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U.S. ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

AMSTE-RP-702-106

Test Operations Procedure (TOP) 7-3-529
AD No.

30 September 1991

INGRESS, EMERGENCY EGRESS, AND EMERGENCY
EVACUATION TESTING OF ARMY AIRCRAFT

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1. SCOPE.

→ This TOP specifies procedures for testing ingress, emergency egress, and emergency evacuation of Army aircraft. Components installed on the interior and exterior of the aircraft as well as personnel equipment may adversely affect ingress and egress from an aircraft. The inherent design of a particular aircraft may also contribute to the time required to egress safely depending on the number of crew doors and exits designated as emergency evacuation routes. The criteria in appendix B provide guidelines for maximum times allowed for emergency egress and emergency evacuation.

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2. FACILITIES AND INSTRUMENTATION/EQUIPMENT.

<u>Item</u>	<u>Requirements</u>
Aircraft hangar or airfield ramp space.	Adequate space must be provided for ingress/egress and emergency evacuation trials. All potential trip hazards within 10 feet of the aircraft must be eliminated.
Digital stopwatch.	Accurate to 0.1 second.
Photographic equipment: a. High speed film camera b. 35mm camera with zoom lenses c. Video recording system with video playback including freeze frame and slow motion capability.	Photographic equipment must be able to capture all critical body maneuvers under various environmental conditions, i.e., day/night.
Anthropometric kit. Anthropometric data will be recorded for test participants (see appendix G).	Height, weight, and various physical dimensions of test participants will be rounded to the nearest 0.1 centimeter (cm) and 1.0 kilogram (kg), respectively.
Bullhorn, flags or hand signals.	Test participants must be able to respond to audible or visual cues as indicated by data collection personnel.
Tape measure.	Accuracy must be within 0.1 cm or 1/8th of an inch.



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Availability Codes	
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A-1	

<u>Item</u>	<u>Requirements</u>
Maintenance stand/platform to elevate photographic and data collection personnel.	The platform must be capable of elevating data collection personnel to a height which will afford visual access from outside the aircraft.
Cushioned area for test participants to land on when conducting emergency evacuation trials.	The cushions must prevent or minimize the potential for injury to test participants as a result of jumping from heights above 5 feet.

3. REQUIRED TEST CONDITIONS.

3.1 Facilities.

3.1.1 The aircraft configuration to be tested shall be that which most closely resembles the normal operational characteristics of that particular type of aircraft. All crewmember seats and passenger seats shall be installed to reflect the appropriate mission function. Seats must be equipped with appropriate safety belts and harnesses.

3.1.2 Ingress/egress and emergency evacuation passageways shall be examined to ensure that latches, handles, handholds, emergency lighting, and associated labeling are in place, functional, and are not obstructed.

3.1.3 Interior access may be required to allow data collection personnel to observe ingress/egress maneuvers from within the aircraft if their presence does not affect the test.

3.1.4 Participants must be appropriately attired to reflect the worst case conditions under a variety of mission scenarios. See appendix E for a listing which identifies the various clothing configurations required for different mission environments.

3.1.5 Exits and entrances shall be selected in accordance with criteria defined in MIL-STD-1472D¹, which states that for emergency evacuation trials, only one half of the normally available exits be used; e.g., trials conducted on the CH-47D

¹Reference letters/numbers match those in appendix H, References.



DEPARTMENT OF THE ARMY
HEADQUARTERS, U.S. ARMY TEST AND EVALUATION COMMAND
ABERDEEN PROVING GROUND, MARYLAND 21005-5055



REPLY TO
ATTENTION OF

AMSTE-TC-D (73-10p)

14 FEB 1992

MEMORANDUM FOR Administrator, Defense Technical Information
Center, ATTN: DDAC, Cameron Station,
Alexandria, VA 22304-6145

SUBJECT: Test Operations Procedure (TOP) 7-3-529, Ingress,
Emergency Egress, and Emergency Evacuation Testing of Army
Aircraft

1. Enclosed are DTIC Form 50 (Encl 1) and two copies of subject
test operations procedure (Encl 2) for assignment of accession
number.

2. Point of contact at this headquarters is Mr. Wolfgang HR.
Schmidt, AMSTE-TC-D, amstetcd@apg-9.apg.army.mil, DSN 298-3677/
2170.

