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Emergency Exit Operation and Location: Type III Exits

Melissa S. Beben

David B. Weed

Civil Aerospace Medical Institute (CAMI)

Federal Aviation Administration

Oklahoma City, OK 73169

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Author ORCIDs: Beben (0000-0003-0587-5984), Weed (0000-0002-5184-6933)

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12. Abstract

This project was an investigation of multiple transport category airplane Type III door dimension changes to evaluate its general impact on safety and egress speed. The goal was to provide rulemakers with a generalizable result to address requests to modify airplane exits for the purpose of increasing the allowed number of passengers per door exit rating. Participants exited the door types in both an individual and group setting. There were 160 participants through six different Type III doors, of which three are currently in operation, and three are experimental. The doors that had a smaller step-up and step-down height had the fastest average egress times and the shortest range of egress times. The finding that a smaller step-up/step-down height results in a quicker egress may have implications for the certification of airplanes with Type III exits with smaller step-up/step-down heights than allowed by regulation.

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List of Abbreviations

ANCOVA	Analysis of Covariance
BtK	Buttock-to-Knee
CAMI	Civil Aerospace Medical Institute
CFR	Code of Federal Regulations
cm	centimeter
EASA	European Aviation Safety Agency
FAA	Federal Aviation Administration
fps	Frames per second
IET-I	Individual Egress Times - Individual
IET-G	Individual Egress Times - Group
IRB	Institutional Review Board
kg	Kilogram
KtF	Knee-to-Floor
M	Mean
MMAC	Mike Monroney Aeronautical Center
NPRM	Notice of Proposed Rulemaking
NTSB	National Transportation Safety Board
PI	Principal Investigator
Sd	Step-down
SD	Standard Deviation
Su	Step-up

Abstract

This project was an investigation of multiple transport category airplane Type III door dimension changes to evaluate its general impact on safety and egress speed. The goal was to provide rule-makers with a generalizable result to address requests to modify airplane exits for the purpose of increasing the allowed number of passengers per door exit rating. Participants exited the door types in both individual and group settings. There were 160 participants through six different Type III doors, of which three are currently in operation, and three are experimental. The doors that had a smaller step-up and step-down height had the fastest average egress times and the shortest range of egress times. The finding that a smaller step-up/step-down height results in a quicker egress may have implications for the certification of airplanes with Type III exits with smaller step-up/step-down heights than allowed by regulation.

1. Introduction

Rapid egress from an aircraft is an important factor in the safety of passengers following an accident or incident. The speed of that egress is highly dependent on the number and size of available exits. The Code of Federal Regulations (CFR) (Emergency Exits, 14 CFR §25.807(g)) states: “The maximum number of passenger seats permitted depends on the type and number of exits installed in each side of the fuselage. Except as further restricted in paragraphs (g)(1) through (g)(9) of this section, the maximum number of passenger seats permitted for each exit of a specific type installed in each side of the fuselage is as follows:” (see **Table 1**).

Table 1
Maximum Number of Passenger Seats by Exit Type

Type A	110
Type B	75
Type C	55
Type I	45
Type II	40
Type III	35
Type IV	9

It also describes Type III exits as “a rectangular opening of not less than 20 inches wide by 36 inches high with corner radii not greater than seven inches, and with a step-up inside the airplane of not more than 20 inches”. Additionally, “If the exit is located over the wing, the step-down outside the airplane may not exceed 27 inches”, and each pair of Type III exits allows for the installation of 35 passenger seats (Emergency Exits, 14 CFR §25.807(a)(3)). This increase in passenger seating on transport category airplanes based on the number and size of installed exit pairs is known as the exit rating (Federal Aviation Administration, 1990).

Over the last three decades, there have been several scientific investigations involving the configuration and design of Type III exits. These efforts were preceded by two fatal aviation accidents that occurred in 1985 and 1991, respectively, where issues involving Type III exits were identified as factors resulting in passenger fatalities. Safety recommendations proposed research to mitigate factors that could possibly impede egress through a Type III exit. These accidents, as well as the research and recommendations, are discussed below.

In 1985, British Airtours Flight 28M, a Boeing 737, caught fire prior to takeoff at Manchester International Airport in England. During the evacuation, only one of the overwing exits was usable due to the other exit being engulfed in flames. Passengers encountered many problems while using the remaining overwing (right) exit. One major issue was that the passenger seated closest to the exit did not understand how to operate the exit. At this time, it was not a requirement that cabin crew brief passengers sitting in an exit row. Other issues included passengers being unaware that the window exit separated from the aircraft, and during the evacuation, one passenger became stuck in the overwing exit and had to be pulled out. These issues slowed down the egress through the overwing exit (Department of Transport, 1988).

In the years following the Manchester accident, several studies were conducted to address egress through Type III exits. The first two studies were conducted at the Federal Aviation Administration (FAA) Civil Aerospace Medical Institute (CAMI). Researchers Rasmussen and Chittum (1989) investigated the influence of adjacent seating configurations on egress through a Type III exit. Next, McLean et al. (1989) conducted research to study the effects of wearing protective breathing equipment while egressing through various exit types, including Type III

exits, in both smoke-filled and clear-air environments. The third study was performed at Cranfield University by Muir et al. (1989) and looked at passenger flow rates between bulkheads and the effects of passageway width on egress through a Type III exit.

A 1989 notice of proposed rulemaking (NPRM) was issued to address passenger briefings for those seated in an exit row. On April 5, 1990, the FAA enacted the Final Rule (Exit Seating, 14 CFR 135.129 1990) for exit row seating, which required all Part 121 and 135 operators to screen and brief passengers assigned seats in exit rows, effective October 5, 1990. This rule provided general guidance on how operators could comply with the rule by stating, “Airlines must take steps to inform passengers sitting in exit rows about what may be required of them in an emergency evacuation.”

In 1991, one year after the Final Rule for exit row seating, a landing Boeing 737 collided with a Fairchild Metroliner awaiting clearance for takeoff at Los Angeles International Airport. During the evacuation of the Boeing 737, both overwing exits were used, with the right exit being used the most due to fire on the left side of the plane. Passengers seated in the exit row had been briefed; however, the passenger seated closest to the right overwing exit became frightened and froze, not being able to open the door or leave her seat. The passenger behind her climbed over the seat back, opened the window exit, and pushed the frightened passenger out onto the wing. Additional issues included the seatback being folded over and blocking 25 percent of the right overwing exit and two passengers having an altercation outside on the wing. The National Transportation Safety Board (NTSB) recognized that there were similarities between the Manchester and Los Angeles accidents. Their report (NTSB, 1991) stated, “. . . many passengers attempted to exit from an overwing exit [Type III] in a very limited period of time”. The NTSB report also stated, “The size of the Type III exit is a limiting factor during an evacuation.” In response to the research in the late 1980s, the FAA issued an NPRM (91-11) proposing increased access to Type III exits on April 9, 1991, followed on May 4, 1992, by a Final Rule to address such issues (Emergency Exit Access 14 CFR 25.813).

Following the issuance of the NPRM 91-11, further research was conducted at CAMI. McLean et al. (1992) conducted a study on the width of the passageway from the aisle to a Type III exit. The study included four seat/exit configurations and used a repeated measures design. Participants were only instructed on overwing exit operation and egress by reading the safety briefing in the seatback pocket. The study revealed that wider pathways and fewer obstructions in the passageway were optimal. This research supported the recommendations outlined in NPRM 91-11; however, this led to several air carriers petitioning for deviations to the rule. Once again, further research into the topic was requested.

In 1995, CAMI (McLean et al., 1995) conducted a study on passageway width and seat/exit configurations using a repeated measures design. However, this study also included a monetary incentive as a means for motivation and to create a sense of urgency, based on research performed by Muir et al. (1992). Participants were instructed they would receive a monetary bonus if they were one of the top three performers in their group. This was intended to encourage participants to perform at their peak during the trials. This study revealed that egress was hindered by narrower passageways and/or large encroachment of the seat into the exit opening. It also found that age was a factor in egress times, with older participants requiring more time to exit the aircraft.

