DOT/FAA/AM-03/15

Office of Aerospace Medicine
Washington, DC 20591

Access-to-Egress II: Subject Management and Injuries in a Study of Emergency Evacuation Through the Type-III Exit

Cynthia L. Corbett
Garnet A. McLean
James E. Whinnery

Civil Aerospace Medical Institute
Federal Aviation Administration
Oklahoma City, OK 73125

October 2003

Final Report

U.S. Department of Transportation

Federal Aviation Administration

NOTICE

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/AM-03/15		

4. Title And Subtitle	5. Report Date
Access-to-Egress II: Subject Management and Injuries in a Study of Emergency Evacuation Through the Type-III Exit	October 2003
7. Author(s)	8. Performing Organization Report No.
Corbett CL, McLean GA, Whinnery JE	
9. Performing Organization Name and Address	
FAA Civil Aerospace Medical Institute P.O. Box 25082 Oklahoma City, OK 73125	
12. Sponsoring Agency Name and Address	10. Work Unit No. (TRAIS)
Office of Aerospace Medicine Federal Aviation Administration 800 Independence Ave. Washington, DC 20591	11. Contract or Grant No.
15. Supplemental Notes	13. Type of Report and Period Covered
This work was performed under task AM-B-01-PRS-93.	14. Sponsoring Agency Code

16. Abstract

The ethical treatment of human research subjects is a requirement of federal regulations. The accomplishment of this goal requires that important bilateral information-sharing between research staff and subjects occurs at all phases of the research process, and that significant safeguards are provided to minimize the potential for injury. Research designs must provide for these activities without negative consequences to the acquisition of valid and reliable data.

Information presented here is an overview of subject- and injury-management procedures utilized during an aeromedical research project designed to assess the effects of changes in airplane cabin configuration and operation on emergency evacuation through a Type-III overwing exit, as well as an analysis of the injuries sustained by subjects during the study. Subject management procedures included medical screening to assure a basic level of subject health and fitness, briefings applicable to important safety issues in the research process, alteration of the research method to eliminate identified sources of injury, and informed subject consent.

All 2,544 subjects completed 4 evacuation trials for a total of 10,176 crossings through the Type-III exit. Fifty-eight (2.3%) of the subjects sustained some type of injury during the evacuations, for a rate of 0.0057 injuries per exit-crossing. Eleven of those injuries (18.6%) were deemed serious. Forty injuries (69.0%) were sustained during high-motivation trials. Differential subject management by flight attendants affected the occurrence of injury, necessitating procedural changes halfway through the study to reduce the injury rate.

Injuries are an undesirable corollary to research involving humans. There is a significant potential for injuries in studies simulating emergency evacuation from airplanes, in which subjects must navigate a chaotic aircraft cabin, compete for the available egress route, and maneuver through the exit to the outside. Experimental evacuations through the Type-III exit illuminate the effects of important factors that influence evacuations, the potential for injury, and improved safety for actual emergencies. Adherence by researchers to the requirement for ethical treatment of research subjects, including attention to factors that affect the number and severity of injuries, enhanced Type-III exit experimental evacuation outcomes and reduced injuries. Application of these principles to transport airplane operations should yield similar improvements to safety.

17. Key Words	18. Distribution Statement
Aircraft Evacuation, Passageway Configuration, Hatch Operation, Competitive Egress, Individual Subject Characteristics, Subject Management, Subject Injuries	Document is available to the public through the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	28	

ACKNOWLEDGMENTS

The authors heartily acknowledge the untiring efforts of those who gave so generously of their time and energy toward the success of this project. The dedication each of them displayed is a tribute to the professionalism embodied in the personnel of the Civil Aerospace Medical Institute and their willingness to assist almost any time or day. Among all those who contributed, special thanks go to our research support staff:

Tracie Allison	Joe Beasley	Rick Butler	Patricia Calvert
Kristi Craft	Chuck DeJohn	David DeSelms	Rick DeWeese
Dave Dyer	Jerrod Epple	Wilma Fairman	Van Gowdy
Ken Larcher	Rusty Lewis	Edward Matheke	Jerry McDown
Ronnie Minnick	Becky Orman	David Palmerton	Keith Porter
Donna Potter	Bryan Provine	Lori Samuel	Robert Shaffstall
Steve Veronneau	Greg Winters	Alex Wolbrink	Kathi Wood

The project could also not have been accomplished without contract personnel, who recruited and managed the subjects, assisted with conducting the evacuation trials, and maintained the evacuation simulator, which was under constant threat of demolition by the onslaught of zealous evacuees. Those in our debt include:

Jason Garvin	Suanne Hanson	Linda Hoover	John Howard
Julianne Jacks	Jerry Johnson	Jim King	Lorri King
Robert McCawley	Heather Munn	Dave Ruppel	Stephanie Sanders
Buck Walker	Vicky Wilson	Rita Odom	

We also wish to thank the fine paramedics from EMSA, Oklahoma City, OK, who helped in those few instances when things went awry. Thank you all for a project well done.

Access-to-Egress II: Subject Management and Injuries in a Study of Emergency Evacuation Through the Type-III Exit

INTRODUCTION

The use of humans in aeromedical research involves important ethical issues that include the responsibility of researchers to safeguard the safety and welfare of their subjects. Ethical standards and federal regulations provide a framework for conducting human experimentation. The National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research (1978) has asserted three principles that apply to the conduct of research involving human subjects: "*respect for persons*… underlies the need to obtain informed consent; …*beneficence* underlies the need to engage in a risk/benefit analysis and to minimize risks; and …*justice* requires that subjects be fairly selected" (U.S. Department of Health and Human Services, 1993). When federal departments and agencies that conduct, support, or regulate research adopt the Federal Policy for the Protection of Human Subjects (1991), they implement these core principles. Codification of the Federal Policy for Federal Aviation Administration (FAA)-sponsored studies is set forth in the *Code of Federal Regulations Title 49 Part 11* (49 CFR 11; Department of Transportation), and *Title 45 Part 46* (45 CFR 46; Department of Health and Human Services).

The Institutional Review Board (IRB) of the Civil Aerospace Medical Institute (CAMI) operates according to procedures outlined in the *Principal Investigator's Guide to Policy and Procedures for the FAA Institutional Review Board* (CAMI, 1998) that comply with 49 CFR 11, 45 CFR 46, and FAA Human Research Subjects Order 9500.25. To ensure that human subjects are adequately protected, the IRB has the authority to review, approve, require modifications in, or disapprove research activities that fall within its jurisdiction.

Since the adoption of the policy, systematic procedures for assessing the risks and benefits associated with specific research apparatus and methods have evolved. IRB requirements for approval of specific research protocols have become more complex as more detailed information has allowed in-depth review of the risks and benefits of the proposed research. This enhancement of research ethics is designed to improve the quality of the research and the safety of research subjects.

Within this context, the information presented here is an overview of subject- and injury-management procedures utilized during an aeromedical research project designed to assess the effects of changes in airplane cabin configuration and operation on emergency evacuation through a Type-III overwing exit, and an analysis of the injuries sustained by subjects during the study. The goals of this report are to enhance safety in future evacuation research by:

1. Describing the procedures used for meeting IRB requirements for risk/benefit analyses, informed subject consent, and reporting requirements for researchers.
2. Describing the injuries sustained in this particular cabin evacuation study.
3. Establishing a standardized methodology for describing injuries that can be used in long-term comparative database development.
4. Providing the aviation industry with a basis for predicting injury (liability estimation) when planning experimental evacuation exercises.

METHOD

Simulated emergency evacuations were conducted utilizing the CAMI narrow-body transport airplane simulator. Forty-eight experimental groups, comprised of 2,544 human subjects, were employed in this study to investigate the effects of factors that control the emergency evacuation of passengers through the transport airplane Type-III overwing exit. Each subject group completed four evacuation trials, yielding a total of 192 trials. Every evacuation trial was managed by two professional airline flight attendants using typical airline procedures and evacuation commands.

