to participant sat by the Type III exit

I would like to draw your attention to the fact that you are sat by an emergency exit, should there be an emergency you would be expected to operate this exit. Instructions showing the method of operation can be found on the safety briefing card in the seat pocket in front of you and on the safety placard on the back of the seat, here.

After the doors are closed

Ladies and Gentlemen, as the safety equipment on this aircraft may differ from that on other aircraft it is in your own best interest 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 take-off. 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 rear of the cabin and an additional exit in the centre of the cabin.

For those of you unfamiliar with the operation of the seat belt it is fastened and adjusted as demonstrated and unfastened like this.

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. Remain seated, pull the mask towards you, and place over nose and mouth and breathe normally. 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 armrests down, and your seat belt is tightly fastened.

Thank you for your attention. We would like to wish you a pleasant flight.

Evacuation Scenarios

Scenario 1

After pre flight briefing " Ladies and gentlemen this is your captain speaking. We are currently in a queue of aircraft awaiting take off and should be airborne in a few minutes."

Engine noise for approximately 20 seconds then the command "Undo your seat belt and get out".

Scenario 2

Following the pre flight briefing a cabin check is made.

A short engine noise lasting approximately 15 seconds is heard then the command " Undo your seat belt and get out "

Scenario 3

Following the pre flight briefing a cabin check is made.

A long engine noise lasting approximately 30 seconds is heard culminating with a large bang is heard then the command " Undo your seat belt and get out "

Appendix H Experiment one raw evacuation times

Evacuation times for the modified Type III exit

* indicates incorrect disposal of the exit hatch.

Subject Number	Configuration	Sex	Age	Handedness	Height	Weight	Total evacuation time	Evacuation time from handle
1	13” Vertical	F	21	Right	161	58	13.52	6.36
	Projection						10.02	6.86
	No Dummy						9.12	5.88
2	13” Vertical	M	35	Right	171	73	4.64	2.80
	Projection						4.60	2.92*
	No Dummy						4.64	3.08
3	13” Vertical	M	24	Left	172	70	7.92	4.58
	Projection						5.64	3.36
	No Dummy						5.02	3.20
4	13” Vertical	F	23	Right	162	59	7.28	5.24
	Projection						7.56	4.88
	Dummy present						7.00	5.14
5	13” Vertical	M	39	Right	170	65	15.16	8.16
	Projection						13.48	6.72
	Dummy present						11.44	5.52
6	13” Vertical	F	21	Right	161	62	16.60	10.72
	Projection						10.44	7.12
	Dummy present						10.16	6.88
7	13” Vertical	F	44	Right	157	62	11.00	8.80
	Projection						7.44	4.40
	Dummy present						6.04	3.88
8	13” Vertical	F	28	Left	162	60	26.00	15.32
	Projection						9.80	5.20
	Dummy present						7.80	5.00
9	13” Vertical	M	31	Right	172	81	5.92	3.20
	Projection						5.32	2.00
	Dummy present						5.32	2.72
10	13” Vertical	F	40	Left	161	52	8.24	4.24
	Projection						7.00	3.88
	Dummy present						6.56	3.60
11	13” Vertical	M	34	Right	177	75	19.44	11.84
	Projection						16.72	10.60
	Dummy present						16.32	11.40
12	13” Vertical	F	20	Left	161	54	10.36	5.92
	Projection						8.20	4.60
	Dummy present						9.36	5.56

13	13" Vertical	F	21	Left	160	58	9.34	6.60*
	Projection						9.52	6.40
	Dummy present						8.76	5.52
14	13" Vertical	M	34	Left	175	70	13.32	5.92
	Projection						7.12	4.40
	Dummy present						5.92	4.12
15	Outboard seat	F	33	Left	164	63	6.08	2.68
	removed						5.92	2.44
							5.44	2.12
16	Outboard seat	M	25	Left	170	65	11.40	6.48*
	removed						11.84	4.48*
							8.60	4.76*
17	13" Vertical	F	23	Right	157	58	9.92	4.96
	Projection						7.20	3.60
	Dummy present						6.44	2.88
18	13" Vertical	F	34	Left	165	64	6.16	3.24
	Projection						4.16	2.36
	No Dummy						4.52	2.50
19	13" Vertical	M	20	Left	171	62	5.44	2.96
	Projection						5.84	3.60
	No Dummy						3.88	2.56
20	13" Vertical	F	35	Left	161	64	5.98	2.96
	Projection						5.96	3.60
	No Dummy						5.84	3.14
21	13" Vertical	M	36	Right	173	69	7.74	4.60
	Projection						7.40	4.76
	Dummy present						6.60	4.56
22	13" Vertical	M	40	Left	171	63	12.32	9.32
	Projection						7.14	4.28
	Dummy present						7.24	4.52
23	13" Vertical	F	43	Left	161	63	10.60	8.08
	Projection						10.84	5.88
	No Dummy						8.56	4.75
24	13" Vertical	M	42	Left	172	70	11.04	5.24
	Projection						9.24	5.10
	Dummy present						9.82	4.84
25	13" Vertical	F	41	Right	160	47	6.56	3.52
	Projection						6.86	3.56
	No Dummy						5.76	2.80
26	13" Vertical	F	48	Left	157	48	10.40	4.48
	Projection						7.40	5.32
	No Dummy						6.88	4.96
27	13" Vertical	M	48	Right	176	70	7.20	2.80*
	Projection						7.16	3.52*
	No Dummy						5.28	2.96*

[illegible]

43	Outboard seat	M	30	Right	175	70	4.84	1.52
	removed						4.44	1.96
							4.08	2.08
44	Outboard seat	F	34	Left	158	66	8.36	4.80
	removed						7.76	3.84
							6.26	3.36
45	Outboard seat	F	23	Right	162	64	8.80	5.16
	removed						6.48	3.56
							5.68	3.72
46	13" Vertical	M	34	Left	175	70	6.64	4.64
	Projection						6.12	4.28
	Dummy present						6.04	3.68
47	Outboard seat	M	25	Left	175	70	9.28	3.60
	removed						7.28	3.40
							6.80	3.44
48	13" Vertical	M	23	Right	173	70	10.16	4.00
	Projection						8.36	4.40
	No Dummy						6.28	3.68

Evacuation times for the Traditional Type III exit

* Indicates incorrect disposal of exit hatch

Subject Number	Configuration	Sex	Age	Handedness	Height	Weight	Total Evacuatio n time	Evacuation time from handle
1	13” Vertical	M	21	Right	177	80	14.80	8.88
	Projection						12.32	8.70
	No Dummy						11.44	6.84
2	13” Vertical	F	28	Right	161	59	12.04	9.24*
	Projection						19.84	17.08*
	No Dummy						12.64	10.56*
3	13” Vertical	M	24	Left	171	68	12.28	8.52*
	Projection						10.20	6.92*
	No Dummy						10.24	6.92*
4	13” Vertical	M	37	Left	169	65	9.24	6.44*
	Projection						8.76	5.64*
	No Dummy						9.80	6.60
5	13” Vertical	F	29	Right	162	68	23.76	17.72
	Projection						19.40	14.52
	No Dummy						18.36	14.60
6	13” Vertical	M	37	Right	175	70	14.24	9.00*
	Projection						14.56	9.44
	No Dummy						11.68	7.84
7	13” Vertical	F	26	Right	175	64	16.82	10.84*
	Projection						17.88	13.16
	No Dummy						16.64	11.68
8	13” Vertical	F	30	Right	156	55	28.56	21.32
	Projection						18.68	12.12
	No Dummy						23.40	15.00
9	13” Vertical	M	32	Left	171	66	12.84	10.72
	Projection						13.04	10.12
	No Dummy						12.80	9.72
10	13” Vertical	M	28	Left	180	70	14.32	9.96
	Projection						10.80	7.00
	No Dummy						9.20	6.20
11	13” Vertical	F	21	Right	165	67	30.92	24.16*
	Projection						18.12	12.92*
	Dummy present						13.40	8.60*
12	13” Vertical	M	22	Right	171	67	29.00	19.28
	Projection						25.00	12.04
	Dummy present						16.56	7.60
13	13” Vertical	F	24	Left	165	57	30.64	26.34
	Projection						28.60	23.56
	Dummy present						19.04	14.76*

[illegible]

29	Outboard seat	M	48	Left	175	75	12.80	6.12*
	removed						11.44	5.48*
							14.48	9.72
30	Outboard seat	M	33	Left	172	80	16.12	11.48*
	removed						11.96	6.76*
							14.08	9.76
31	Outboard seat	F	40	Right	164	59	7.40	5.24*
	removed						13.36	7.76*
							7.28	5.24*
32	Outboard seat	M	37	Right	165	75	17.08	11.28
	removed						11.20	8.36
							11.48	9.00
33	Outboard seat	M	41	Right	174	62	12.52	7.68*
	removed						9.72	7.08
							10.28	7.68
34	Outboard seat	F	31	Right	161	56	18.82	13.76*
	removed						13.20	6.96*
							13.62	7.06*
35	Outboard seat	M	23	Left	176	63	15.08	8.04
	removed						13.80	9.32
							10.80	8.16
36	13" Vertical	F	36	Right	157	60	12.20	7.84*
	Projection						12.12	8.64*
	Dummy present						22.12	18.44
37	13" Vertical	M	32	Right	175	80	7.44	5.92
	Projection						9.62	7.48
	Dummy present						6.88	5.32
38	13" Vertical	M	26	Left	178	80	18.88	15.48
	Projection						15.40	11.48
	Dummy present						13.00	9.40
39	13" Vertical	F	23	Left	159	65	25.60	22.88
	Projection						18.40	15.52
	Dummy present						15.68	13.40
40	13" Vertical	F	24	Left	165	70	9.60	7.04*
	Projection						10.00	8.04
	No Dummy						9.72	7.80
41	13" Vertical	F	43	Left	157	61	19.68	15.96
	Projection						17.52	13.36
	No Dummy						20.68	17.60
42	13" Vertical	F	20	Left	160	47	15.52	10.64*
	Projection						15.24	10.80*
	No Dummy						14.48	8.84*
43	13" Vertical	F	23	Left	157	57	18.52	12.40*
	Projection						20.12	13.04*
	No Dummy						21.08	11.52

[illegible]

On passenger boarding

Ladies and Gentlemen. Welcome on board. For your personal safety, any light articles which you brought aboard the aircraft should be placed in the overhead bins or under the seat in front of you. Please ensure that hand luggage does not obstruct the aisles or any emergency exit. Passengers are asked to refrain from smoking until the no smoking signs have been switched off. Portable telephones must not be used at any time. Electronic items such as computers, tape recorders etc. may only be used when the seat belt signs are off.

After the doors are closed

Ladies and gentlemen. As the safety equipment on this aircraft may differ from that on other aircraft it is in your own best interest 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 take-off. This contains details of the demonstration. Please note the brace position, which you will be asked to adopt in the event of an emergency landing.

The emergency exits are clearly marked and are being pointed out to you. These are the two doors at the rear of the cabin. There is also an additional overwing emergency exit located in the centre of the cabin. Floor level lighting will illuminate showing the routes to these exits.

For those of you unfamiliar with the operation of the seat belt it is fastened and adjusted as demonstrated and unfastened like this.

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. Remain seated, pull the mask towards you, place over nose and mouth and breathe normally. Adults should fit their own masks before assisting children.

A lifejacket is stowed in a pocket beneath your seat. Remove it from the container. Pass the jacket over your head and pull the tapes down, cross them at the back, bring to the side and tie the tapes securely in a double bow. To inflate the jacket pull the red toggle sharply downwards. It can also be inflated or topped up by blowing into this tube. The jacket has a light and a whistle for attracting attention. Please note: your life jacket must only be inflated outside the aircraft otherwise this would obstruct your exit.

Please now ensure your seat table is folded away, your seat back is upright with the armrests down, and your seat belt is tightly fastened.

Thank you for your attention. We would like to wish you a pleasant flight.

Additional exit briefing

Before we take off I would like to advise you that you are sat next to an emergency exit. Should there be a need to evacuate this aircraft, you may have to operate the exit.

Appendix J Experiment Two Briefing cards

- i Pictorial briefing card
- ii Simplified pictorial briefing card
- iii Photographic briefing card
- iv Pictorial with words briefing card

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

على الطائرة لسداد متك

Please study and leave on the aircraft



Takeoff and landing
Décollage et atterrissage
Start und Landung
Decollo e atterraggio
Despegue y aterrizaje

الاقلاع والهبوط

उड़ान का आरंभ और उतराई

Start und Landung

Decollo e atterraggio

Despegue y aterrizaje

Απογείωση και προσγείωση



Emergency landing
Atterrissage forcé
Notlandung
Atterraggio forzato
Aterrizaje forzoso

الهبوط في حالة الطوارئ

दुर्घटना के समय जहाज का उतराई

Atterrissage forcé

Atterraggio forzato

Aterrizaje forzoso

Αναγκαστική προσγείωση



Landing on water
Amerrissage
Wasserung
Ammeraggio
Amaraje

الهبوط على الماء

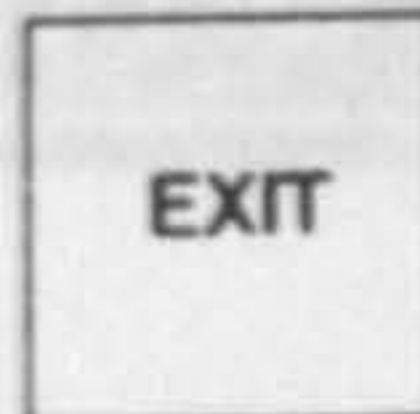
जल पर उड़ान का आरंभ

Amerrissage

Wasserung

Ammeraggio

Αναγκαστική προσβαλίσωση



Emergency exit
Sortie de secours
Notausgang
Uscita di emergenza
Salida de urgencia

خروج في حالة الطوارئ

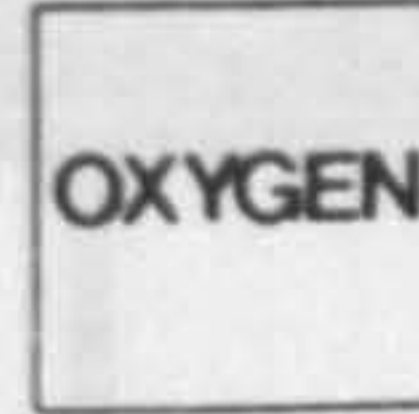
दुर्घटना के समय जहाज से निकलने का रास्ता

Sortie de secours

Notausgang

Uscita di emergenza

Εξοδος κινδύνου



Oxygen
Oxygène
Sauerstoff
Ossigeno
Oxigeno

الأكسجين

वायुसौजन्य

Oxygène

Sauerstoff

Ossigeno

Οξυγόνο



No smoking
Ne pas fumer
Nicht rauchen
Non fumare
No fumar

منع التدخين

शिगरेट आदि न फेविये

Nicht rauchen

Non fumare

No fumar

Μη καπνίζετε



Remove high heel shoes
Enlevez les souliers à hauts talons
Schuhe mit hohem Absatz ausziehen
Togliere le scarpe contacco alto
Quitense los zapatos de tacón

