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Evaluation of Egress From Side-Facing Seating With Deployed Inflatable Safety Equipment

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16. Abstract

This research project was developed as part of an effort to address questions arising from special conditions concerning side-facing seats on transport category airplanes and to examine any effect airbags used for occupant crash protection might have during an egress event. This report examines the history of proposed use of airbags on airplanes through the special conditions and briefly examines the current state of research relating to side facing seats. The experimental trials developed for this project were designed to look at an initial worst case scenario involving multiple sets of overlapping airbags and what, if any, impediment they might pose to an egress event. This study found no statistically significant difference in egress times with the airbags present than those trials that did not contain airbags in the passageway, though there was a slight delay thanks to their introduction.

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INTRODUCTION

Background

The Federal Aviation Administration (FAA) has as one of its main goals the mission to provide the safest aerospace system in the world. It works to accomplish this through regulations and standards that address protection of aircraft occupants in the event of a crash, and egress from the aircraft after such an incident has occurred. The ongoing effort to maintain the safety of the aerospace system requires the issuance of special conditions to address the certification of certain items. A Special Condition is defined by the Code of Federal Regulations (CFR) 14, Part 11.19 as "...a regulation that applies to a particular aircraft design. The FAA issues special conditions when we find that the airworthiness regulations for an aircraft, aircraft engine, or propeller design do not contain adequate or appropriate safety standards, because of a novel or unusual design feature." Special conditions are a relatively quick way to approve innovations, but they are extremely specific and limited in scope to whomever is applying for the exemption, be it the airframe manufacturer (e.g., Federal Aviation Administration, 2009a; 2009b; 2009c; 2016b), a specific airline (e.g., Federal Aviation Administration, 2011), the manufacturer of the product (e.g., Federal Aviation Administration, 2004; 2005; 2006), or even an aircraft interiors modification company for a non-commercial transport airplane (e.g., Federal Aviation Administration, 2016a). Special conditions are established to lay out the criteria that the proposed system would have to meet to be considered at least as safe as the existing standards and to not introduce new hazards. The criteria are based primarily on an understanding of systems and advances in technology gained through research performed by the applicant or from publically available sources of information. The onus is then on the requestor to show that the modification meets the special condition before the installation is approved. Additional rulemaking, such as to bring a commonly requested feature to multiple aircraft or to update existing regulations to include more modern features, requires more evidence provided by an abundance of demonstrations, which usually remains proprietary information owned by the company doing the demonstrations, or through research which is published and publically available. The Civil Aerospace Medical Institute (CAMI) supports such research activities through teams like the Cabin Safety Research Team (CSRT), which includes under its umbrella of interest, research pertaining to the evacuation of occupants from airplanes. This report is in support of such an effort, being the process of establishing enough data to support decision making for the use of emergency air bags to limit axial rotation of the leg (leg-flail) in side-facing seats on airplanes, specifically looking at the requirements set forth in special conditions relating to egress.

Airbags

Airbags have long been considered for use on transport category aircraft as a means of improving occupant protection during an accident, with an early example being the proposed use of airbags to meet certification requirements for occupant head injury mitigation (Federal Aviation Administration, 1997). Since then, multiple requests and proposals have been put to the FAA to allow the use of airbags on aircraft, most often mounted with the occupant restraint system or lapbelt (Federal Aviation Administration, 1997; 1999; 2000; 2004; 2005; 2006; 2008; 2009a; 2009b; 2009c; 2011). All of the special conditions concerning airbags have two requirements related to occupant egress: that the airbags must not introduce new injury mechanisms or injure the occupant in such a way it would impede their egress, and that the airbags must not impede egress 10 seconds after the event which caused them to deploy. The reasoning behind the 10 second limit, as spelled out in most of the special conditions, is that the event that would cause the bags to deploy (a crash) would not be occurring simultaneously with the evacuation of the airplane. The primary concern in egressing after a lapbelt mounted bag has been deployed are, first, that the airbag would end up in the aisle or passageway, possibly causing impediment if the bags were still rigid from inflation, and second, that the airbag would introduce a slip hazard with occupants stepping on the bag. There have been demonstrations by the manufacturers attempting to address these issues in the course of attempting to meet the special conditions, but there has not been formal, published research looking at the matter prior to this study.