Four independent variables were included. Of these, two were related to the airplane configuration and two were related to the subject groups. Exit hatch disposal location consisted of having the hatch placed either inside or outside the Type-III exit, and configuration of the passageway from the center aisle to the exit was varied using four different passageway widths and aft seat assembly encroachments into the projected exit opening. Three different subject group sizes (30, 50, and 70) were employed to create the subject density variable, and group motivation level was manipulated by allowing individuals within half the groups the opportunity to gain double pay by being among the fastest evacuees.

Also of interest were subject physical characteristics (gender, age, waist size, height) previously shown to significantly affect emergency egress (e.g., McLean &

George, 1995). See McLean, Corbett, Larcher, McDown, Palmerton, Porter, Shaffstall, and Odom (2002) for a full description of the study.

SUBJECT MANAGEMENT

Recruitment. The fair and equitable selection of subjects requires that the burdens and benefits of research be distributed equally among the various segments of the population of interest and underlies the researchers' obligation to recruit broadly so as not to undermine scientific integrity. Subjects were recruited for this study by way of public service announcements on television and radio, newspaper advertisements, and fliers distributed at businesses, churches, and civic organizations in the greater Oklahoma City, Oklahoma, area.

A local company (ATSA, Inc.) was responsible for recruitment and administrative management of subjects. As the first step in the process, respondents to the advertisements were informed about the nature of the study and the general requirements for participation. Upon indicating a desire to participate in the research, prospective subjects then provided an array of personal information necessary for ATSA to determine their suitability for the specific activities required during the experiment. Once this process was completed successfully, subjects were scheduled to participate in the study.

Medical Screening. As part of the screening process, a personal information and health questionnaire was administered (see Appendix A), which allowed ATSA to determine the fitness of individual subjects for participation in the evacuations. Certain conditions peremptorily disqualified individuals from participation. These included prosthetic limbs, pregnancy, Type-I diabetes, active hepatitis and hepatitis C in remission, active tuberculosis, serious cardiopulmonary disorders, blindness, and deafness. Other conditions (e.g., arthritis, recent surgery, contagious or chronic disease, history of psychopathology, heart problems, or concussion, having had an electrocardiogram or electroencephalogram) identified the subject for further evaluation by a research team physician. Failure to clear the medical screening successfully resulted in prospective subjects being dismissed from the study, based on the risk potential to the subject or the research staff.

Subject In-processing. As subjects entered the laboratory on test day, their gross motor agility was assessed by a step-over task (Figure 1), utilizing a 16" high barrier similar to the exit sill of a Type-III exit. Subjects' names were then checked against the registration roster (Figure 2), and those who had already been approved were issued a numbered vest (Figure 3). Subjects who required additional medical screening, had difficulty clearing the

Figure 1. A step-over task assessed gross motor agility as subjects entered lab on test day.

Figure 2. Each subject's name was checked against the registration roster for clearance.

Figure 3. Qualified subjects were issued numbered vests.

barrier, appeared to be under the influence of alcohol or drugs, or exhibited a potentially disqualifying condition not reflected on the health questionnaire, were directed to a medical interview room (Figure 4). Subjects who arrived without a health questionnaire on file had to complete the health questionnaire, as well as the medical screening, if necessary, before they could participate.

Figure 4. Subject is interviewed by physician concerning potentially disqualifying health condition.

Subjects qualified for study participation were directed to a classroom where they received a sealed packet that contained information and consent forms. While they waited for the medical screening process to be completed, the subjects completed a questionnaire that assessed their knowledge of safety procedures on commercial transport aircraft. Once the group quota (30, 50, or 70; gender mix) of qualified subjects was met for the particular experimental condition being tested, a research team member began the sequence of briefings that would prepare the subjects for participation.

The **Initial Briefing** reiterated the nature of the research, including a more detailed description of the evacuation task than the subjects had been given previously (Appendix B). The briefing included proscriptions against participation by subjects with active disability or illness, as well as those under the influence of drugs, alcohol, or medications. The hazards and risks associated with evacuation research were also described. In addition, subjects in the high-motivation groups were advised that they could receive bonus pay if they were among the first 25% of the passengers to evacuate the airplane simulator, performance being averaged across all four evacuation trials. Subjects were allowed to ask questions before proceeding.

The **Subject Information Form** (Appendix C) required subjects to provide additional personal information (e.g., gender, age, education, occupation, flight history) and provided locations for their (measured) height, weight, and waist size to be entered by a research team member. The form would be used later to facilitate database construction.

The **Individual's Consent to Voluntarily Participate in a Research Project** – Form N (for low-motivation groups; Appendix D) or Form I (for high-motivation groups; Appendix E) was read aloud as the subjects followed along (Figure 5). The form explained the purpose, procedures, and duration of the research, benefits and risks to the subjects and to society, confidentiality of the information collected, voluntary nature of participation, medical care in the event of injury, and whom to contact for answers to pertinent questions about the research. (See 49 CFR 11.116 and 45 CFR 46.116 for the general requirements for informed consent.) Subjects were again given ample opportunity to ask questions before signing the consent form.

Figure 5. A research team member reads the consent form as subjects follow along.

Once the briefings, informed consent process, and associated measurement activities (Figures 6-8) were finished, the subjects' paperwork was individually reviewed for completeness, and the subjects were photographed to link vest numbers with their appearance (Figure 9). The photographs were used to identify the subjects in case the vest number was obscured from the video camera during the experiment and subject appearance had to be used to facilitate data entry/analysis. A brief recess was then provided before escorting the subjects to the simulator for the experimental evacuations.

Figure 6. Female subject's weight is documented.

Figure 8. Research team members measure and record male subject's waist size.

Figure 9. Photographs were taken of all subjects to link vest numbers with appearance.

Figure 7. Male subject's height is documented.

Figure 10. Subjects are familiarized with the simulator and research team.

A **Familiarization Briefing** (Figure 10) was conducted)outside the airplane simulator to allow subjects to become acquainted with the equipment layout around the simulator, the evacuation route, and the research team members who could be addressed if a subject had a problem or needed assistance. Another opportunity for subjects to ask questions was provided. Each subject was then issued a boarding card with a specific seat assignment before entering the simulator and being seated (Figure 11).

Figure 11. Subjects board the simulator and seat themselves according to the boarding card.

A **Safety Briefing** (Appendix F) was delivered inside the simulator by the principal investigator (PI) after an introduction of the flight attendants and an explanation of their roles in the evacuations. Subjects in the high-motivation groups were again instructed about the bonus pay that would be awarded to those in the group who were the fastest to evacuate. Subjects were provided a final opportunity to ask questions before the PI read the *pre-trial briefing* (in Appendix F), in which the subjects were told that the plane had crashed, was on fire, and they had to hurry to get out alive. The PI then exited the cabin to begin the evacuation trial, leaving the flight attendants seated in their jumpseats waiting for the start buzzer to sound.

Hatch Operators. Four subjects in each group were randomly assigned to be hatch operators as they came through the initial processing line. The hatch operators were sequestered from the rest of their evacuation group once their paperwork, physical measurements, and photographs had been completed. They were briefed about the specific task they had to accomplish, using only the graphic representation of hatch operation depicted on a typical airline safety briefing card. They were advised that the hatch weighed 45 pounds and were asked if they were willing and able to operate the hatch for an evacuation. Only one female declined; she was replaced with another female of similar age and stature. Hatch operators (n=192) ranged in age from 18 to 64, in weight from 99 to 285 pounds, and in height from 60 to 77 inches. There were 103 males and 89 females; 182 were right-handed and 10 were left-handed.

A timed barbell curl task (26-pound barbell curled repetitively for 15 seconds) was used to assess the hatch operators' upper torso strength and stamina. This task was intended to allow statistical prediction of an individual's hatch-operating effectiveness; however, the sensitivity of the task proved to be inadequate, as males averaged 12 curls and females averaged 10 curls, with only one small female demonstrating difficulty. She achieved only 4 curls and had moderate difficulty handling the hatch, but was not disqualified. For the remainder of the subjects, neither the barbell task nor hatch operation proved to be remarkably challenging.