انزع الأحذية ذات الكعب العالي

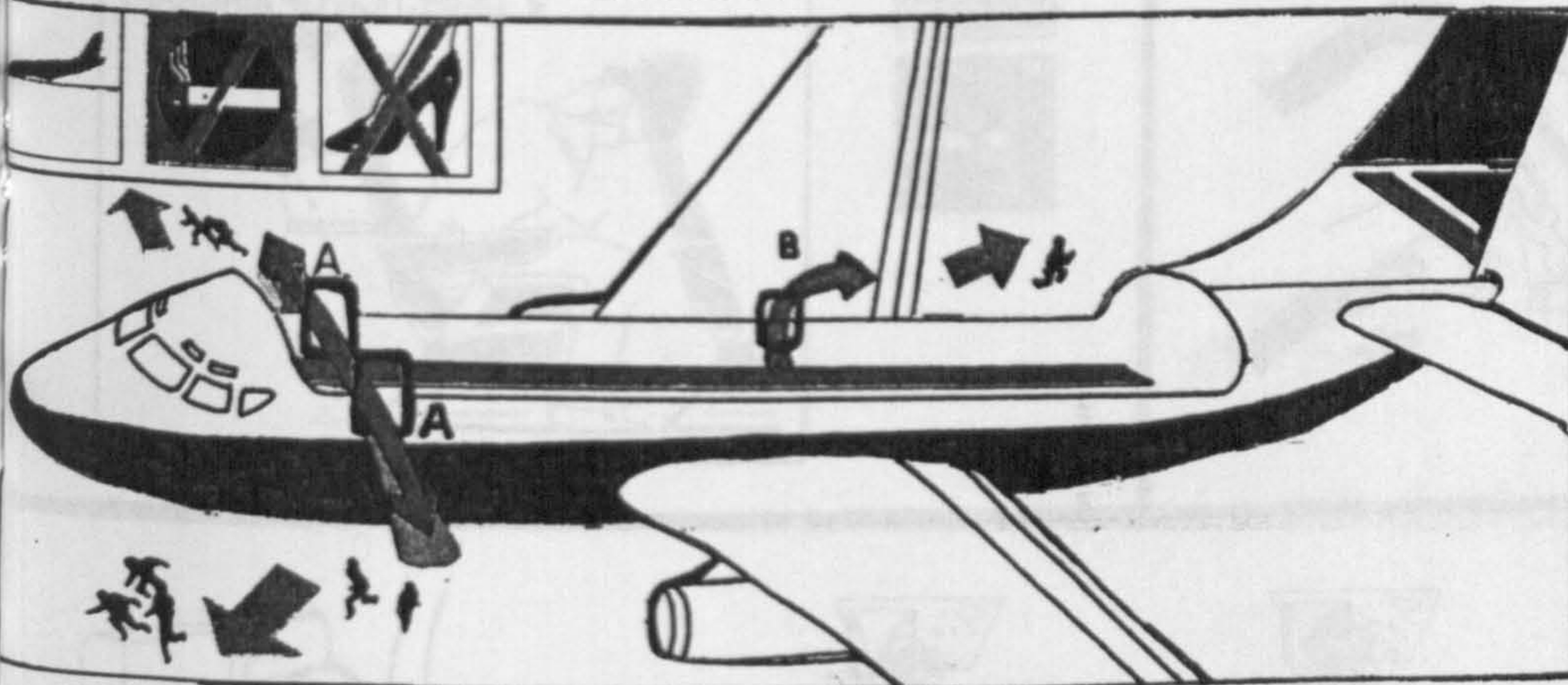
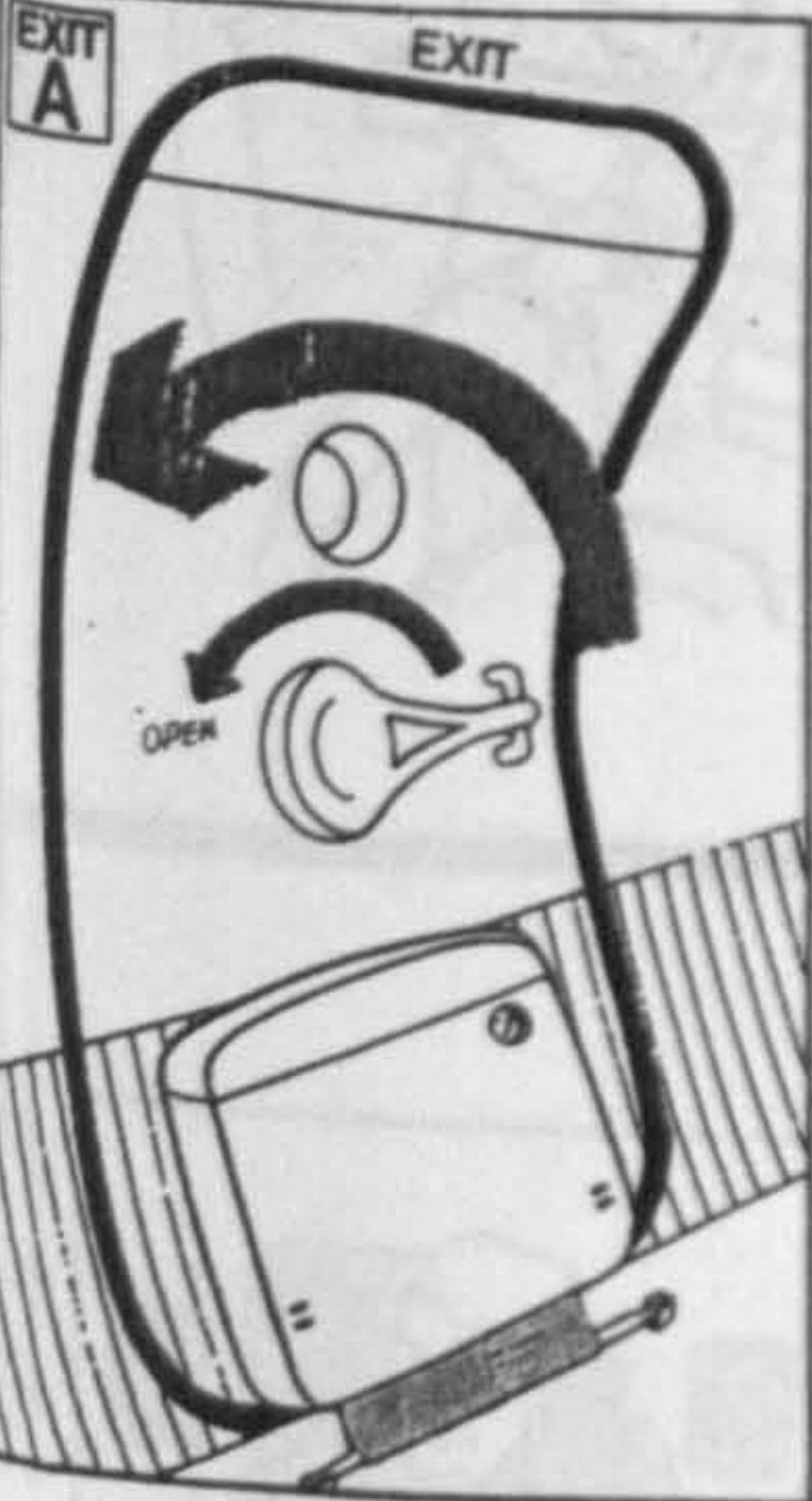
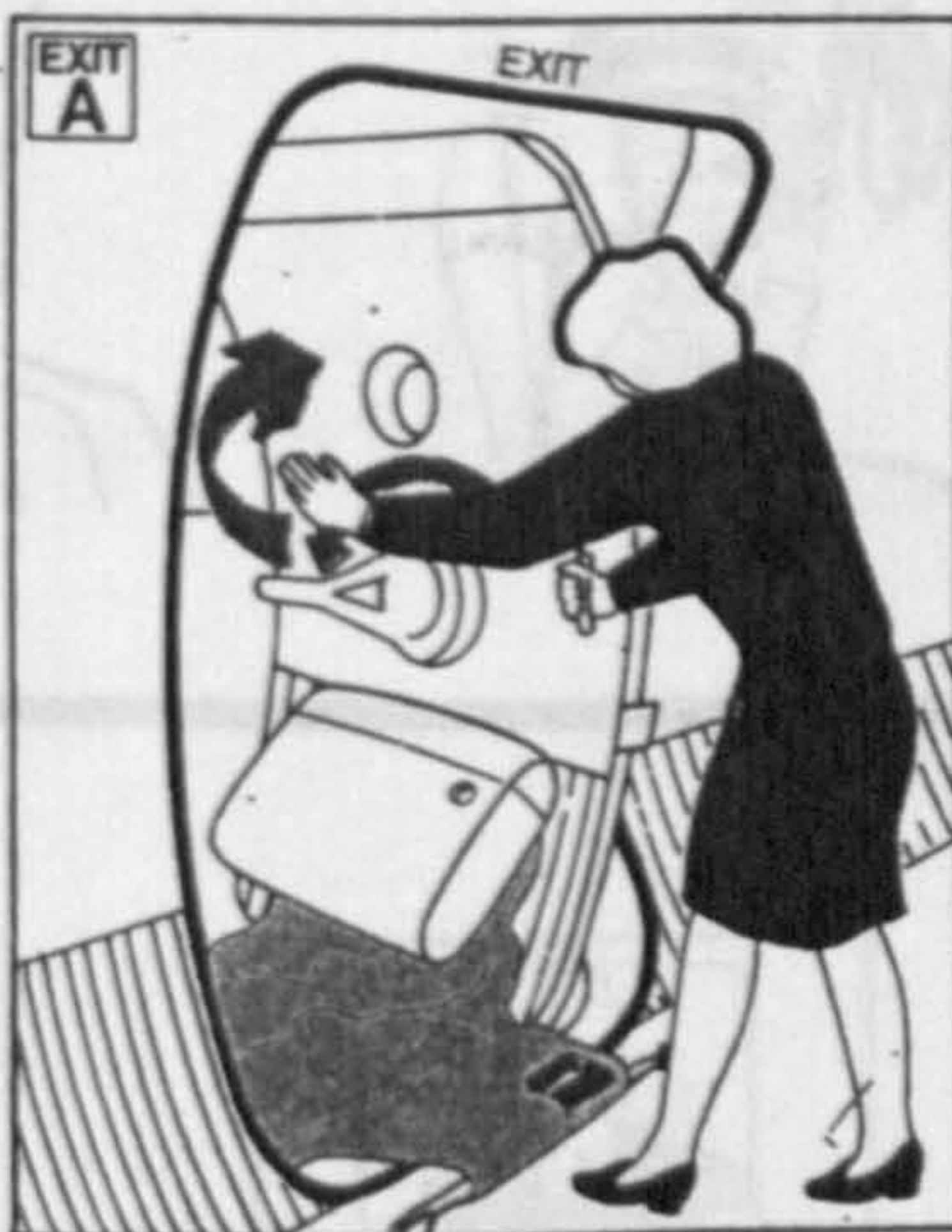
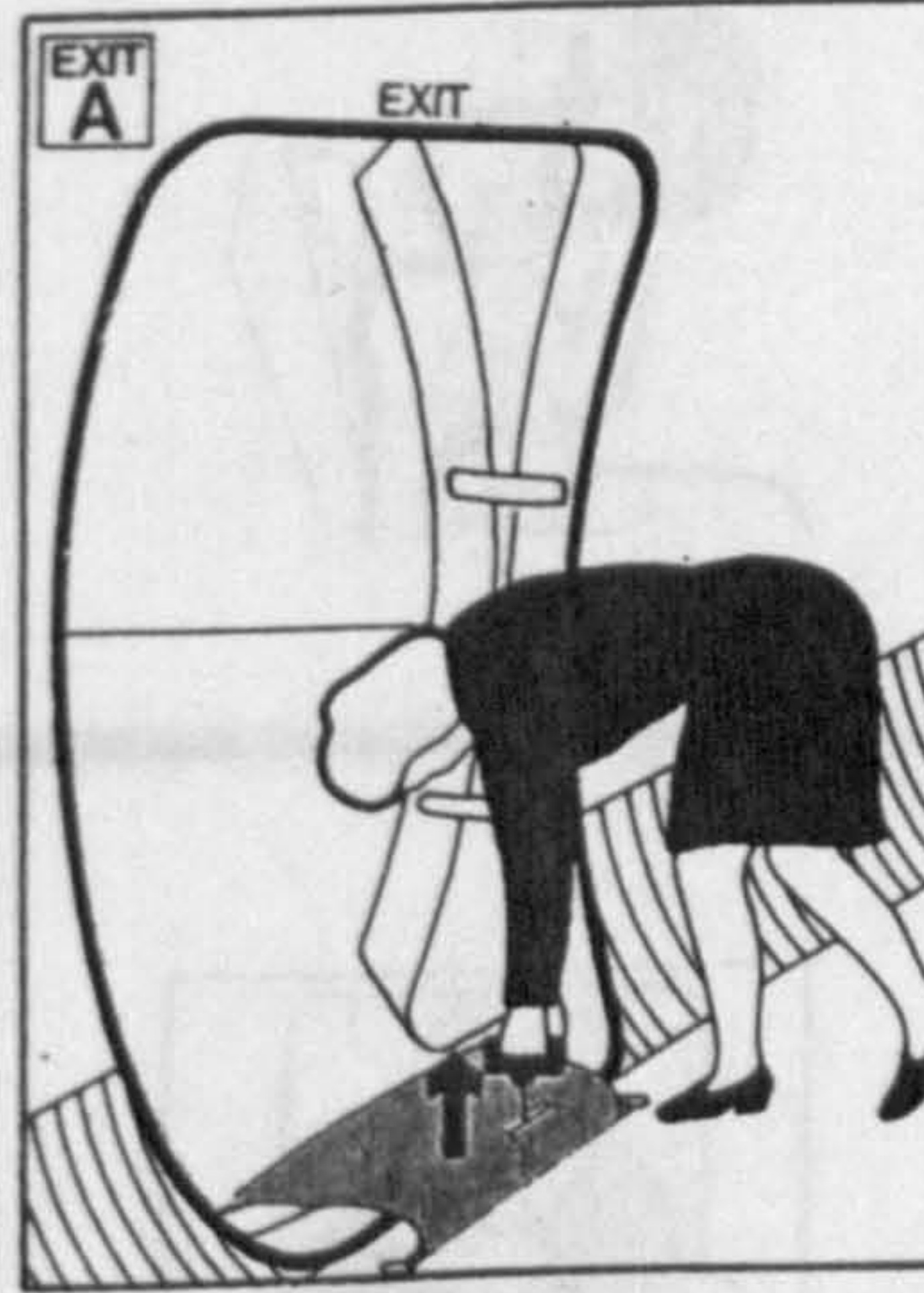
ऊंची पाड़ी वाले जूते उतार दें

Enlevez les souliers à hauts talons

Schuhe mit hohem Absatz ausziehen

Togliere le scarpe contacco alto

Βγάλτε τα Ψιλοτάχουνα



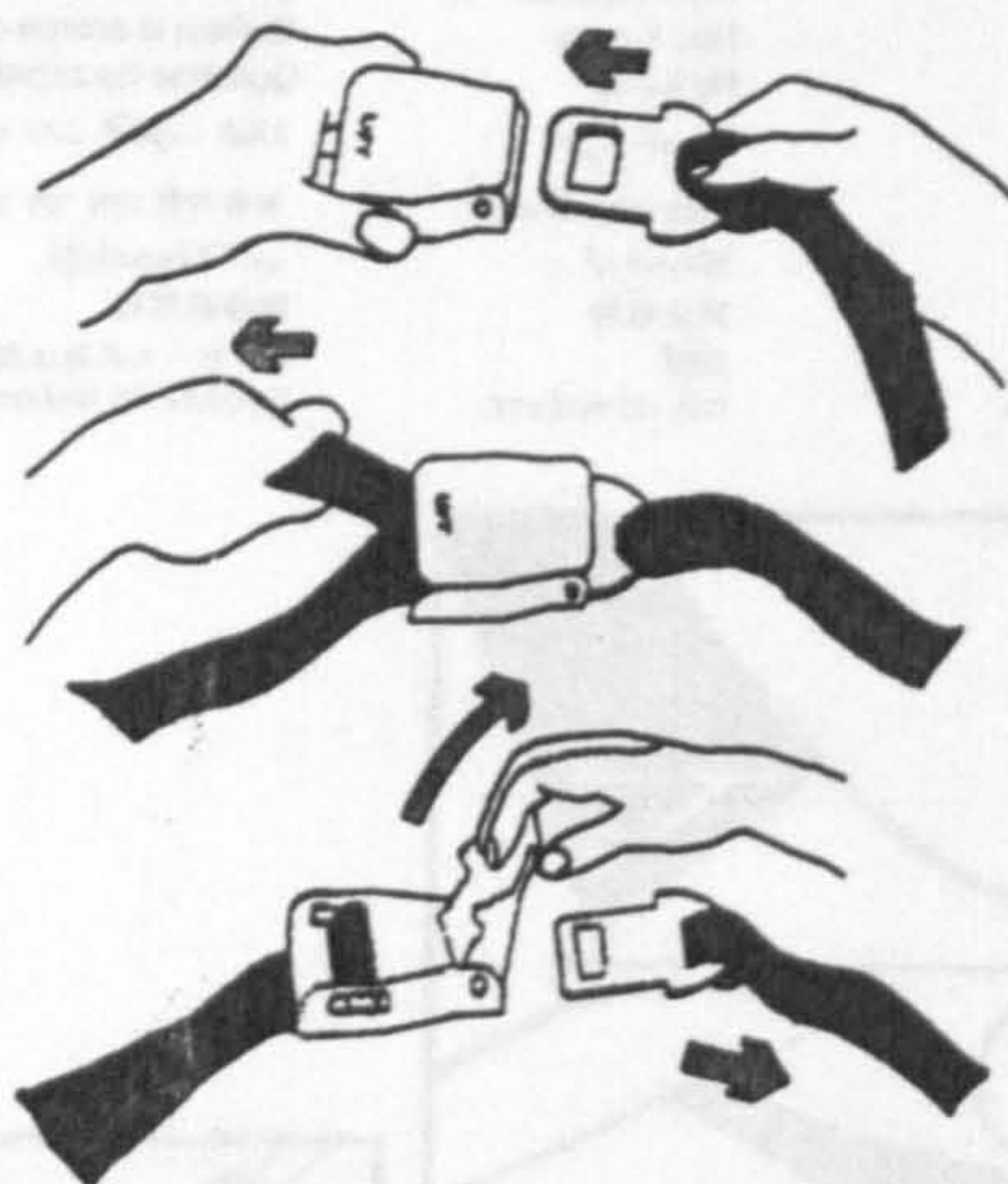
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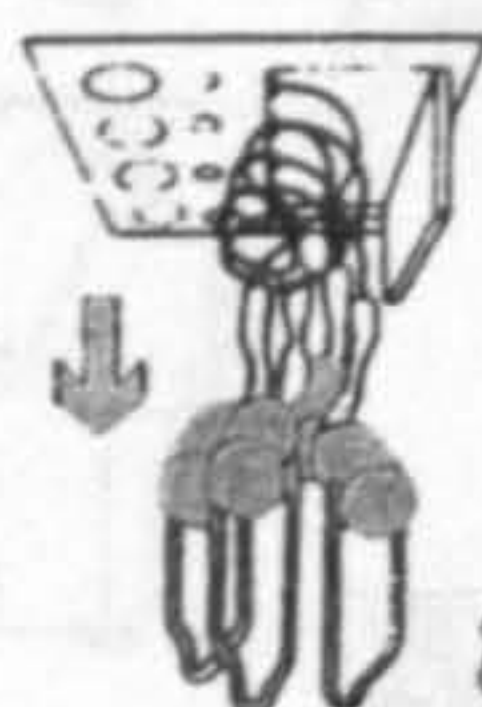
FOR YOUR SAFETY
POUR VOTRE SÉCURITÉ
FÜR IHRE SICHERHEIT
PER LA VOSTRA SICUREZZA
PARA SU SEGURIDAD
PARA A SUA SEGURANÇA

على الطائرة لسلامتك

Please study and leave on the aircraft



OXYGEN



Life jacket under seat



Place over head



Tie around waist
under jacket



Exit first, then inflate

ii Simplified pictorial briefing card

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

على الطائرة لسلامتكم

Please study and leave on the aircraft



Takeoff and landing
Décollage et atterrissage
Start und Landung
Decollo e atterraggio
Despegue y aterrizaje
الإقلاع والهبوط

उड़ान का उड़ान और उतर ।
उड़ान और उतर ।
起飛和降落
起飛および着陸
'Απογείωση και προσγείωση



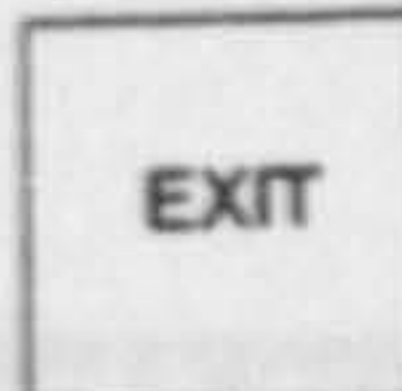
Emergency landing
Atterrissage forcé
Notlandung
Atterraggio forzato
Aterrissage forzado

الهبوط في حالة الطوارئ
الهبوط في حالة الطوارئ
緊急着陸
緊急着陸
'Αναγκαστική προσγείωση



Landing on water
Amersage
Wasserung
Ammaraggio
Amaraje

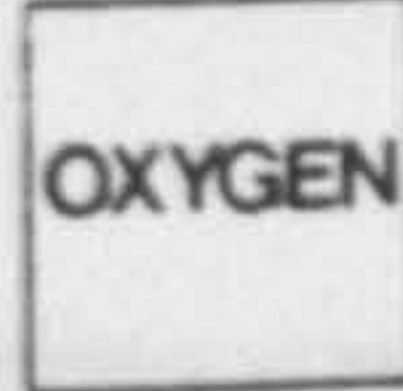
الهبوط على الماء
الهبوط على الماء
水上着陸
水上着陸
'Αναγκαστική προσβαλάρωση



EXIT

Emergency exit
Sortie de secours
Notausgang
Uscita di emergenza
Salida de urgencia

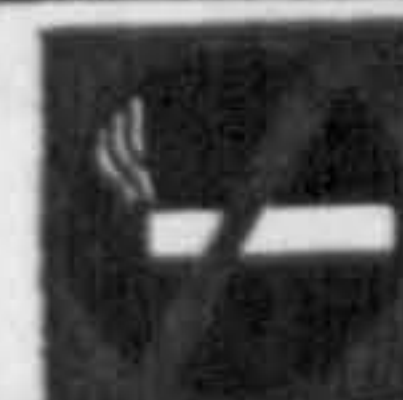
مخرج في حالة الطوارئ
مخرج في حالة الطوارئ
大平門
大平門
Εξοδος κινδύνου