In 2000, the NTSB released a safety report that renewed interest in Type III exits. CAMI responded by conducting a large-scale study of simulated emergency exits through a Type III exit. This study involved passageway configurations, hatch disposal location, group size, and motivation level. The findings led to a series of reports that addressed these issues involving

egressing through a Type III exit. The first report (McLean et al., 2002) found that there is a minimal impact on egress due to passageway configuration if ergonomic minimums are in place. It found that the physical characteristics of participants did produce large differences in performance, which led to further investigation (Corbett et al., 2003 and McLean & Corbett, 2004).

The European Aviation Safety Agency (EASA) stated in a 2008 report, “Studies have determined that in accidents to aircraft configured with Type III exits, 50% of passengers that evacuate through exits use the overwing exits. While this proportion reduces to approximately 30% in high fire intensity accidents, it illustrates the importance of Type III exits to the evacuation system” (EASA, 2008). In addition, the FAA has a long-standing history of receiving requests to alter the dimensions and surroundings of the Type III overwing exit. This request would alter the allowable exit rating and allow more passengers on the aircraft. These alterations may have unknown effects on the established exit ratings, which, in turn, could have consequences for aircraft certification and passenger safety.

This project was designed to answer the research question of, does individual or group egress times differ as a function of Type III exit opening size while accounting for anthropometric differences in participants, as previous evacuation research has shown that participant age, girth, and gender have impacted evacuation performance (McLean et al., 2002; Weed et al., 2021)

2. Method

2.1. Experimental Design

The goal of this research was to investigate differences in egress times afforded by changes to the size of the Type III exit opening. This resulted in a 2x3x3 within/between subject's design looking at the effects of Exit Width (20 inches (control) x 30 inches), Exit Height (36 inches (control) x 41 inches x 48 inches), and step-up/down height (20 inches up/27 inches down (control) x 15 inches up/22 inches down x 8 inches up/15 inches down). These effects were compared by measuring both individual and group egress times. This was accomplished by simulating the door exit portion of an airplane evacuation using multiple Type III exit sizes/shapes onto a simulated airplane wing. For baseline intra-group comparison, all participants would experience the control exit opening condition (A). This research protocol was approved by the FAA Institutional Review Board (IRB).

Demographic and anthropometric measurements for all participants were measured and recorded following methodologies used in previous airplane evacuation research (Weed et al., 2021). These measurements were taken both for use in determining what, if any, measured individual differences co-varied with egress and to allow for a sample check comparison to previous evacuation research and the general American public. This research question assumes the null hypothesis that there is no difference in egress times (individual or group) between the different exit opening size configurations, while the alternate hypothesis is that there is a difference.

As there were two phases of this study, egress as an individual and egress in a group, there are two definitions for individual egress time variables. Individual egress times collected in the individual egress phase are referred to as Individual Egress Times – Individual (IET-I). Individual egress times collected in the group egress phase are referred to as Individual Egress Times – Group (IET-G).

2.2. Equipment and Facilities

This project used the Flexible Aircraft Cabin Simulator (FlexSim), a modular narrow-body aircraft simulator designed for airplane cabin evacuation research (Figure 1).

Figure 1
Exterior Picture of the FlexSim

2.3. Type III Exit Doors

Six different Type III exit doors were evaluated in this project: a standard Type III exit, two larger doors (denoted III+) that have received FAA approval, and three experimental doors that have not received FAA approval (Figure 2). The standard Type III door was used in all scenarios for establishing an intra-group baseline to compare against the various alternative and experimental configurations.

Type III Exit Opening Sizes

A. (Control) Standard Type III (20Wx36H) with a step up of 20” and a step down of 27”
B. Alternative Type III+1 (20Wx41H) with a step up of 15” and a step down of 22”
C. Alternative Type III+2 (30Wx48H) with a step up of 8” and a step down of 15”
D. Experimental Type III+1(20Wx48H) with a step up of 8” and a step down of 15”
E. Experimental Type III+2 (30Wx36H) with a step up of 20” and a step down of 27”
F. Experimental Type III+3 (30Wx41H) with a step of 15” and a step down of 22”

Figure 2
Visual of Exit Sizes Used in This Project

Type III Exit A Type III Exit B Type III Exit C Type III Exit D Type III Exit E Type III Exit F (Additional pictures of the Type III exit doors can be found in Appendix A)

2.4. Anthropomorphic Measurement Equipment and References

Two Health-O-Meter 500KL Digital Physician Scales were used to measure participant height and weight, while cloth tailor’s measuring tapes were used to measure the participant's girth around the waist. Custom-built knee-to-floor measuring devices were used to collect sitting knee-to-floor (KtF) height measurements. These measuring devices consisted of a steel engineer’s metric ruler modified for attachment and height range that was mounted to an aluminum footplate for stability and a handle for ease of movement and placement (F**igure 3**). These measuring devices were made in-house and calibrated against existing rulers to ensure accurate measurements. Two anthropometers were used to collect participant shoulder width, hip breadth, and sitting buttock-to-knee (BtK) length. Measurement reference photos for each of the anthropometric measurements taken in this project were developed for staff training and reference and posted at measurement stations for staff to show participants what was being measured and how (Figures 4-8).

Figure 3
Knee-to-Floor Height Measurement Tool – Front and Side View

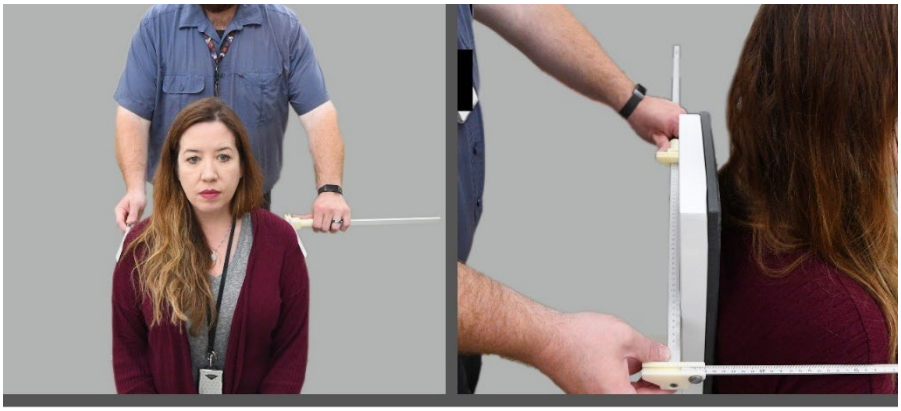
Figure 4
Anthropometric Measurement Reference: Buttock-to-knee Length, Knee-to-floor Height

Buttocks-to-Knee Length/Knee Height, Sitting:

* Seated, feet in line with thighs (apart), knees at 90°

* Sit tall, look straight ahead with hands resting loosely on thighs

Figure 5
Anthropometric Measurement Reference: Shoulder Width



Shoulder Width – Bideltoid Breadth:

* Seated, feet in line with thighs (apart), knees at 90°
* Sit tall, look straight ahead with hands resting loosely on thighs
* Flex elbows to 90°, hands straight, palms facing inward

Figure 6
Anthropometric Measurement Reference: Sitting Hip Width

Hip Width, Sitting:

* Seated, feet and knees together, knees at 90°
* Sit tall, look straight ahead with hands resting loosely on thighs
* Flex elbows to 90°, hands straight, palms facing inward

Figure 7
Anthropometric Measurement Reference: Waist Circumference

Waist Circumference (Girth):

* Stand tall

* *Weight evenly distributed on both feet, heels together as much as possible

* Point to belly button with LEFT index finger, once tape is in place let arms hang relaxed at the sides with shoulders relaxed

Figure 8
Anthropometric Measurement Reference: Height and Weight

Standing Height/Weight:

* Face forward and stand tall

*Weight evenly distributed on both feet, heels together as much as possible

* Shoulders relaxed, arms hang loosely at sides

* Look straight ahead at target

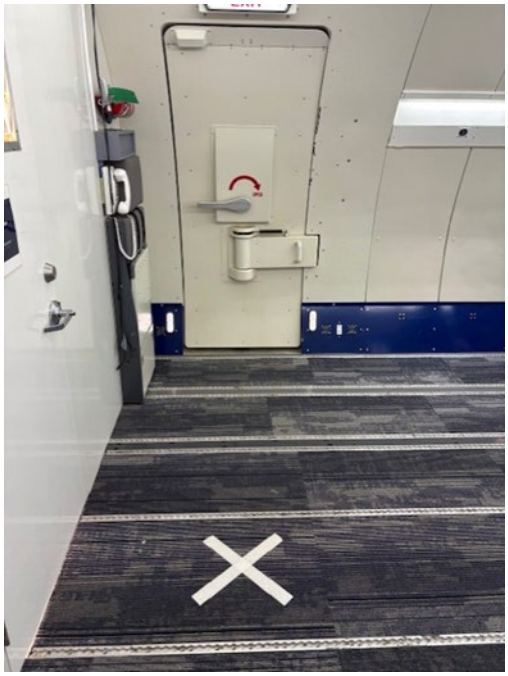
Condition presentation was counterbalanced to control for presentation effects. The counterbalanced test matrix is illustrated in **Table 2**. This design was selected to collect the data required to answer the research question. The number of groups (16) was selected to allow for proper counterbalancing of the run order and to obtain enough data for each Type III exit. The group size (10) was selected to create a group evacuation scenario for the test day, which would involve both individual trials for each participant and an overall group trial. Pre-test analysis showed that 48 data points would provide enough statistical power to identify a moderate effect. Data were collected in two phases for each group: an individual test/practice series (Phase I) and a group evacuation series (Phase II).

Table 2
Door Order Test Matrix

Run/Group #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1st run exit type	A	B	C	D	A	B	C	E	A	B	C	F	A	D	E	F
2nd run exit type	B	C	D	A	B	C	E	A	B	C	F	A	D	E	F	A
3rd run exit type	C	D	A	B	C	E	A	B	C	F	A	B	E	F	A	D
4th run exit type	D	A	B	C	E	A	B	C	F	A	B	C	F	A	D	E

Phase I: This phase collected data on how individuals traversed through the Type III exits by themselves, with no other participants in the simulator. Each participant was stationed at a starting point, 70 inches from the door opening (Figure 9), marked by an X. Timing began when the first foot reached a certain spot inside the cabin, 8.5 inches from the door opening (illustrated in Figure 10 by the wall monument) until the entire body cleared a certain spot outside of the cabin (Figure 11). This phase was also used to train the participants on how to egress through Type III exits to prepare them for Phase II of the study, where they egressed with a group of other participants.

Figure 9
Starting Point for Participant



Phase II: This phase collected data on how a group of 10 participants traversed through the Type III exits. The groups were stationed at a starting point, 70 inches from the door opening (Figure 9), marked by an X. Timing began when the first participant's foot reached a designated measurement spot approximately 8.5 inches inside the cabin (**Figure 10** by the wall monument) until the entire body of the last participant was outside the cabin indicated by passing the outer edge of the open exit door (Figure 11).

Figure 10
Timing Began

Figure 11
Timing Ended

2.5. Participants

Participants were provided by a contractor recruiting from the state of Oklahoma for this project. Participant recruitment criteria were that they be able to read and communicate in English, be physically able to participate in a rapid simulated airplane egress, have not participated in previous aircraft evacuation experiments or training, and not have had any recent surgeries or medical conditions that would put them at increased risk of injury during the experimental trials. Participants were pre-screened for these requirements prior to arrival at the testing location by the contract recruiter and confirmed by research personnel once on site.
This project used 16 groups of 10 participants (160 total). The study ran two groups per session

over an 8-week period. For each session, 25 participants were recruited, with 10 participants for each of the two runs and an additional 5 participants as backup in case there were participants who withdrew or were injured. Each participant group was approximately half females and half males and ranged in age from 18 to 60 years (there were two participants over age 60 who were overlooked in screening), with no more than 40% of the participants falling in any given single decade category. For example, using age groups 18-30, 30-40, 40-50, and 50-60, no decade group contained more than 40% of the total participants.

2.6. Procedure

Before the commencement of the research project, all procedures and documents were approved by the FAA's Institutional Review Board to ensure a reasonable level of safety and confidentiality for all participants.

On the day of testing, participants passed through the security screening checkpoint to ensure they were not bringing unnecessary items with them. Phones, keys, and other personal items were put inside Ziploc bags to be held until the end of the study session. The participants received their initial briefing (Appendix B: Initial Participant Briefing) of the study and were read the informed consent form (Appendix C: Informed Consent). After signing the informed consent document, participants were given a participant information form (Appendix D: Pre-test Information). Upon turning the form in and being accepted as suitable for participation, the participants received a vest with their participant number. This number tracked each participant throughout the study.

Participants were taken to one of several visually isolated stations (for privacy) for anthropometric measurement by a same-gendered member of the research staff (Appendix E: Participant Anthropometrics Worksheet).

Anthropometers were used to collect participant shoulder width, hip breadth, and sitting buttock-to-knee (BtK) length. After collection, participants were taken to a holding area located by the FlexSim to wait their turn for Phase I of the study. When called for Phase I, participants were taken out to the FlexSim, where they egressed through four Type III exits (Figure 2) individually. For each Phase I trial, participants were stationed at the starting line (X, Figure 9) in the airplane aisle next to the exit row before each trial began. Participants were instructed to evacuate "as quickly as possible" through the exit upon hearing the buzzer indicating trial start, to evacuate completely through the exit opening and down the ramp, and to return to the aircraft entrance for the next trial. After the PI pushed the buzzer to start the trial, the participant evacuated the exit. After the fourth evacuation, the participant returned to the holding area until all participants had completed Phase I evacuations. Once all participants were finished with the Phase I runs, Phase II of the study began. Each group boarded the FlexSim in the order of their vest number, which was issued to mirror their age group. Participants were lined up in the aisle at the starting line next to the exit opening being tested, determined by the trial run (see Table 2), and received a reiteration of the trial procedure. The PI signaled the start of each evacuation with the buzzer. Participants re-boarded the simulator after each evacuation—four in total. The participants then received a group debriefing (Appendix F) and turned in their numbered vests. Participants were given payment for participation and dismissed.

2.7. Data Reduction/Analysis

Data collection was pen and paper for demographic and anthropometric information. Video data were collected by recording participants egressing through Type III exits at 30 frames per second (fps) in high definition (HD). All video data were reviewed using Windows Media Player,

using the advanced speed settings to allow the research team to step through each video frame-by-frame. Four personnel from the research team were trained as a group in video data reduction using the criteria described for measuring individual egress times described previously in this report. Data checking was conducted by one of the researchers via random selection of data points from the other members of the research team for evaluation. All data checked in this manner were within 2 video frames, which was deemed acceptable for inter-rater reliability. Microsoft Office Excel 2016 and IBM SPSS version 28 were used for all data entry and analyses.

3. RESULTS

3.1. Demographics

A total of 160 participants were recruited; all completed the study with usable data. Of the participants, 90 were female (56.3%), and 70 were male (43.8%). Ages ranged from 19 to 65 years *(M_{Age} = 39.50, SD_{Age} = 11.62)*.

3.2. Anthropometrics

Overall group anthropometric data are presented in Table 3. Anthropometric data for females only are presented in Table 4. Anthropometric data for males only are presented in Table 5.