Each hatch operator was employed on only one evacuation trial, with each one being individually escorted to the simulator and seated adjacent to the Type-III exit immediately before the evacuation trial in which he/she would participate (Figure 12). The hatch operator was again shown the briefing card depicting the intended mode of hatch operation. After the trial the hatch operator was sequestered from the hatch operators who had not already participated to preclude the possibility of information sharing with subsequent hatch operators.

Experimental Procedure. A start buzzer was used to signal the beginning of each evacuation. At the sounding of the buzzer, the hatch operator removed the hatch and disposed of it (Figure 13). The flight attendants loudly and enthusiastically commanded the subjects to unbuckle their seatbelts and proceed through the Type-III exit, continuing their shouts and gestures throughout the evacuation (Figure 14). After each trial was completed,

Figure 12. Hatch operator is individually seated in simulator (safety monitor in row ahead).

Figure 13. Hatch operator removes and disposes of hatch at the start of the evacuation.

Figure 14. Subjects evacuate through the Type-III exit onto padded “winglet.”

Figure 15. Control station for audiovisual recording of the evacuation trials.

Figure 16. Safety monitor positioned to oversee the evacuation and sound the stop bell if necessary.

Figure 17. Paramedics secure injured subject on stretcher in preparation for evacuation to hospital.

subjects were regrouped to begin the next trial. All subjects (except hatch operators) completed four evacuations (192 trials) for a total of 10,176 individual subject crossings through the Type-III exit.

All trials were videotaped from both inside and outside the simulator (Figure 15) to allow time-based analysis of the evacuations. Digital photographs were also used to archive specific events, such as individual subject behavior, misplacement of the hatch, subject injuries, and simulator damage. Detailed analysis and results from the first (naïve subject) evacuation trial for each group can be found in McLean et al. (2002).

Injury Management. A safety monitor (research confederate) was positioned in the outboard seat of the row immediately forward of the Type-III exit and was instructed to sound the emergency-stop bell if an unsafe condition occurred at the exit (Figure 16). Otherwise, the safety monitor was to remain as unobtrusive as possible. Trials were not stopped, even for injuries, if the subject could be removed from the evacuation path without further injury to him/herself or to other subjects, which was the case in all trials that involved injuries (i.e., no trials were stopped). The research team maintained a first-aid kit and wheelchair on site as first-response measures for injuries. Medical staff from the CAMI Clinic and/or paramedics from the local emergency management service (EMSA) were present to provide first aid for injuries (Figure 17) and to facilitate safe transport of subjects to a local hospital, if necessary. ATSA personnel accompanied injured subjects through initial treatment, hospital referral and transport, and follow-up. A log of all injuries/outcomes was kept for subsequent analysis, as well as IRB reporting requirements.

Injury Analysis. Of the 2,544 subjects employed in the study, 51% were males and 49% were females. They ranged in age from 18 to 65 years, in weight from 95 to 416 pounds, and in height from 54 to 81 inches. Figure 18 provides a scatter plot of subjects by weight and height, highlighting those attributes of the 58 subjects who sustained injuries. Thirty-one females and 27 males were injured in the evacuations, resulting in a total rate of 0.0057 injuries per exit-crossing (58 injuries/10,176 crossings). Eighteen (31%) injuries were sustained during the low-motivation trials (Trials 1 through 96) and 40 (69%) injuries were sustained during the high-motivation trials (Trials 97 through 192). Figure 19 illustrates the distribution of injury types. Eleven of the injuries were deemed serious, based on the following criteria: (1) resulted in the fracture of a bone, (2) caused severe muscle or tendon damage, (3) exhibited profuse bleeding, (4) required surgical treatment, or (5) required hospitalization. Of those 11 serious injuries, 6 ankle/knee injuries were incurred.

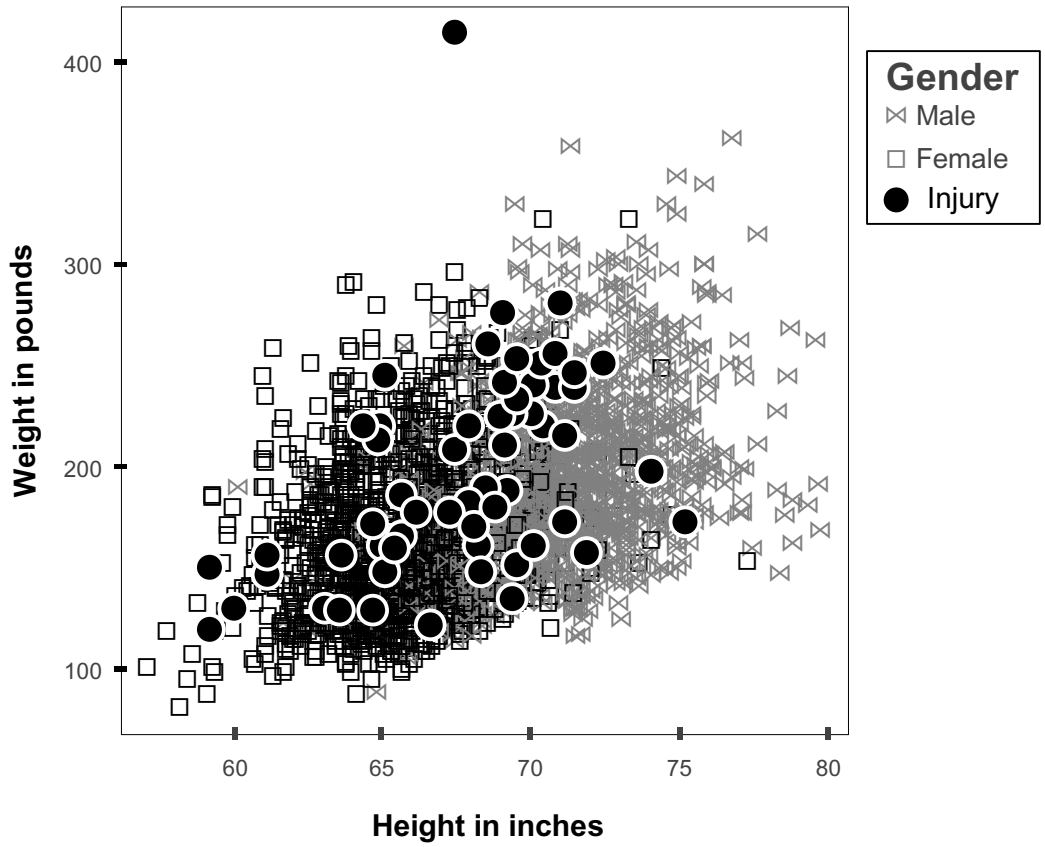

Figure 18. Injured subjects identified within the entire subject sample.

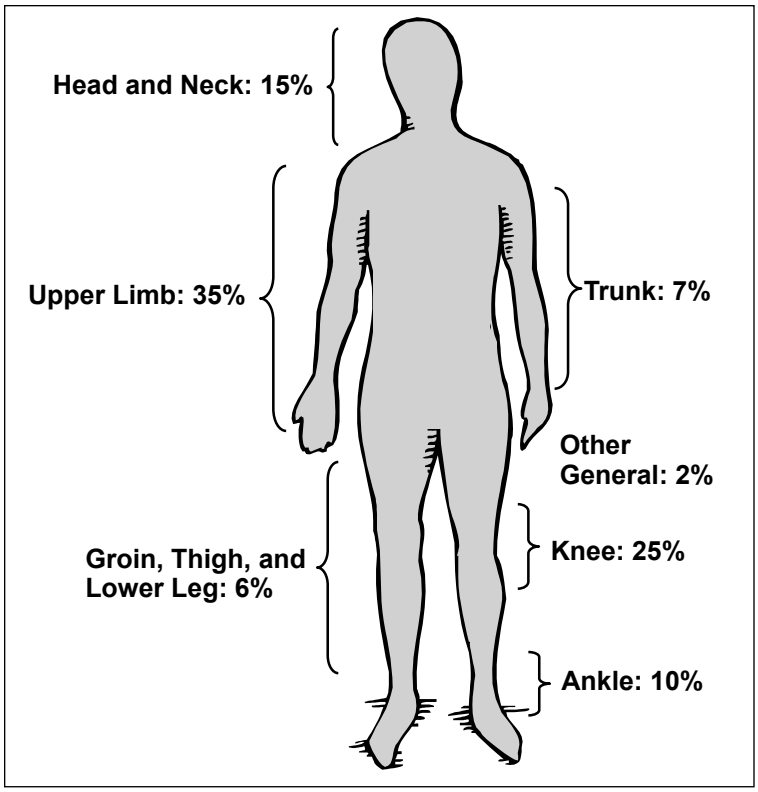

Figure 19. Distribution of subject injuries.