FOR THE COMMANDER:

2 Encls

for Kenneth Balliet
FREDERICK D. MABANTA
C, Technology Development Div
Directorate for Technology

would require that the right side passageway be used for three trials and the rear loading ramp be used for another three trials. To simplify the process, it may be easier to designate a whole side of the aircraft as having blocked passageways.

3.2 Support Requirements. Logistical support will be required to assist in facilitating and ensuring that required aircraft, equipment, and personnel are made available. Scheduling of test participants and the numbers required will depend on the extent of tests conducted and type of aircraft used.

3.3 Personnel.

3.3.1 Representative personnel should be used which meet the 1st percentile female to the 99th percentile male population.² To simulate a worst case scenario, the largest available personnel should be used for emergency egress and emergency evacuation trials.

3.3.2 Adequate personnel shall be provided to serve as passengers, data collectors, equipment operators, and safety officers. Crewmembers used in ingress/egress trials from the cockpit should be familiar with the type of aircraft used. Passengers used in emergency evacuation trials should not be familiar with the aircraft configuration.

3.4 Uniform Configuration. The Army has a wide variety of uniform configurations for varying mission scenarios. Uniforms selected for ingress/egress testing should contain a realistic sampling which will address the most extreme operational conditions. A worst case configuration may comprise both cold weather and nuclear/biological/chemical (NBC) protective clothing. The list on page E-2 presents elements of the various combinations which can be worn to represent actual combat clothing. A checklist is provided on the Ingress/Egress data sheet (appendix E) where details of uniform configurations can be noted.

4. TEST PROCEDURES.

4.1 General. Ingress, emergency egress, and emergency evacuation testing will be conducted to determine compliance with criteria specified in Appendix B. The procedures for each test are similar in approach and methodology with the exception of the various configurations of clothing, aircraft, and exits used. Emergency evacuation requires that the crew and passengers use half of the available hatches and passageways to evacuate the aircraft. The use of emergency exits may require that

²See appendix H.

maintenance personnel remove these doors/hatches or cockpit covers prior to actual testing in order to conduct the test in a nondestructive manner. If any emergency doors, windows, etc. have been removed to prevent damage, then an appropriate amount of time should be added to the egress time to account for not having to remove these during the actual timed event.

a. Walk-Through Inspection. Prior to testing, a walk-through inspection of the aircraft shall be conducted to ensure that door handles, latches, location aids (labels), and emergency lighting are operational and that walkways are accessible and not obstructed. If problems are noted, have the appropriate maintenance personnel repair the item.

b. Site Preparation. Photographic equipment must be set up in the optimum position to capture photographically the chain of events. A demarcation line shall be marked 5 feet from all exits used on the test. Cushioning pads may be required on the ground outside the aircraft to prevent injury to crew and passengers when conducting emergency evacuation trials. Data collection equipment shall be positioned in the least obtrusive location so as not to impede or influence the test results.

c. Orientation. Prior to each test, a briefing session will be conducted with all test personnel and participants to explain the test objectives. The test participants will not know which side of the aircraft they will be exiting from until the signal is given at the start of the test.

4.2 Ingress.

a. Ingress tests will be conducted to determine compatibility with criteria specified in appendix B for emergency egress/evacuation procedures. Although there is no time element specified in the reference documents, times may be compared to egress times in order to identify existing or potential problems associated with ingress maneuvers.

b. Ingress trials will begin with the test participants standing at the 5-foot line. Upon being given a start signal by test personnel, test participants will open the required hatches/doors, enter the aircraft, close the doors, proceed to their crew position and fasten themselves into the seat, connect all communication plugs, put hands and feet on the flight controls, and give a thumbs-up sign at which time the timing will stop. See appendix D for a checklist which illustrates the required parameters of the test(s). It is recommended that at least three trials be conducted for each maneuver and passageway used.