Side-Facing seats

Side-facing seats on aircraft are a unique configuration that has been the subject of ongoing research for many years (see DeWeese, Moorcroft, Abramowitz, and Pellettiere, 2012). One of the areas of concern with side-facing seats is with the occupant facing towards the centerline of the aircraft, the majority of the force that would be applied during an impact would be perpendicular to the occupant's orientation, which is not a configuration that was specifically accounted for when dynamic testing requirements for seats was developed. Providing the same level of safety for occupants of these seats as is provided occupants of fore/aft facing seats can be challenging. Airbags have been used to aid in occupant protection from these perpendicular forces, primarily to mitigate head and neck injury. The special conditions for side-facing seats also include a provision that the axial rotation of the occupants lower legs be limited to 35 degrees from the normal seated position. This requirement is intended to prevent the legs from rotating far enough that they end up breaking during the impact, thus impairing occupant egress (Federal Aviation Administration, 2013a; 2013b). The use of airbags that would deploy close to the occupant's legs was suggested as a way to meet this requirement (Federal Aviation Administration, 2016a; 2016b). This arrangement emphasizes the concerns raised with lapbelt deployed airbags, and so the CSRT accomplished a research project to investigate the impediment/slipping issue that may or may not occur with proposed aviation airbags in general, and leg-flail prevention airbags in particular.

METHOD

Facilities/Materials

All research plans and materials were approved by the CAMI Institutional Review Board (IRB) to ensure that human subjects safety and privacy issues were properly addressed before the commencement of the project. This research project utilized the CSRT Classroom located of the CAMI building. This project also used the CSRT Lab Room, also located on the first floor of the CAMI building. This project utilized two medical scales to gather participant height and weight information and two tailoring flexible tape measures to gather participant girth measurements. A stopwatch was used to determine timings for starting experimental trials.

Mock-up/Seats

A mock-up was built for this project in the CSRT Laboratory Room to represent the cabin of a small, corporate jet sized airplane (Figure 1). The mock-up contained a total of 12 seats: six individual simulated aircraft seats repurposed from an aircraft cabin simulator (“target seats”) and six free-standing fixed leg conference style seats (“additional seats”). The target seats were 44.5 inches tall as measured from the floor to the top of the seat back, and 21 inches wide with a seating surface 18 inches off the floor with a 19-inch-wide by 19-inch-deep seating surface. The additional seats were 35 inches tall with a seating area 18 inches off the floor and had an 18-inch wide by 19-inch deep seating surface. All seats were oriented to be perpendicular to the nominal forward of the mock-up (“side-facing”). The target seats were secured to the mock-up platform with aircraft seating track with a 20-inch main aisle, marked with fluorescent tape, and 21.5-inch lateral separation measured from the outside edge of one armrest to the same point on the next seat's armrest. The additional seats were set up in the same basic configuration toward the nominal aft of the target seats; there was a 40-inch separation between the additional seats and the target seats and a ramp enabling a two-inch rise over a four foot run leading from the additional seating area to the mock-up platform. The additional seating positions were marked on the floor to be repositioned in the event of drifting during egress. The mock-up platform was flat and covered in carpet of the same type installed in the full size cabin simulators operated by the CSRT; additional carpet was extended to cover the floor housing the additional seating, and a ramp was installed to eliminate any confounding variables resulting from transitioning from the floor to the platform. A simulated exit was established at the nominal forward end of the mock-up with another ramp extending from the mock-up to the floor of the lab. The exit was located 25 inches forward of the foremost target seats and consisted of two partitions with an exit width of 31 inches centered on the main aisle and no overhead limitations. The exit partitions were clearly marked on the outside edges with florescent tape to aid in exit discrimination during the data reduction phase.

Figure 1: Picture of mock-up taken through forward opening, looking aft.

Airbags

The side-facing seat leg flail airbags ("airbags") were donated for this research by a single manufacturer. When fully inflated, the airbags were approximately 20 inches in length with a cross section that resembles a "D" with the flat section facing aft. After discussion with the manufacturer, it was determined that shop air could be used to safely inflate the airbags to a level approximating the immediate time after their deployment in an emergency event. The airbags were connected in parallel to two compressed air outlets outputting approximately 100psi. The airbags were mounted to the target seats approximately 12 inches from the floor and, when fully inflated, all airbags were no less than 2 inches off the floor (all airbags were resting on the floor when not fully inflated). All airbags were mounted on the mock-up forward side of the target seats. All airbags had at least one point where they were able to touch the airbag across the aisle from their position (Figure 2).