OXYGEN

Oxygen
Oxygène
Sauerstoff
Ossigeno
Oxigeno

الأكسجين
الأكسجين
酸素
酸素
Οξυγόνο



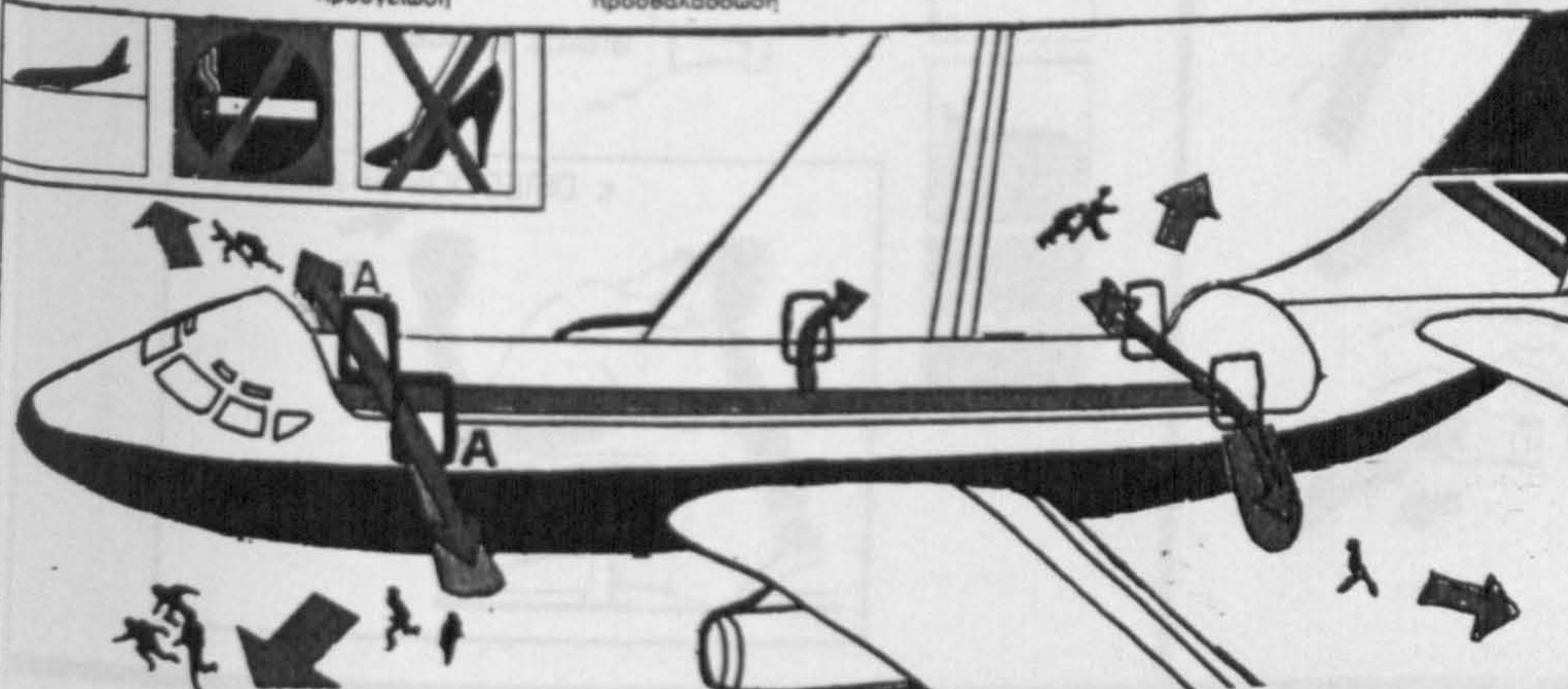
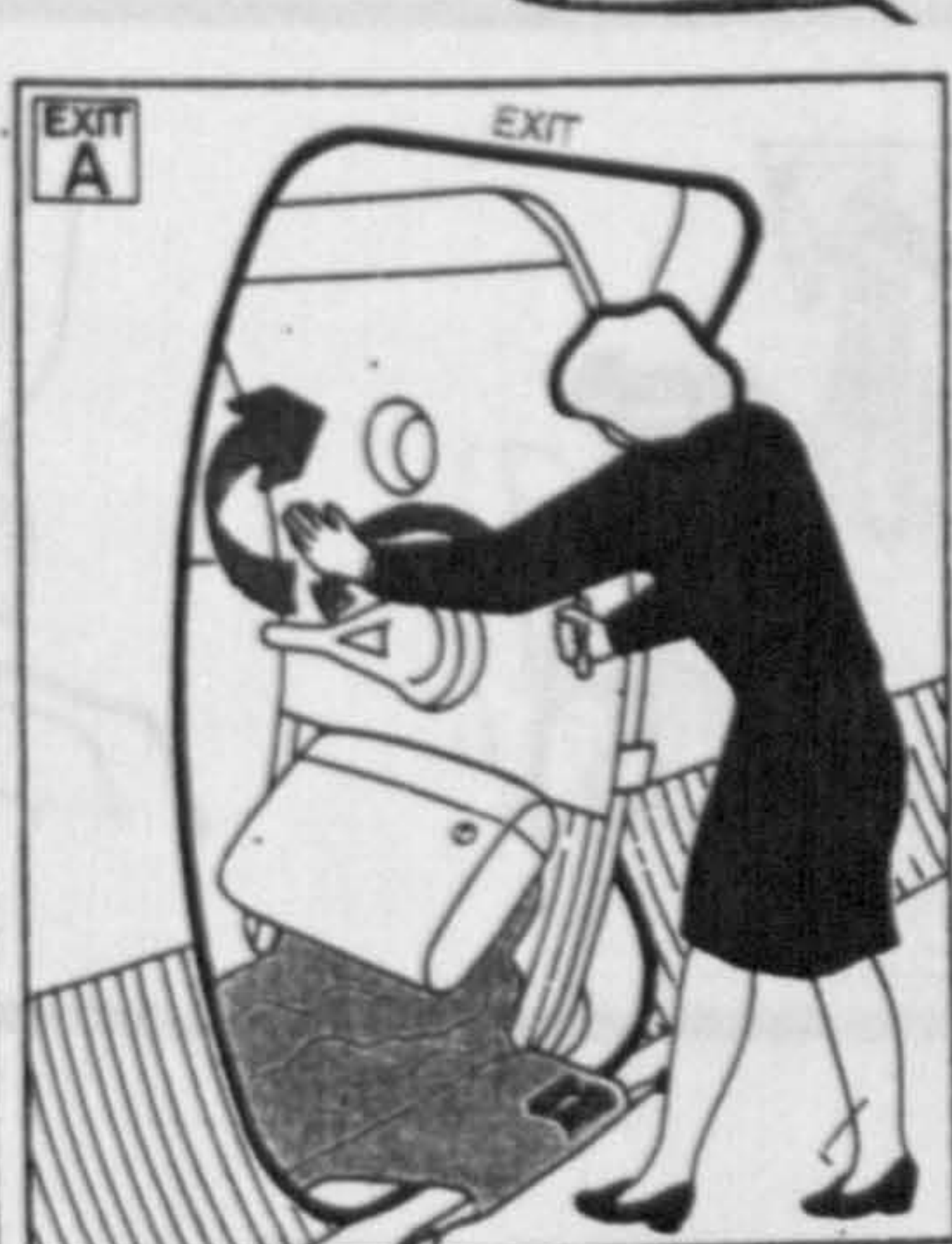
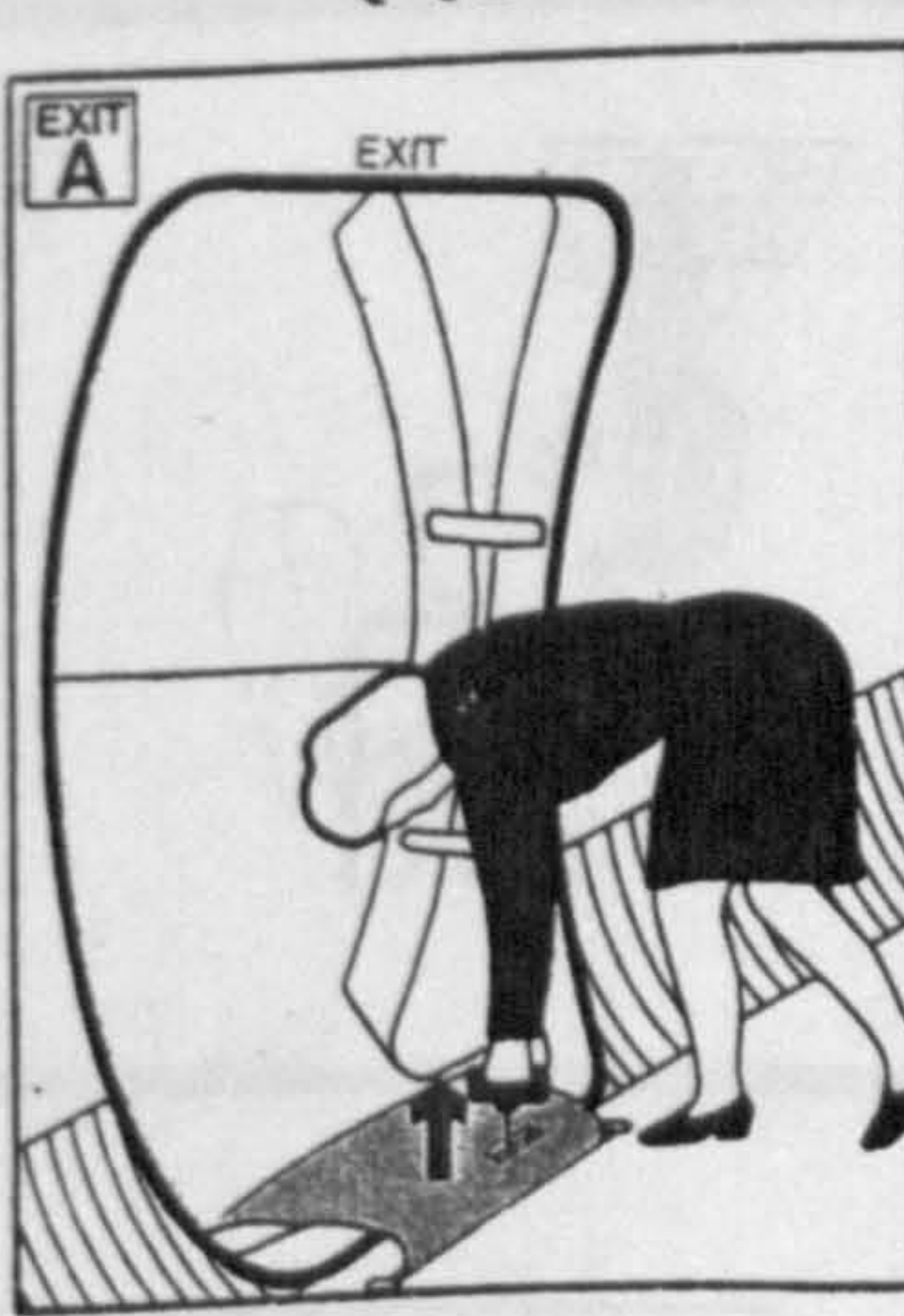
No smoking
Ne pas fumer
Nicht rauchen
Non fumare
No fumar

ممنوع التدخين
ممنوع التدخين
禁止吸烟
禁止吸烟
Μή καπνίζετε

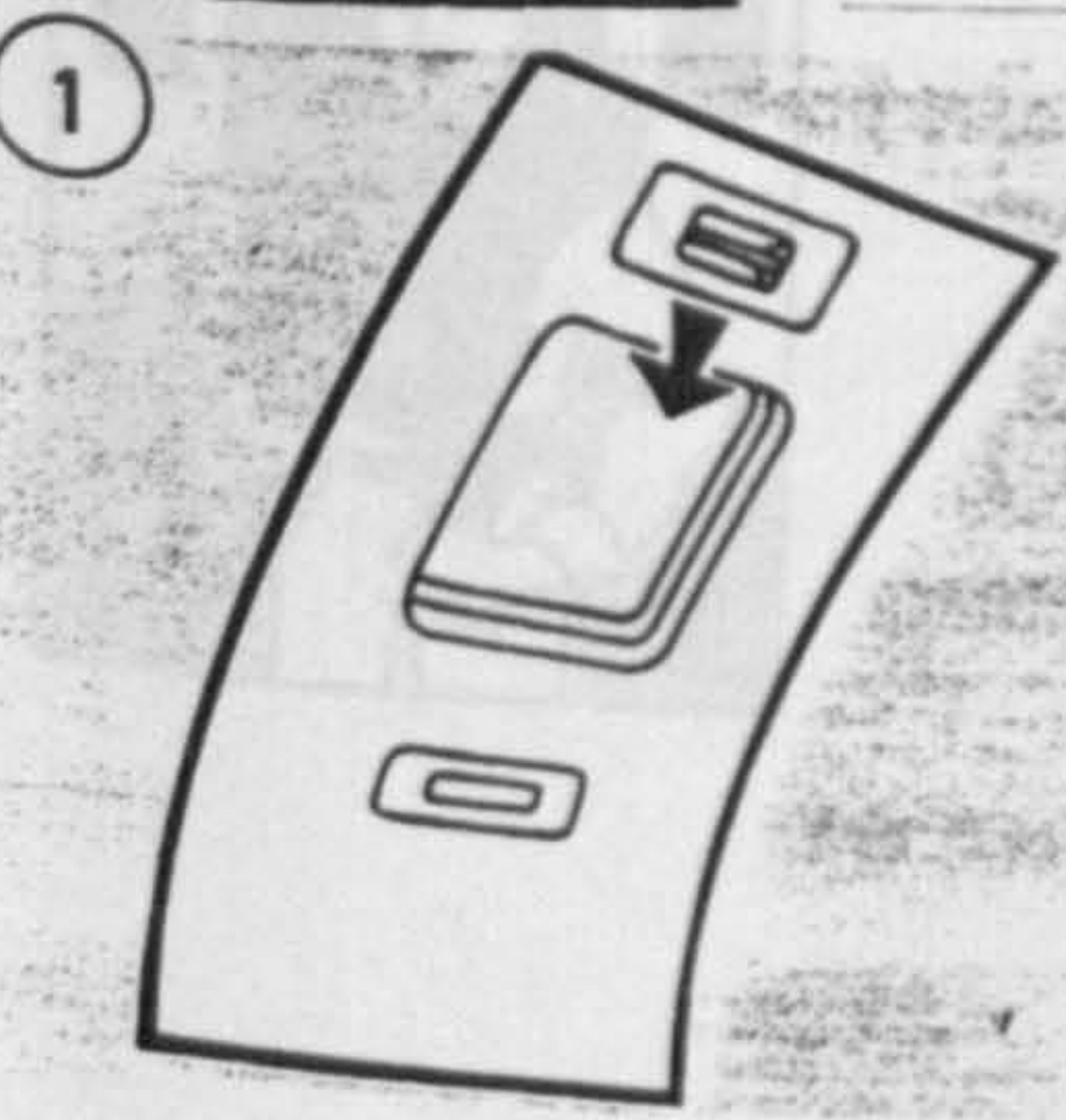
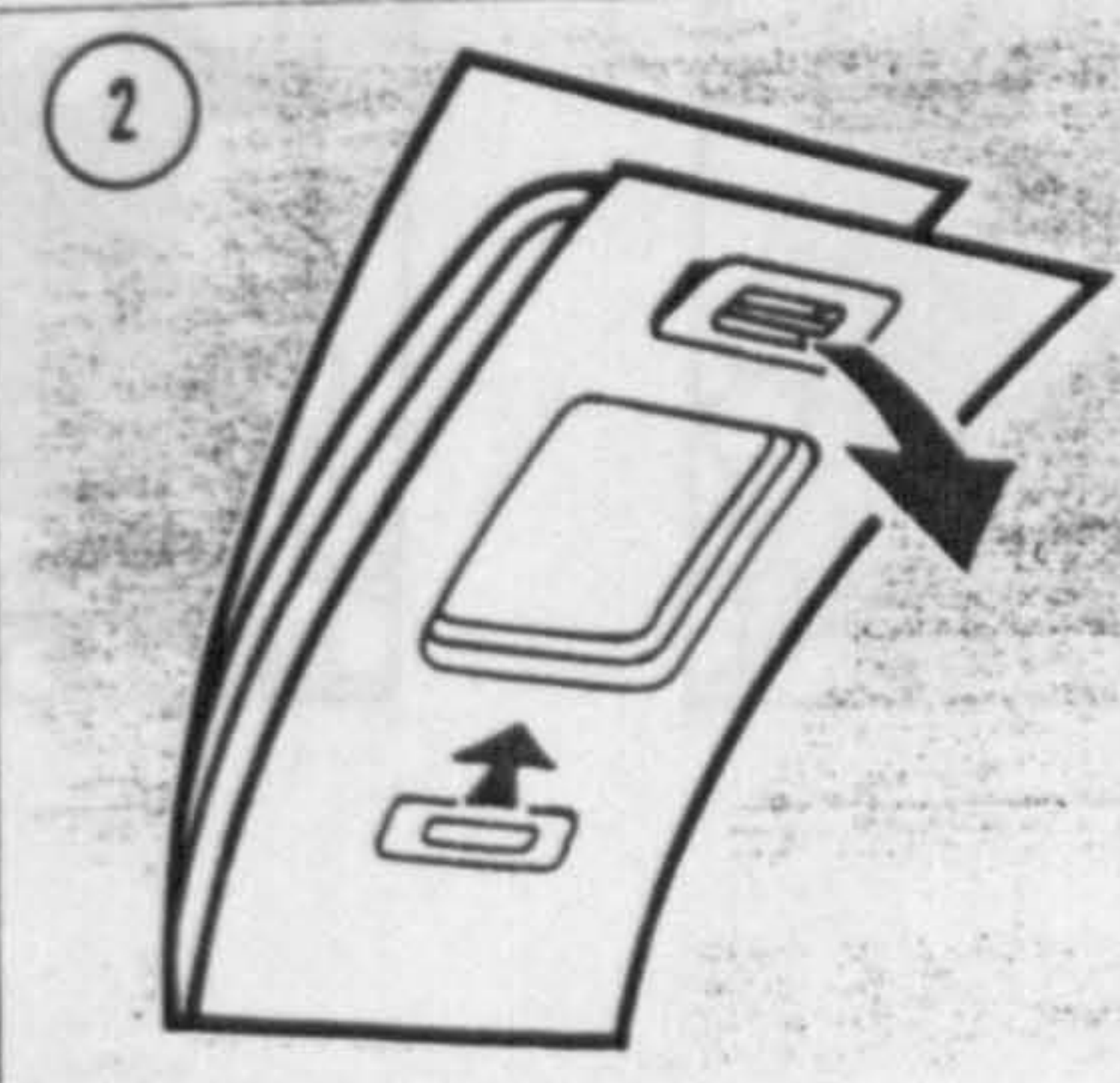
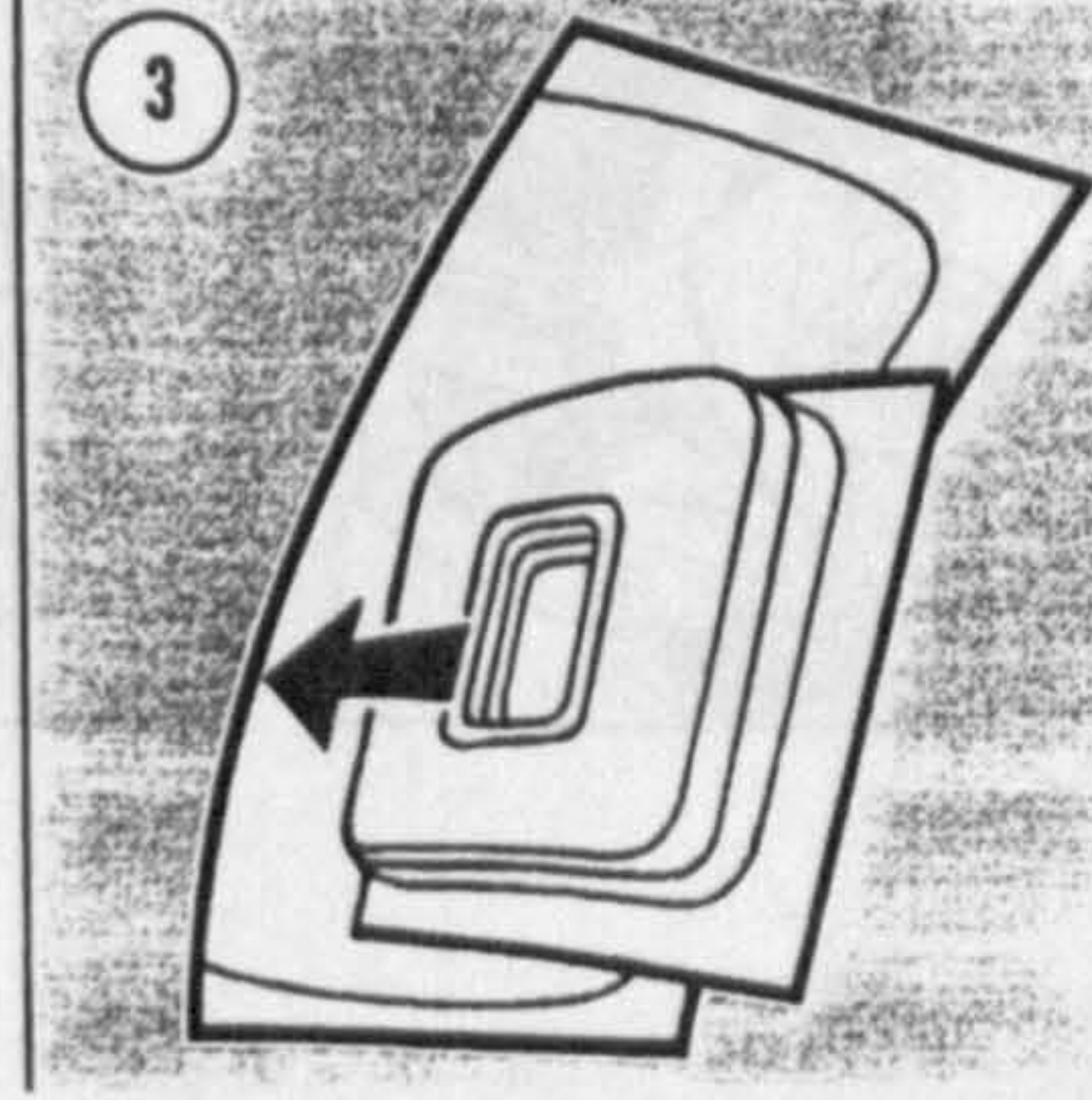


