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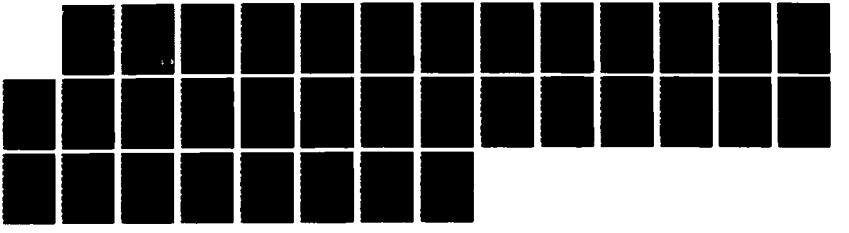

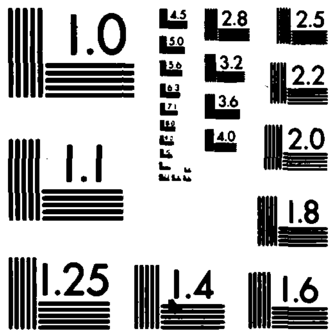

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)
This TOP describes test methods to be employed in the evaluation of survival equipment provided aviators for use in emergencies in which normal support, transportation, environmental protection, and communications may be interrupted for extended periods. Tests will be conducted to measure physical characteristics, system compatibility, human factors design, maintenance characteristics and reliability of survival equipment.

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

AMSTE-RP-702-106
*Test Operations Procedure 7-3-095 13 June 1986
AD No.

SURVIVAL EQUIPMENT (AVIATION)

1. SCOPE. This Test Operations Procedure (TOP) outlines test methods to be employed in the evaluation of survival equipment. Survival equipment is defined as life support equipment provided aviators for use in emergencies in which normal support, transportation, environmental protection, and communications may be disrupted for extended periods. It includes equipment designed for use on land and/or water. Typical items are survival vests, life preserver or flotation devices (water wings, inflatable boat, collars), and hoisting harnesses. The tests will be conducted to measure the physical characteristics, system compatibility, human factors design, maintenance characteristics, and reliability of survival equipment. The procedures described in this document will provide test plan writers with sufficient information to develop tests which are adequate to determine the suitability of survival equipment which is provided for use in Army aviation.

This TOP supersedes TOP 7-3-095, Survival Equipment (Aviation), 21 January 1971, and 7-3-090, Rescue Equipment, Aircraft Crash, 27 January 1971.

Approved for Public Release; Distribution Unlimited.

a. The determination of functional suitability is one test requirement. Additional tests must address reliability, maintainability, safety aspects associated with use, compatibility with personal equipment and appropriate aircraft, and suitability of the equipment from the human factors standpoint.

b. Tests are conducted under operational conditions by personnel representative of those who will use the equipment in actual aviation operations and with current Army aircraft. The test will include the observations of supervisory test personnel together with those of appropriate specialists called upon to comment on the equipment. Test personnel will be interviewed and their observations and recommendations recorded on questionnaires and correlated with other test information. Still and motion pictures and/or video will be taken during testing.

c. The data collected during the test will be reviewed to obtain subjective and objective indicators which characterize the equipment's performance. Tabulations, charts, and other graphic displays will be employed to present these indicators. Analysis of the data will include comparisons with performance criteria and with the performance indicators obtained from the use of standard survival equipment and kits employed in similar or identical mission roles.

2. FACILITIES AND INSTRUMENTATION. Static and dynamic tests will be conducted, under various environmental conditions, to determine the effectiveness of survival equipment in meeting specified criteria on land and in water. Tests will be conducted using aircrews equipped with survival equipment and apparel which could impede their performance. Aircraft and equipment will be operated and maintained by test personnel representative of those skills normally assigned to such duties.