4.3 Emergency Egress.

a. Emergency egress trials are conducted to determine compliance with criteria specified in appendix F. Failure to meet specific criteria will require further analysis to determine the exact nature of the problem and what corrective action will be required.

b. Emergency egress trials will begin with the crewmember or passenger seated and belted in his seat within the aircraft. For crewmembers, all communication system cables, night vision system cables, and other personal devices shall be connected, and hands and feet shall be on the flight controls. Upon being given a visual signal by test personnel, the test participant will attempt to egress the aircraft as quickly as possible through the designated passageways. This will be done by unfastening only the seat belt (restraint system) and exiting the cockpit area and aircraft. When the demarcation line is crossed, timing of the maneuver will be terminated. See appendix D for a checklist which illustrates the required parameters of the test(s). It is recommended that at least three trials be conducted for each maneuver and passageway used. Following completion of trials, crewmembers will make a subjective judgment of the ability to reach and open exits for emergency egress from an aircraft that is inverted or on its side to evaluate the pilot's ability to reach and open exits.

4.4 Emergency Evacuation.

a. Emergency evacuation trials are conducted to determine compliance with criteria specified in appendix B. Failure to meet specific criteria will require further analysis to determine the exact nature of the problem and what corrective action will be required.

b. Emergency evacuation trials are conducted with a full complement of crew and passengers. The same procedure is followed as in the emergency egress trial using any available exit, including the emergency jettisonable door(s), cockpit canopies, and plexiglass windows for escape. The doors, windows, canopies, etc. can be removed by maintenance personnel in order to conduct nondestructive testing. Passengers on these trials should not be intimately familiar with the aircraft. If any emergency doors, windows, etc., have been removed to prevent damage, then an appropriate amount of time should be added to the egress time to account for not having to remove these during the actual timed event.

5. DATA REQUIRED.

Data collected will identify any problems associated with crew and passenger ingress and egress on a wide variety of fixed- and rotary-wing aircraft. Data collected for all tests will include the following:

- a. Type of test (i.e., ingress, emergency egress, emergency evacuation).
 - b. Aircraft type.
 - c. Test participants' names, crew positions, grades, and MOS.
 - d. Number of passengers.
 - e. Side of aircraft used and passageways used.
 - f. Number of trials.
 - g. Environmental conditions (day/night).
 - h. Clothing configuration worn.
 - i. Elapsed times to complete trials (three trials).
 - j. Visual observations and feedback from test participants.
 - k. Applicable or relevant anthropometric data (see appendix G) of particular test participants who experienced difficulty during the trials.
6. PRESENTATION OF DATA.

Data collected will be compiled and presented in either tabular or narrative form. Noncompliance with specific criteria will be discussed along with any other problems which may have contributed to failure to meet the criteria.

Forward comments, recommended changes, or any pertinent data which may be of use in improving this publication to Commander, U.S. Army Test and Evaluation Command, ATTN: AMSTE-TC-D, Aberdeen Proving Ground, MD 21005-5055. Technical information may be obtained from the preparing activity: Commander, U.S. Army Aviation Technical Test Center, ATTN: STEAT-MP-P, Ft. Rucker, AL 36362-5276. Additional copies are available from the Defense Technical Information Center, Cameron Station, Alexandria, VA 22304-6145. This document is identified by the accession number (AD No.) printed on the first page.

APPENDIX A. DEFINITIONS

Emergency Egress - The actions performed by a crew-member or a passenger to quickly and safely egress the aircraft under emergency conditions.

Emergency Evacuation - The actions performed by the crew and passengers to quickly and safely egress the aircraft under emergency conditions.

Emergency evacuation time requirement - Refers to the time required of crewmembers and passengers to evacuate the aircraft after crash landing using only one half of the exits. Time requirements are specified in MIL-STD-1472D, para 5.14.4.1.2*.

Emergency evacuation time - The amount of time in minutes, seconds, and tenths of seconds it takes the entire crew with a full complement of passengers to release their restraint systems and in specific operational gear and aviation life support equipment (ALSE), exit the designated doors/passageways and move 5 feet away from the aircraft, using one-half the available exits.

Ingress - The time it takes for the crew to enter the aircraft, position and strap themselves into their seats in preparation for takeoff. There are no specific time criteria cited in the guidance documents. However, emergency egress times may be used as a baseline to compare ingress times and possible significant differences.