Table 3
Anthropometric Measurement Descriptive Statistics (Overall Group; N=160)

	Range	Minimum	Maximum	Mean	Std. Deviation
Height (cm)	49.00	144.90	193.90	169.10	8.10
Weight (kg)	131.40	45.80	177.20	89.05	22.93
Girth (cm)	84.00	68.00	152.00	102.61	17.97
Shoulder Width (cm)	19.10	37.40	56.50	46.85	4.03
Hip Breadth (cm)	27.00	30.20	57.20	42.73	5.40
BtK (cm)	33.30	48.80	82.10	61.47	4.27
KtF (cm)	18.90	46.00	64.90	54.34	4.54

Table 4
Female Participant Anthropometric Descriptive Statistics (N=90)

	Range	Minimum	Maximum	Mean	Std. Deviation
Height (cm)	36.60	144.90	181.50	164.68	6.46
Weight (kg)	94.30	45.80	140.10	85.38	20.70
Girth (cm)	71.70	68.00	139.70	101.65	17.21
Shoulder Width (cm)	19.10	37.40	56.50	45.82	4.10
Hip Breadth (cm)	21.70	35.50	57.20	44.99	4.91
BtK (cm)	33.30	48.80	82.10	60.31	4.32
KtF (cm)	18.50	46.00	64.50	51.69	3.44

Table 5
Male Participant Anthropometric Descriptive Statistics (N=70)

	Range	Minimum	Maximum	Mean	Std. Deviation
Height (cm)	34.30	159.60	193.90	174.73	6.35
Weight (kg)	120.00	57.20	177.20	93.76	24.88
Girth (cm)	80.40	71.60	152.00	103.84	18.95
Shoulder Width (cm)	16.10	39.50	55.60	48.17	3.54
Hip Breadth (cm)	20.70	30.20	50.90	39.83	4.57
BtK (cm)	15.90	56.60	72.50	62.96	3.74
KtF (cm)	17.10	47.80	64.90	57.74	3.37

3.3. Individual Egress Time – Individual Descriptives

The descriptive results for individual egress times collected during the individual egress phase by Type III door exit type are shown in Table 6. Data points were fully captured for each door type except Door A due to a video malfunction that resulted in losing the results from two participants. Door dimensions, including step-up (Su) height and step-down (Sd) height, are included in the table.

Table 6
Descriptive Data (in seconds) for Individual Egress by Type III Door Exit Type

Door	N	Mean	Minimum	Maximum	Std. Deviation
A (20Wx36H) (Su 20”/Sd 27”)	158	3.52	1.30	9.57	1.36
B (20Wx41H) (Su 15”/Sd 22”)	120	2.73	1.10	5.57	0.89
C (30Wx48H) (Su 8”/Sd 15”)	120	1.76	0.53	3.43	0.49
D (20Wx48H) (Su 8”/Sd 15”)	80	1.91	0.60	3.80	0.60
E (30Wx36H) (Su 20”/Sd 27”)	80	2.83	1.30	7.00	0.89
F (30Wx41H) (Su 15”/Sd 22”)	80	2.28	0.97	3.90	0.62

3.4. Individual Egress Time – Individual Covariate Analysis

Based on previous research showing that participant demographics and anthropometry may influence individual egress times, a multiple regression was conducted to determine which, if any, of the measures of individual differences should be included in further analyses as covariates. This multiple regression analysis was conducted with age, gender, height, weight, girth, shoulder width, sitting hip width, buttock-to-knee length, and floor-to-knee height as the predictors, with individual egress time as the dependent variable. The results showed that age (β=0.097, t=2.50, p=0.013), gender (β=-0.139, t=2.25, p=0.025), and weight (β=0.295, t=2.47,

p=0.014) of participants were significant predictors of egress time and were thus included in covariate analyses.

3.5. Individual Egress Time – Individual by Type III Door Exit Type

There was a statistically significant difference between Type III door exit type, while controlling for participant age, gender, and determined by one-way ANCOVA ($F(5,629=87.991$, p = <0.001, partial eta-squared=0.411). A post hoc analysis of estimated marginal means was conducted to explore the differences. Figure 12 shows the plots of the differences in estimated marginal means of individual egress times. This post hoc test showed that the individual egress times for all doors were significantly different than that of the control door A (Table 7).

Figure 12
Estimated Marginal Means of Individual Egress Times – Individual by Door Type

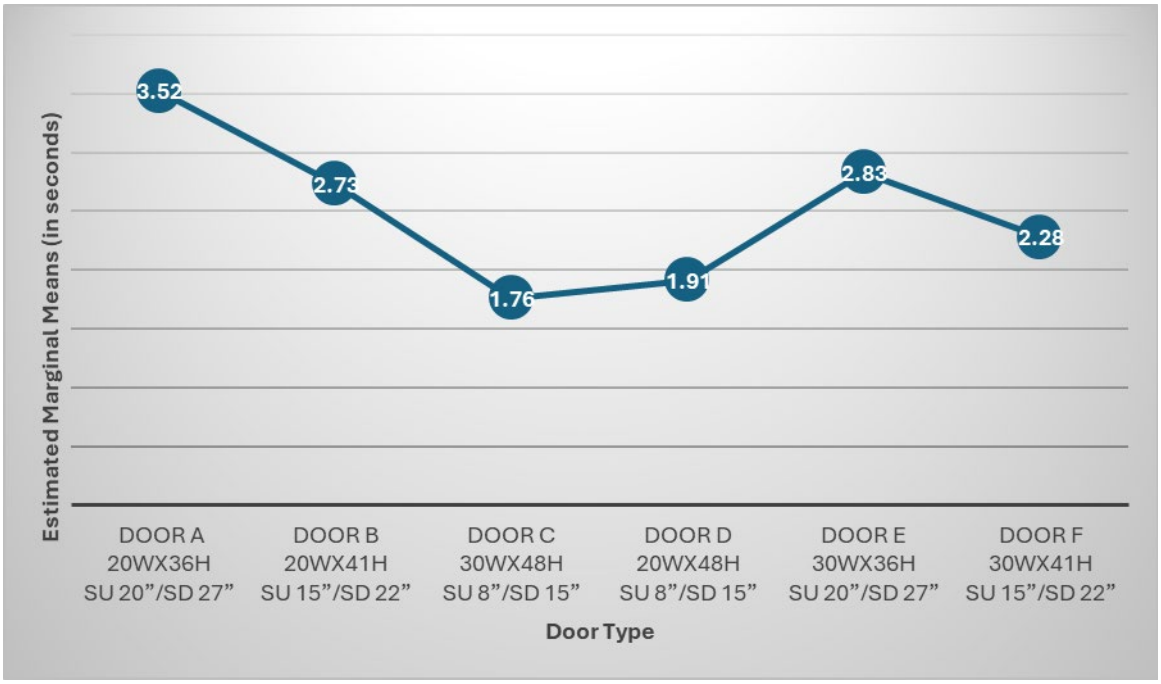


Table 7
Individual Egress Times – Individual Mean Difference Tests, Comparison of Door A to All Others

Door Type	Mean Difference	Std. Error	Sig
Door B	0.81	0.10	< 0.001
Door C	1.78	0.10	< 0.001
Door D	1.62	0.11	< 0.001
Door E	0.67	0.11	< 0.001
Door F	1.18	0.11	< 0.001

3.6. Individual Egress Time – Group Descriptives

The descriptive results for individual egress times collected during the group egress phase by Type III door exit type are shown in Table 8. Data points were fully captured for each door type except Door A due to a video malfunction that resulted in losing the results from two participants. Door dimensions, including step-up height and step-down height, are included in the table.

Table 8
Descriptive Data for Individual Egress within a Group by Type III Door Exit Type

Door	N	Mean	Minimum	Maximum	Std. Deviation
A (20Wx36H) (Su 20”/Sd 27”)	160	1.40	0.55	2.82	0.43
B (20Wx41H) (Su 15”/Sd 22”)	120	1.11	0.38	2.18	0.32
C (30Wx48H) (Su 8”/Sd 15”)	120	0.70	0.30	1.13	0.18
D (20Wx48H) (Su 8”/Sd 15”)	80	0.76	0.22	1.93	0.23
E (30Wx36H) (Su 20”/Sd 27”)	80	1.00	0.50	2.33	0.28
F (30Wx41H) (Su 15”/Sd 22”)	80	1.05	0.57	1.77	0.24

3.7. Individual Egress Time – Group Covariate Analysis

Similar to the previous analysis, a multiple regression was conducted to determine which, if any, of the measures of individual differences should be included in further analyses as covariates. This multiple regression analysis was conducted with age, gender, height, weight, girth, shoulder width, sitting hip width, buttock-to-knee length, and floor-to-knee height as the predictors, with individual egress time as the dependent variable. The results showed that age (β=0.168, t=4.27, p<0.001) and weight (β=0.324, t=2.73, p=0.007) of participants were significant predictors of egress time and were thus included in covariate analyses.