2.1 Facilities. A suitable operational airfield and authorized air space are required to conduct the tests.

2.2 Instrumentation

ITEM	MINIMUM REQUIREMENT
HFE instrument kit	Should include anthropometry kit; stopwatch
Video and Cameras	To document typical use of the test item and incompatibilities, failures, or other problems
Video tape recorder and cassettes	As required

ITEM	MINIMUM REQUIREMENT
Questionnaires, data sheets, comment sheets	Questionnaires should be consistent with guidelines in TECOM Pamphlet 602-1[1]

2.3 Equipment

ITEM	MINIMUM REQUIREMENT
Appropriate operational aircraft	Will include all aircraft in which the test item is planned to be used. Aircraft must be in the standard configuration (as it relates to man-machine interface) normally found in Army aviation units, and be fully operational
Aircrew protective equipment, clothing	All protective masks, helmets, gloves, clothing, night vision devices, and personal items (e.g., glasses) of appropriate dimensions/fit should be included for compatibility testing
Videotape and still Cameras	To document typical use of the test item and document incompatibilities, failures, or other problems

2.4 Other Support

ITEM	MINIMUM REQUIREMENT
Aircrew	Crewmembers and maintenance personnel with proper MOS and ASI, in case of ALSE maintainers, and training
Inspection personnel	For pretest and post-test, as required
Photographic support	Photo Lab support in taking and/or developing photos

[1]Footnote letters/numbers match those in Appendix D.

	MINIMUM REQUIREMENT
Survival training facilities	Wilderness areas exhibiting appropriate climatic characteristics

ITEM	MINIMUM REQUIREMENT
In-water facilities	Ocean, pool, or lake as required to demonstrate in-water performance of the test item. Rescue swimmer and water craft support must be included.
Survival equipment	Maintenance facilities and test equipment required
Other support	From outside agencies, as required

3. PREPARATION FOR TEST. All background material and documentation concerning the survival equipment being tested should be reviewed in order to understand the history of the survival equipment development, predecessor survival equipment, the purpose of the impending tests, and the standards which the survival equipment is expected to meet. A determination of the performance areas to be evaluated must be made followed by the development of sound test procedures. Appropriate questionnaires and data collection sheets will accompany the test plan. A list of support requirements and a feasible test schedule must be developed prior to beginning of testing.

3.1 Document Review. All standards, specifications, directives, procedures and letters relevant to the characteristics, history, and testing of the survival equipment should be studied. This information is valuable in the development of the introduction, objectives, issues, and criteria sections of the test plan. In addition, the types of tests to be conducted should be formulated in part on the basis of the information extracted from the documents reviewed. The documents to be reviewed are to include, but are not limited to, the following:

a. Material Needs (MN); Letter Requirement (LR), Letter of Agreement (LOA), and Required Operational Capability (ROC) or other requirement documents.

b. All relevant AMC/TECOM directives and pamphlets.

c. The Test Design Plan (TDP).

d. Relevant standards and specifications.

e. Pertinent laboratory reports.

f. Guidelines for test design and statistical analysis.

g. Any applicable test data and material available from the procuring agency or developer/contractor.

h. Any prior test documentation on similar equipment.

3.2 Develop Objectives. The Test Directive (TD), TDP, and requirement documents are good sources for the development of test plan objectives. A discussion of the overall objectives will be written into the introduction section of the test plan, while the specific objectives will be written for each subtest in the Details of the Test section.

3.3 Develop Criteria. Specific criteria for minimum performance characteristics should be developed. Sources for such criteria will include military standards and specifications, requirement documents, and test directives.

3.4 Determine Data Requirements. Performance measures and user assessment instruments will be constructed on the basis of the criteria developed. Appropriate measures should be determined so that obtained performance can be matched against those criteria. The required data will be listed in Details of Test. When a Test Design Plan (TDP) is provided, data requirements of the TDP should be fully satisfied by the DTP.

3.5 Design Test Procedures and Materials. Subtests for obtaining the required data should be designed. Each procedure will be described fully under "Data Acquisition Procedure" in Details of Test.

4. TEST CONTROLS. Once performance criteria are developed, measures which assess performance against the criteria are constructed. Then the procedures for obtaining the measures are established. This process, which includes selection of people to be tested, test administration, data analysis, and test reporting, must be done with sufficient controls so that the data will be compared to the criteria with reliability and validity. The following considerations are applicable to test development.