***NOTE:** Research has shown that in helicopter crashes with post-crash fires, the available escape time is only 7 to 16 seconds. For a crew to survive under these conditions, they must be able to safely egress the aircraft within 10 seconds (30 seconds for aircraft fitted with crash-resistant fuel tanks). As a result of this short time factor, it becomes imperative that crewmembers be required to unfasten only their safety harness when emerging from their crew position. Any additional tasks involving manual disconnection from aircraft-mounted equipment shall be considered unacceptable. Design guidance for this issue is contained in AFSC DH 2-8^b, Design Note 3F1, Paragraph 2.3, Emergency Egress.

APPENDIX B. CRITERIA

1. Ingress and Egress

- a. Hatches for Normal Exit and Entrances
MIL-STD-1472D, para 5.14.3.1
- b. Exit markings
MIL-STD-1472D, para 5.14.3.1.1
- c. Handholds and Footholds
MIL-STD-1472D, para 5.14.3.2 and 5.14.4.1.7
- d. Latches
MIL-STD-1472D, para 5.14.3.4.2

2. Emergency Evacuation

- a. Simplicity
MIL-STD-1472D, para 5.14.4.1.1
- b. Evacuation Time
MIL-STD-1472D, para 5.14.4.1.2
- c. Evacuation Aids
MIL-STD-1472D, para 5.14.4.1.6
- d. Handholds
MIL-STD-1472D, para 5.14.4.1.7
- e. Control Protection
MIL-STD-1472D, para 5.14.4.2.5
- f. Latch Force Actuation (Emergency Exits)
MIL-STD-1472D, para 5.14.4.2.4
- g. Emergency lighting
MIL-STD-1472D, para 5.14.4.2.1

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APPENDIX C. AIRCRAFT EMERGENCY EGRESS/EVACUATION CONFIGURATIONS

<u>Aircraft</u>	<u>Left Side</u>	<u>Right Side</u>	<u>Crew</u>	<u>Additional Crew/ Passengers</u>
UH-1H/V	Cockpit door jettisonable (emergency egress)	Cockpit door jettisonable (emergency egress) Two cabin doors used for normal ingress/egress	Pilot Copilot	8-10
OH-58A/C	Rear access door (emergency egress) Copilot cockpit door	Rear access door (emergency egress) Pilot cockpit door	Pilot Copilot	2
OH-58D	Copilot cockpit door	Pilot cockpit door	Pilot Copilot	0
CH-47C/D	Jettisonable cockpit door Rear ramp 4 cabin portholes (push out)	Jettisonable cockpit door Cabin door 4 cabin portholes (push out)	Pilot Copilot Flight engineer Crewchief	32

<u>Aircraft</u>	<u>Left Side</u>	<u>Right Side</u>	<u>Crew</u>	<u>Additional Crew/ Passengers</u>
AH-64	Copilot canopy (front)	Pilot canopy (rear)	Pilot Copilot gunner	0
UH-60	Copilot cockpit door	Pilot cockpit door	Pilot Copilot Flight engineer	12
	Cabin door	Cabin door		
AH-1	Pilot hatch (enter from right)	Copilot gunner hatch (enter from left)	Pilot Copilot	0
U-21	Normal ingress/ egress cabin door	Emergency egress window/cockpit and passenger exits on top of fuselage	Pilot Copilot	6
OV-1D RV-1D	Pilot cockpit door and overhead hatch	Copilot cockpit door and overhead hatch	Pilot Copilot	0
C-12C/D	Step door/ Cargo door	Emergency egress window	Pilot Copilot	7

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APPENDIX D. SAMPLE INGRESS/EMERGENCY EGRESS/
EMERGENCY EVACUATION CHECKLIST

Aircraft Type _____ Date _____

Type Test Conducted: (Check one) Ingress____ Emergency:
Egress____ Evacuation ____

Check when
complete

1. Uniform configurations have been determined. _____
2. Number of trials for each test type and uniform configuration have been determined. _____
3. Aircraft has been inspected and is ready for trial to begin; all designated exits are operable. _____
4. Area around aircraft has been cleared of obstructions. _____
5. Seats are properly adjusted for each participant. _____
6. Environmental conditions (e.g., day/night) have been annotated. _____
7. Side of aircraft and passageways have been determined for the type test to be conducted. _____
8. Test participants have been briefed and the required number of passengers has been obtained (emergency evacuation only). _____
9. Photographic and data collection personnel positioned. _____
10. Test participants positioned at 5 ft. mark* or in crew seats.** _____
11. Aircraft armor panel (if applicable) has been deployed (egress/evacuation only). _____
12. Start cue initiated by data collectors. _____

*Helmet and flight gloves off.