3.8. Individual Egress Time – Group by Type III Door Exit Type

There was a statistically significant difference between Type III door exit type while controlling for participant age and weight, determined by one-way ANCOVA ($F(5, 632 = 118.99$, p = <0.001, partial eta-squared = .485). A post hoc analysis of estimated marginal means was conducted to explore the differences. Figure 13 shows the plots of the differences in estimated marginal means of individual egress times – group. This post hoc test showed that the individual egress times for all doors were significantly different than that of the control door A (Table 9).

Figure 13
Estimated Marginal Means of Individual Egress Times Group by Door Type

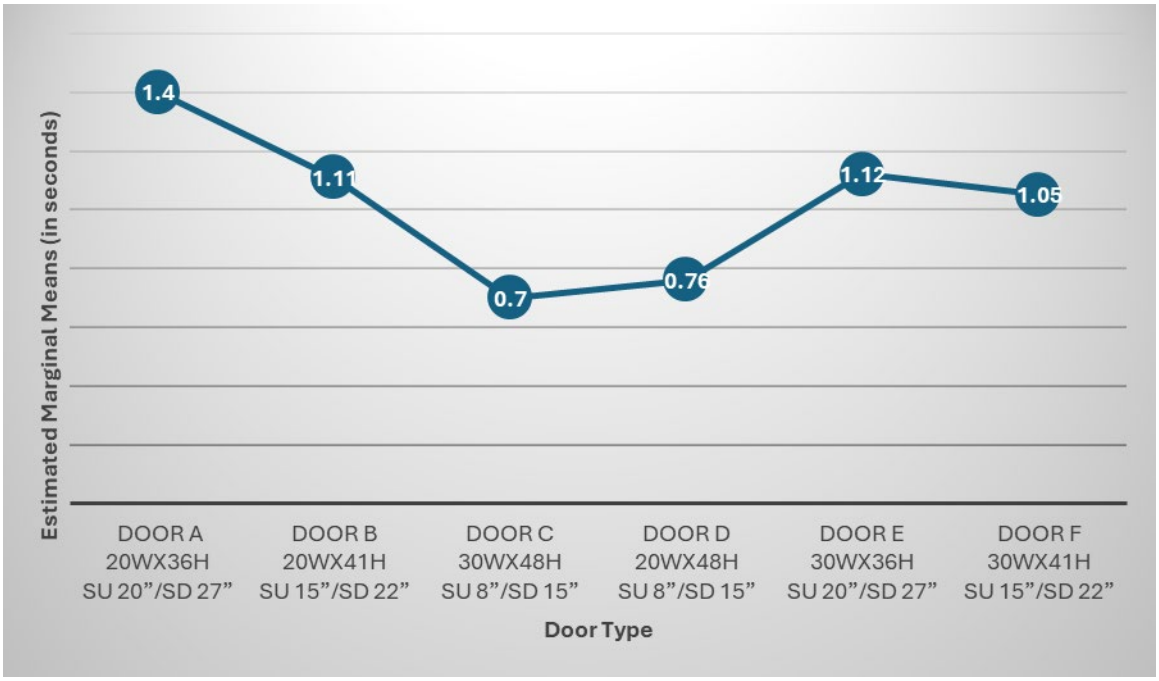


Table 9
Individual Egress Times – Group Mean Difference Tests, Comparison of Door A to All Others

Door Type	Mean Difference	Std. Error	Sig
Door B	0.29	0.03	< 0.001
Door C	0.70	0.03	< 0.001
Door D	0.64	0.04	< 0.001
Door E	0.26	0.04	< 0.001
Door F	0.38	0.04	< 0.001

4. DISCUSSION

This study evaluated Type III door dimension changes to determine their general impact on safety and egress speed. Every participant egressed through four different Type III door sizes in both individual and group settings.

The doors that had smaller step-up and step-down heights (Doors C/D, 8” up, 15” down) had the fastest average egress times and the shortest range of egress times versus the other step-up/down height doors (Doors B/F, 15” up, 22” down; Doors A/E, 20” up, 27” down). When compared to the control condition of a Type III exit matching current regulations, all the experimental condition doors performed better, with those having the smallest step-up/down heights showing the most improvement in egress times in both individual and group settings.

Door width appeared to play a lesser role than step-up/down height in egress times, with some differentiation shown in the individually collected individual egress times (IET-I), such that the doors that were wider had a smaller average egress time than those that were narrower. More simply, width influenced egress time but not to the degree of step-up/down height.

Like previous Type III egress research (McLean et al., 2002), individual differences in participant characteristics played some role in egress timing, with age, gender, and weight accounting for enough of the variance in individually collected egress times to be considered covariates. The direction of this effect is also similar to previous research in that as age and weight increased, so did egress times in both the individual and group settings. For the individual setting, gender played a role that was not seen in the group setting but was like previous work showing that females tended to egress slower than males.

This study was designed with an individual and group data collection phase. This was done partially as a safety measure since previous Type III exit research has included severe participant injuries. Comparison between the individually collected and group-collected egress times showed a similar trend, in that all doors were faster than the control condition, and that the widest door with the least step-up/down height was the fastest. There were differences in egress times due to conditions as well; door width seemed to play a larger factor, with all 30-inch-wide doors performing better in the group egress condition than all 20-inch-wide doors. The covariate effects also changed, with age falling off as a covariate in the group collection condition. This is discussed further in the limitations section.

5. LIMITATIONS

Due to the goal of this study to specifically measure the effect of changes in the Type III exit size width and height on egress, there were differences in what the participants encountered and what may occur in an evacuation from a normally operating airplane. The Type III exits in this test did not include any seats in the egress path. This made for a more open path to get through the exit, leading to cleaner data for the influence of exit height and width on egress.

This study did not include participants having to open the door on signal, which would represent passengers having to operate the exit door during an evacuation and may represent a delay in the total evacuation. Due to the nature of the design, this study was unable to draw a conclusion on performance differences between the individual and group data collection egress times. These differences could be attributable to training effects or social motivation in a group setting. Further research would need to be conducted if this is an effect of interest.

6. CONCLUSIONS

This study was designed to answer the research question, 'Does egress time differ as a function of Type III door dimensions, specifically step-up/step-down height and width?' The results have shown that step-up/down heights have a significant influence on egress times through a Type III overwing exit. Having a smaller step-up/step-down height on a Type III exit decreases the amount of time that it takes to get out of the exit. Door width also had some effect on egress times but not as much as step-up/step-down heights. Also, younger individuals are quicker to get out of any door than older passengers.

The finding that a smaller step-up/step-down height results in a quicker egress may have implications for the certification of airplanes with Type III exits with smaller step-up/step-down heights than allowed by regulation. Further research would need to be conducted on specific configurations to determine what kind of variances in passenger credit would be appropriate for changes to the Type III exit step heights.

7. REFERENCES

Corbett, C.L., McLean, G.A., Whinnery, J.E. (2003). Access-To-Egress II: Subject Management and Injuries in a Study of Emergency Evacuation Through the Type-III Exit. Federal Aviation Administration Office of Aerospace Medicine Report DOT/FAA/AM-03/15. https://www.faa.gov/sites/faa.gov/files/data_research/research/med_humanfacs/oamtechreports/0315.pdf

Department of Transport, Aircraft Accident Investigation Branch. (1988). Report on the Accident to Boeing 737-236 Series 1, G-BGJL at Manchester International Airport on 22 August 1985. Report No. AAIB 8/88. AAIB. https://assets.publishing.service.gov.uk/media/5422efe840f0b61342000277/8-1988_G-BGJL.pdf

Department of Transportation, Federal Aviation Administration, Exit Row Seating: Notice of Proposed Rule Making, NPRM 90-12, Docket No.25821, Federal Register, Vol. 55, No. 66, 5 April 1990

Department of Transportation, Federal Aviation Administration, Increased Access to Type III Exits: Notice of Proposed Rule Making, NPRM 91-11, Docket No. 26530, Federal Register, Vol. 56, No. 68, 9 April 1991.