An *SPSS® 11* logistic regression analysis was performed to assess the predictability of injury occurrence in relation to the independent variables (group motivation, group density, hatch disposal location, and passageway configuration) and subject characteristics (gender, age, weight, and height). Because of the extremely small number of injuries relative to the large number of subjects, the regression model could not accurately predict the *occurrence* of injury.

However, for those injuries that did occur, additional chi-square analyses of the relationships between each independent variable and injury-occurrence revealed significant differences for low (18) versus high (40) group motivation levels (χ^2 [1, N=58]=8.345, p = .004), without effects related to group density (χ^2 [2, N=58]=3.310, p = .315), hatch disposal location (χ^2 [1, N=58]=0.069, p = .793), and passageway configuration (χ^2 [3, N=58]=7.379, p = .061). The lack of significance in the passageway configuration analysis occurred in spite of the fact that a remarkable number of injuries occurred in the 10" configuration (22), when compared with the 6" (12), 13" (16), and 20" (8) configurations (see Table 1).

Given the predominance of injured ankles/knees in the serious injury category, a second logistic regression analysis was conducted to determine the predictability of the *type* of injuries, i.e., ankle/knee injuries versus all others. Only the combination of group motivation level (low) and subject gender (female) was found to predict the type of injury (72% of the time); however, there was no ability to predict whether the ankle/knee injury was serious or not. Of the 22 total ankle/knee injuries, the 12 low-motivation ankle/knee injuries were evenly distributed between males and females; however, 9 of the 10 high-motivation injuries were incurred by females (see Table 2). The significance of this disproportionate ankle/knee distribution was confirmed by a cross-tabs chi-square analysis (χ^2 [1, N=22]=4.023, p = .04).

Injury Classification System. Classifications systems have been developed and used to assess the mortality or morbidity resulting from injury or illness and to define anatomic injury location and severity. Examples include the Abbreviated Injury Scale (AIS), Organ Injury Scales, Trauma and Injury Severity Score (TRISS), International Classification of Diseases (ICD), Glasgow Coma Score, Glasgow Pediatric Coma Score, and the Orchard Sports Injury Classification System (OSICS). The first AIS,

Table 1. Occurrence of Injuries

	Group Motivation Level			
	Low		**High**	
Passageway Configuration	***Hatch Disposal Location***			
	In	**Out**	**In**	**Out**
6" wide; Outboard seat removed	**2**	**2**	**5**	**3**
10" wide; 14" encroachment	**3**	**6**	**8**	**5**
13" wide; 10" encroachment	**1**	**2**	**9**	**4**
20" wide; 5" encroachment	**2**	**0**	**4**	**2**
Total	**8**	**10**	**26**	**14**

Table 2. Frequency of Ankle/Knee Injuries

Passageway Configuration	*Group Motivation Level*			
	Low		**High**	
	Subject Gender			
	Male	**Female**	**Male**	**Female**
6" wide; Outboard seat removed	**1**	**2**	**1**	**1**
10" wide; 14" encroachment	**3**	**2**	**0**	**3**
13" wide; 10" encroachment	**1**	**1**	**0**	**3**
20" wide; 5" encroachment	**1**	**1**	**0**	**2**
Total	**6**	**6**	**1**	**9**

published in 1971, was an attempt to establish a uniform rating system and standardize the language used to describe injuries. Since then, the AIS has evolved into a widely used procedure for describing impact injury and its severity, containing more than 500 separate injury descriptions (Greenspan, McLellan, & Greig, 1985), and has been used in the assessment of injuries in an impact crash of a civilian airliner (Rowles, Kirsh, Macey, & Colton, 1992).

Reliable information concerning the injury rates from evacuation research is necessary for continued improvement of aerospace safety operations associated with aircraft cabin egress. As a result of the divergence in injury type between motivation-level conditions in this study, the Aeromedical Injury Classification System (AICS) was developed for coding subject injuries so that a database can be constructed to allow cumulative analysis of injuries in future evacuation research studies. This method of classification, adapted from the aforementioned classification systems, will provide a basis for identifying and defining injury patterns and frequency of occurrence. It is anticipated that the database will assist in the preparation of research protocols and certification studies of cabin evacuations.

Contained within the 5-character alphanumeric classification code are the body region of the injury, the specific location on the body (left/right/medial), the type of injury, on-site or off-site treatment, and the severity of injury (see Table 3). Application of the classification code to the current set of injuries is illustrated in Table 4.

DISCUSSION

Research that depends on the experimental manipulation of a subject's environment carries a distinct, if slight, risk of physical injury. This is particularly true for studies involving aircraft emergency evacuations, in which subjects must rapidly navigate a chaotic aircraft cabin, compete for available egress routes, and maneuver through the exit to the outside. Restricted cabin configurations, small (Type-III) exits, actions required for hatch operation, and increased subject motivation typically amplify this potential. The history of evacuation research indicates that while the potential for physical injury is unquestionable, much can be done to minimize the relevant hazards. This is accomplished by the proactive application of corrective solutions to known hazards; attention by the research staff to developing risks or hazards during the execution of any evacuation research study is also required to counter emergent peril.

Provision of information that promotes health and safety without compromising the collection of valid and reliable data is mandatory, whereas provision of information to subjects about the experimental contingencies of an evacuation research activity may or may not be desired from an experimental design standpoint. This typically means little information is given about the specific evacuation research question being addressed or the variables being manipulated. However, full disclosure is required for the potential hazards and risks associated with evacuation contingencies, so that a prospective subject may understand the stakes involved and make informed decisions about the wisdom of his/her participation. This is especially true with regard to individual health or ergonomic limitations that a subject may possess.

While the application of these principles is significant with regard to respect for the human subjects, the research staff, and the research activity to be conducted, the probability of injury during any sizable evacuation research study is nonetheless considerable. Past injuries have ranged from minor scrapes, bumps, and bruises to serious bone fractures and joint trauma, with the mode of egress being a major determinant of the injury type and severity. In general, studies of evacuation through

Table 3. Aeromedical Injury Classification System

Body Area (First Character in Code)				
Head and Neck	**Upper Limb**	**Trunk**	**Lower Limb**	**General**
H – Head N – Neck J – Jaw M – Mouth Y – Nose	S – Shoulder U – Upper arm E – Elbow R – Forearm W – Wrist P – Hand	C – Chest O – Abdomen D – Thoracic spine L – Lumbar spine V – Cervical spine	B – Buttock G – Groin/hip T – Thigh K – Knee Q – Lower leg A – Ankle F – Foot	X – Multiple areas Z – Not specified

Directional Term (Second Character in Code)			
L – Left Side	R – Right Side	O – Medial	Z – Not Specified

Type of Injury (Third Character in Code)			
Bone	**Joint**	**Soft Tissue**	**Other**
F – Fracture G – Avulsion/ Chip Fracture S – Stress Fracture Q – Old fracture/ Mal /Non-Union	D - Dislocation U – Recurrent Instability/ Subluxation C – Chondral/ Articular Cartilage/ Meniscal Damage L – Ligament Tear/Sprain	M – Muscle Tear/Sprain R – Complete Tendon Rupture H – Haematoma/ Bruising/ Cork K - Laceration A - Abrasion P - Puncture	E – Contact Without Evidence of Injury (With or Without Pain) Z – Not Specified

Treatment (Fourth Character in Code)	**Severity** (Fifth Character in Code)
M – Medically Treated Onsite S – Surgery Offsite O – No Onsite Treatment	1 – Minor 2 – Moderate 3 – Serious 4 – Unknown