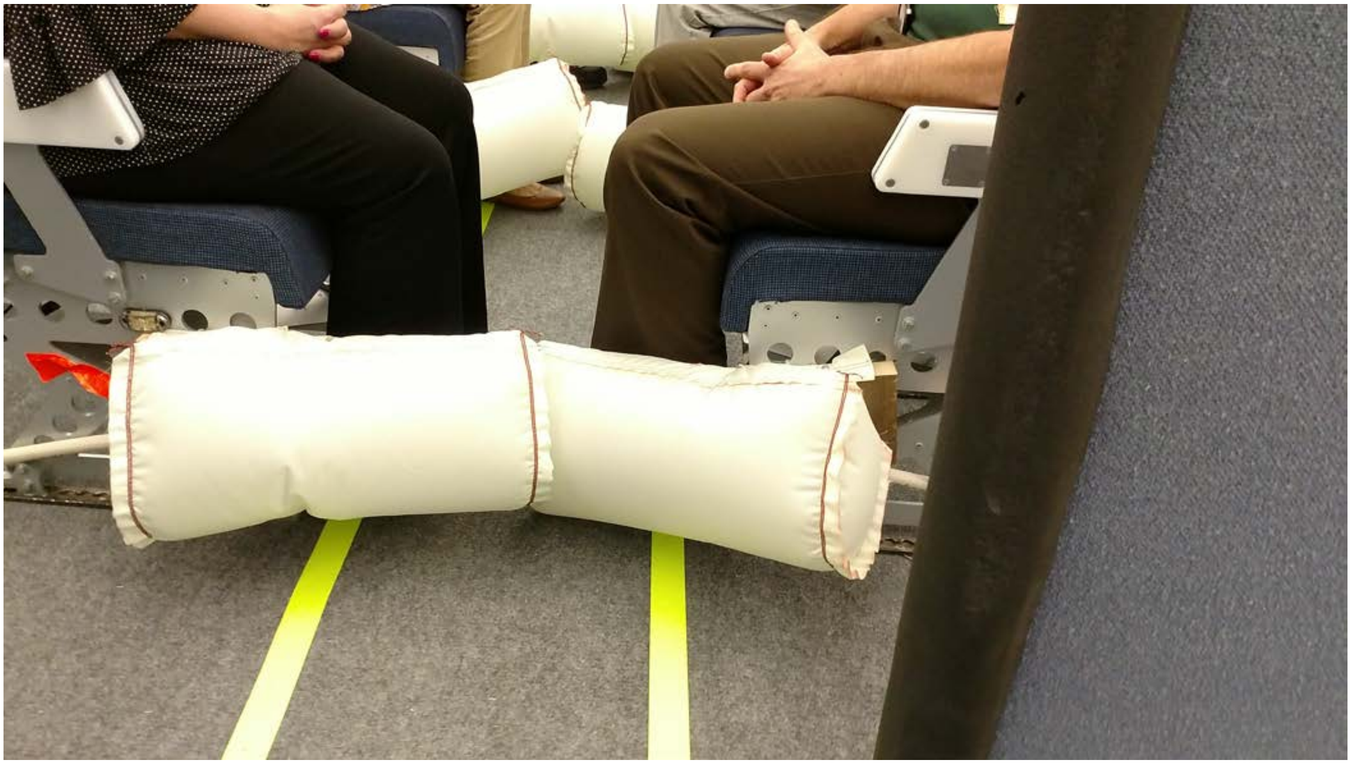

Figure 2: Airbags fully deployed with participants; the picture was taken from just outside forward opening of mock-up.

Signal

A buzzer activated by push button was installed in the CSRT Lab Room to act as the trial start signal. The buzzer was clearly audible through the testing room.

Questionnaires

A pre-test questionnaire (Appendices B and C) were given to each participant, and the answers were transferred to electronic format by the principal investigator for ease of analysis. The pre-test questionnaire contained questions to collect participant flight history, aircraft evacuation history, and a question about any neck, knee, or back injuries that may affect their performance. The post-test questionnaire collected self-report experiential data about the egress trials including the participant's opinion of easiest and most difficult seats of egress.