**Helmet and flight gloves on.

13. Ingress trials commence when test participants have crossed the 5-ft. demarcation line. Time is stopped when test participants have entered the aircraft, donned helmet and gloves, made all necessary connections/secured themselves in their crew position with hands and feet on controls, and given a visual indication that ingress is complete. _____
14. Emergency egress trials commence when test participants are fully strapped/connected into their crew seats and a visual indication is given to the test participants to start egressing the aircraft. Time is stopped when the crew has egressed the aircraft and crossed the 5-foot demarcation line. _____
15. Emergency evacuation trials commence when a visual indication is given to the test participants to start egressing the aircraft through passageways designated as evacuation passageways. Timing will stop when all crewmembers and passengers have crossed the 5-ft. demarcation line using only one half the available hatches and emergency exits. _____

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APPENDIX E. SAMPLE INGRESS/EMERGENCY EGRESS/
EMERGENCY EVACUATION DATA SHEET
(Please circle the type test conducted above)

Date _____ Aircraft type _____

TEST PARTICIPANTS' NAMES, CREW POSITIONS

CLOTHING/EQUIPMENT CONFIGURATION

TYPE:	Flight Suit _____	NBC:	
	Survival Vest _____	Mask _____	
	Gloves _____	AUIB or Overgarment _____	
	Helmet _____	Gloves _____	
	Body Armor _____	Footwear _____	
	Flight Boots _____	Other _____	

(SEE BACK OF DATA SHEET FOR COMPLETE LIST OF CLOTHING AND EQUIPMENT.)

SIDE OF AIRCRAFT

/LOCATION OF EXITS USED TEST CONDITIONS

ELAPSED TIME

1.	_____	_____
2.	_____	_____
3.	_____	_____
4.	_____	_____
5.	_____	_____
6.	_____	_____
7.	_____	_____
8.	_____	_____
9.	_____	_____
10.	_____	_____

OBSERVATIONS

1. FLIGHT SUITS
 - a. Standard flight suit
 - b. Aircrew Uniform Integrated Battlefield (AUIB (NBC)
 - c. Aircrew Battle Dress Uniform (ABDU) (NEW VERSION)
2. GLOVES
 - a. Standard flight gloves
 - b. Cold weather gloves
 - c. NBC gloves
3. VESTS
 - a. SRU-21/P
 - b. Survival Armor Recovery Vest, Insert and Packets (SARVIP)
 - c. Aircrew Microclimate Unit Conditioning System (AMCS)
 - d. Life preserver unit (LPU-10/P)
4. BODY ARMOR
 - a. Standard body armor
 - b. SARVIP body armor
5. MASKS
 - a. M24 NBC protective
 - b. M43 NBC protective
6. JACKETS
 - a. Flight jacket
 - b. Winter parka
 - c. NBC overgarment
7. NIGHT VISION GOGGLES
 - a. AN/PVS-5
 - b. AN/AVS-6
8. HELMETS
 - a. SPH-4 flight helmet
 - b. Integrated helmet and display sight system (IHADSS) (AH-64 aircraft only)
9. BOOTS
 - a. Standard flight boots
 - b. Standard NBC overboots
 - c. Green vinyl overshoe (GVO)
 - d. Arctic flight boots

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10. HARNESSES

- a. OV-1 ejection seat harness
- b. Helicopter crewman safety harness
(harness assembly, NSN 1680-00-169-0656)
- c. Standard "monkey harness"

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APPENDIX F. SAMPLE INGRESS/EMERGENCY EGRESS/
EMERGENCY EVACUATION QUESTIONNAIRE

Name _____
Aircraft Type _____

Date _____

Test Conducted: (Check One) Ingress____ Emergency: Egress____
Evacuation____

1. Were the latch/door handles labeled to provide an indication of the direction required to open?

Yes____ No____ N/A____

If no, please describe the handle and location _____

2. Are latch/door handles turned in a consistent direction throughout the aircraft for similar type passageways?

Yes____ No____ N/A____

If no, please describe the difficulty you encountered and the location of the passageway _____

3. Did you encounter any latch/door handles that you felt required excessive force to open?

Yes____ No____ N/A____

If yes, please describe problems and the location of the latch _____

4. Were handholds and footholds spaced close enough together to enable easy access to the aircraft?

Yes____ No____ N/A____

If no, please describe the nature of the difficulty and the location of the footholds and handholds _____

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5. Were handholds and footholds spaced close enough together to enable easy egress from the aircraft?