Remove high heel shoes
Enlevez les souliers à hauts talons
Schuhe mit hohem Absatz ausziehen
Togliere le scarpe contacco alto
Quítense los zapatos de tacón

ازعج الأحذية ذات الكعوب العالية
ازعج الأحذية ذات الكعوب العالية
除掉高跟鞋
除掉高跟鞋
Βγάλτε τα Ψιλοτάχουνα



EXIT B



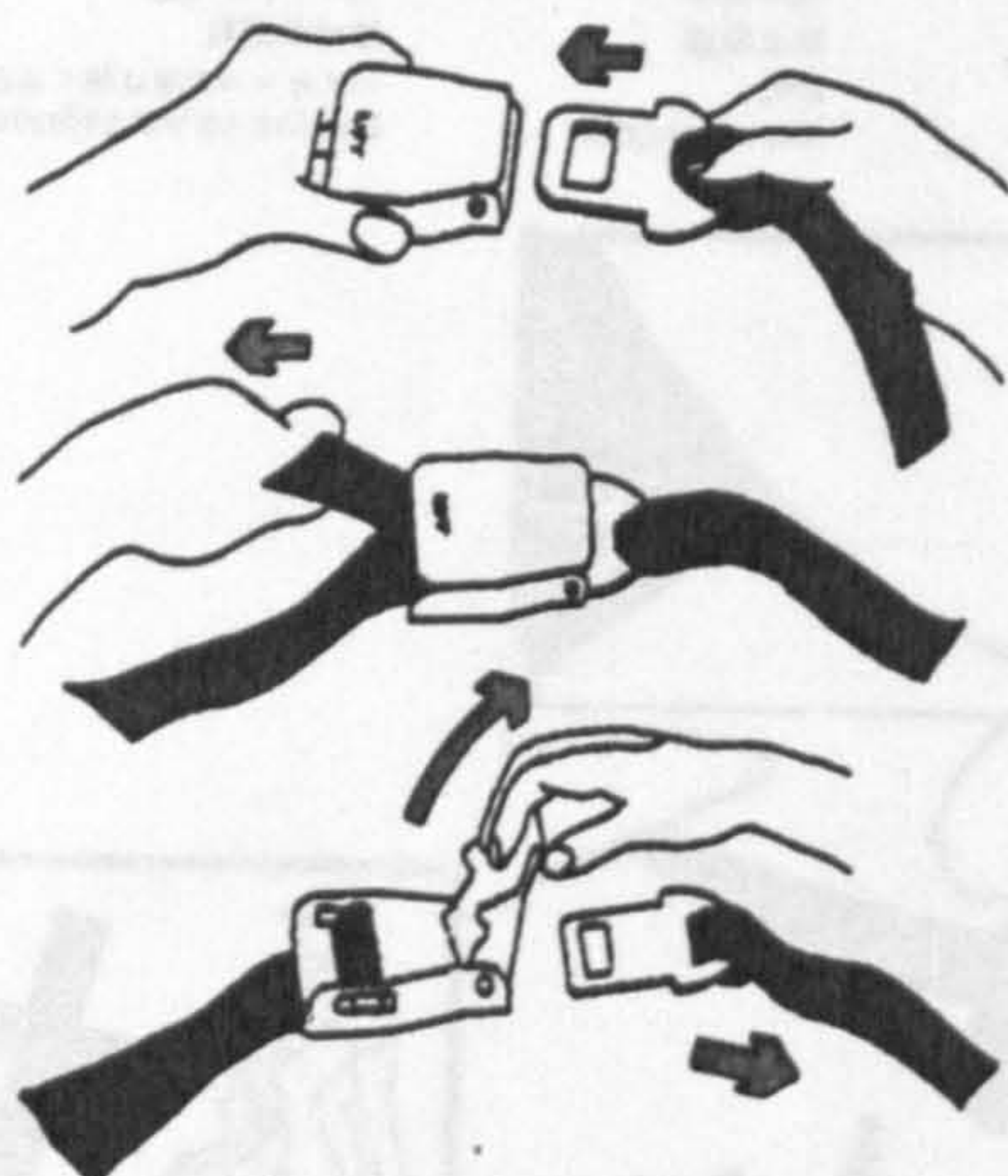
Boeing 737

ISSUE
2

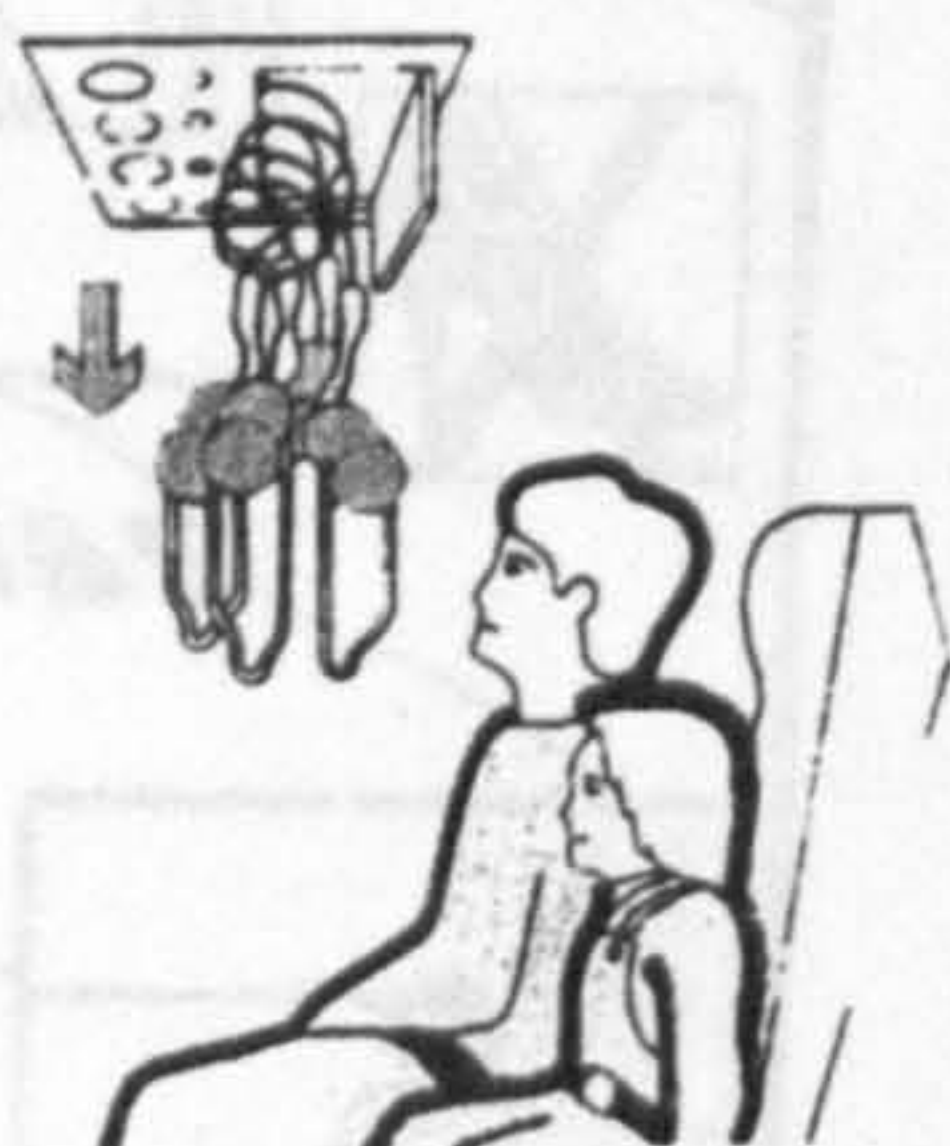
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PER LA VOSTRA SICUREZZA
PARA SU SEGURIDAD
PARA A SUA SEGURANÇA
على الطائرة لسلامتك

Please study and leave on the aircraft



OXYGEN



Cranfield

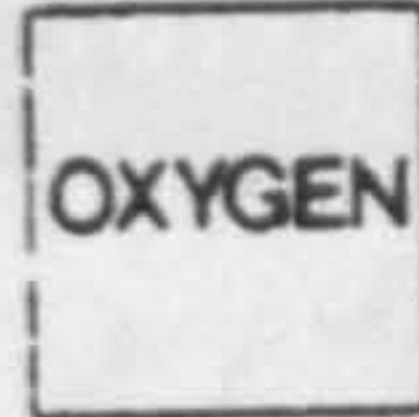
College of Aeronautics



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

على الطائرة لسلك

Please study and leave on the aircraft



Takeoff and landing
Décollage et atterrissage
Entstehung und Landung
Decollo e atterraggio
Despegue y aterrizaje

Emergency landing
Atterrissage forcé
Notlandung
Atterraggio forzato
Aterrizaje forzoso

Landing on water
Amerrissage
Wasserung
Ammaraggio
Amaraje

Emergency exit
Sortie de secours
Notausgang
Uscita di emergenza
Salida de urgencia

Oxygen
Oxygène
Sauerstoff
Ossigeno
Oxígeno

No smoking
Ne pas fumer
Nicht rauchen
Non fumare
No fumar

Remove high heel shoes
Enlevez les souliers à hauts talons
Schuhe mit hohem Absatz ausziehen
Togliere la scarpa contacco allo
Quitense los zapatos de tacón

الإقلاع
الهبوط
الهبوط على الماء
مخرج الطوارئ
أكسجين
عدم التدخين
إزالة الأحذية ذات الكعب العالي

الهبوط على الماء
الهبوط القسري
الهبوط القسري
الهبوط القسري
الهبوط القسري
الهبوط القسري
الهبوط القسري
الهبوط القسري