Data Collection/Reduction

Video was recorded using four Sony PMW-300K1 high definition video cameras at 30 frames per second. Video angles included a forward facing angle (camera located beyond the rear of the mock-up), an aft facing angle (camera located beyond the exit of the mock-up), an airbag/aisle observation angle (camera located to the "starboard" side of the mock-up), and an exit observation angle (camera located to the "port" side of the mock-up, perpendicular to the exit). All recordings were delivered as Windows Media Video (.wmv) files with a digital time code applied (established with the trial starting signal) based on the 30 frames per second format of the video. Data extraction was accomplished with Windows Media Player and entered into Microsoft Excel. After conversion of the time codes from base 30 to decimal fractions of a second, the data was transferred to IBM SPSS version 23 (Armonk, NY: IBM Corp.) for statistical analysis. Variables of interest were defined as follows:

"Overall Egress Time" was defined as the time from the start of the trial ("signal") to the time stamp when the final participant of the group had completely crossed through the exit opening (no parts of their body or clothes were within the exit aperture/blocked from the camera view by the exit partition).

"Individual Egress Time" was defined as the time stamp when one participant had fully exited the mock-up minus the time stamp when the preceding participant had fully exited the mock-up. Therefore, this measurement was not recorded (i.e., available) for the first individual out for each trial. This measurement has been shown by previous research as a reliable measurement to allow for between-subject analysis of egress and any effects of the independent variables and their interactions (McLean et al., 2002).

"Bag Interaction" was defined utilizing an approach/avoid dichotomy and was recorded utilizing three levels: no interaction, step through (participant did not deviate walking pattern when encountering an airbag), and step over/around (participant showed deviation in walking pattern at airbag locations, either an exaggerated stepping motion [step over] or in some cases where the airbags had previously been stepped/kicked through, participants altered step patterns from a straight line toward the exit to walk around/through the opening between the airbags).

Experimental Design

This research project was designed to investigate the effects of leg-flail airbags in the aisle on egress and, from the observations, provide insight to the special condition proposed for their governance on aircraft and to begin establishing data to support future rulemaking governing use of occupant airbags on airplanes. Two main questions were posed for this project: Are there significant differences between egress times with and without the airbags, and are there significant differences in egress times based on the delay between the event causing the airbags to be deployed and egress? To answer these questions, the project was designed to collect comparison data with an egress from the mock-up with no airbags (control) and then from multiple egresses containing the airbags at different time intervals between the cessation of airflow and the starting buzzer sounding (experimental trials) with the intervals being set at no-delay (airflow stops, buzzer sounds), 5-second delay (airflow stops, 5 seconds pass, buzzer sounds), and 10-second delay (airflow stops, 10 seconds pass, buzzer sounds). For ease of between-group comparisons the order of the trials were the same for each group and seating was assigned on a per trial basis to ensure each participant was in a target seat for two of the trials. Each group experienced five runs: familiarization, control, 5-second delay, no-delay, and 10-second delay. The design of the mock-up was determined after establishing that the proposed aircraft configurations which would employ the airbags would usually have one or two pairs of airbag interactions at most and less than 12 people interacting with them. The mock-up was designed then to include three pairs of overlapping airbags and accommodate 12 participants. It was then estimated through power calculations that four groups of 12 would provide enough data to begin examining the issues of airbag egress interactions, assuming a medium effect size was present.

Participants

The participants for this project were drawn from standing agreements between the CSRT/CAMI and local, State, and Federal Agencies who use CSRT facilities for their own training purposes to provide volunteer research participants when there are small scale studies to be conducted by the CSRT research staff that fall on the same dates as their training activities. Additional research participants were drawn from Federal employees at CAMI. Participants received no compensation beyond the satisfaction of contributing to the improvement of aviation safety.