Emergency Exits. 14 CFR §25.807 (2004). https://www.govinfo.gov/content/pkg/CFR-2010-title14-vol1/pdf/CFR-2010-title14-vol1-part25-subpartD-subjectgroup-id1145.pdf

Emergency Exit Access. 14 CFR §25.813 (2009). https://www.govinfo.gov/app/details/CFR-2023-title14-vol1/CFR-2023-title14-vol1-sec25-813

European Aviation Safety Agency, Notice of Proposed Amendment (NPA) No 2008-04. https://www.easa.europa.eu/en/document-library/notices-of-proposed-amendment/npa-2008-04

Federal Aviation Administration. (1990). *Uniform distribution of exits*. Advisory Circular AC 25.807-1. https://drs.faa.gov/browse/excelExternalWindow/6FF1D45D47746E60862569D10073258F.0001

McLean, G.A., Chittum, C.B., Funkhouser, G.E., Fairlie, G.W., Folk, E.W. (1992). Effects of Seating Configuration and Number of Type III Exits on Emergency Aircraft Evacuation. Federal Aviation Administration Office of Aerospace Medicine Report DOT/FAA/AM-92/27. https://www.faa.gov/sites/faa.gov/files/data_research/research/med_humanfacs/oamtechreports/AM92-27.pdf

McLean, G.A., George, M.H., Chittum, C.B., Funkhouser, G.E. (1995). Aircraft Evacuations Through Type III Exits I: Effects of Seat Placement at the Exit. Federal Aviation Administration Office of Aerospace Medicine Report DOT/FAA/AM-95/22. Dynamic Regulatory System

McLean, G.A., Corbett, C.L., Larcher, K.G., McDown, J.R., Palmeron, D.A., Porter, K.A.,

Shaffstall, R.M., Odom, R.S. (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. Federal Aviation Administration Office of Aerospace Medicine Report DOT/FAA/AM-02/16. https://libraryonline.erau.edu/online-full-text/faa-aviation-medicine-reports/AM02-16.pdf

McLean, G.A., Corbett, C.L. (2004). Access-To-Egress III: Repeated Measurement of Factors That Control the Emergency Evacuation of Passengers Through the Transport Airplane Type-III Overwing Exit. (DOT/FAA/AM-04/2).

https://www.faa.gov/sites/faa.gov/files/data_research/research/med_humanfacs/oamtechreports/0402.pdf

Muir, H., Bottomley, D., Hall. J. (1992). Aircraft Evacuations: Competitive Evacuations in Conditions of Non-Toxic Smoke. Civil Aviation Authority UK, Paper 92005, March 1992.

National Transportation Safety Board. (1991). Accident Report: Runway Collision of USAIR Flight 1493, Boeing 737 and Skywest Flight 5569 Fairchild Metroliner, Los Angeles International Airport, Los Angeles California, February 1, 1991. Report No. NTSB/AAR-91/08. NTSB.
https://www.ntsb.gov/investigations/AccidentReports/Reports/AAR9108.pdf

National Transportation Safety Board. (2000). Safety Study: Emergency Evacuation of Commercial Airplanes. Report No. NTSB/SS-00/01. NTSB.
https://www.ntsb.gov/safety/safety-studies/Documents/SS0001.pdf

Rasmussen, P.G., Chittum, C.B. (1989). The Influence of Adjacent Seating Configurations on Egress Through a Type III Emergency Exit. Federal Aviation Administration Office of Aerospace Medicine Report DOT/FAA/AM-89/14.

Weed, D.B., Beben, M.S., Ruppel, D.J., Guinn, K.J., Jay, S.M. (2021). Effects of Airplane Cabin Interiors on Egress I: Assessment of Anthropometrics, Seat Pitch, and Seat Width on Egress. Federal Aviation Administration Office of Aerospace Medicine Report DOT/FAA/AM-21/0

8. Appendix A: Type III Exit Door Views

Figure 14

Type III Exit A View and Measurement – Inside View

Figure 15

Type III Exit A View and Measurement – Outer View

Figure 16
Type III Exit B View and Measurement – Inside View

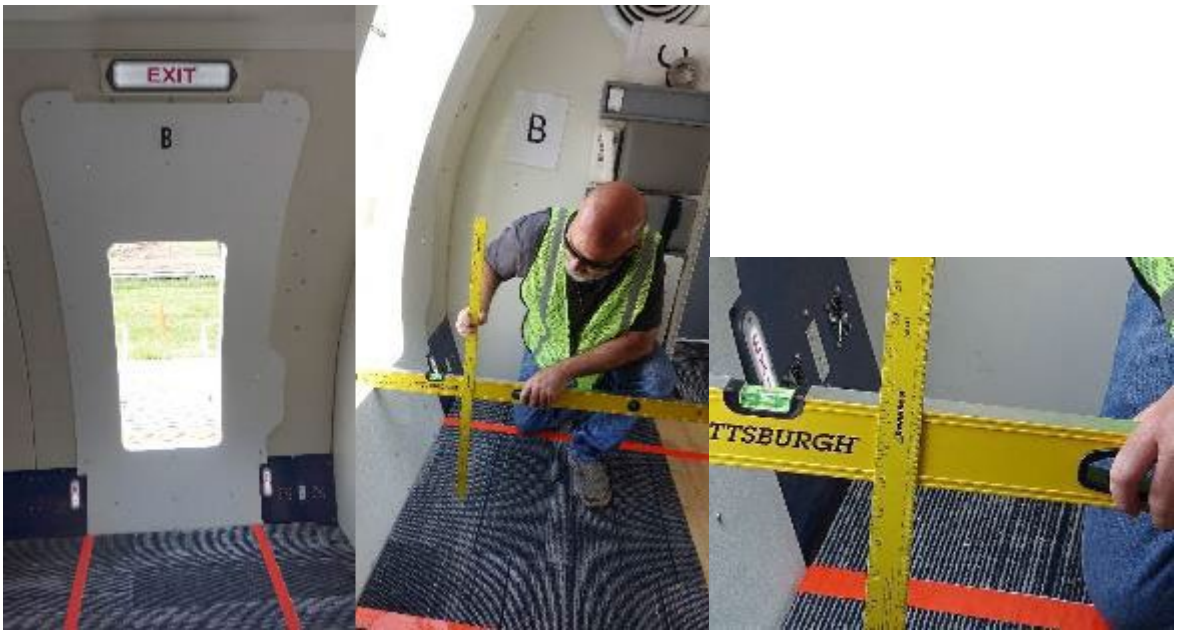


Figure 17
Type III Exit B View and Measurement – Outer View

Figure 18
Type III Exit C View and Measurement – Inside View

Figure 19
Type III Exit C View and Measurement – Outer View

Figure 20
Type III Exit D View and Measurement – Inside View

Figure 21
Type III Exit D View and Measurement – Outer View

Figure 22
Type III Exit E View and Measurement – Inside View

Figure 23
Type III Exit E View and Measurement – Outer View

Figure 24
Type III Exit F View and Measurement — Inside View

Figure 25
Type III Exit F View and Measurement – Outer View

9. Appendix B: Initial Participant Briefing

Emergency Operation and Location

Good morning. Welcome to CAMI. I am Melissa Beben, from the Protection and Survival Laboratory of the Civil Aerospace Medical Institute. Today you will be participating in a research project designed to investigate ways in which to improve safety in 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 air travelers in the future. The area of concern for today's trials is Type III overwing exit door dimensions. In today's study, you will be asked to egress through several Type III door designs in both an individual setting and a group setting. The study will consist of two phases. In Phase 1, you will be taken to the simulator (FlexSim), where you will egress through four Type III exits. When finished, you will be placed in a holding area until Phase II starts. For Phase II of the study, you will be taken out to the FlexSim and will egress through four Type III exits as a group with nine other individuals. At the end of Phase II of the study, you will receive a group debriefing.