Table 4. Subject Injuries by Classification Code and Subject Attributes

Code	Injury	Subject Attributes			
		Gender	Age	Wt/lb	Ht/in
KLHM2	Left (L) knee bruise; treated/released by CAMI clinic	Female	55	164	65
KLLM2 KLRM2	L and Right (R) knee sprain/strain; not seen by clinic; seen by personal physician	Male	18	178	71
ARLM2	R ankle sprain/strain; treated/released by paramedic	Female	44	198	66
HOKM2	Forehead laceration; treated/released by paramedic	Male	45	171	68
HOKS3	Forehead laceration required stitches; referred to ER	Male	34	165	68
KLLS3	L knee sprain/strain required surgery; referred to ER	Male	54	219	70
KRLM2	R knee sprain/strain; treated/released by CAMI clinic	Male	60	227	69
PLLM2 SLLM3	Hand and shoulder sprain/strain; referred to ER	Male	48	157	69
KLLM2	L knee sprain/strain; treated/released by CAMI clinic	Male	46	239	71
PRHM1	R hand bruised; treated/released by CAMI clinic	Male	19	211	69
KLLM3 ALLM3	L knee/ankle sprain/strain; referred to ER	Female	42	233	71
KRLM3	R knee sprain/strain; referred to ER	Male	44	252	71
ELLM2	L elbow sprain/strain; treated/released by CAMI clinic	Male	66	220	69
JLLM2 SLHM2	L jaw and L shoulder bruised; treated/released by CAMI clinic	Female	40	173	64
KLLM2	L knee sprain/strain; treated/released by CAMI clinic; seen by personal physician	Female	51	284	64
KRHM2	R knee bruised; treated/released by CAMI clinic	Male	39	162	72
ALFS3	L ankle fracture required surgery; referred to ER	Male	46	415	68
KRHM2	R knee bruised; treated/released by CAMI clinic	Female	41	209	67
TLLM2	L hamstring strain; treated/released by CAMI clinic	Male	50	275	71
RRAM2	R forearm abrasion; treated/released by CAMI clinic	Female	46	143	69
ARAM2	R ankle abrasion; treated/released by CAMI clinic	Male	53	151	66
KLHO1	L knee bruised; declined treatment	Female	64	130	65
SRLS3	R shoulder sprain/strain required surgery; referred to ER	Male	35	189	69
RRKM1	R forearm laceration; treated/released by paramedic	Male	19	127	68
PZHM1	Finger bruised; treated/released by paramedic	Female	47	161	64
SZHM2	Shoulder bruised; treated/released by paramedic	Female	58	210	69
RZAM1	Arm abrasion; treated/released by paramedic	Female	29	174	66
KRCS3	R knee patella torn; treated/released by paramedic; seen by personal physician	Female	28	208	70
KRAM2	R knee abrasion/bruised; treated/released by CAMI clinic	Female	38	152	60
KRHM2	R knee bruised; treated/released by CAMI clinic	Female	34	219	70
NOAM2	Neck abrasion; treated/released by CAMI clinic	Female	25	134	63
RRAM2	R forearm abrasion/bruised; treated/released by CAMI clinic	Female	52	241	66
PLHM1	L thumb bruised; treated/released by CAMI clinic	Female	35	262	68
RZAM1	Arm abrasion; bandage by research team	Female	47	214	68
ZZAM1	Scratched by another subject; bandage by research team	Female	54	142	62
RZAM1	Arm abrasion; bandage by research team	Male	46	168	69
PRLM2 QRHM2 LRHM2	R thumb, leg, lower back bruised; treated/released by CAMI clinic; seen by personal physician	Male	46	233	72
ALFS3	L ankle/foot sprain/fracture required surgery; referred to ER	Female	38	215	66
ERHM2	R elbow bruised; treated/released by CAMI clinic	Female	47	136	60
WLHM2	L wrist bruised; 2 broken fingernails; treated/released by CAMI clinic	Female	53	236	70
HOKS3	Forehead laceration required stitches; referred to ER	Male	40	192	69
WLLM2	L wrist sprain/strain; referred to ER	Female	36	209	65
CLHM2	L ribs bruise; treated/released by CAMI clinic	Female	41	129	63
SRHM2 CRHM2	R shoulder and ribs bruised; treated/released by CAMI clinic; seen by personal physician	Male	40	192	69
HOHM2	Head bruised; treated/released by CAMI clinic	Female	62	119	59
SRDM3	R shoulder dislocated; referred to ER	Male	37	200	73
KZHO1	Knee bruised; declined treatment	Female	33	130	68
HOHO1	Head bruised; declined treatment	Male	50	173	74
ZZAO1	Scratched by another subject; declined treatment	Male	42	251	72
KLHO1	L knee bruised; declined treatment	Female	29	183	67
CZHM2	Ribs bruised; not treated at CAMI; treated by personal physician	Male	48	167	65
MOHM1	Bit tongue; declined treatment	Male	20	166	72
QZAO1	Shin abrasion; declined treatment	Female	18	169	68
HOHO1	Head bruised; declined treatment	Male	18	236	72
ALMO1	L ankle sprain/strain; declined treatment	Female	53	189	68
GZLM2	Pulled groin; treated/released by CAMI clinic	Female	27	152	62
WZAM2	Wrist abrasion/bruised; treated/released by paramedic	Female	44	208	64
KRHM2	R knee bruised; treated by personal physician	Male	41	264	70

the Type-III exit have proven to offer minimal hazards with correspondingly minor injuries, typically minor cuts and bruises; the number of such injuries are generally determined by the character of the evacuation process. Calm, orderly evacuations have produced fewer injuries, whereas highly energetic and disordered evacuations have resulted in significantly more (personal observations in McLean, George, Funkhouser, & Chittum, 1996). The relationships between experimental designs that do not modulate evacuation *energy* and injury potential have been less clear, limiting the ability to devise relevant proactive solutions.

The occurrence of injuries in the current study generally conformed to expectations, as the absolute number of injuries was small, and the rate of injury per subject through the exit was minuscule. None of the independent variables, not even subject motivation level, was shown to systematically predict the general occurrence of injury, although twice as many injuries occurred during the (highly energetic) high-motivation trials as in the low-motivation trials. The high-motivation trial injuries were generally limited to bumps, bruises, and minor lacerations and appeared to result from the especially aggressive and chaotic nature of the subjects in and near the exit during the evacuations. The very small number of injuries in the more controlled low-motivation trials was predictable; however, these low-motivation injuries were much more severe than had been expected, as ankle and knee strains, sprains, and fractures accounted for about two-thirds of them.

Once identified, this enigma prompted strict scrutiny of the remaining low-motivation evacuations, which led to identification of a single evacuation command used by the flight attendants as the likely source of injury. This command, *step through – foot first,* required subjects to place one leg through the exit, straddle the sill, transfer their weight to the leading foot on the ground, and then pull their trailing leg out. This maneuver appeared to promote injury, and the result was either twisting the leading ankle and/or knee that supported the bulk of the subjects' body weight or hitting their trailing knee against the exit sill as their leg was pulled through the exit opening. This was particularly troublesome (and likely injurious) for subjects who had a history of knee or ankle weakness or who were severely overweight, as seen in Figure 17, which shows a large subject (416 pounds) who fractured his left ankle on his second evacuation trial. He had no apparent difficulty on the first trial.

Identification of this contingency resulted in a change to the evacuation command set at the midpoint of the study, i.e., the point at which the research design was balanced vis-à-vis the independent variables. From that point on, the cabin crew did not use the *step through – foot first* command, reducing the proportion of knee and ankle injuries.

Three hatch operators, two of whom required stitches, hit themselves on the head with the hatch when they pulled it from the exit opening. They reported that they had expected the hatch to be heavier than it was, thereby inducing them to be more forceful than was necessary to remove it, striking themselves on the forehead with the top edge of the hatch (Figure 20).

Figure 20. Hatch operator lacerated his head with the top edge of the hatch.

As a precaution after the two injuries requiring stitches, the interior rim of the hatch was faced with rubber tubing for added protection. This action eliminated further injuries produced by overzealous hatch operation. (Note that the introduction of blood into the research environment necessitated the use of prescribed clean-up procedures to prevent exposure to blood-borne pathogens; see Figure 21.)