4.1 Choosing and Imposing a performance measure. Performance measures will be realistic and should apply directly to the criteria. If, for example, a speed criterion for donning the armor vest is applied, timed trials (stopwatch) will be used rather than subjective estimates. Performance measures will be reliable. Sufficient trials will be performed in order to discount variability factors. Other factors affecting reliability of performance measurements are listed below.

a. Electro-Mechanical Instrumentation. Instrumentation will be calibrated prior to use. If more than one of the same kind of instrument is to be used, care will be taken to note any calibration differences between the instruments. Battery driven equipment will be checked for battery integrity, and spare batteries will be available.

b. Questionnaire or Subject Comment Sheets. These should be written clearly and should include instructions in order to avoid ambiguity. A sufficient number of items must be included in order to adequately sample the performance area being measured. Questionnaires should always be tailored to the test item and; if possible, the questionnaires should be pre-tested on a similar population to that of the test. When practical a post-test interview should be accomplished by the HFE with the test subjects to obtain consensus opinions.

c. Observation or Event Records. Observation records normally require sampling over a substantial period of time to obtain representative data. Event records (e.g., equipment breakdown) are essentially logs and require recording of all designated events.

4.2 Selecting Test Conditions. Test conditions must be selected such that the performance measures are obtained under conditions representative of those under which the survival equipment is used. If there is reason to believe that a certain variable (e.g., ambient temperature) will substantially affect the performance of the survival equipment then the tests should be conducted under different conditions (e.g., hot, cold) to determine the effects of that variable. If a variable is not of interest for test purposes (e.g., participants age), that variable should be randomized over the test conditions if there is a reasonable chance that it may have any effect on performance of the survival equipment or apparel. Order effects, such as fatigue or learning, should be counterbalanced.

4.3 Selecting and Assigning Participants

a. Participants should be representative of the user population. Personnel that may differ from the typical user should not be used for testing.

b. The number of participants per test condition should be adequate to satisfactorily sample the expected user population.

c. Participants should be randomly assigned to each test group to achieve balance. If, because of small sample size, balance is not achieved, sample groups should be systematically equalized, or matched, when two or more groups are being compared under different test conditions.

d. If the number of participants is too small to achieve reasonable sample sizes in different conditions, the participants may be exposed to more than one condition. If this is done, all participants should not be used in the same sequence. Example: subgroup I, condition 1 (hot), condition 2 (cold); subgroup II: condition 2 (cold), condition 1 (hot).

e. Make sure that test participants include the extreme of the user population. Although the 5th and 95th percentiles frequently have been used to define the extremes, in the present case, it could be preferable to exceed those percentiles since the test items must be made in a sufficient number of sizes to fit the entire aircrew population.

f. In situations where activation of the test item has a potential for injury (e.g., in CO_2 inflation of a life raft), the test item should be activated on or adjacent to an anthropometric dummy before testing with human participants.

4.4. Data Reporting. With respect to reporting measurements:

a. Measurements will be reduced to International System of Units (SI). Customary units will be included in parenthesis after the metric unit, if deemed necessary.

b. Numerical observations will be rounded to the nearest tenth, unless designated otherwise.

c. Time measures will be reported to the nearest tenth of a second, unless greater precision is indicated by the nature of the task.

d. The performance tests will be broken down into independent sections for various items of survival equipment. However, since these articles frequently are worn together, should there be a requirement to test more than one (e.g., water wings and NBC garments), some of the subtests can be integrated.

5. PERFORMANCE TESTS. This section presents the basic procedures to be used in performing the subtests. The subtests described employ the instrumentation, equipment, and controls described in the earlier sections of this TOP. The following points apply to the use of this section.

a. Since this TOP is generic and applies to evaluation of survival equipment used in conjunction with aviation helmets, masks, and clothing in general, during hot, temperate, and cold conditions, the subtests and procedures reflect the subtests and procedures typically applied in such evaluations. However, these may differ in the case of specific equipment, and the test designer should make changes accordingly. In all cases, communicate to the test personnel the necessary planning and controls.

b. The "Data Required" and "Data Acquisition Procedure" for each of the following TOP subtests correspond with "Data Required" and "Data Acquisition Procedure" in the Details of Test section of the Test Plan.

c. Often, data from one subtest applies to another subtest. For example, with respect to the testing of a survival vest, some of the donning, fitting, and doffing data are applicable to the compatibility issues.