Procedure

Prior to testing, the participants were brought to the CSRT Classroom to review the informed consent (Appendix A) with the research staff. Participants signed and returned a copy of the informed consent to the research staff to indicate they wished to be a part of the test. Participants were then assigned a numbered vest and provided demographic information (height, weight, girth, age, gender) in a testing area partitioned off at the back of the classroom with a same-sex research assistant. Participants then returned to their seats and were given the pre-test questionnaire (Appendix B) to fill out. Once completed, the participant handed the form back to a research assistant. Once all participants had returned their completed pre-test questionnaire, the group was taken down to the CSRT Laboratory Room and given a briefing and demonstration walkthrough of the mock-up, which was prepared with the airbags secured away from the floor and against the forward side of the aircraft seats, out of the way and view of participants. For all trials, the principal investigator was on the port side of the mock-up to ensure uniformity of the apparatus (additional seat location/orientation and airbag disposition), with a research assistant (#1) directing the traffic flow of participants before and between trials, an assistant (#2) on the starboard side of the mock-up to ensure uniformity of the apparatus and act as safety on that side, and a third assistant (#3) stationed at the shop air valve and operating the signal buzzer. Participants were told to take a seat and given the evacuation signal with no additional warning as a practice/familiarization run. The signal to start was directed by the principal investigator and activated by assistant #3. Once this was completed the participants were assigned seats for the first trial (control) to gather the egress data for later comparison. After this first trial, the airbags were released to hang limply by the seats. Participants were given their seat assignments for the trial and, once seated, the airbags were inflated. Each of the experimental trials followed the same procedure: the airflow was initialized, airbags were visually inspected by the principal investigator and assistant #2 and adjusted as needed. After non-verbal confirmation that the airbags were ready, assistant #3 received the signal to cut the airflow and sound the buzzer at the appropriate time as demanded by the trial. Once all trials were completed, the participants were taken back to the CSRT classroom and given the post-test questionnaire (Appendix C). Once this and the numbered vests were returned to the research staff, the participants were debriefed and received answers to any project related questions they had before being dismissed.

RESULTS

Participants/Demographics

Forty-eight (48) participants volunteered to participate in this study. When asked about pre-existing conditions that may impact egress, two participants self-reported they had knee replacements in their history, one self-reported a weak ankle, and one self-reported having experienced lower back pain. When asked if they would still like to participate given the physical nature of the trials, all four indicated they would participate. On examination of the egress data, these four participants were among the average egress timings. All 48 participants who volunteered were included in the final data analysis. Detailed group (male/female) and overall demographic information are reported in Table 1.

Group (N)		Age (Years)	Height (Inches)	Weight (Pounds)	Girth (Inches)
Females (24)	Min	20	61	123	28
	Max	72	70	267	52
	Mean	45.1	64.9	187.2	39.3
	SD	13	2.6	44.7	7.1
Males (24)	Min	28	67	146	33
	Max	68	75	330	50
	Mean	52	70.1	223	42.1
	SD	10.7	2.2	43.5	4.7
Overall (48)	Min	20	61	123	20
	Max	72	75	330	72
	Mean	48.5	67.5	205.1	40.7
	SD	12.3	3.5	47.3	6.2

Table 1: Participant Demographics

Egress Times

Detailed individual and overall group egress times are reported in Table 2. In the course of this project, there were 16 overall egress times that encompass 192 individual exit crossings and 176 individual egress times (see *Data Collection/Reduction* – "Individual Egress Time").

	Group 1				
	Trial:	**Control**	**No Delay**	**5(s) Delay**	**10 (s) Delay**
Overall:	End	14.67	16.73	16.30	16.13
Individual:	Minimum	0.77	0.97	0.8	0.7
	Maximum	1.57	1.6	1.87	1.63
	Mean	1.08	1.18	1.16	1.13
	Standard Deviation	3.90	4.29	4.28	4.20
	Group 2				
	Trial:	**Control**	**No Delay**	**5(s) Delay**	**10 (s) Delay**
Overall:	End	12.60	12.80	13.30	12.70
Individual:	Minimum	0.57	0.5	0.77	0.63
	Maximum	1.33	1.53	1.47	1.2
	Mean	.92	.93	.99	.96
	Standard Deviation	3.21	3.41	3.56	3.37
	Group 3				
	Trial:	**Control**	**No Delay**	**5(s) Delay**	**10 (s) Delay**
Overall:	End	11.17	13.73	14.13	14.03
Individual:	Minimum	0.67	0.7	0.73	0.8
	Maximum	1	1.47	1.37	1.8
	Mean	.85	1.02	1.04	1.06
	Standard Deviation	3.09	3.91	3.65	3.72
	Group 4				
	Trial:	**Control**	**No Delay**	**5(s) Delay**	**10 (s) Delay**
Overall:	End	12.60	14.10	14.23	13.90
Individual:	Minimum	0.60	0.63	0.73	0.53
	Maximum	1.17	1.6	1.4	1.33
	Mean	.92	1.03	1.03	1.03
	Standard Deviation	3.38	3.87	3.59	3.70

Table 2: Egress Times by Groups and Trials

There was a slight increase in overall egress times between the control run and the runs with airbags, with the biggest difference being an increase of 2.96 seconds in group 3, (5 second delay trial). However, when evaluating individual egress times there were no statistically significant differences between the trials based on groups ($p = 0.332$).