Combined, these two ameliorative measures appeared to reduce the number of injuries that had occurred from previously unidentified evacuation contingencies. Attention to the details surrounding the occurrence of the injuries allowed the causal relationships to be identified, resulting in appropriate solutions. The application of vigilance and proactive planning in the operational transport airplane environment should offer similar rewards.

Finally, injury pattern and injury rate information, such as that derived from ASICS, is essential for further

Figure 21. Safety officer decontaminates bloody hatch.

understanding injuries associated with evacuation research and the variables that can cause or reduce injuries. Development of this type of classification system and associated database can also improve compliance with reporting requirements necessary for conducting research using human subjects. Furthermore, the careful definition of injury patterns associated with evacuation studies can be extremely useful in the medical response planning phases of research protocols. Knowing the type of injuries to expect may provide cost-effective procedures for enhancing subject safety by ensuring appropriate preventive and response measures.

REFERENCES

Civil Aerospace Medical Institute (1998). *Principal investigator's guide to policy and procedures for the FAA Institutional Review Board*. Retrieved June 27, 2002, from http://www.cami.jccbi.gov/aam-700/700IRBSOP.HTML

Federal Policy for the Protection of Human Subjects; *Federal Register* 56 [June 18, 1991]: 28002-28032.

Greenspan, L, McLellan, BA, & Greig, H (1985). Abbreviated Injury Scale and Injury Severity Score: A scoring chart. *The Journal of Trauma*, 25(1), 60-64.

McLean, GA, Corbett, CL, Larcher KG, McDown, JR, Palmerton, DA, Porter, KA, Shaffstall, RM, & Odom, RS (2002). *Access-To-Egress I: Interactive effects of factors that control the emergency evacuation of naïve passengers through the transport airplane Type-III overwing exit (DOT/FAA/AM-02/16)*, Washington, DC: Office of Aerospace Medicine[1].

McLean, GA, & George, MH (1995). *Aircraft evacuations through Type-III exits II: Effects of individual subject differences (DOT/FAA/AM-95/25)*, Washington, DC: Office of Aviation Medicine.[1]

McLean, GA, George, MH, Funkhouser, GE, & Chittum, CB (1996). *Aircraft evacuations onto escape slides and platforms I: Effects of passenger motivation (DOT/FAA/AM-96/18),* Washington, DC: Office of Aviation Medicine[1].

Mosher, DL (1988). Balancing the rights of subjects, scientists, and society: 10 principles for human subject committees. *The Journal of Sex Research,* 24, 378-385.

National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research; *The Belmont Report: Ethical Principles and Guidelines for the Protection of Human Subjects of Research.* DHEW Publication No. (OS) 78-0012. Washington, DC: US Government Printing Office, 1978.

Rowles, JM, Kirsh, G, Macey, AC, & Colton, CL (1992). The use of injury scoring in the evaluation of the Kegworth M1 aircrash. *The Journal of Trauma*, 32(4), 441-447.

U.S. Department of Health and Human Services (1993). *Protecting human research subjects.* S/N 017-040-00525-3. Washington, DC: U.S. Government Printing Office.

[1]This publication and all Office of Aerospace Medicine technical reports are available in full-text from the Civil Aerospace Medical Institute's publications Web site: http://www.cami.jccbi.gov/aam-400A/index.html

Appendix A

SUBJECT INFORMATION and HEALTH QUESTIONNAIRE

Name: _____ Subject #: (get explanation)_____

Sex:_____ Age:_____ Vest #:_____

Highest school year completed: 8 9 10 11 12 13 14 15 16 17 18 19 20

What is your occupation? _____

Do you have any disability or medical condition that could prevent you from being able to rapidly evacuate an airplane?
Yes_____ No_____ If "Yes", please explain: _____

Directions: If you **can** answer **YES** to the question, then circle **YES.** If you cannot answer **YES** to the question, then circle **NO.** Answer all the questions!

Are you presently taking any medication or drug?	YES	NO
Are you pregnant?	YES	NO
Have you had surgery recently?	YES	NO
Have you had alcohol or drug problems?	YES	NO
Have you ever had hepatitis?	YES	NO
Do you presently have any contagious disease?	YES	NO
Have you ever had problems with your knees or ankles?	YES	NO
Have you ever been told that you have an eye astigmatism?	YES	NO
Do you need eye glasses to see?	YES	NO
Are you hard of hearing?	YES	NO
Do you get hay fever?	YES	NO
Do you suffer from asthma?	YES	NO
Are you troubled by constant coughing?	YES	NO
Have you ever had a chronic chest condition?	YES	NO
Has a doctor ever said you had blood pressure problems?	YES	NO
Do you have any learning disabilities?	YES	NO
Do you have pains in the heart or chest?	YES	NO
Are you often bothered by pounding of the heart?	YES	NO
Does your heart often race like mad?	YES	NO
Do you often have difficulty in breathing?	YES	NO
Do you sometimes get out of breath just sitting still?	YES	NO
Have you ever had TB (Tuberculosis)?	YES	NO
Are your ankles often badly swollen?	YES	NO

Do you suffer from frequent cramps in your legs?	YES	NO
Has a doctor ever said you had heart trouble?	YES	NO
Does heart trouble run in your family?	YES	NO
Have you had multiple sclerosis (MS)?	YES	NO
Are you troubled with a serious bodily disability or deformity?	YES	NO
Were you ever treated for severe anemia (thin blood)?	YES	NO
Do you have diabetes (sugar disease)?	YES	NO
Do you suffer from any chronic disease?	YES	NO
Has a doctor ever said you had stomach ulcers?	YES	NO
Do you drink more than six cups of coffee or tea a day?	YES	NO
Do you usually take two or more alcoholic drinks a day?	YES	NO
Do you suffer from frequent severe headaches?	YES	NO
Do you have spells of severe dizziness?	YES	NO
Do you frequently feel faint?	YES	NO
Did you ever have a fit or convulsion (epilepsy)?	YES	NO
Did you ever have a nervous breakdown?	YES	NO
Were you ever a patient in a mental hospital (for your nerves)?	YES	NO
Are you claustrophobic?	YES	NO
Are you dyslexic?	YES	NO
Have you ever had a serious head injury?	YES	NO
Have you ever had a concussion?	YES	NO
Have you ever been knocked unconscious?	YES	NO
Have you ever fainted?	YES	NO
Do you have arthritis or any other condition that limits your mobility?	YES	NO
Do you have any problems with your coordination?	YES	NO
Do you have any problems with, or diseases of your muscles?	YES	NO
Have you ever had an electrocardiogram (EKG)?	YES	NO
Have you ever had an electroencephalogram (EEG)?	YES	NO

DO NOT WRITE BELOW THIS LINE

Subject Information Form Review

Acceptable _____ Referred to physician _____

Investigator: _____ Date: _____

If referred to physician:

Health Status: Excellent _____ Good _____ Fair _____ Poor _____

Acceptable: _____ Not Acceptable: _____

Appendix B

Initial Subject Briefing

Welcome to the Protection and Survival Laboratory of the Civil Aeromedical Institute. Today you will be participating in a research project designed to study ways to improve safety in commercial air travel. Your participation is greatly appreciated and of the utmost importance. You can take a great deal of satisfaction in knowing that the results of your actions today may save the lives of passengers in the future. The focus of today's experiment is emergency airplane evacuations, or in other words, getting out of the airplane as fast as possible. Emergency evacuations are performed on real aircraft when an accident or malfunction occurs which demands that passengers leave the airplane as fast as possible for their own safety.

In today's experiment, you will be required to sit in our airplane mock-up and perform four simulated emergency evacuations. You may be called upon to remove the escape hatch that weights 45 pounds. You will be required to get up from your seat, move to and through the exit. The exit opening is 38 inches high and 20 inches wide (show pictures), with an exit sill 19 inches above the cabin floor inside the mock-up and 27 inches above the wing outside the airplane. You will be shown the exterior of the mock-up before entering. You will be given a boarding card that lists a seat number. Take that seat when you enter the airplane mock-up.