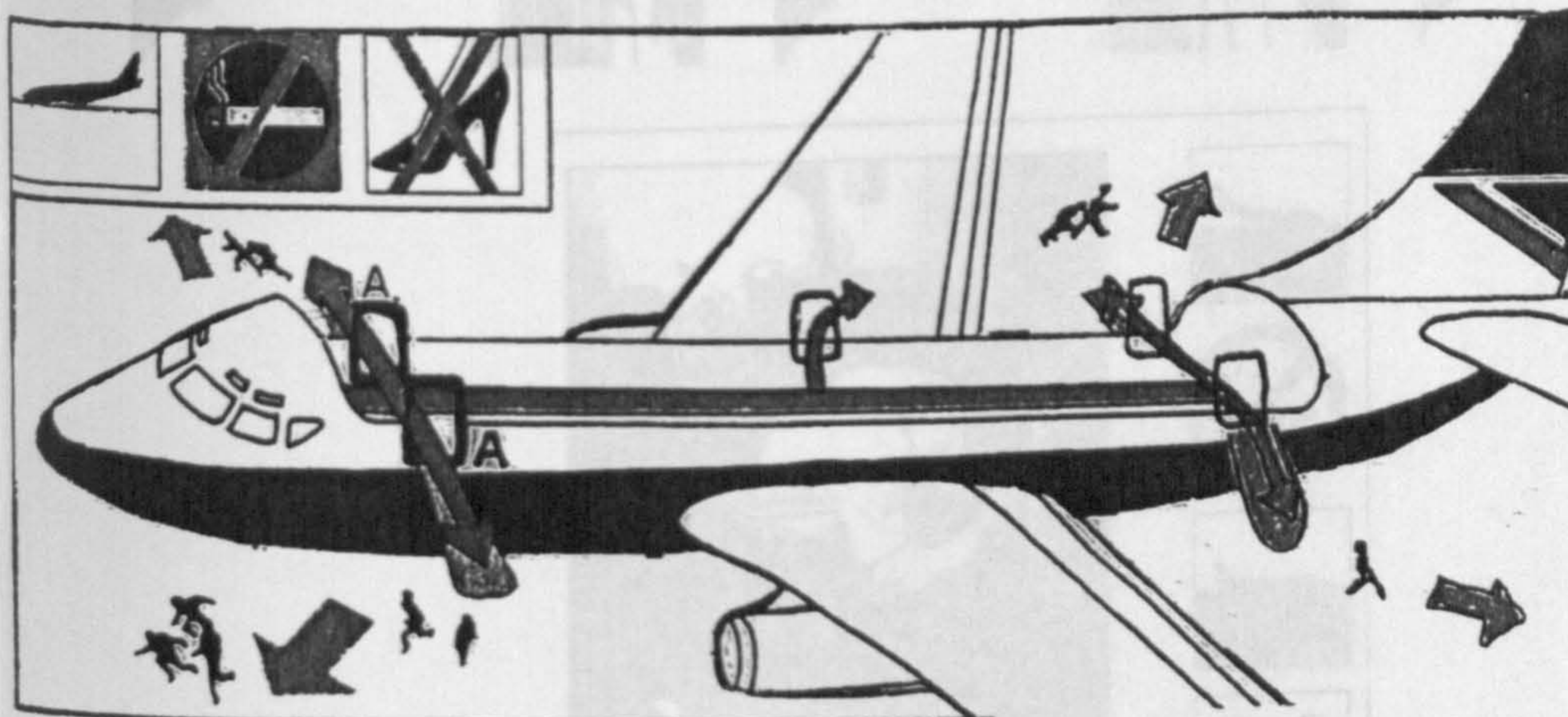
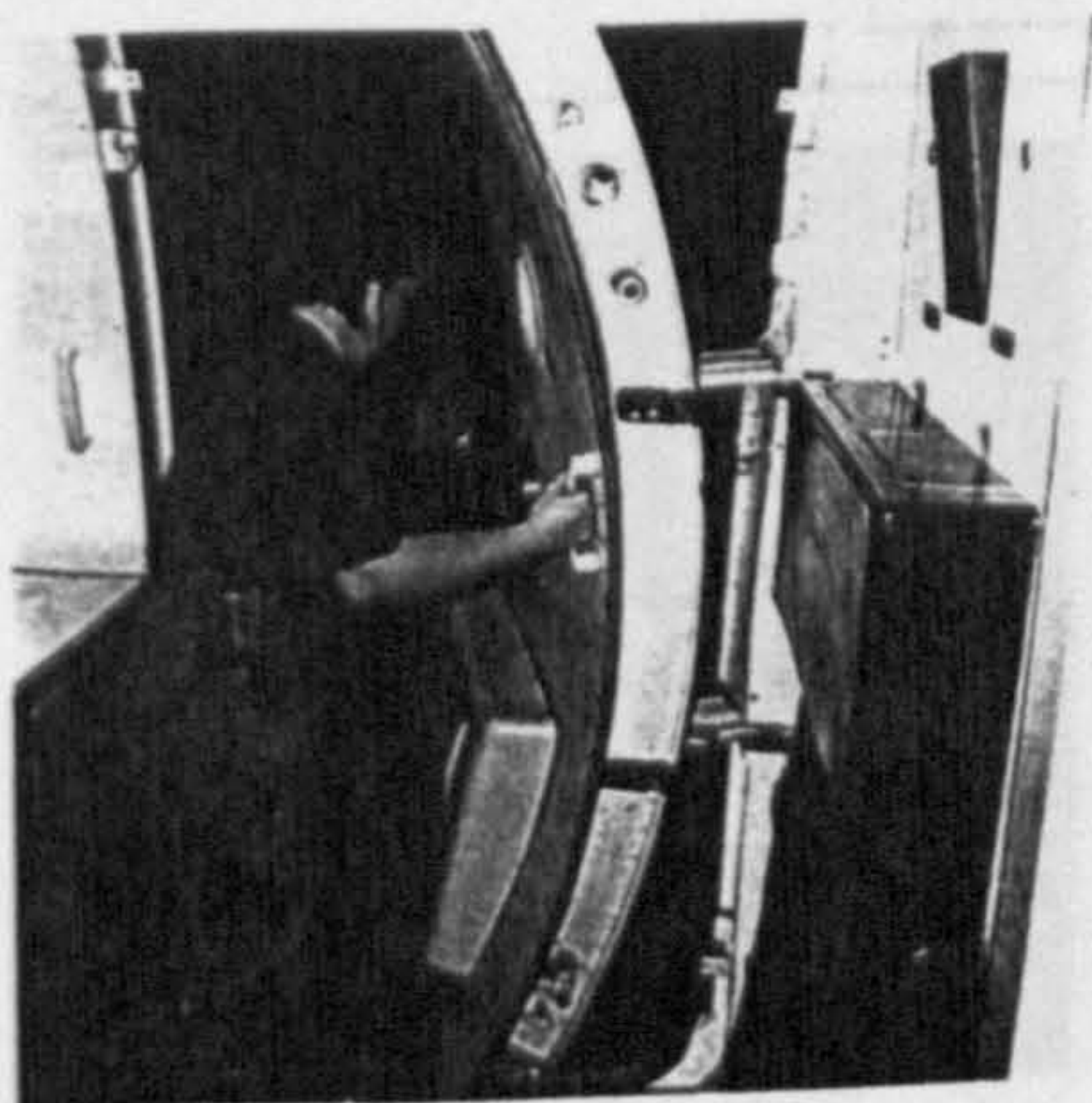
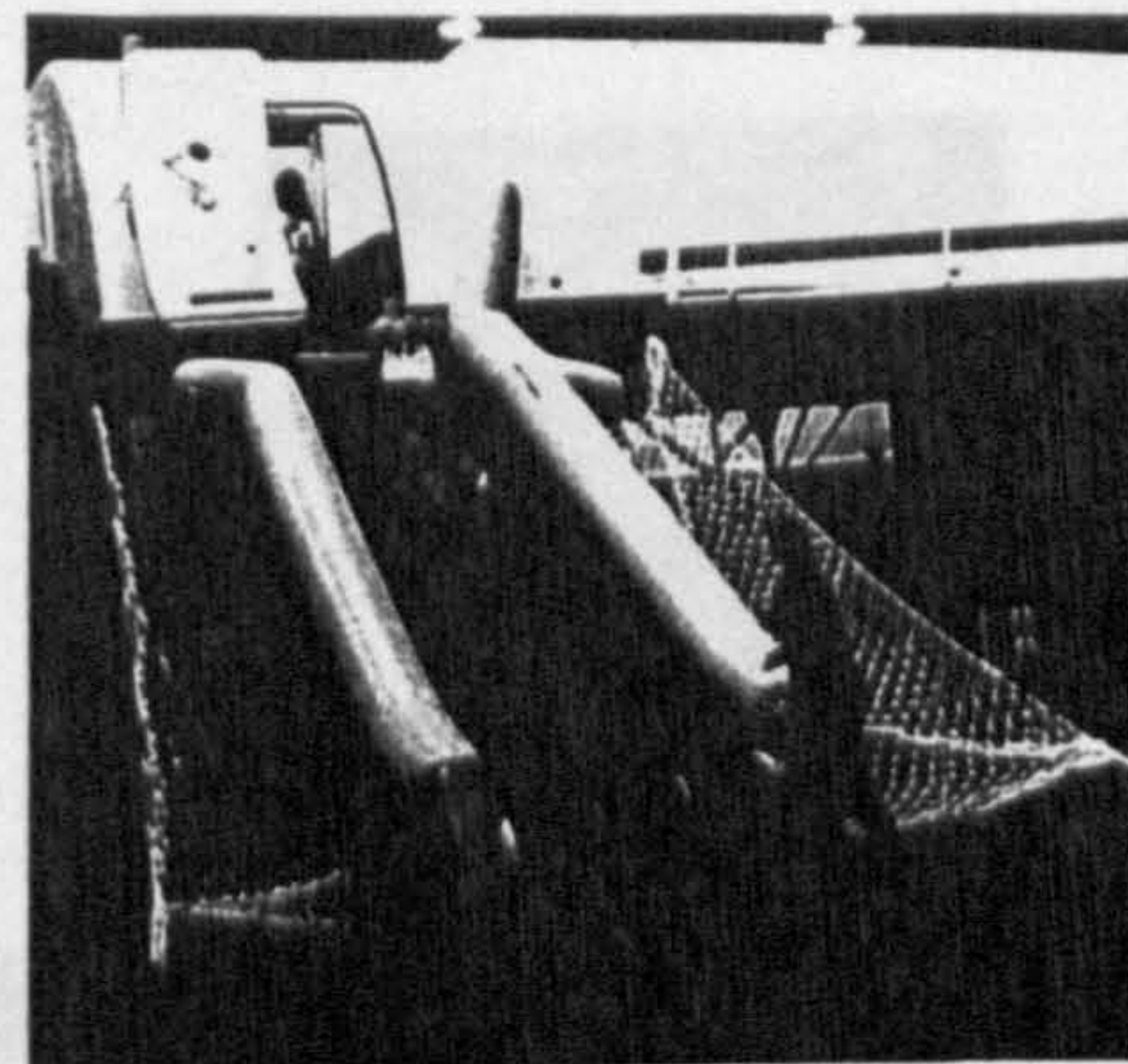
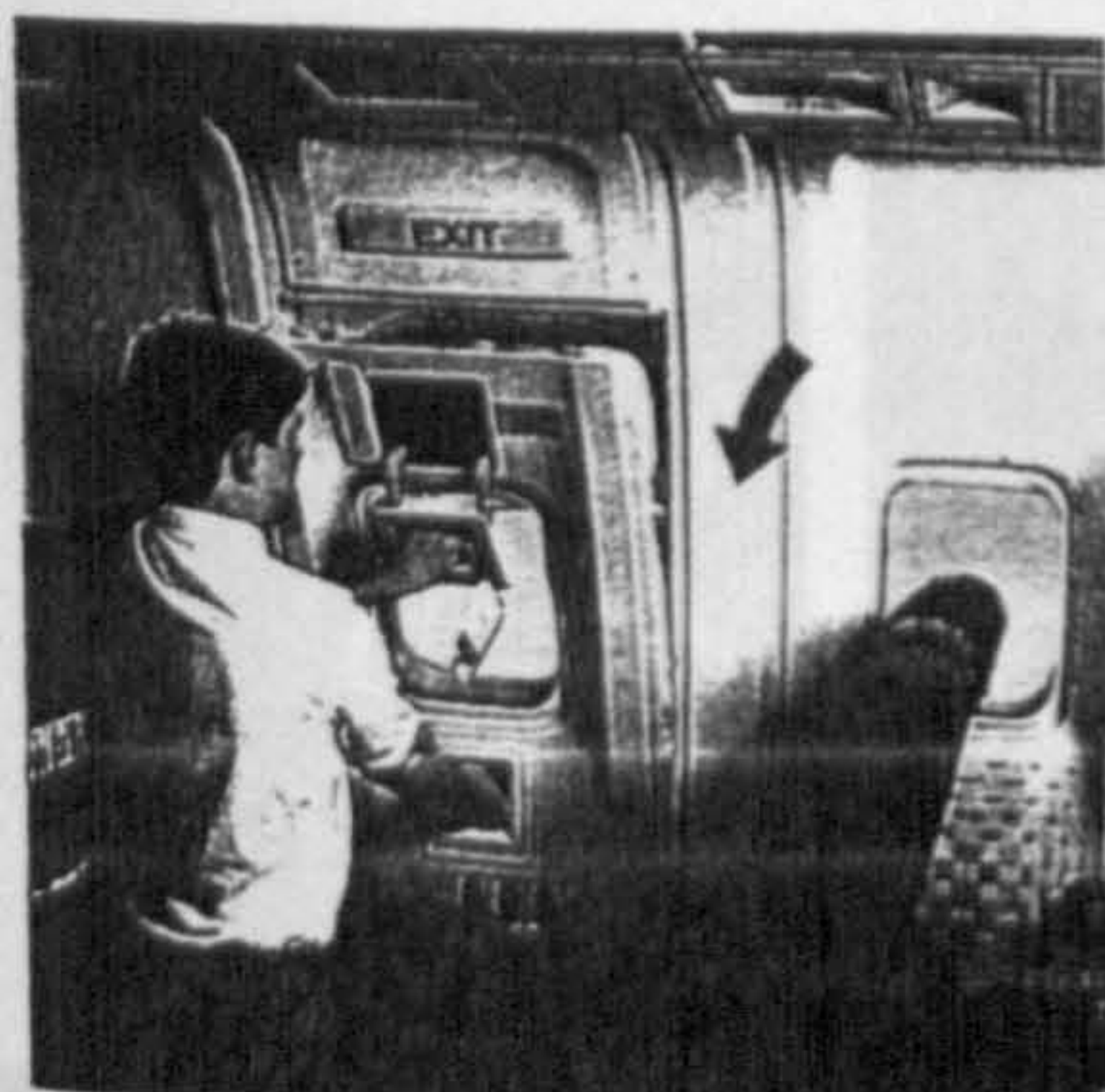
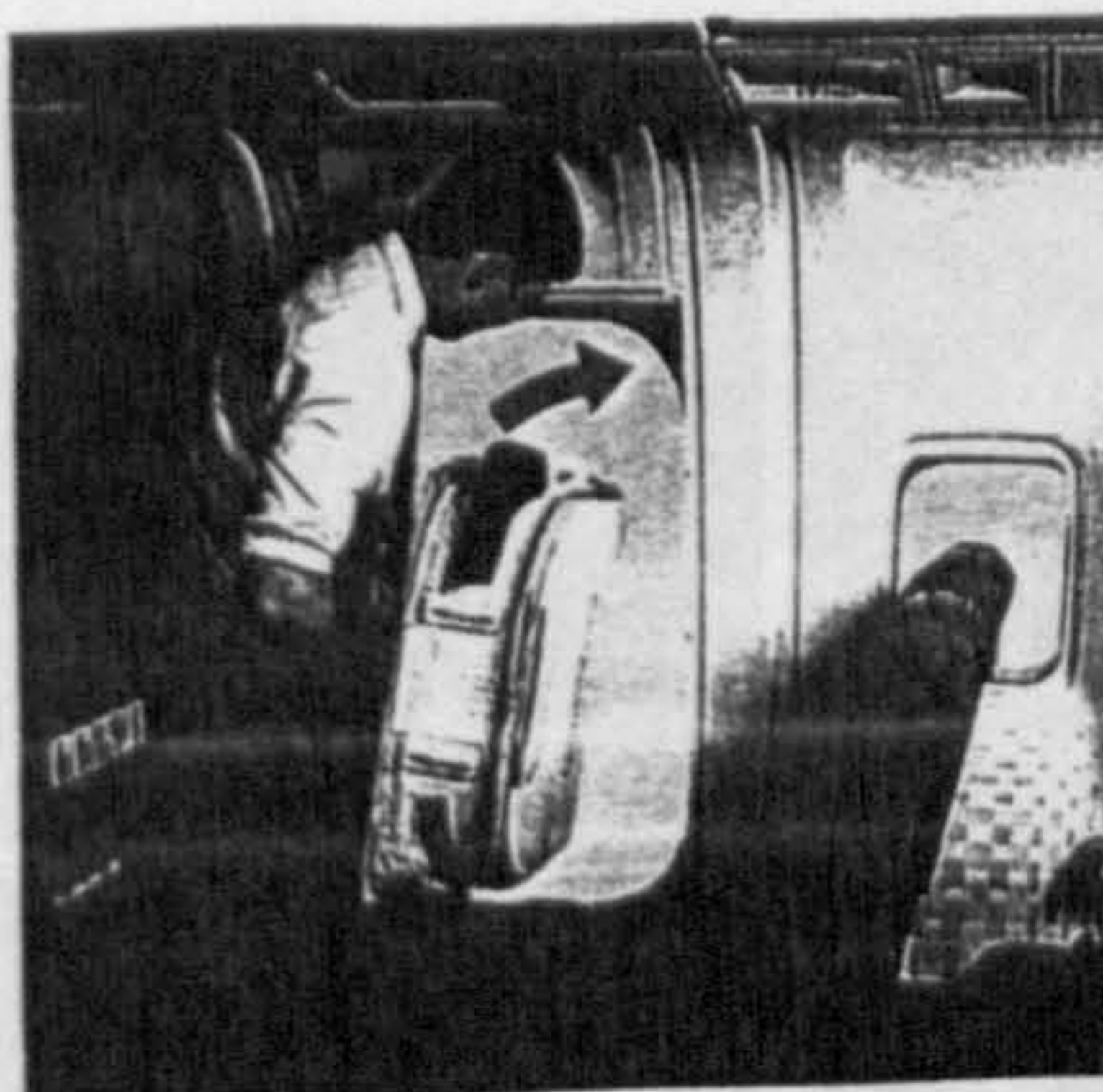
الهبوط على الماء
الهبوط القسري
الهبوط القسري
الهبوط القسري
الهبوط القسري
الهبوط القسري
الهبوط القسري
الهبوط القسري

الهبوط على الماء
الهبوط القسري
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الهبوط القسري

الأكسجين
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أكسجين

لا تدخن
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لا تدخن

إزالة الأحذية ذات الكعب العالي
إزالة الأحذية ذات الكعب العالي
إزالة الأحذية ذات الكعب العالي
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إزالة الأحذية ذات الكعب العالي
إزالة الأحذية ذات الكعب العالي



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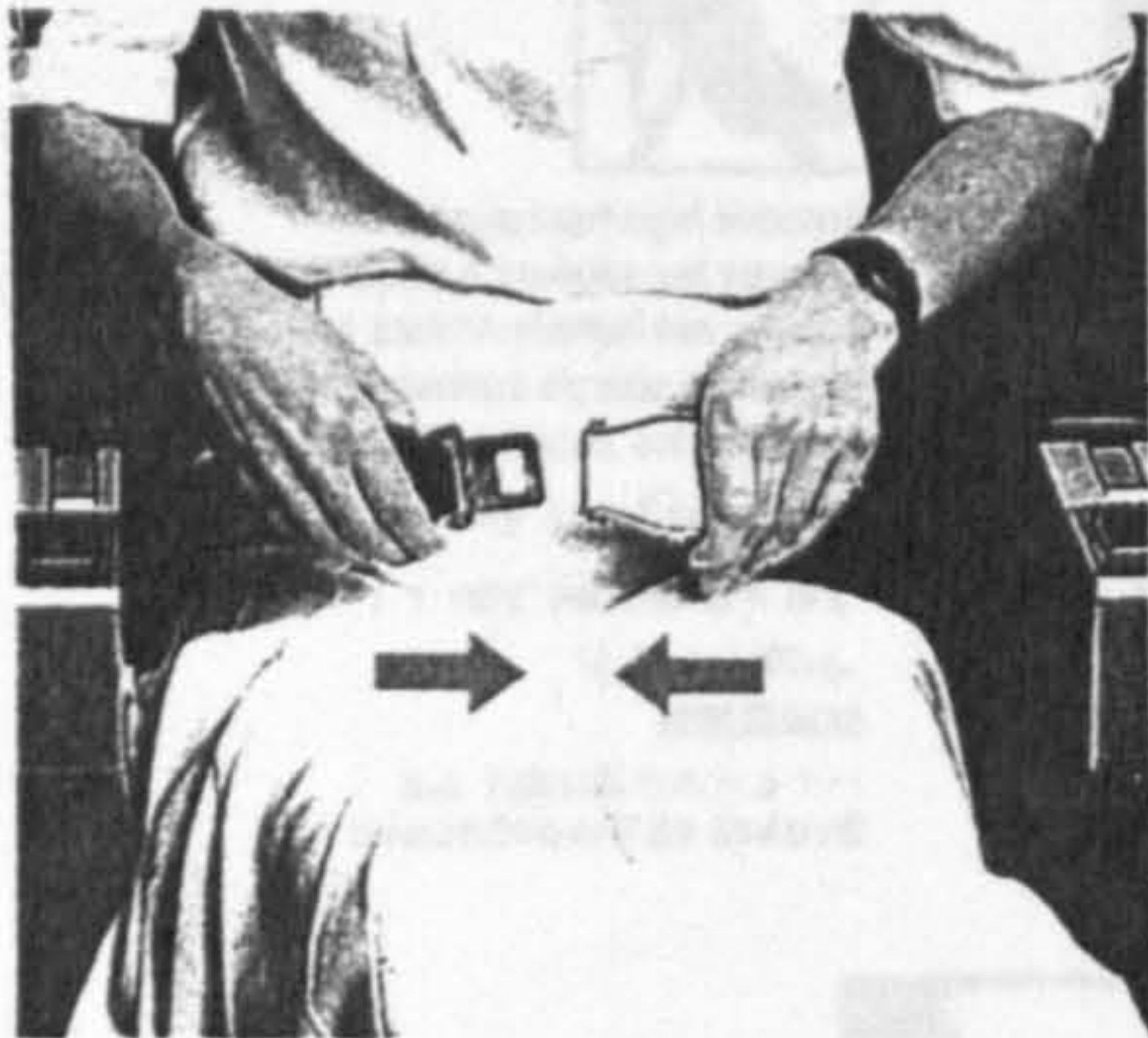
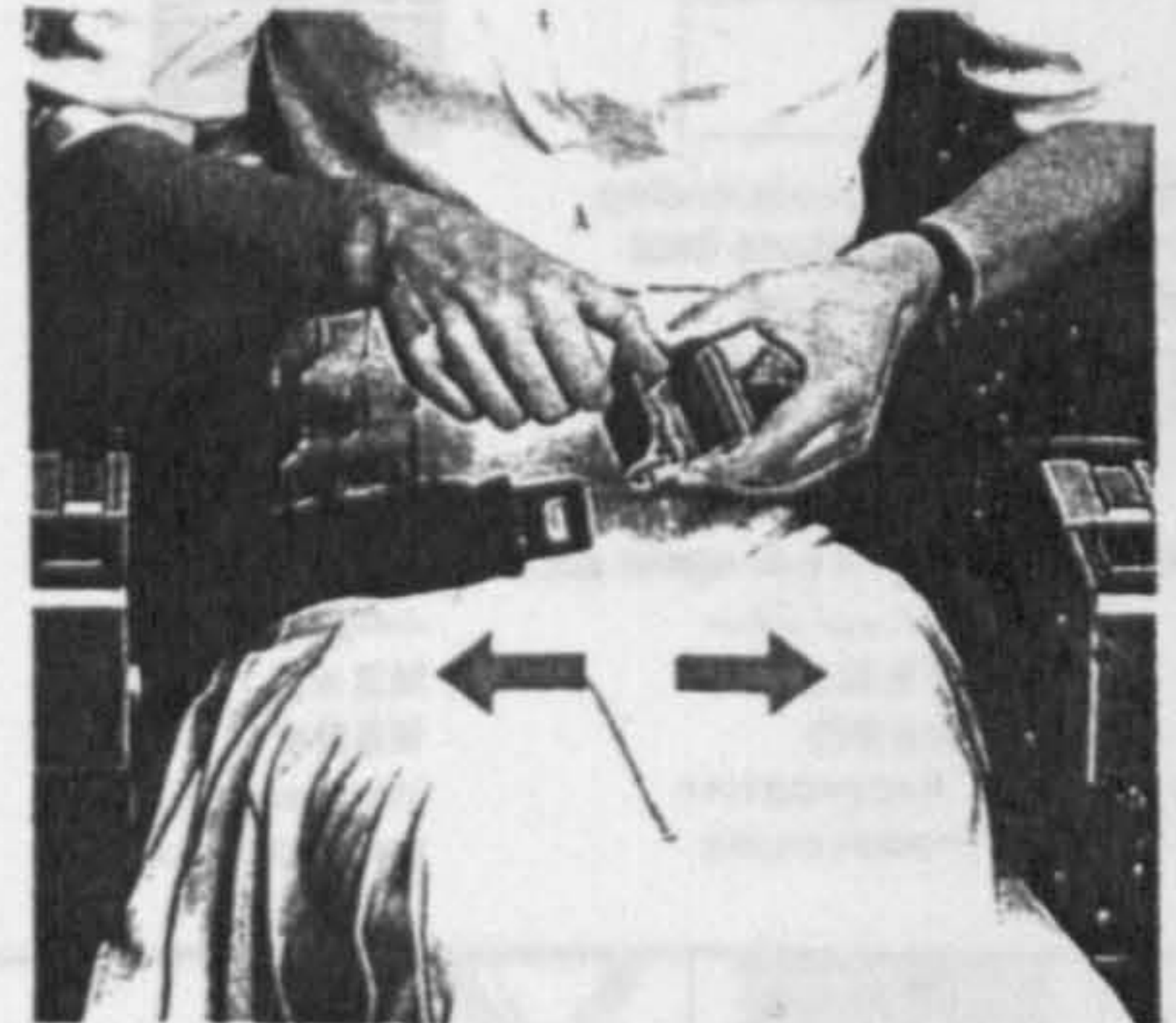
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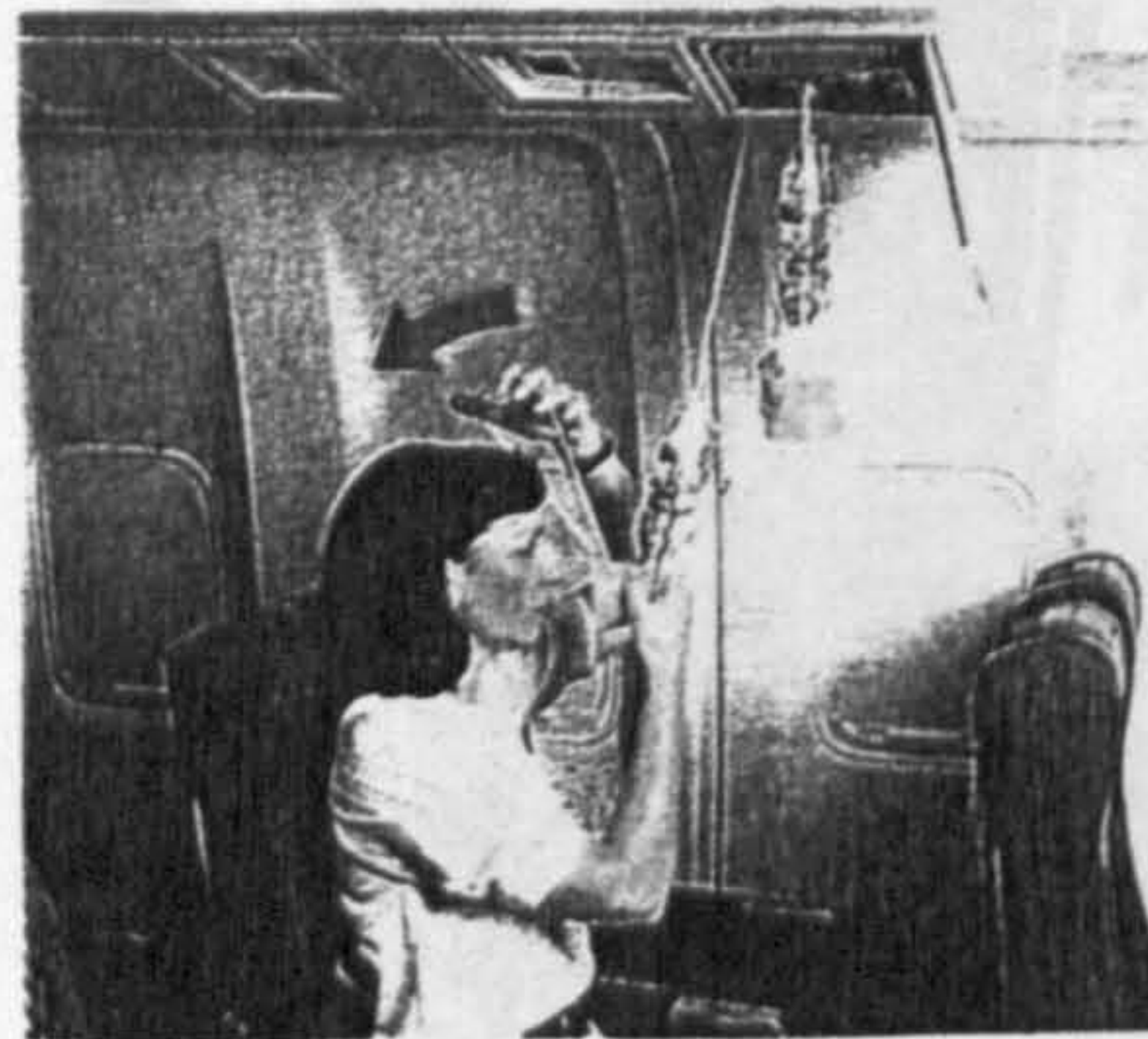
FOR YOUR SAFETY
POUR VOTRE SÉCURITÉ
FÜR IHRE SICHERHEIT
PER LA VOSTRA SICUREZZA
PARA SU SEGURIDAD
PARA A SUA SEGURANÇA