Demographics by Egress Times Interactions

Demographics information was analyzed in comparison to individual egress times by trial and average individual egress times created by averaging the individual egress time of each participant across all trials. Of the demographics information collected, only age was significant both in multiple separate trials individual egress times and the average individual egress time $F(1,46) = 6.432$, $p = 0.015$. Further analysis found no other variables or interaction of variables accounting for statistically significant variance in average individual egress time.

Airbag Interactions

This project produced 360 individual data points on participant/airbag interaction. Of those, the majority (224) were instances where participants chose to step through the area of the bag while the remaining 136 interactions were choices to step over or avoid the bag. One trial contains an exception to this, however, as during group four, trial four, one participant chose to sit in such a way as to not engage with the airbag and this lack of interaction led the airbag to remain parallel to the aisle, leaving a large enough gap in the aisle that there was no need for half of that group to evidence avoidance behavior of the airbags in the aisle. While this was a behavioral difference with potential consequences on the dataset, analysis of the data did not indicate a significant difference in bag interactions based on looking at the other trials that group experienced with airbag interactions.

Post-Test Questions

All participants completed the post-test questionnaire. Of the 48 participants in this project, four (8%) reported some difficulty during the evacuation. When asked which seat was the easiest to get out of, 12 participants (25%) expressed no preference, 12 (25%) preferred the non-aircraft seats, 11 (22.9%) preferred the aircraft seats, and the remaining 13 (27.1%) indicated a specific seat with the aircraft seat immediately adjacent and to the left of the exit receiving the majority of the preference with 7 (14.6% total) of the specifications. When asked which seat was the most difficult seat to get out of, two participants (4.2%) gave no answer, 21 (43.8%) indicated no specific chair as difficult, 10 (20.8%) indicated the non-aircraft seats, 8 (16.7%) indicated the aircraft seats, and the remaining 7 (14.7%) indicated a specific chair with the aircraft middle right seat receiving two specifications (4.2%) as the most difficult and the rest receiving one specification each. No definitive pattern could be discerned from the responses to the questions pertaining to participant perception of the most and least difficult trial.

DISCUSSION

In regard to egress with airbags in the passageway, this study found no statistically significant difference in egress times with the airbags present than those trials that did not contain airbags in the passageway, though there was a slight delay thanks to their introduction. What was of interest, however, was the cause of the delays that were seen. When reviewing the video data, it was clearly seen that the participants generally fell into two patterns when it came to the airbags, termed here as approach or avoid (Figure 3). Avoid behavior, in this context, refers to those participants who went out of their way, or spent time to avoid interacting with the airbags during the egress trials; most often this was seen as a step-over behavior and led to hesitation to place the feet for a high step that was not noticed during the actual trials but was very easy to identify during data breakdown (Figure 4). The other avoidance behavior occurred more toward the tail-end of the group during some trials where, having been moved aside by previous occupants, the latter avoider could simply step through an opening between the airbags with enough body movement to indicate to the camera that they were still actively avoiding touching the bags.

The approach behavior in this context was applied to those who demonstrated either no discernable avoidance behaviors, as the second class of avoid participants discussed earlier, or actively kicked through the bags when they were in the way (Figure 5). These participants' only obstacle to egress from the mock-up appeared to be caused by social convention and the participants ahead of them in the queue. A further interesting psychological observation was that the majority of participants were not "active" approachers or avoiders, active meaning doing the same behavior through all three experimental trials but were, instead, "passive" and followed the example of the participants ahead of them. No slipping on the bags was observed during any of the trials, though the airbags were resting on the ground at some point during the active experimental trials.

Figure 3: Capture of both Approach (Participant 14) and Avoid (Participant 10, in front of 14) behavior towards the airbags.