To participate today, you must not have any physical disabilities that prevent you from being able to evacuate through the exit. You must have no illnesses, such as heart disease, or other conditions, such as pregnancy, that restrict your ability to exercise. You must not be under the influence of alcohol or any drug, including certain prescription drugs. If this applies to you, please notify one of the research team. Although no real danger will exist in our evacuations today, we want you to understand the potential risks of injury associated with the evacuations. These may include, but are not limited to, cuts, bruises, and broken bones. These injuries can occur from bumping into seats or other cabin equipment and from slipping, tripping, falling, or being pushed. Still, we ask that you evacuate the mock-up as fast as possible, so that we may collect realistic data.

You should already have a subject information form. Please make sure you have recorded your subject number and your vest number on this form (pause). In a moment we will ask you to complete another form that gives us your informed consent to participate. This is a form that lets us show that you have been told about the tests, that you understand the procedures you will be required to carry out, and that you are willing to participate voluntarily. We will read the consent form aloud to you and answer any questions you may have. After completion of the evacuations, return to this room to complete your pay voucher. At all times please keep in mind the seriousness of this investigation and the importance of the results in helping save passenger lives.

For subjects in the high motivation groups:

Twenty-five percent of you will receive double the regular pay for your participation today. Success in being one of those to get this bonus pay depends on getting out of the airplane mock-up ahead of as many other people as possible. In order to win the bonus, you must be in the fastest ¼ of evacuees to get out the exit, averaged across all four evacuations. This means you might be the last person out of the mock-up in one of the evacuations, but still be able to win the bonus if you improve your relative position in the other evacuations. Don't give up. You will be seated in a different location for each evacuation - sometimes close to the exit and sometimes farther away. The seating rotation is balanced so that when all the evacuations are completed, everyone will have had an equal chance of winning the bonus. Questions?

Appendix C

IMPORTANT! PLEASE READ THIS FIRST!

SUBJECT INFORMATION FORM

As part of my participation in the experiment, I agree to provide the information requested below. This includes my name, age, gender, and health history, as well as my height, weight, and waist size - as measured and recorded by members of the research team. Also, I may be given personality profile evaluations. These standardized tests will be used to compare the group characteristics with the general population. I acknowledge that I am giving this information prior to being notified of the details of the experiment, but I understand that I may retrieve any information I provide should my participation in the experiment not be needed. **I certify that any information that I provide is accurate to the best of my knowledge.**

Signature: _____ Date: _____

Printed Name: _____ Subject #: *_____

*Your Subject # is: the first letter of your last name, followed by the last 4 digits of your Social Security Number. For example, John Doe, SSN=XXX-XX-0363. This person's Subject # would be: D-0363.

Are you left-handed _____ or right-handed_____

Sex:_____ Age: _____

Approximately how many commercial flights have you taken? _____

Highest school year completed: 8 9 10 11 12 13 14 15 16 17 18 19 20

Vest #_____

What is your occupation? _____

DO NOT WRITE BELOW THIS LINE

Tension 1_____ Tension 2_____

Weight _____ Height_____ Waist_____

Appendix D

Individual's Consent to Voluntarily Participate in a Research Project – Form N

I, _____, understand that this research project entitled *Passenger Escape from Aircraft using a Type III Exit* is being sponsored by the Federal Aviation Administration and is being directed by G. A. McLean, Ph.D., of the Civil Aeromedical Institute (CAMI). I have been hired by ATSA, Inc. to participate in this study.

PURPOSE: I understand that this project is designed to look at ways to improve commercial aircraft safety. The specific topic is escape from airplanes through a Type-III emergency exit. These exits, usually located over the wing, are used on commercial aircraft to allow passengers to get out of the cabin when an accident or malfunction occurs. There are federal standards governing these exits, and this study will help identify methods of using the exits in a more beneficial way.

DESCRIPTION OF STUDY: I understand that this research will be conducted using the FAA CAMI Aircraft Cabin Evacuation Facility (evacuation simulator), and will involve 2400 subjects, each of whom will be required to evacuate the airplane mock-up four times. As such, I will be seated inside the mock-up with my seatbelt fastened, and, when the start signal is given, I will unbuckle my seatbelt and move quickly to, and through, the exit to the outside of the mock-up. I understand that after exiting the mock-up, I must move out of the way of others coming out behind me. I understand that the trials I participate in will be videotaped. Between trials, I will remain outside the mock-up until I receive instructions from the research team. It is important that I always follow the directions given by the researchers and the flight attendant.

RISKS: I understand there are possible injuries that I could receive from my participation in this study. Such injuries could include, but are not limited to, bruises, cuts, strains, sprains and/or broken bones. These usually result from slipping, tripping, falling, jumping onto other subjects, or being pushed. In previous Type-III exit studies at this institute, the most serious injuries have been minor cuts, bruises, strains, and sprains. These were principally caused by lack of subject attention, and participation by subjects whose day-to-day activities do not include physical exertion. The estimated likelihood of such minor injuries is typically less than 1 per one hundred persons exiting through a Type-III exit. Most of the subject groups participating in Type-III evacuations for purposes of education or research have had *no* injuries, even with repeated evacuation trials. I have been briefed and shown pictures about the Type-III exit and how to properly accomplish these activities, and I have had opportunities to ask any questions I have concerning the research and my participation. All my questions have been answered to my satisfaction.

Subject's Initials _____

SUBJECT RESPONSIBILITIES: I certify that I have no physical disabilities that would prevent me from being able to evacuate the airplane mock-up, nor any illnesses, such as heart disease, or other conditions, such as pregnancy, that restrict my ability to exercise, move nimbly, or which could make this activity additionally hazardous.

I further certify that I am NOT under the influence of any medication or chemical substance, including alcohol, that may compromise my own safety or the safety of others directly associated with the research. I also acknowledge that I must withdraw NOW from participation in the project if I have any such condition or am under any such influence.

I agree to allow still photographs and/or videotapes to be made of me as required during the research, with the understanding that these records are the property of the U.S. Government, and that I am not entitled to monetary or other benefits, now or in the future, for the use of this material. I understand that I will not be identified by name in any pictures or videotapes of me that are used.

I understand that it is important to be accurate and honest with my responses on the subject questionnaires and any other questions the researchers may have about the research and my participation during the study.

I understand that it is very important to pay attention and follow all instructions from the research team. I understand that I must not trample or knock down any other person, or use excessive physical force while maneuvering to the exit. I hereby release the FAA from any and all claims that may arise as the result of my own negligence and/or failure to follow the instructions of the CAMI personnel.

Subject's Initials _____

BENEFITS: The major benefit to me will be my payment from ATSA, Inc. The major benefits to the FAA and the flying public will be improved safety on commercial aircraft.

COMPENSATION AND INJURY: I have been made aware that accident insurance coverage for this activity is provided only through the State of Oklahoma Workers Compensation Insurance Fund in relation to my employment for this project by ATSA, Inc., and that necessary immediate care of any resultant medical problems may be provided by the CAMI Clinic until, or unless, transportation to another medical facility is obtained. Follow-on care would be provided by local clinics and hospitals that would require verification of my Workers Comp insurance. I agree to provide CAMI, if requested, with copies of all insurance and medical records arising from any such care for injuries/medical problems.

Subject's Initials _____

SUBJECT'S ASSURANCES: I understand that my participation in this study is voluntary. I have not given up any of my legal rights or released any individual or institution from liability for negligence. I understand that I may withdraw from this study at any point during or between trials without penalty or

loss of benefits to which I am otherwise entitled. I understand that if new findings develop during the course of this research that may relate to my decision to continue participation, I will be informed.

Subject's Initials _____

I understand that all records of this study will be kept confidential, and that I will not be identified by name or description in any reports or publication about this study, except where photographs may include my picture. If I have questions about this study, or need to report any adverse effects from the research procedures, I will contact Dr. McLean at 405-954-5518.

I have read this consent document. I understand its contents, and I freely consent to participate in this study under the conditions described. I understand that I may request a copy of this consent form.

Do you understand that participation in this research project involves a risk of injury and that there are things you can do to reduce that risk?