To participate in the trials, you must not have any physical disabilities that would prevent you from being able to move rapidly and quickly exit from an aircraft. You must have no illnesses, such as chronic heart disease, or have other conditions, such as pregnancy, that would restrict your ability to exercise. You must not have had recent surgery, that is, within the last 6 months, that would affect your mobility, such as on your back, knees, legs, ankles, or feet. You must not be under the influence of alcohol or any drug, including prescription drugs, which would impair your ability to follow instructions and move quickly and controllably. You must have met the requirements of the CDC’s current definition of a full COVID-19 vaccination. Although we have taken great care to reduce the possible risk of danger for today’s trials, we want you to understand that previous airplane evacuations, both real and simulated, have included injuries to participants, such as bruises, cuts, sprains, and rarely, broken bones. These injuries can be caused by bumping into seats or other cabin fixtures, or slipping, tripping, and falling. Please remember, these injuries are also rare; in our last major evacuation study of Type III exits involving 2500 people, only approximately 2% of participants received injuries. With this in mind, we ask that you perform today’s egress as rapidly as possible to let us collect realistic data.

In a moment, we will provide you with an informed consent document, which I will read aloud, and I will answer any questions you may have about it. This document lets us know you have been told about the information we will record, the tests you will be participating in today, understand the procedures, and are willing to participate. After signing the informed consent, should you choose to participate, you will be given a participant information form. This form will ask you to record your age and answer other questions about education, health, and past evacuation experience. DO NOT PUT YOUR NAME ON THIS DOCUMENT. When you hand this document to one of the research staff, you will be given a vest with a number on it. This number will be used to identify you to the research staff and the records we will keep. This is one of our methods of maintaining your confidentiality; none of the data we will be collecting will have your name associated with it.
After you have received and donned your numbered vest, we will be taking you down to the CAMI building, Room 127, where we will measure your height, weight, shoulder width, girth, sitting upper leg length, and sitting hip width. Once that is completed, the trials will begin.
Are there any questions?

10. Appendix C: Informed Consent

Informed Consent to Participate in Research Study

(Emergency Operation and Location)
Principal Investigator (PI): **Melissa Beben, M.S.**, Civil Aerospace Medical Institute
Co-investigators: **David Weed, M.A.** and **Levi Breeding, M.A.**, Civil Aerospace Medical Institute
Sponsors: **Federal Aviation Administration**
Contractor: **TBD**

10.1. Invitation to Participate in Research Study

Melissa Beben invites you to participate in a research study regarding Type III overwing exits. This study is sponsored by the Federal Aviation Administration (FAA) and AIR-600, who have no financial interest in this study. The study will be conducted at the Mike Monroney Aeronautical Center (MMAC) Campus, Civil Aerospace Medical Institute (CAMI) Building, and the Flexible Aircraft Simulator (FlexSim), located adjacent to CAMI.
You have been hired by (Contractor TBD) as a possible research subject for this project. You have been selected because you are a representative of the flying public, are reasonably healthy, mobile, and not under the influence of any alcohol or drugs, prescription or otherwise, which may impair your mobility, cognition, or decision-making process. You have also met the CDC's current definition of a full COVID-19 vaccination at least 14 days prior to participation. Any potential subject who is not reasonably healthy, mobile, or who is under the influence of any alcohol or drugs, prescription or otherwise, which may impair your mobility, cognition, or decision-making process, and/or who has not met the CDC's guidelines for a full COVID-19 vaccination may not participate in the study. Potential subjects will be required to wear an N95 mask during participation for both health and confidentiality reasons. Potential subjects with beards should note that the mask provides reduced exposure protection (up to 40% increased viral exposure risk) compared to not having a beard.
Please take some time to consider these requirements and review this document. If you decide to participate, after consideration and review, please sign this form to show that you want to voluntarily take part.

10.2. Description of Participant Involvement

If you agree to participate in this study, your involvement will last approximately 5 hours. During this time, you will be asked to arrive at the MMAC Visitor Center, located at 6500 S. MacArthur Blvd, Oklahoma City, Oklahoma. There you will receive a group briefing about this form and project and will be given a chance to sign this form to signal your voluntary participation in this project. After signing, you will be given a participant number and transported to the CAMI building for anthropometric recording, including measurement of your height, weight, girth, shoulder width, sitting hip breadth, and sitting buttock-to-knee length. After collection, you will be taken to a holding area located by the simulator (FlexSim) for your turn for Phase I of the study. When you are called for Phase I, you will be taken out to the simulator (FlexSim) where you will egress through four Type III exits. When finished, you will return to the holding area until Phase II starts. For Phase II of the study, you will be taken out to the FlexSim and will egress through four Type III exits as a group with nine other individuals. At the end of Phase II of the study, you will be taken back to the CAMI building for debriefing and will be transported back to the MMAC Visitor Center for any final paperwork with (Contractor TBD) before being dismissed.

10.3. Potential Benefits

Your direct benefit for participating in this project is your payment from (Contractor TBD). This project will benefit aviation safety and the flying public as a whole by providing information to allow the FAA to maintain or improve safety on commercial aircraft.

10.4. Risks and Discomforts

The researcher has taken steps to minimize the risks and discomforts of this study. Even so, this project carries a greater than minimal risk to participants. In addition to slips, trips, or falls, which might be expected during any egress simulation, this project carries low risk due to the step up/step down procedure while exiting a Type III exit. Fall protection will be provided around the exit ramps of the simulator in the form of large foam mats that have been used in previous evacuation training and research projects for the same purpose and by safety monitors at the exits during the egress trials. You may experience discomfort during the anthropometric measurement portion of this project, as a same-sex researcher will measure around your waist with a tailor's tape measure and, with an anthropometer, touch the tops of your shoulders, the front of one of your knees, and the sides of your hips while seated. Please note that some participants requiring glasses for corrected to normal vision in previous research have suffered damage to their glasses during evacuation trials, and that danger is present today.

10.5. Compensation

You will be paid (TBD) by (Contractor TBD) for your participation in this study.

10.6. Participant's Rights

You will not give up any legal rights or release any individual or institution from liability for negligence by signing this form and participating in this study. You have the right to withdraw from this study at any point during the study without penalty or loss of benefits to which you are otherwise entitled. You have the right to be informed should any new findings develop during the course of this research project that may relate to your decision to continue participation.
You have the right to receive and keep an unsigned copy of this form for your records. You have the right to receive an electronic copy of any publications relating to this research project. You can contact the Principal Investigator at the number provided at the bottom of this form.

10.7. Cost to Participant

You will not incur any costs for participating in this research study.

10.8. Confidentiality

All paper records created during the course of this study will be kept in a locked file cabinet maintained by the Protection and Survival Laboratory, Cabin Safety Research Team, in the CAMI building. All records of this study will refer only to the participant number you will be assigned should you agree to participate in this study. Electronic data collected during this research project will be kept on a password-protected, external storage drive kept in a locked filing cabinet when not in use. All still photographs used in publications related to this research project will have subject faces blurred or otherwise obscured to ensure subject confidentiality. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared.

All paper records of informed consent documents will be maintained, as stated above, for a minimum of 15 years at CAMI. After that time, if the records are deemed essential, they will be maintained at CAMI, otherwise, they will be transferred to the National Archives in accordance with FAA order 1350.14B.

10.9. Injury

Every effort to prevent injury as a result of your participation will be taken. It is possible, however, that you could develop complications or injuries as a result of participating in this research study. In the event of injury during this research project, first aid will be provided by on-site first responders. Any required follow-on care will be coordinated by your contractor's representative and the first responders.