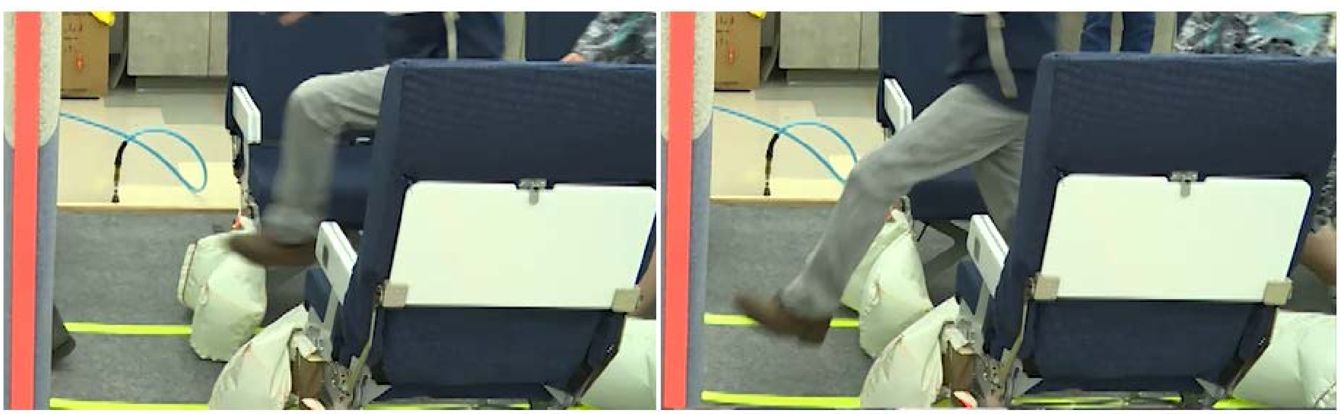

Figure 4: Two captures in sequence demonstrating the avoidance/step-over behavior.

Figure 5: Two captures in sequence demonstrating the approach/kick-through behavior.

Demographics analysis showed an interesting interaction between sex and individual egress times, in that males were significantly faster on average than females throughout the study. Previous evacuation research has shown that the greatest variance in egress times is individual difference, with the greatest predictor being age and weight; McLean, et. al., (2002) found that older, heavier females were the slowest to egress through a type III exit, the closest this study was to supporting those findings were that the females were slower than the males, though that can probably be explained by the differences in physical activity required by this study versus the previously mentioned egress research.

As with all research projects, this one had its limitations that could be addressed with further research. Though only mentioned by a few participants, an issue was the design of the mock-up, requiring a two-inch ramp between the area with non-airplane seats, and the area with the simulated airplane seats and airbags. This did not appear to influence the results, as there was a definite queue that formed during the evacuation that seemed to preclude the gradual two-inch rise from slowing the participants down. Future changes to the mock-up could eliminate this issue by assuring the two areas are on the same level. Alternatively, mounting a full complement of simulated aircraft seats to a platform and only having some incorporate the airbag system would address this issue. Participants in this study, though urged to do so, did not exhibit a sense of urgency or great haste in performing the evacuation trials; this could be improved in the future by more urging from the researchers or possibly monetary incentives. Also of note is the state of the airbags during these trials was not exactly as it would be during an evacuation after a crash because the airbags are designed to cushion an impact by bleeding air from the bag during the event. The airbags' condition in this study could be considered closer to an inadvertent deployment rather than post-crash. Post-crash airbags would hypothetically be less inflated which may or may not have an effect on egress times compared to those found in this study. Hindsight also suggests having one condition with the bags completely deflated yet lain in the aisle as an improvement to the current study to test for both this hesitation effect and better address the concern of passengers slipping on the airbags.

Future Research

The debrief of participants and discussion of this project with other researchers has brought up excellent questions for further consideration. Future research studies could include similar trials with more participants, possibly separate trials in an emergency lighting situation where the participants are less able to see the airbags and trials with the airbags in a post-deployment/post-impact state to investigate the hesitation effect mentioned above.

Conclusion

Based on the results of this initial study of airbag material laying in the main aisle of the cabin, there appears to be little impact on an evacuation overall. Given the benefits of the airbag system, the prevention of breaking passengers' legs before an evacuation can commence far outweighs the slight increase in main aisle transit times.

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APPENDIX A: INFORMED CONSENT

CIVIL AEROSPACE MEDICAL INSTITUTE

Individual's Consent to Voluntarily Participate in a Research Project

I, ________________________________, understand that this research project entitled *Evaluation of Egress from Side Facing Seating with Deployed Safety Equipment* is being sponsored by the Federal Aviation Administration and is being directed by D. B. Weed, MA, of the Civil Aerospace Medical Institute (CAMI), Oklahoma City, OK. He is assisted by researchers Melissa Beben, M.S., and Kenneth Larcher, M.A.S, as well as technicians David Ruppel and Kelly Guinn.