In such situations, consolidate parts of overlapping subtests and/or data sheets.

d. If possible, run the subtests on the currently fielded (control) equipment as well as on the test item for comparison.

5.1 Initial Inspection/Physical Characteristics. The overall objective of this subtest is to determine whether the survival equipment and system support package (SSP) are complete, consistent with specifications, undamaged, and ready for testing. Those not meeting these criteria should not be used.

5.1.1 Data Required.

a. Record of test item dimensions and weight, using caliper and scale, recorded in SI units.

b. Record of serial numbers and part numbers (as appropriate).

c. Photographs of the survival equipment and accessories as required.

d. List of damage to survival equipment and/or shipping containers.

e. List of any survival equipment discrepancies from specifications.

5.1.2 Method.

a. Inspect the survival equipment, accessories, and shipping containers for physical damage. Particular attention will be placed on identifying dents, damage, bent or cracked parts, abrasions, tears, missing parts, or incomplete/loose bonds (rubber to metal, stitching), or loose parts (e.g., screws). Photograph and record the data on the Initial Inspection Data Sheet.

b. Inventory the survival equipment package, compare contents to packing sheet, and record any shortages on the Initial Inspection Data Sheet.

c. Weigh and measure each survival equipment component, matching measurements against those listed in the appropriate Military Specification, or as specified in test item specification or requirement documents. Measurements should be done with tape measures and caliper from the HFE kit and should include:

(1) Component circumference, width, length, and height, when required.

(2) Any component dimensions designated important in the Military Specification.

5.2 Comfort and Crew station Compatibility

Assess the characteristics of the survival equipment with respect to comfort and crewstation compatibility during use.

5.2.1 Data Required.

a. Anthropometric measurements of test participants as specified in TDP.

b. Times required for emergency egress trials.

c. Completed HFE observation work sheets.

d. Completed HFE questionnaires.

e. Results of flight control interference measurements.

f. Completed fit/range of adjustment work sheet.

g. As appropriate, comments and suggestion of Army Aviation Accident Investigation experts.

h. Videotapes showing typical usage of item and problems.

5.2.2 Method.

a. Prior to any flight testing, a large male and small female, representative of a 95th percentile (waist, chest, mid-shoulder height) male aviator and a 5th percentile female soldier (waist, chest, mid-shoulder height) respectively, wearing clothing configurations 1 through 5 of table 1, should be observed as they exercise all controls and view all displays of the operational aircraft with which the equipment will be used, while seated and wearing the restraint harness. Particular attention will be given to restrictions in flight control movement and any inability to reach and/or view cockpit displays, instrumentation, and emergency equipment. Flight control restrictions should be measured using a tape measure from the HFE instrumentation kit when the seat is in its vertical and horizontal extremes of travel and the neutral position. Videotapes should be made to record the restrictions.

b. Observations regarding control, display, and equipment access, should be made during flight by at least five different aviators in each aircraft type. Results will be gathered using a comfort and crewstation compatibility questionnaire. An example may be found in Appendix C, Part 2.

Table 1
Clothing Configurations

Equipment	1	2	3	4	5
Flight suit	X	X	X	X	X
Flight helmet	X	X	X	X	X
Flight gloves	X	X	X	X	X
Boots	X	X	X	X	X
Survival vest only	X	X	X	X	X
Survival vest with armor		X	X	X	X
Personal flotation device			X		X
Life raft			X		X
NBC outer garment, gloves, and protective masks				X	X

c. A test participant representative of a large male aviator (95th percentile chest, waist, and mid-shoulder height), wearing clothing configurations 1 and 5 of table 1, should be observed performing normal ingress and emergency egress procedures into/from the operational aircraft with which the equipment will be used. Emergency egress trials will begin with the test participant seated in a static aircraft, with the restraint harness fastened, and his hands on the flight controls. A signal will be given by the HFE observer and timing will start. The test participant will be instructed to exit as fast as he safely can. Timing will cease when both of the test participant's feet are on the ground and he has moved 5 feet away from the aircraft. This procedure should be accomplished for each crew position and one passenger position (if applicable) in each aircraft type. Emergency egress times will be recorded to the nearest 1/10 second using a digital stopwatch.