على الطائرة لسلامتک

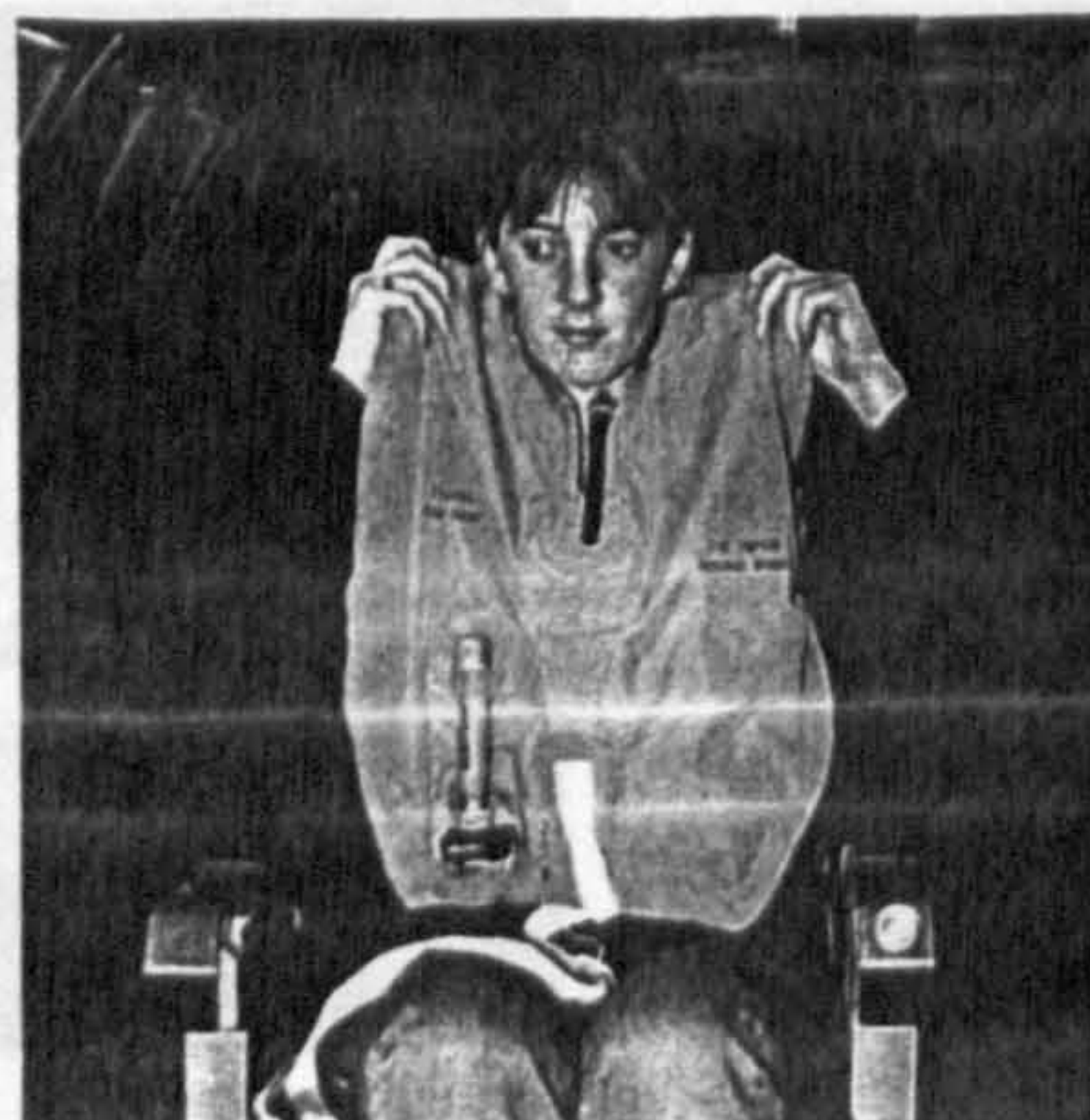
Please study and leave on the aircraft



Brace
Brace



OXYGEN



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

على الطائرة لسلامتک

Please study and leave on the aircraft



Takeoff and landing
Décollage et atterrissage
Start und Landung
Decollo e atterraggio
Despegue y aterrizaje
الإقلاع والهبوط

उड़ान का उठान और उतरान।
جهاز کا اڑنا اور اترنا۔
起飛和降落
離陸および着陸
Απογειωση και προσγειωση



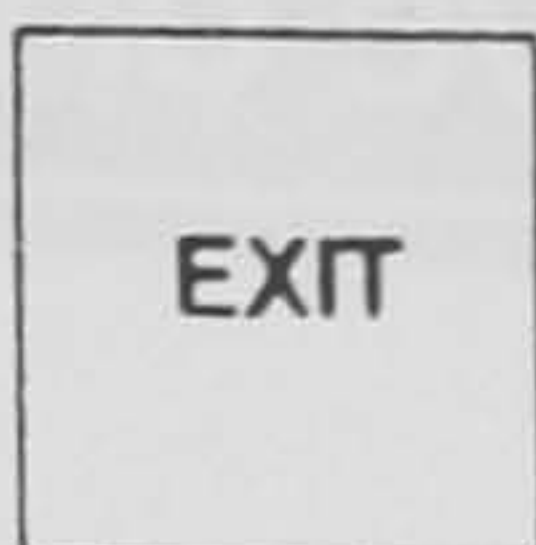
Emergency landing
Atterrissage forcé
Notlandung
Atterraggio forzato
Aterrizaje forzoso
اضبوط في حالة الطوارئ

دُشْتِنا کے سامنے جھڑنا کا اترنا۔
دشْتِنا کے سامنے جھڑنا کا اترنا۔
緊急降落
緊急着陸
Αναγκαστική προσγειωση



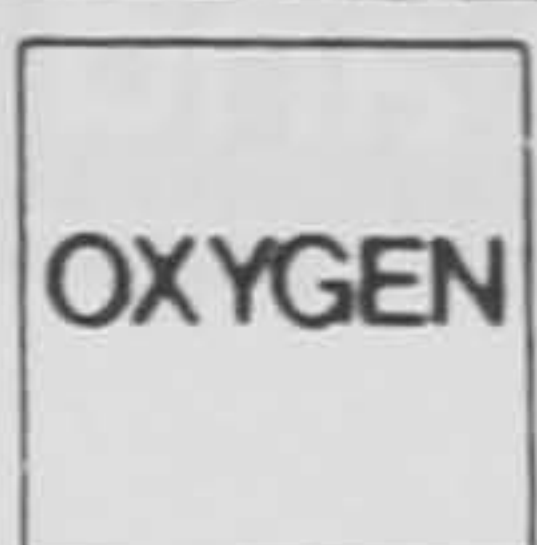
Landing on water
Amerrissage
Wasserung
Ammaraggio
Amaraje
اضبوط على الماء

پانی پر جھڑنا کا اترنا۔
پانی پر جھڑنا کا اترنا۔
降落水面
緊急落水
Αναγκαστική προσθαλάσσιση



Emergency exit
Sortie de secours
Notausgang
Uscita di emergenza
Salida de urgencia
خروج في حالة الطوارئ

دُشْتِنا کے سامنے باہر نکلنے کا راستہ۔
دُشْتِنا کے سامنے باہر نکلنے کا راستہ۔
大平門
非常口
Εξοδος κινδύνου



Oxygen
Oxygène
Sauerstoff
Ossigeno
Oxígeno
الأكسجين

آکسیجن
شیر
酸素
酸素
Οξυγόνο



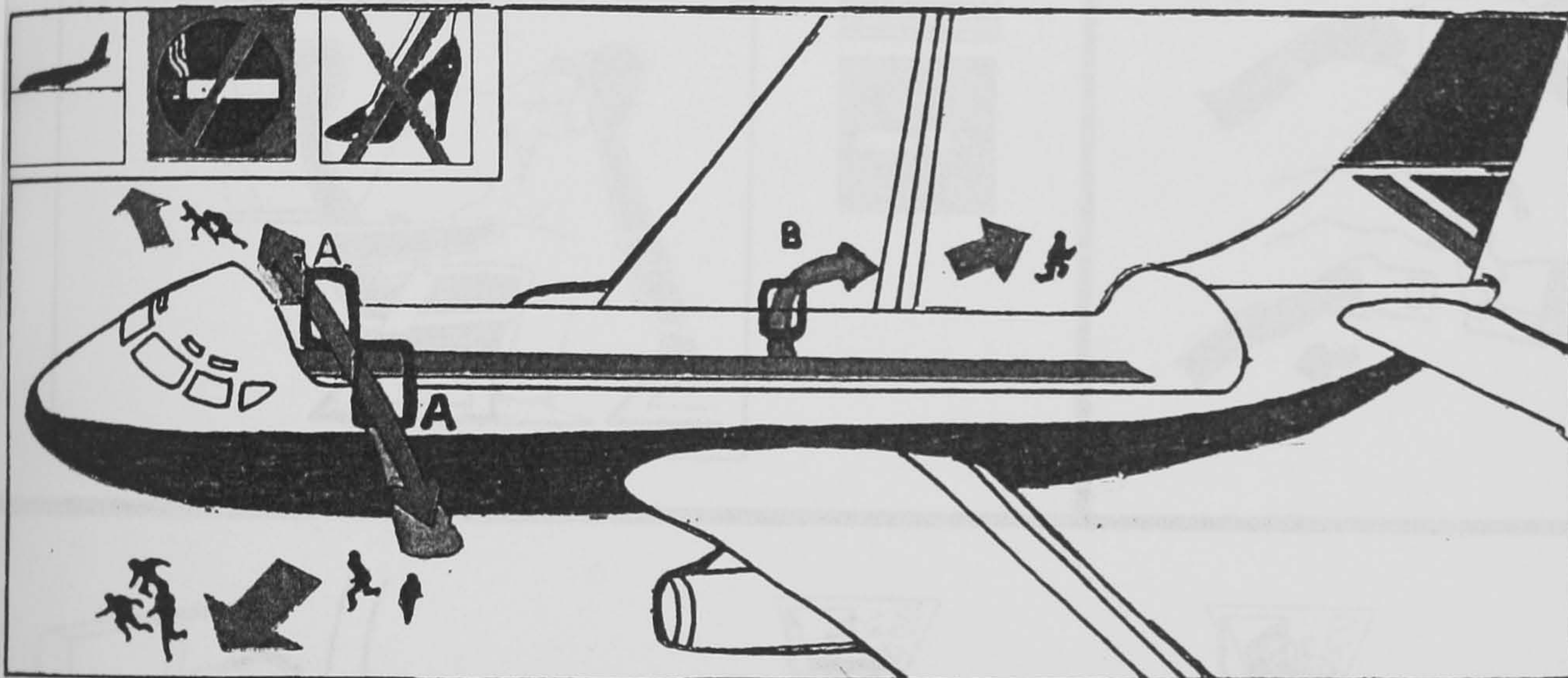
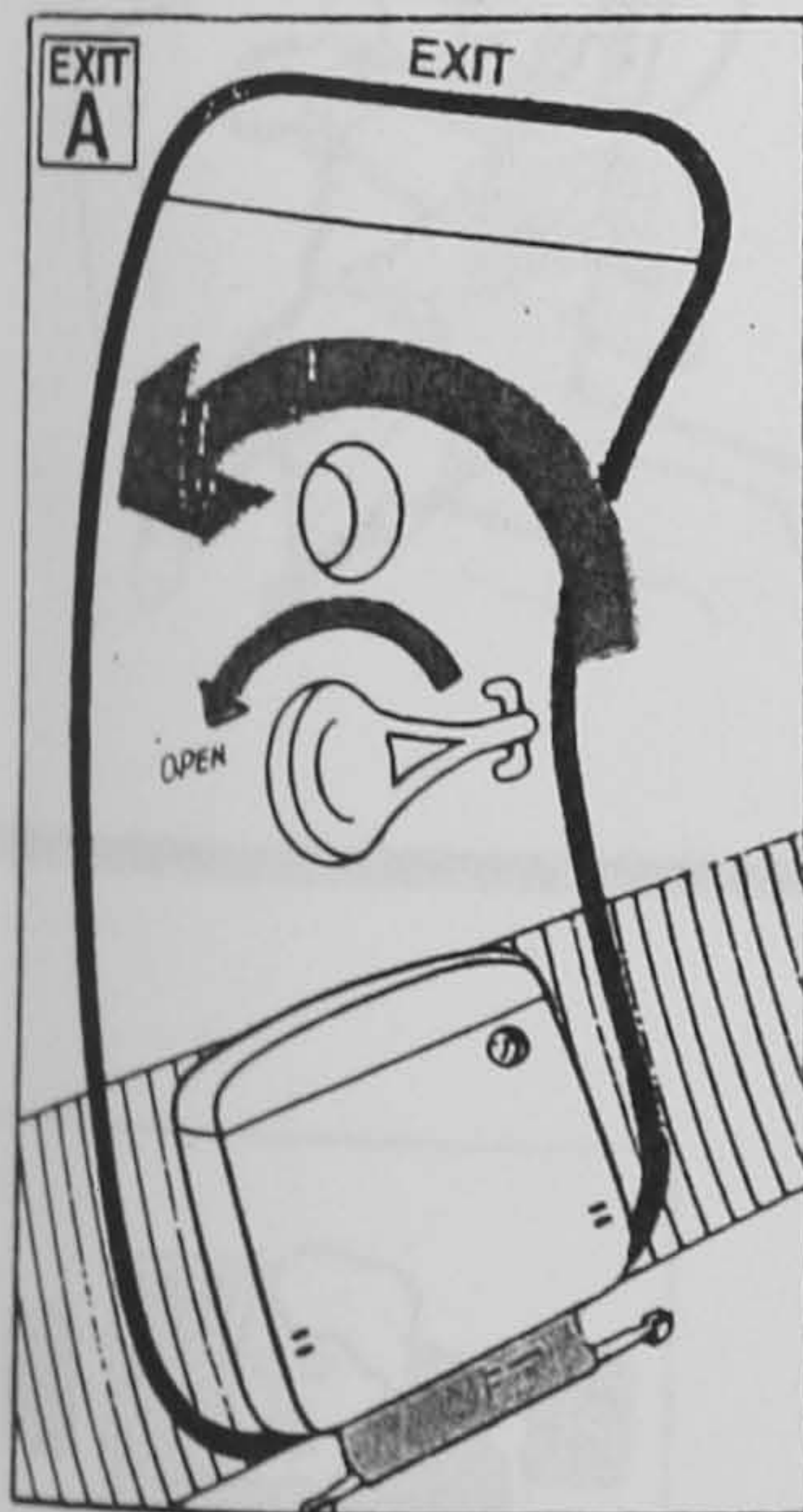
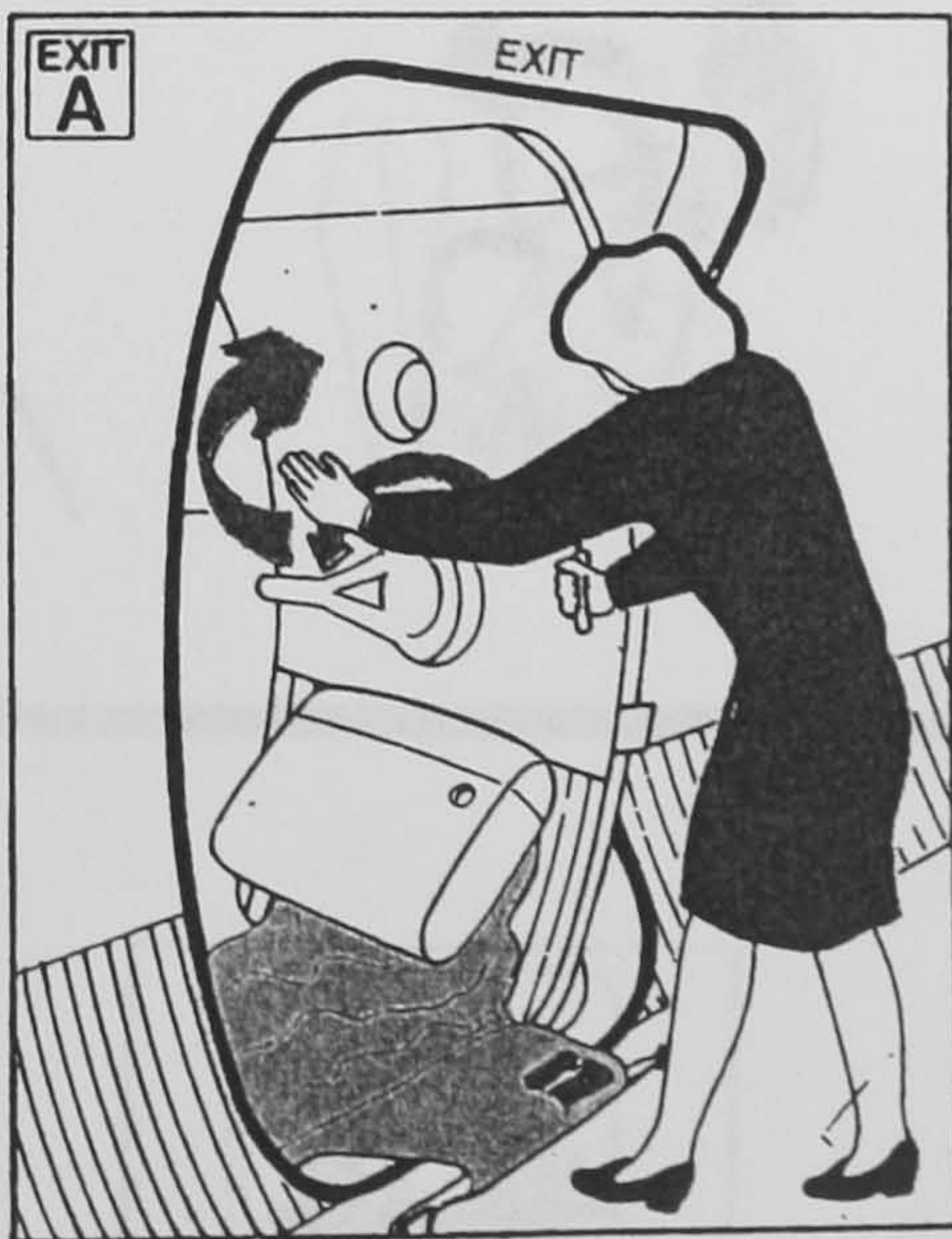
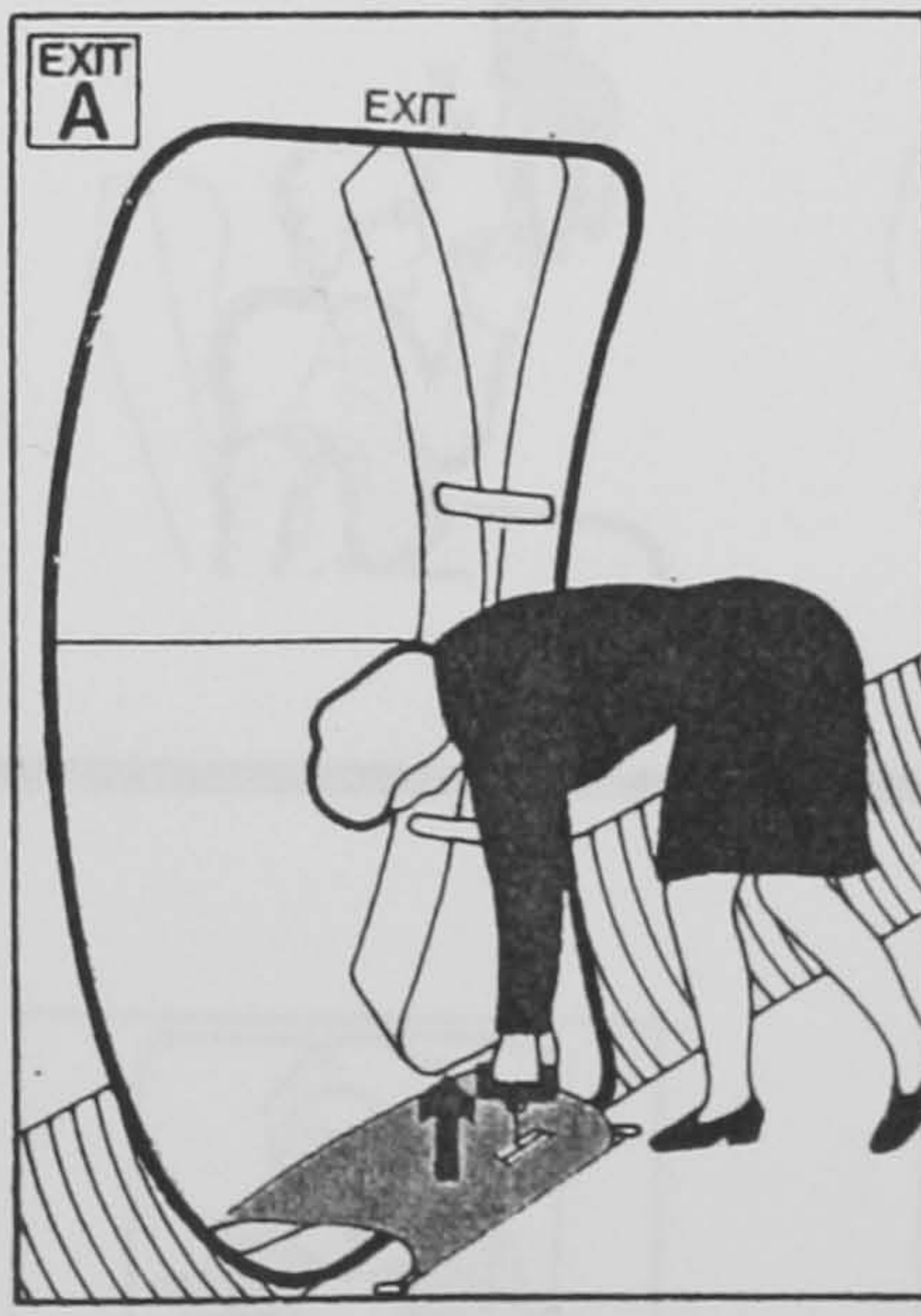
No smoking
Ne pas fumer
Nicht rauchen
Non fumare
No fumar
ممنوع التدخين