10.10. Voluntary Nature of the Study

Participation in this research project is completely voluntary. You have the right to withdraw from this study at any point during or between trials without penalty or loss of benefits to which you are otherwise entitled. If you choose to withdraw before full completion of the study, you will be paid for the time worked by (Contractor TBD) as calculated from the time of the initial briefing at the MMAC Visitor Center to the time of your withdrawal. If you choose to withdraw before the trials have started, you may request your demographic and anthropometric data be returned to you. If you choose to withdraw after participating in any trials, your data will be retained for the integrity of the research data already collected. If you choose to withdraw, (Contractor TBD) will process your payment, and you will be transported back to the MMAC Visitor Center in a timely manner and allowed to leave the facility.

10.11. Participation and Withdrawal

Your participation in this study is voluntary, and it is your choice whether to participate or not. You may decline or withdraw participation from the study at any time. The choice to decline or withdraw from the study will not cause any penalty or loss of any benefit to which you are entitled as described above.

Melissa Beben, or another research staffer, may decide to stop or withdraw you from the study under certain circumstances without your permission. Some possible reasons that you may be removed from the study are such as a risk or harm to your medical or psychological interest, not following the study instructions, intentionally causing harm to yourself or others, or other administrative reasons. In the event that your participation in the study ends early, you may request or you may be requested to speak to the Principal Investigator and/or contractor representative.

At any time during this research study, the Principal Investigator or research team will share any new information that may affect your health or well-being and will discuss your continued participation in the study. At any time, if you would like to speak privately regarding your participation in this study, please notify a member of (Contractor TBD) or a member of the research team.

10.12. Contact Information

If you have questions about the study, please ask them before signing this form. You can ask any questions that you have about this study at any time.
For questions, concerns, or complaints about this study, please contact the Principal Investigator, Melissa Beben, at 405-954-7528 (email: Melissa.Beben@faa.gov) or David Weed at 405-954-9218 (email: David.Weed@faa.gov).

If you feel that you have been treated unfairly, or you have questions regarding your rights as a research participant, you may contact the Civil Aerospace Medical Institute Institutional Review Board (a group of people who review the research to protect your rights) at 405-954-1000, Dr. Thomas Chidester.

10.13. Participant Requirements Criteria

In order to participate in this study, I agree to the following criteria:

- I am a representative of the flying public
- I am reasonably healthy and mobile
- I am not under the influence of any alcohol or drugs, prescription or otherwise, which may impair my mobility, cognition, or decision-making process
- I have met the CDC's current definition of a full COVID-19 vaccination at least 14 days prior to participation
- I agree to wear an N95 during participation

_____

Printed Name of Participant

_____ _____

Signature of Participant or Legal Representative Date

10.14. Audio/Visual Records of Participants

In order to participate in this study, I agree to the following criteria:

- I am a representative of the flying public
- I am reasonably healthy and mobile
- I am not under the influence of any alcohol or drugs, prescription or otherwise, which may impair my mobility, cognition, or decision-making process
- I have met the CDC's current definition of a full COVID-19 vaccination at least 14 days prior to participation
- I agree to wear an N95 during participation

_____

Printed Name of Participant

_____ _____

Signature of Participant or Legal Representative Date

10.15. Audio/Visual Records of Participants

- Audio/video will be used as a part of the study procedures.
- Upon completion of the study, these recordings will be retained for data analysis and may be used in presentations or publications related to this project.
- Please sign below if you are willing to be recorded.
- You will not be able to participate in this research project if you are not willing to be recorded

_____

Printed Name of Participant

_____ _____

Signature of Subject or Legal Representative Date

10.16. Signature and Consent to be in the Research Study

I have been informed about the purpose, procedures, possible benefits, and risks of this research study. I have read (or someone has read to me) this form, and I have received a copy of it. I have had the opportunity to ask questions and to discuss the study with an investigator. My questions have been answered to my satisfaction. I have been told that I can ask other questions at any time. I voluntarily agree to participate in this study. I am free to withdraw from this study at any time without the need to justify my decision. If I withdraw, I will not lose any benefit to which I am otherwise entitled. I agree to cooperate with the principal investigator and the research staff and to inform them immediately if I experience any unexpected or unusual symptoms.

Participant: By signing this consent form, you indicate that you are voluntarily choosing to take part in this research.

_____

Printed Name of Participant

_____ _____

Signature of Participant or Legal Representative Date

10.17. Investigator

Principal Investigator:

I have fully explained this study to the subject or his/her representative to the best of my ability. As a representative of this study, I have explained the purpose, the procedures, and the possible benefits and risks that are involved in this research study. I have answered the subject's questions to his/her satisfaction before requesting the signature(s) above. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily. There are no blanks in this document. A copy of this form has been given to the subject or his/her representative.

_____

Printed name of Principal Investigator

_____ _____ _____

Signature of Principal Investigator Date Time

11. Appendix D: Pre-test Information

Emergency Operation and Location

Pre-Test Participant Information Form

As part of my participation in this project, I agree to provide the information requested below. This includes my age, gender, select recent health information, and evacuation history. I understand that my anthropometric information will be recorded by a trained member of the research staff. I understand that I may retrieve this information form should my participation in this project not be needed. **I certify that any information I provide is accurate to the best of my ability (**check one**)**: **Yes_ No___**

What is the highest level of education you have completed **(circle one)**?

Some high school | High school graduate or equivalent | Trade school

Technical certification | Some college | Associate degree

Bachelor's degree | Graduate degree

What is your age (in years)? _____

What is your gender? _____

Have you participated in evacuation research in the past (circle one)? Yes No

Have you recently (within the last 6 months) undergone surgery related to your back, legs, feet, or ankles?

Yes No

Are you currently under the influence of alcohol or drugs (prescription or otherwise) that may affect your mobility or reaction time? Yes No

Do you currently have trouble moving quickly? Yes No

Do you suffer from a chronic condition that may affect your ability to evacuate an aircraft safely (such as dizziness, temporary loss of hearing, balance issues, etc.)? Yes No

Do you wish to continue your participation in this study? Yes No

Please take this form to the research staff when you are finished.

To be filled in by research staff

Participant Vest Number:

12. Appendix E: Participant Anthropometrics Worksheet

Emergency Operation and Location Participant Anthropometrics Worksheet

Participant Number:

_____

Participant Height (inches):

_____

Participant Weight (pounds):

_____

Participant Girth (inches):

_____

Participant Shoulder Width (inches):

_____

Participant Buttock-to-Knee Length (inches):

_____

Participant Hip Width (inches):

_____

13. Appendix F: Participant Debriefing

Emergency Operation and Location

Thank you for your participation in our study. This project is an investigation of multiple transport category airplane Type III door dimensions, both in service and experimental. Overall, we are studying six different Type III door exits. You were introduced to four of these exits. Sixteen groups will participate in this study, which will allow for proper counterbalancing of the run order and ensure that we gather enough data for each Type III exit.

You completed two phases of this project. In Phase I, you were asked to egress through four Type III exits alone. Your body movements and egress techniques were recorded and will be evaluated. This phase was also used to train you on how to egress through Type III exits in order to prepare you for Phase II of the study. In Phase II of the study, you were asked to egress through four Type III exits as a group. Data collected for this phase included both individual egress times and group egress times.

Our goal is to provide rulemakers with a generalizable result to address requests to modify airplane exits for the purpose of increasing the allowed number of passengers per door exit rating. You have helped us by providing information on whether door dimension changes impact safety and egress speed.

If you have any questions or comments, feel free to ask now.

If you have further questions or comments, please contact Melissa Beben at melissa.beben@faa.gov. Results of this study will be published and will be publicly accessible in the Fall of 2023. If you want to be notified of the publication, please email Melissa Beben, and you will be added to a list. Please remember that you are entitled to an unsigned copy of the informed consent form and are able to pick one up when you check out with the contractor representatives.

Thank you again for your participation. Have a great day.