PURPOSE: This project is designed to evaluate egress procedures and safety equipment related to side facing seats in airplanes. Specifically, this test is to determine if airbags on side facing seats will slow egress from an aircraft.

CONFIDENTIALITY ASSURED: I understand that all records of this study will be kept confidential, and that I will not be identified by name in any reports or publications about this study. I understand that this document will be the only place my name will be recorded in this project. I understand that I will be provided with a participant number should I agree to participate in this research project and that all collected data will refer only to that participant number.

DESCRIPTION OF STUDY PROCEDURE: I understand that my demographic information (gender, age, height, weight, waist measurement) will be recorded in a private room with a same gender researcher and I will provide flight and evacuation experience information before the study trials begin. I agree to provide accurate answers to demographic and test questions. I will receive instructions about which seat I will use for each trial and when and where to evacuate. I understand that my actions will be video-recorded. I will provide feedback about the research experience after the trials.

DISCOMFORT AND RISKS: I understand that the probability of harm or discomfort anticipated in this research is slightly greater than that encountered in daily life or during the performance of routine examinations and tests. I will be exposed to a buzzer sound. I will be egressing from a simulated aircraft cabin. I understand that the greatest anticipated risk of injury is a possible slip, trip, or fall. I understand that the risk of injury as a result of participating in this study is slight. I understand that the researchers have taken precautionary measures to mitigate this anticipated risk. I understand that I have the option to review these mitigations before consenting to this study.

____ By initialing here I confirm that I have read and understand the above description of risk in this study.

INJURY AND COMPENSATION: I agree to immediately report any injury, adverse effect or suspected adverse effect to Mr. David Weed (phone 405-954-9218). Cost of medical care, lost wages, direct or indirect losses incurred as a result of participation in this study are not covered by the Civil Aerospace Medical Institute (CAMI). These costs are generally covered by your personal insurance or through the Worker's Compensation Insurance Fund as provided by your employer.

PARTICIPANT RESPONSIBILITIES: I agree to allow still photographs and/or videos 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 videos of me that are used. I understand that it is important to follow instructions, perform the tasks to the best of my ability, and to be accurate and honest with my responses to demographic and test questions.

BENEFITS: I understand that the major benefit to the flying public and me will be improved safety on commercial aircraft. I understand that I will not be receiving any other compensation for participation in this research project.

PARTICIPANT'S ASSURANCES: I understand that my participation in this study is voluntary and that I may withdraw from the study at any point without penalty.

I have read this consent document. I understand its contents, and I freely consent to participate in this study under the conditions described. All my questions have been answered to my satisfaction. I understand that 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 contact David B. Weed at 405-954-9218, should I have additional questions.

Signature of Participant	Date
Signature of Investigator	Date
Signature of Witness	Date

APPENDIX B: PRE-TEST QUESTIONNAIRE

Pre-Test Questionnaire Vest Number: ______________

1. Have you been a research participant in research at CAMI before?

Yes No

2. How many flights have been on in the last 12 months?

____

3. Have you ever flown on a small (less than 20 passenger/corporate) airplane before?

Yes No

4. Have you participated in an aircraft evacuation before?

Yes No

4a. If yes, was it during training, research, or unscheduled?

Training Research Unscheduled

5. Do you have any issues that you feel might impair your ability to rapidly egress from an airplane (neck/knees/back injuries)?

Yes No

5a. If yes, please indicate the type of impairment you are referring to:

____

APPENDIX C: POST-TEST QUESTIONNAIRE

Post-Test Questionnaire   Vest Number: ______________

1. Did you experience any difficulties with the evacuations?

Yes   No

1a. If Yes, Please describe in a few words what you had difficulty with:

____

____

2. Which seat, if any, did you feel was the easiest to get out of?

____

3. Which seat, if any, did you feel was the most difficult to get out of?

____

4. Which trial, other than the first, did you feel was the easiest for you?

2nd   3rd   4th

5. Which trial, other than the first, did you feel was most difficult for you?

2nd   3rd   4th

6. Do you have any suggestions to improve the ease of evacuation?

____