سیڑھ اُتار کر نہ دیکھو۔
سیڑھ اُتار کر نہ دیکھو۔
禁止吸烟
禁煙
Μη καπνίζετε



Remove high heel shoes
Enlevez les souliers à hauts talons
Schuhe mit hohem Absatz ausziehen
Togliere le scarpe contacco alto
Quitense los zapatos de tacón
ازعجی الاحذیة ذات الكعوب العالية

کچی مڈی جوتے نہ اُتارو۔
کچی مڈی جوتے نہ اُتارو۔
除掉高跟鞋
ハイヒールの靴は脱くこと
Βγάλτε τα Ψιλοτάχουνα



Hold operating handles firmly

Pull

ou

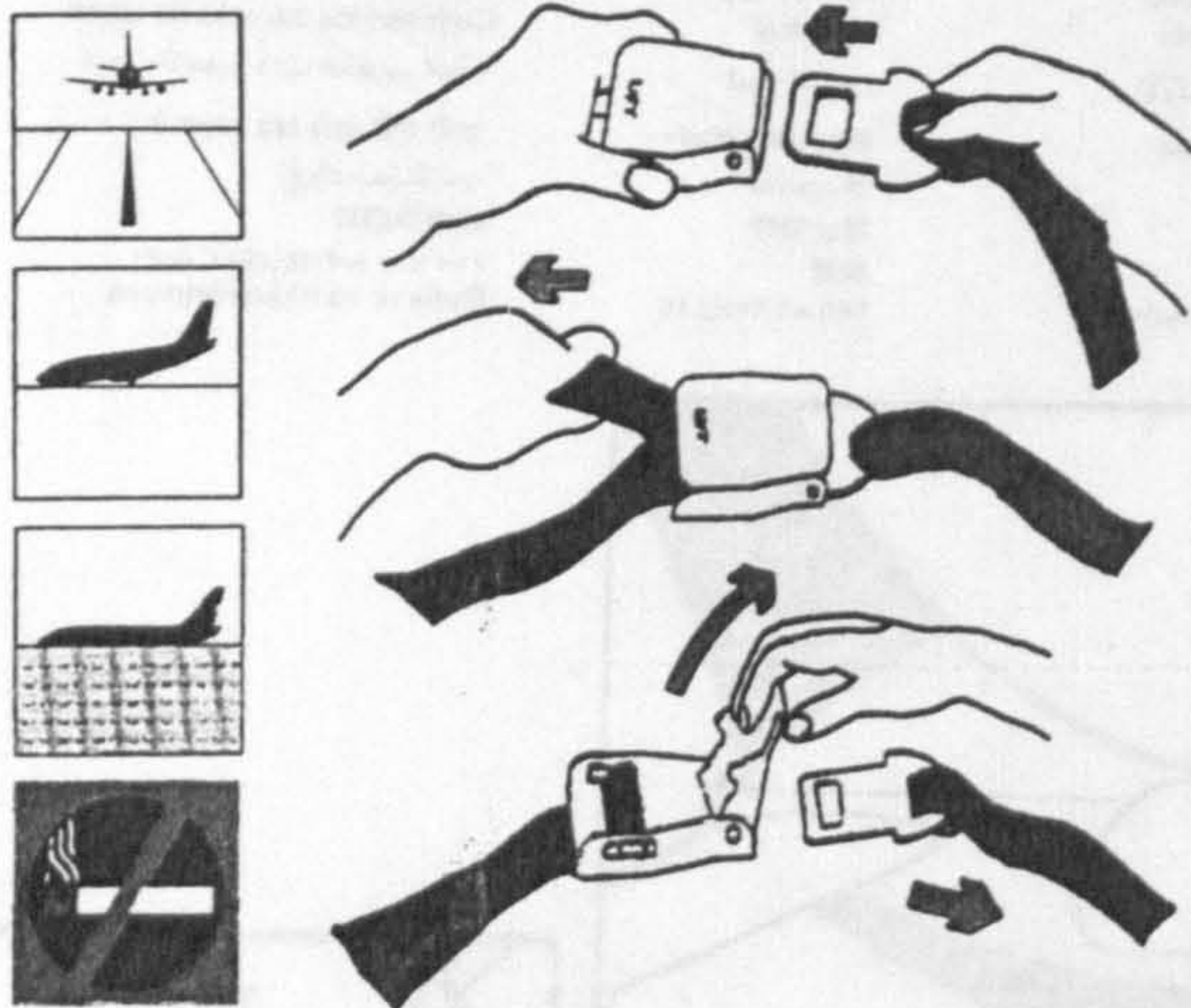
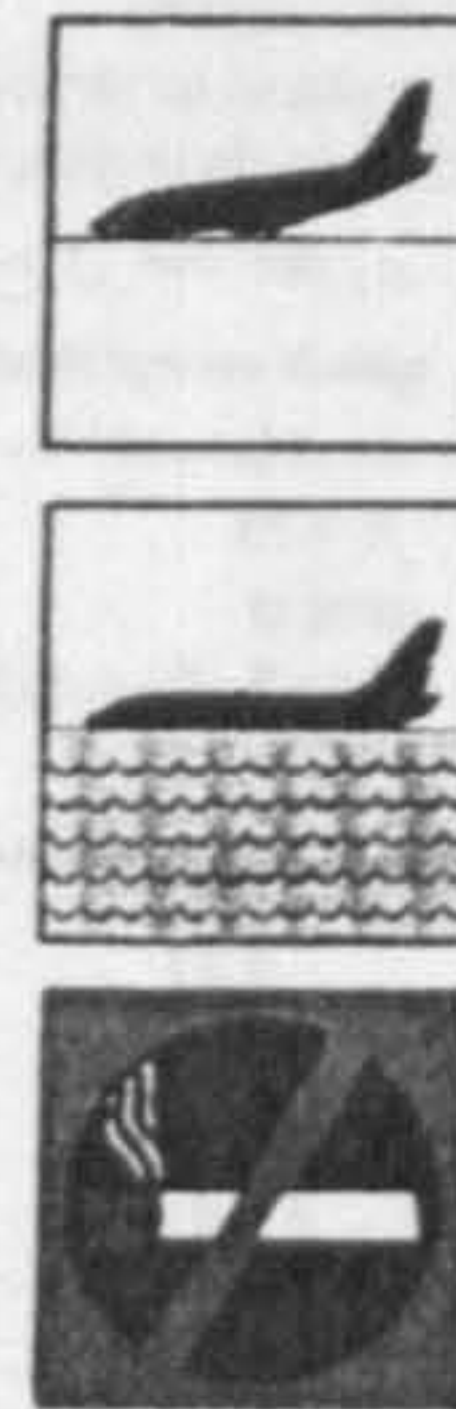
Turn the exit on its side
Place exit through exit aperture
out onto the wing

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

على الطائرة لسلامتكم

Please study and leave on the aircraft



OXYGEN



Life jacket under seat



Place over head



Tie around waist
under jacket



Exit **first**, then inflate

Appendix K Verbal exit briefing

Verbal instructions

To operate the exit you must grip the operating handles firmly.

Pull down the red handle.

Lift the exit in towards you.

Turn the exit on its side and throw it out on to the wing.

Appendix L Experiment two Video briefing

Video Briefing

The monitors screen dimensions were $11\frac{1}{2}$ X 9 inches (29cm X 23cm). The screen was on top of the seat back in front of the exit approximately 39 inches (100cm) from the participants eyes.



The video showed a male passenger seated adjacent to the Type III exit. The passenger remained seated while operating the exit. The description below was heard simultaneously as the passenger performed the actions.

“Instructions for the operation of the Type III exit. Hold the operating handles firmly, pull the upper handle down, lift the exit inwards towards you, turn it on its side and place it out onto the wing”

Appendix M Experiment two Questionnaire

**Cranfield University
Human Factors Group**

Questionnaire

Volunteer Number

Please complete the relevant sections of the questionnaire and return it to the researcher

☒ Tick as applicable

1. Did you pay close attention to the pre flight safety briefing given by the cabin crew member?

Yes ☐

No ☐ → go to Q.2

If yes, did this aid your escape?

Yes ☐

No ☐

If yes, how did it aid your escape? _____

If no, why didn't it aid your escape? _____

If you did not receive an additional safety briefing please go to question 3

2. Did you pay close attention to the additional safety briefing given by the cabin crew member, indicating that you were seated next to the overwing exit and might therefore be required to operate it in an emergency situation?

Yes ☐

No ☐ → go to Q.3

If yes, did this aid your escape?

Yes ☐

No ☐

If yes, how did it aid your escape? _____

If no, why didn't it aid your escape? _____

3. Did you study the safety card in detail?

Yes ☐
No ☐ → go to Q.4

If yes, did this aid your escape?

Yes ☐
No ☐

If yes, how did it aid your escape? _____

If no, why didn't it aid your escape? _____

4. Did you study the diagrams on the safety card/placard showing the method of operating the overwing exit in detail?

Yes ☐
No ☐ → go to Q.5

If yes, did this aid your escape?

Yes ☐
No ☐

If yes, how did it aid your escape? _____

If no, why didn't it aid your escape? _____

5. If you have any suggestions of ways in which the safety briefing or card/placard could be improved, such that they increase your likelihood of escape in an emergency situation please write them in the space below:

If you did not receive verbal operating instructions for the Type III exit please go to question 7.

6. Did you listen carefully to the cabin crew’s verbal description of how to open and dispose of the Type III exit?

Yes ☐
No ☐ → go to Q.7

If yes, did this aid your operation of the Type III exit?

Yes ☐
No ☐

If yes, how did it aid you in the operation of the Type III exit?

If no, why didn’t it aid you in the operation of the Type III exit?

If you did not watch a video showing the operation of the Type III exit please go to question 8.

7. Did you watch the video demonstration of the operation of the Type III exit?

Yes ☐
No ☐ → go to Q.8

If yes, did this aid your operation of the Type III exit?

Yes ☐
No ☐

If yes, how did it aid you in the operation of the Type III exit?

If no, why didn't it aid you in the operation of the Type III exit? _____

8. Please indicate which form of safety information provided you with the most help in operating the Type III exit?

- ☐ Pre flight safety briefing
- ☐ Additional Safety briefing
- ☐ Safety card
- ☐ Verbal operating instructions from the cabin crew
- ☐ Video demonstration

Why was this the most helpful? _____

9. Is there any further information which would have been useful to you prior to operating the Type III exit? _____

10. In opening the exit, please rate how easy or difficult you found the following by circling the appropriate number on the scale below:

	Very Easy	Very Difficult
The location of the exit in relation to your seat	1-----2-----3-----4-----5-----6-----7	
Finding the exit's operating handle	1-----2-----3-----4-----5-----6-----7	
The clarity of exit operating instructions (exit diagram)	1-----2-----3-----4-----5-----6-----7	
Using the exit's operating handle	1-----2-----3-----4-----5-----6-----7	
Opening the exit	1-----2-----3-----4-----5-----6-----7	
Disposing of the exit	1-----2-----3-----4-----5-----6-----7	
The weight of the exit	1-----2-----3-----4-----5-----6-----7	
The size of the exit	1-----2-----3-----4-----5-----6-----7	

Clarity of instructions for disposing of the door (exit diagram) 1-----2-----3-----4-----5-----6-----7

Exiting through the exit onto the wing 1-----2-----3-----4-----5-----6-----7

11. Please describe in detail anything about the overwing exit that caused you difficulty.

12. Did you operate the overwing exit from a seated or standing position?

Seated ☐
Standing ☐

For what reason did you operate the exit from this position?

13. Did you find the exit to be:

HEAVIER
LIGHTER
THE SAME AS EXPECTED

14. Did you find that it took you:

LONGER
ABOUT THE SAME
LESS TIME

than you expected in opening the exit
and evacuating

15. Please rate your level of agreement with the following statements on the 7 point scale.

	Strongly disagree	Strongly agree
If I was unfortunate to be involved in an aircraft accident my chances of survival would be minimal.	1-----2-----3-----4-----5-----6-----7	
Pre flight briefings provide essential safety information.	1-----2-----3-----4-----5-----6-----7	
Passengers do not need to watch the pre flight safety briefings every time they fly.	1-----2-----3-----4-----5-----6-----7	
Passengers should read the safety cards carefully.	1-----2-----3-----4-----5-----6-----7	

16. How many times have you flown as an airline passenger before? (counting a return flight journey as one flight)

- Never ☐
- 1-5 ☐
- 6-10 ☐
- 11-15 ☐
- 16-20 ☐
- 21-25 ☐
- 26-30 ☐
- 31+ ☐

17. How long ago was your last flight? _____

18. Have you ever experienced an aircraft emergency situation?

- Yes ☐
- No ☐ → go to Q.19

If yes, what kind of emergency situation was it and what happened?