d. Observe at least two test participants as they operate closures and fasteners while wearing gloves or cold weather mittens. This will be accomplished using both hands and again with either hand alone. Equipment-related compatibility problems with each clothing configuration (including life support equipment) should be assessed.

e. Comfort, compatibility, wearability, and survival equipment effects on seat comfort will be assessed by having all flight test participants complete a comfort and crewstation compatibility questionnaire after initial use and again at the end of the test period. Five different aviators in each aircraft type will wear survival equipment during flights of at least 2 hours duration.

f. The range of adjustment of each size of survival equipment will be measured using a tape measure. These measurements will be compared to the anthropometric data in TR 72-52-CE[2], Anthropometry of U.S. Army Aviators-1970 to identify the user population the equipment will fit. In addition, appropriate anthropometric measurements will be taken of individuals observed or reporting fit problems. These measurements will also be taken of personnel having cockpit compatibility or fit problems while wearing survival equipment.

g. Comments and suggestions will be solicited from the Army's aviation accident investigation experts, regarding the proposed locations in the various aircraft for placing survival equipment not worn by the aircrew. Their views should address the likelihood of kit damage and kit accessibility in survivable crashes. Such comments or professional opinions could preclude the placement of kits in vulnerable aircraft structure areas.

h. An appropriate structural integrity test or analysis will be conducted to determine if proposed kits will remain attached to the airframe

when subjected to survivable crash loads. This test or analysis can be a part of the contractor's statement of work and/or addressed in AVSCOM's airworthiness release. Such crash loads are defined in AMCP 706-203, Engineering Design Handbook, Helicopter Engineering, Part One, Preliminary Design, August 1974.

5.3 Performance - Land

To assess the performance characteristics of the survival equipment with respect to survival on land.

5.3.1 Data Required.

a. Completed comfort and use questionnaire (appendix C, part 1). This is a sample questionnaire and may be adapted to a particular test item.

b. Comments by users and observations regarding survival equipment identification and accessibility made by a human factors engineer.

c. Results of testing in an escape-and-evasion environment.

d. Comments, opinions, and/or test results of the U.S. Army Aeromedical Research Laboratory regarding proposed survival equipment.

5.3.2 Method.

a. Five test participants will wear the survival equipment in an escape and evasion "E & E" environment using an "E & E" course. The course will be designed so that test participants will be required to encounter a variety of terrain types and use the survival equipment and any related items as designed.

b. During the "E & E" course, the following tests will be conducted.

(1) Survival equipment accessibility using either hand alone.

(2) Comfort and compatibility. A sample questionnaire is shown in appendix C, part 2.

c. Test participants involved in the "E & E" course will complete the comfort and use questionnaire (app C, part 1).

d. Survival equipment compatibility with NBC equipment, including accessing, opening, closing, and replacing items, and compatibility jettison of any ballistic armor plate. Test participants will perform these functions while wearing clothing configuration 4 of table 1.

e. Two test participants familiar with the survival equipment and any related items, and wearing clothing configurations 1 and 4 of table 1 will attempt to identify the features of the equipment visually and again while blindfolded using one hand only.

f. During the conduct of the "E & E" course, test participants will be asked to use developmental items or new functions of the equipment to determine their utility under field conditions.

g. Aeromedical Research Laboratory will be given an opportunity to independently test and evaluate kit components of special interest to the medical community. In addition, the Aeromedical Research Laboratory will be requested to comment, provide expert opinions, and/or provide input to Detailed Test Plans.

5.4 Performance - Water

To assess the performance characteristics of the survival equipment in a water survival environment.