Yes___ No___ N/A___

If no, please describe the nature of the difficulty and the location of the footholds and handholds_____

6. Were the emergency lighting systems adequate in illuminating egress locations under dark or low light conditions?

Yes___ No___ N/A___

If no, please describe the difficulty you encountered and the location of the passageway_____

7. Were there any obstructions within the walkways which seriously impeded your egress from the aircraft?

Yes___ No___ N/A___

If yes, please describe the difficulty and the location of the obstruction_____

8. Did you have serious difficulty egressing through any emergency evacuation exit?

Yes___ No___ N/A___

If yes, please describe the difficulty and the location of the passageway_____

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9. Did certain clothing configurations seriously impede your attempts to ingress or egress the aircraft?

Yes___ No___ N/A___

If yes, please describe the clothing worn, the type of ingress or egress maneuver conducted, and difficulties associated with this aircraft type_____

10. Please list additional comments_____

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APPENDIX G. DESCRIPTIVE PARTICIPANT DATA

DEMOGRAPHIC DATA

NAME _____ GRADE _____ MOS _____

SEX: M__ F__ AVIATOR: YES__ NO__ HANDEDNESS: RH__ LF__ AMB__

EYEGASSES: DON'T WEAR__ NEAR-SIGHTEDNESS__ FAR-SIGHTEDNESS__

ANTHROPOMETRIC DATA

<u>DIMENSION</u>	<u>MEASUREMENT*</u>	<u>PERCENTILE^{2,3}</u>
WEIGHT	_____	_____
STATURE	_____	_____
ACROMIAL HEIGHT	_____	_____
HIP BREADTH (Sitting)	_____	_____
SHOULDER CIRCUMFERENCE	_____	_____
SHOULDER BREADTH	_____	_____
BUTTOCK-HEEL LENGTH	_____	_____
SITTING HEIGHT	_____	_____
CHEST CIRCUMFERENCE	_____	_____
CHEST DEPTH	_____	_____
WAIST CIRCUMFERENCE	_____	_____
HEAD CIRCUMFERENCE	_____	_____
FACE LENGTH	_____	_____
FACE WIDTH	_____	_____
FUNCTIONAL REACH (HARNES LOCKED)	_____	_____ **

*Measurements in cm or kg

**Percentile values have not been established for this measurement.

^{2,3}See appendix H.

APPENDIX H. REFERENCES

REQUIRED REFERENCES

1. MIL-STD-1472D, Human Engineering Design Criteria for Military Systems, Equipment and Facilities, 14 March 1989.
2. TR-72-52-CE, Anthropometry of U.S. Army Aviators - 1970, U.S. Army Natick Laboratories, December 1971.
3. TR-89/027, 1988 Anthropometric Survey of U.S. Army Personnel: Summary Statistics Interim Report, U.S. Army Natick Laboratories, March 1989.

FOR INFORMATION ONLY

- a. AFSC Design Handbook, DH 2-2, Series 2-0 Aeronautical Systems, Crew Stations and Passenger Accommodations, 30 September 1981.
- b. AFSC Design Handbook 2-8, Life Support, 14 October 1983.
- c. TECOM TOP 1-2-610, Human Factors Engineering, Part 1-Test Procedures, 30 November 1983.
- d. TECOM PAM 602-1, Man-Material Systems, Questionnaire and Interview Design (Subject Testing Techniques), July 1975.
- e. USARTL-TR-79-22A, Aircraft Crash Survival Design Guide, Volume 1, Design Criteria and Checklists, December 1980.
- f. USARTL-TR-79-22E, Aircraft Crash Survival Design Guide, Volume 5, Aircraft PostCrash Survival, January 1980.