19. How often do you carry out strenuous physical exercise?

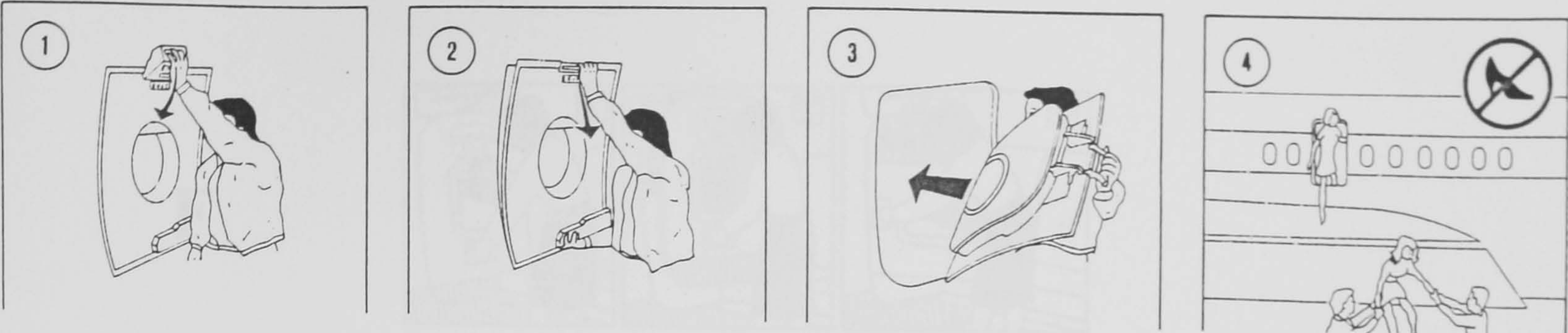
- Once a day ☐
- 3+ times a week ☐
- 1-2 times a week ☐
- 1-2 times a month ☐
- less than 1-2 times a month ☐

20. If there are any further points you would like to make please use the space provided below:

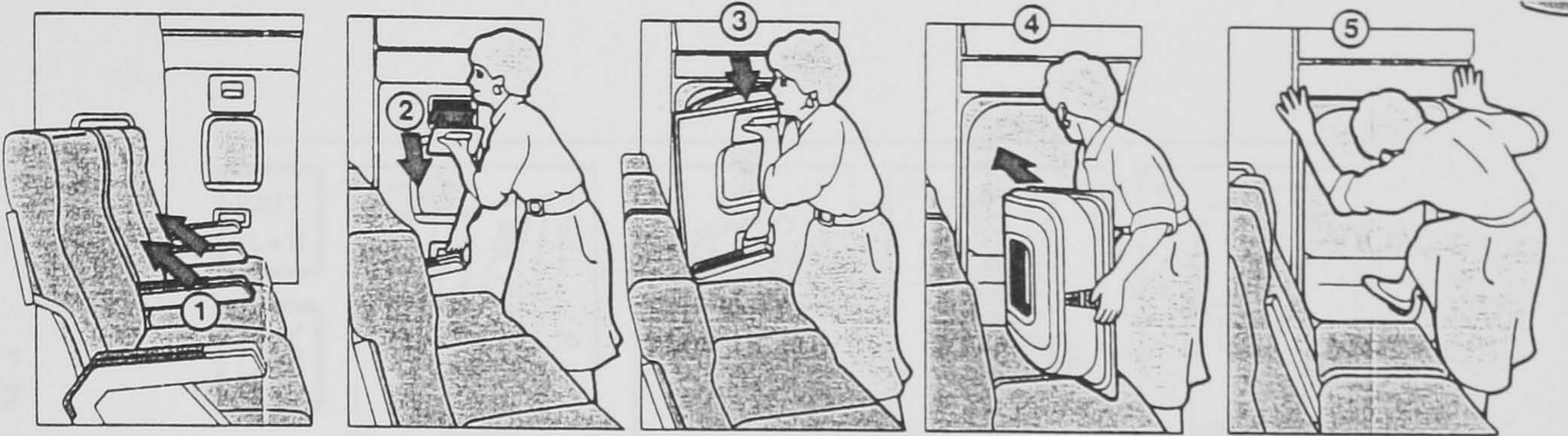
THANK-YOU

Appendix N Type III exit briefing instruction options

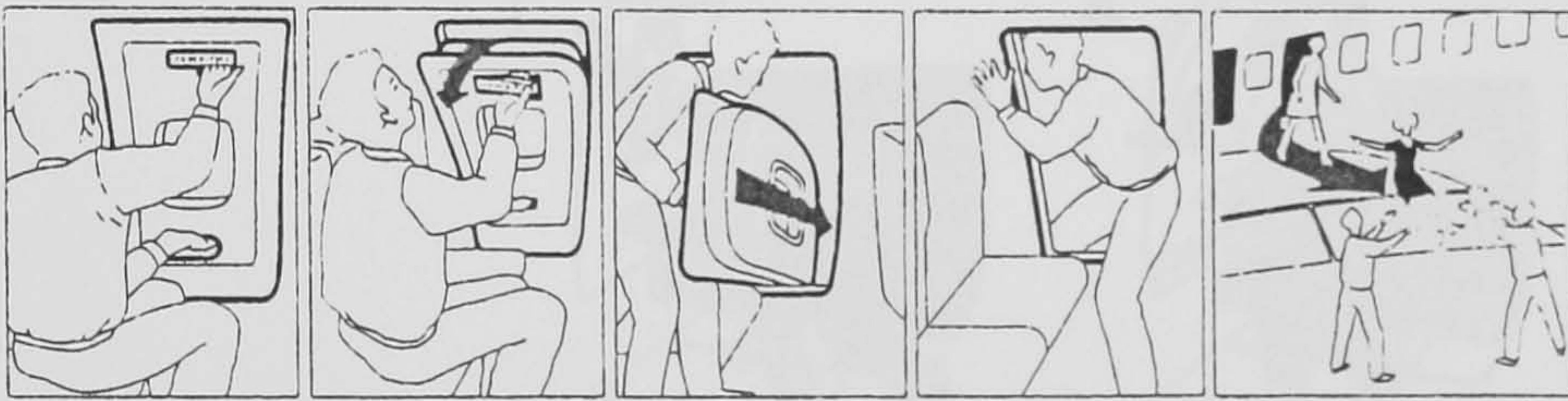
A



B



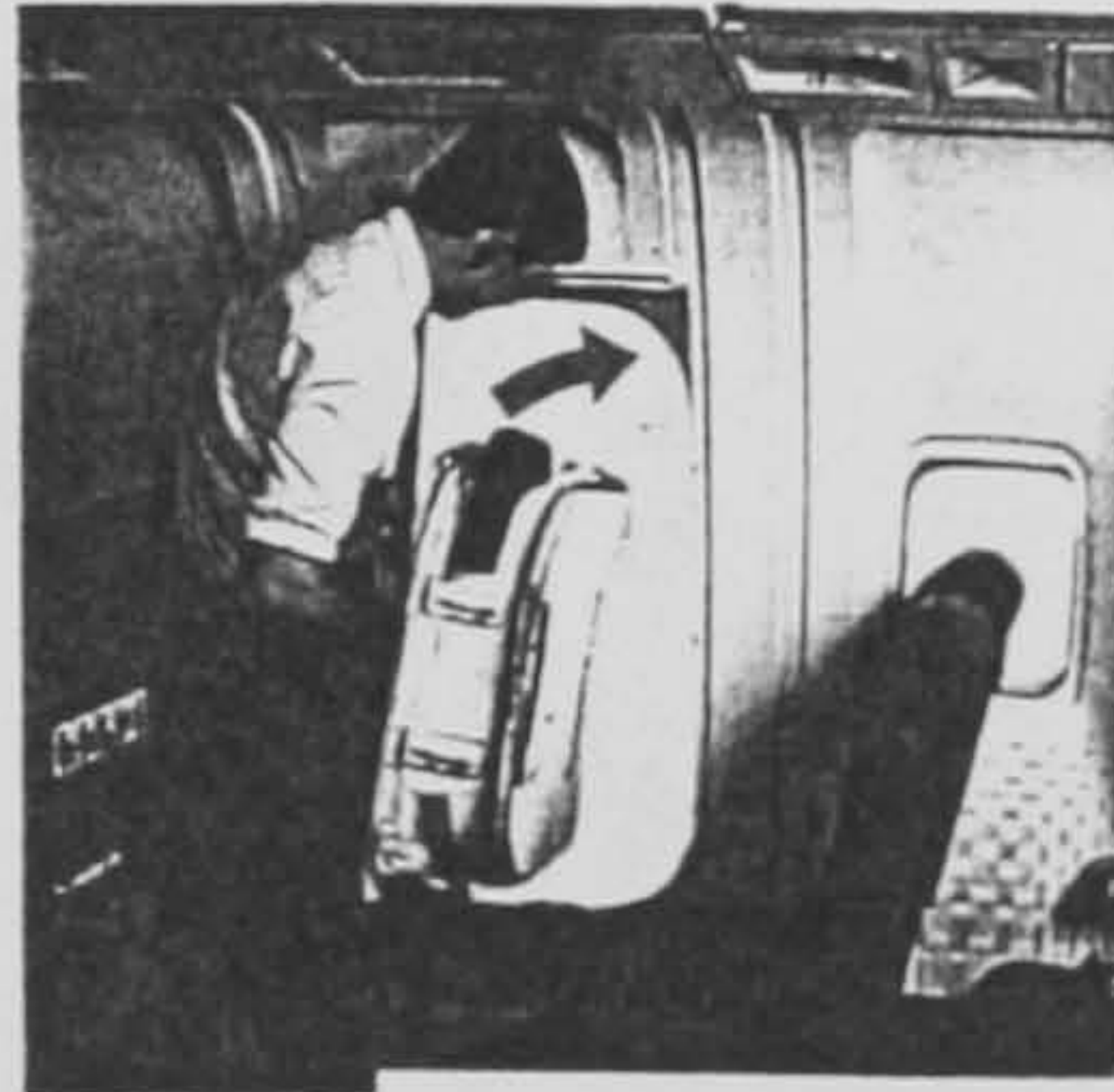
C



D

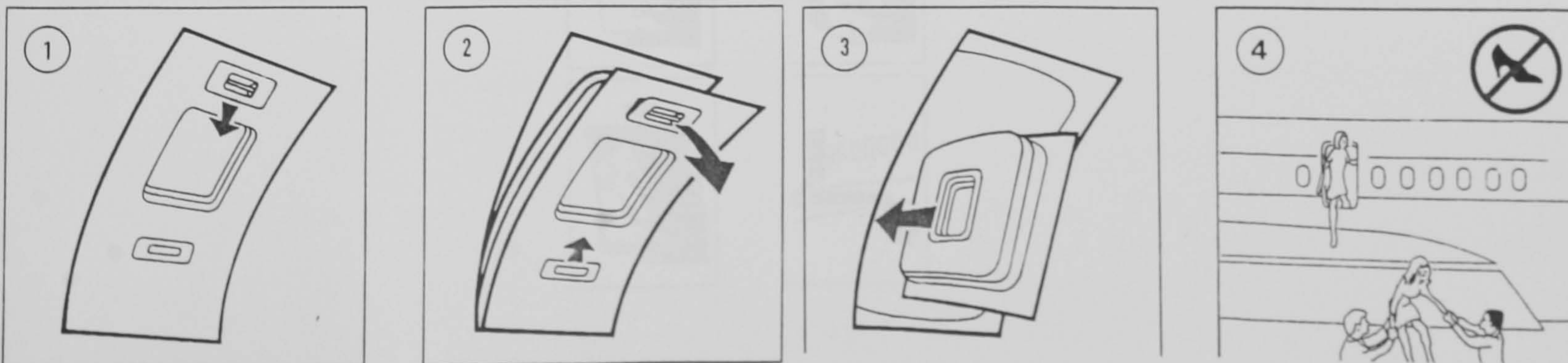
Exit B (overwing)

Sortie B (sur les ailes) / Ausgang B (über Tragflächen) / Uscita B (sulle ali) / Salida B (sobre el ala)



EXIT B

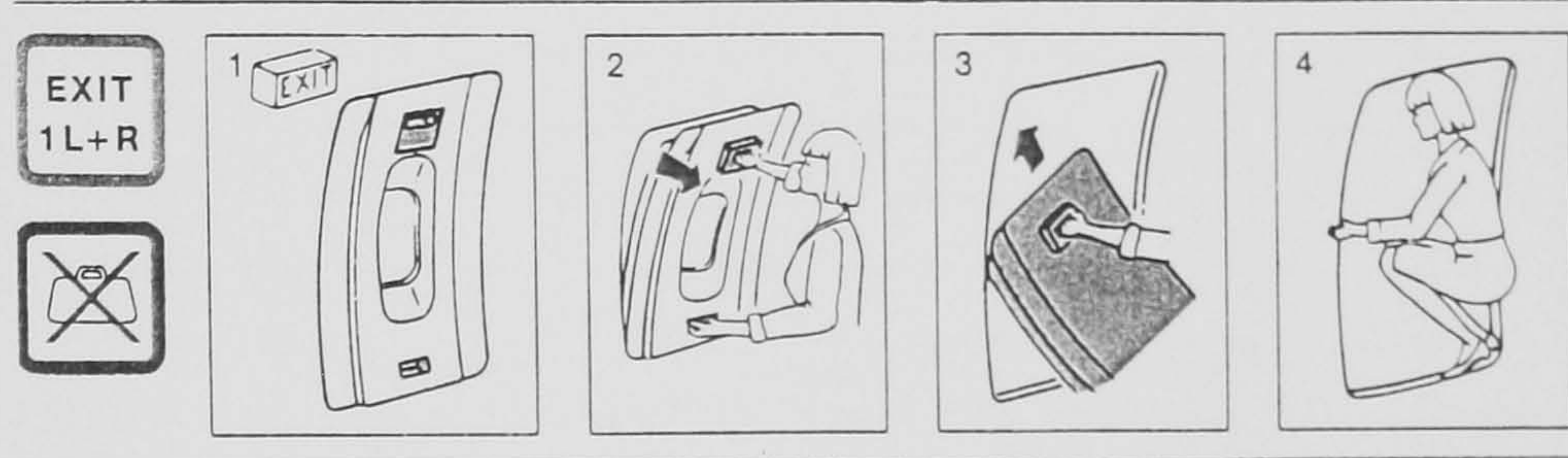
E



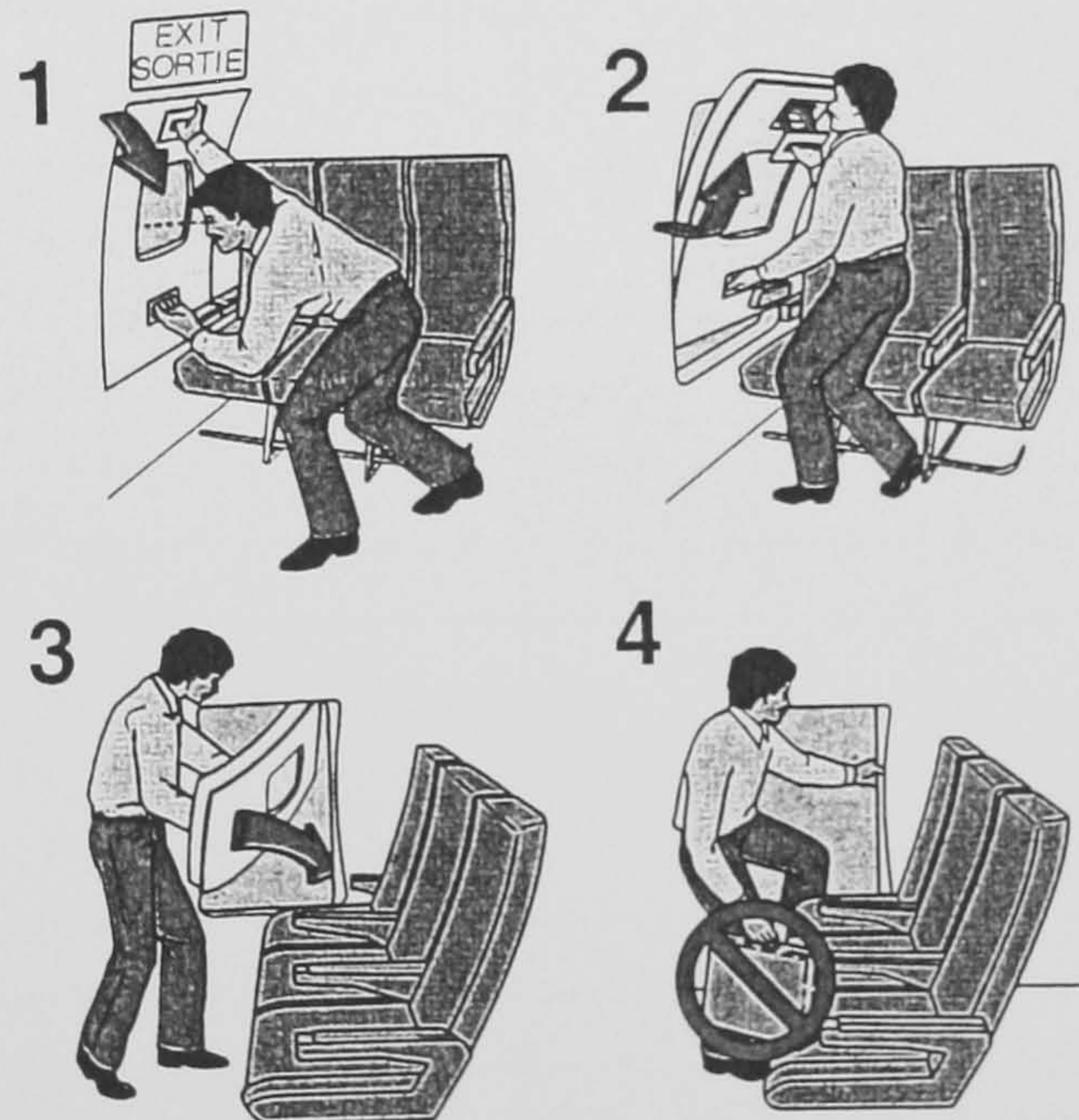
F



G



H



I



Appendix O Experiment two raw evacuation times

No	M/F	Condition	Life jacket donning	Handle to Exit Available	Handle to wing	"Open" to wing
1	F	card 1	48.52	9.65	19.47	25.31
2	M	card 1*	43.18	10.84	12.40	21.64
3	M	card 1*	44.06	9.04	11.16	17.90
4	M	card 1	38.12	10.52	12.96	16.92
5	M	card 1	49.00	6.00	9.00	10.28
6	M	card 3*	41.62	13.26	16.34	20.72
7	M	Video*	41.48	3.89	5.29	8.87
8	F	Video*	37.70	12.72	14.04	16.20
9	F	Video*	42.88	11.36	21.12	28.36
10	F	Video*	32.24	8.24	8.24	10.32
11	M	Video*	41.60	4.68	6.88	11.24
12	M	Video*	69.30	7.04	18.24	21.32
13	M	Verbal*	40.28	15.60	17.28	24.09
14	M	Verbal	42.05	4.56	6.20	7.92
15	F	Video*	67.57	9.40	12.20	16.76
16	F	Card 1*	29.60	9.66	11.22	13.22
17	M	Verbal*	52.23	7.08	9.52	17.04
18	M	Verbal*	34.92	9.56	11.36	19.92
19	M	Nothing	46.52	9.70	13.70	20.72
20	F	Card 1*	49.39	17.50	23.04	28.96
21	M	Nothing	39.44	4.26	6.52	11.60
22	M	Card 3	49.42	9.94	12.56	22.02
23	M	Card 3	61.60	5.88	7.28	12.28
24	F	Verbal*	50.56	9.12	13.76	18.20
25	M	card 2*	57.80	7.96	7.96	21.00
26	M	card 2*	39.08	5.04	8.28	10.08
27	F	Verbal*	50.24	12.48	15.56	18.36
28	M	Card 3	76.47	11.64	15.08	16.48
29	F	Verbal*	75.23	14.04	26.44	36.12
30	F	Card 1	62.66	13.91	18.83	20.83
31	F	Verbal	74.48	19.72	23.96	27.08
32	F	Nothing	44.80	23.13	25.24	30.48
33	M	Card 2*	45.56	7.26	9.18	12.80
34	M	Card 2	44.12	13.60	16.80	22.20
35	F	Card 2*	56.36	12.40	14.16	19.96
36	F	Card 3	48.52	14.48	24.88	27.12
37	F	Card 3	46.40	9.36	14.40	24.36
38	F	Card 2	58.40	10.72	14.88	23.87
39	F	Card 2	39.28	12.64	15.84	21.60
40	F	Card 2*	50.39	9.56	12.84	18.00
41	F	Card 3	51.08	39.88	39.88	46.41
42	F	Card 3	39.36	7.28	9.56	12.24

* Indicates that the exit was correctly disposed of onto the wing

No	M/F	Condition	Life jacket donning	Handle to Exit Available	Handle to wing	"Open" to wing
43	M	Nothing	46.24	5.82	8.86	9.60
44	M	Nothing	46.28	7.70	11.44	18.58
45	F	Nothing	54.36	9.14	12.28	20.43
46	M	Video	49.78	4.64	8.56	10.04
47	M	Card 4*	38.28	8.44	13.60	17.96
48	F	Nothing	55.56	16.16	19.72	25.28
49	F	Card 4*	41.84	17.68	19.84	28.68
50	F	Nothing	38.30	10.20	15.92	17.88
51	M	Card 4*	52.79	18.28	23.32	34.32
52	F	Card 4	72.26	6.8	12.92	28.4
53	F	Card 4*	56.88	13.14	16.64	23.32
54	F	Card 4	47.04	10.44	18.44	20.88
55	M	Card 4	46.29	9.26	12.96	15.33
56	M	Card 4*	51.23	10.56	12.99	16.43

* Indicates that the exit was correctly disposed of onto the wing