(Initial one) YES _____ NO_____

_____ _____

Research Subject Date

_____ _____

Investigator Date

_____ _____

Witness Date

Appendix E

Individual's Consent to Voluntarily Participate in a Research Project – Form I

I, _____, understand that this research project entitled *Passenger Escape from Aircraft using a Type III Exit* is being sponsored by the Federal Aviation Administration and is being directed by G. A. McLean, Ph.D., of the Civil Aeromedical Institute (CAMI). I have been hired by ATSA, Inc. to participate in this study.

PURPOSE: I understand that this project is designed to look at ways to improve commercial aircraft safety. The specific topic is escape from airplanes through a Type-III emergency exit. These exits, usually located over the wing, are used on commercial aircraft to allow passengers to get out of the cabin when an accident or malfunction occurs. There are federal standards governing these exits, and this study will help identify methods of using the exits in a more beneficial way.

DESCRIPTION OF STUDY: I understand that this research will be conducted using the FAA CAMI Aircraft Cabin Evacuation Facility (evacuation simulator), and will involve 2400 subjects, each of whom will be required to evacuate the airplane mock-up four times. As such, I will be seated inside the mock-up with my seatbelt fastened, and, when the start signal is given, I will unbuckle my seatbelt and move quickly to, and through, the exit to the outside of the mock-up. I understand that, after exiting the mock-up, I must move out of the way of subjects coming out behind me. I understand that I am being offered double the regular pay for being among the fastest 25% of subjects to evacuate the mock-up, *averaged across all four evacuation trials*. I understand that the trials I participate in will be videotaped. Between trials, I will remain outside the mock-up until I receive instructions from the research team. It is important that I always follow the directions given by the research team and the flight attendant.

RISKS: I understand there are possible injuries that I could receive from my participation in this study. Such injuries could include, but are not limited to, bruises, cuts, strains, sprains and/or broken bones. These usually result from slipping, tripping, falling, jumping onto other subjects, or being pushed. In previous Type-III exit studies at this institute, the most serious injuries have been minor cuts, bruises, strains, and sprains. These were principally caused by lack of subject attention, and participation by subjects whose day-to-day activities do not include physical exertion. The estimated likelihood of such minor injuries is typically less than 1 per one hundred persons exiting through a Type-III exit. Most of the subject groups participating in Type-III evacuations for purposes of education or research have had *no* injuries, even with repeated evacuation trials. I have been briefed and shown pictures about the Type-III exit and how to properly accomplish these activities, and I have had opportunities to ask any questions I have concerning the research and my participation. All my questions have been answered to my satisfaction.

Subject's Initials _____

SUBJECT RESPONSIBILITIES: I certify that I have no physical disabilities that would prevent me from being able to evacuate the airplane mock-up, nor any illnesses, such as heart disease, or other conditions, such as pregnancy, that restrict my ability to exercise, move nimbly, or which could make this activity additionally hazardous.

I further certify that I am NOT under the influence of any medication or chemical substance, including alcohol, that may compromise my own safety or the safety of others directly associated with the research. I also acknowledge that I must withdraw NOW from participation in the project if I have any such condition or am under any such influence.

I agree to allow still photographs and/or videotapes to be made of me as required during the research, with the understanding that these records are the property of the U.S. Government, and that I am not entitled to monetary or other benefits, now or in the future, for the use of this material. I understand that I will not be identified by name in any pictures or videotapes of me that are used.

I understand that it is important to be accurate and honest with my responses on the subject questionnaires and any other questions the researchers may have about the research and my participation during the study.

I understand that it is very important to pay attention and follow all instructions from the research team. I understand that I must not trample or knock down any other person, or use excessive physical force while maneuvering to the exit. I hereby release the FAA from any and all claims that may arise as the result of my own negligence and/or failure to follow the instructions of the CAMI personnel.

Subject's Initials _____

BENEFITS: The major benefit to me will be my payment from ATSA, Inc. The major benefits to the FAA and the flying public will be improved safety on commercial aircraft.

COMPENSATION AND INJURY: I have been made aware that accident insurance coverage for this activity is provided only through the State of Oklahoma Workers Compensation Insurance Fund in relation to my employment for this project by ATSA, Inc., and that necessary immediate care of any resultant medical problems may be provided by the CAMI Clinic until, or unless, transportation to another medical facility is obtained. Follow-on care would be provided by local clinics and hospitals that would require verification of my insurance. I agree to provide CAMI, if requested, with copies of all insurance and medical records arising from any such care for injuries/medical problems.

Subject's Initials _____

SUBJECT'S ASSURANCES: I understand that my participation in this study is voluntary. I have not given up any of my legal rights or released any individual or institution from liability for negligence. I understand that I may withdraw from this study at any point during or between trials without penalty or loss of benefits to which I am otherwise entitled. I understand that if new findings

develop during the course of this research that may relate to my decision to continue participation, I will be informed.

Subject's Initials _____

I understand that all records of this study will be kept confidential, and that I will not be identified by name or description in any reports or publication about this study, except where photographs may include my picture. If I have questions about this study, or need to report any adverse effects from the research procedures, I will contact Dr. McLean at 405-954-5518.

I have read this consent document. I understand its contents, and I freely consent to participate in this study under the conditions described. I understand that I may request a copy of this consent form.

Do you understand that participation in this research project involves a risk of injury and that there are things you can do to reduce that risk?

(Initial one) YES _____ NO_____

_____ _____
Research Subject Date

_____ _____
Investigator Date

_____ _____
Witness Date

Appendix F

Subject/Safety Briefing

The experiment we are conducting today is very important to the future of aviation safety. To ensure that you get all the information you need, please remain quiet and listen at all times to the instructions of the research team.

Emergency aircraft evacuations are conducted when extreme situations such as a crash with fire develop. They require passengers to get out of their seats, hurry to the exit, and get outside the exit as fast as possible. Although you must move very fast, do not trample, knock down, or use excessive physical force on the other passengers during these evacuations. Even though the tests only simulate real emergencies, such as aircraft fires, the potential risks of injury are similar to those you could experience in a real evacuation.

While we have taken every foreseeable precaution to insure your personal safety, occasionally the unexpected happens. If an unsafe condition occurs, a member of the research team will stop the evacuation by sounding this alarm (sound bell). If you hear the alarm at any time during the evacuation, immediately stop moving, stay where you are, and wait for further instructions.

This buzzer will be used to start each evacuation (sound buzzer). The only emergency exit available is the window exit there on the right side of the airplane (point). Please take a moment to look over there to see where the exit is located. There are uniformed flight attendants here in the cabin today (point). They are in charge of the cabin during the evacuation. Please follow any instructions that they may give you. After you evacuate the mock-up, move down the ramp to the right and walk alongside the facility inside the rope. A researcher will be there to meet you.

For subjects in the high motivation groups:

Twenty-five percent of you will receive double the regular pay for your participation today. Success in being one of those to get this bonus pay depends on getting out of the airplane mock-up ahead of as many other people as possible. In order to win the bonus, you must be in the fastest ¼ of evacuees to get out the exit, averaged across all four evacuations. This means you might be the last person out of the mock-up in one of the evacuations, but still be able to win the bonus if you improve your relative position in the other evacuations. Don't give up. You will be seated in a different location for each evacuation - sometimes close to the exit and sometimes farther away. The seating rotation is balanced so that when all the evacuations are completed, everyone will have had an equal chance of winning the bonus. Questions?

Pre-evacuation Trial Briefing: Is everyone ready? (Pause)

Please make sure your seatbelt is fastened securely around you. To fasten your seatbelt, insert the metal fitting into the buckle (demonstrate). Tighten the belt by pulling on the loose end of the strap. To release the belt, lift up on the buckle flap. In a short time the start buzzer will sound to signal the beginning of the evacuation. When you hear the buzzer, immediately unbuckle your seatbelt, get up, and leave the aircraft through the exit as fast as you can. If you have any questions, please ask now (pause).

Remember – we are simulating a commercial plane crash in which an *intense fire* has developed. To stay alive we must get out of here as fast as we can. *Hurry!*

Ready?