5.4.1 Data Required.

a. Results of in-water testing with respect to the use of closures and adjustments and other life support equipment (e.g., flotation equipment).

b. Results of rescue/pickup.

c. Results of in-water testing using life preserver provisions, accessing and use of survival items and functions.

d. Results of in-water testing using the survival equipment with the NBC ensemble.

e. Completed comfort and use questionnaires.

f. The effects of water, particularly salt water, upon the equipment and any related items should be reported.

5.4.2 Method.

a. In-water testing will be accomplished using at least two test participants representative of a large male aviator (95th percentile chest, waist, and mid-shoulder height), and a 5th percentile female soldier (waist, chest, mid-shoulder height), wearing clothing configurations 3 and 5 of table 1. Each test participant will be observed attempting to complete the following tasks while in a swimming pool, then in open water such as a lake or ocean when deemed appropriate depending on equipment design and usage.

(1) Operation of all closures and fasteners with either hand alone and with both hands.

(2) Activation of any personal flotation devices with either hand alone and with both hands.

(3) Visual identification, access, use and replacement of survival items or equipment using either hand alone and with both hands.

(4) During pool testing, a test participant familiar with the contents of the survival equipment and wearing clothing configurations 1 and 5 of table 1 will attempt to identify its items and features while in the water and blindfolded.

(5) With respect to survival equipment such as life boats, test participants must perform maneuvering tasks, accessing attached survival gear, and re-inflation, if necessary.

b. If the survival equipment includes or consists of developmental items which interfere with helicopter rescue equipment, in-water test participants, wearing clothing configurations 3 and 5 of table 1, will be observed attempting to use a rescue hoist. This will be accomplished using a crane (swimming pool environment) and a helicopter rescue hoist. Compatibility with Army and Navy rescue equipment and procedures will be assessed. During hoisting, participants will simulate unconsciousness. Problems and incompatibilities will be noted and recorded.

c. In-water test participants will complete the comfort and use questionnaire at the end of the test cycle.

d. Safety swimmers and rescue personnel should be on hand for all testing.

5.5 Logistic Supportability. A subtest will be included to evaluate all the various elements of logistic supportability characteristics using AMCR 700-15[4] and Test Operations Procedure (TOP) 7-3-507[5] as a guide.

5.6 Reliability. When reliability is to be assessed, a subtest will be included using Test Operations Procedure 7-3-508[6] as a guide.

5.7 Storage (Extreme Climatic Environment). When extreme climatic environmental storage is to be evaluated a subtest will be included using TOP's 7-4-008[7], 1-1-006[8] and 7-4-005[9] as a guide.

5.8 Safety.

To assess the safety aspects of the survival equipment.

5.8.1 Data Required.

a. Review of the developer's safety assessment report.

b. Results of initial safety inspection.

c. List of safety problems found during the test.

d. Completed safety checklist. A sample checklist, illustrating survival vests and life rafts, is shown in appendix B, part 1.

5.8.2 Method.

a. The developer's safety assessment report will be reviewed to determine the presence of identified hazards and limitations on testing.

b. The safety engineer will inspect the survival equipment using the safety checklist as a guide. Potential hazards with respect to health, wear, crewstation compatibility, and emergency egress transportation and handling will be noted. The safety checklist will be updated throughout the conduct of the test.

c. Review of the airworthiness release (AWOR), if one is required.

d. Observations and professional judgment of appropriate specialists on the crashworthiness and post-crash accessibility of survival equipment mounted in the aircraft, and on the potential for causing personnel injury if the item is worn on the body.

6. DATA REDUCTION AND PRESENTATION.

6.1 Analytical Requirements. The types of analytical procedures which can be employed to reduce test data include, but are not limited to, the following:

6.1.1 Summary Data from Questionnaires

a. Mean. For some data in which skewness, or departure from a normal distribution exists, more appropriate measures of central tendency may be the mode or the median.

b. Standard Deviation.

c. Percent.

The mean and standard deviation will be used respectively to summarize the central tendency and participant variability of the data. When single items are being compared in respect to frequency, percentage may be

used (e.g., "56% responded "Very Good" or "Better").

6.1.2 Summary Data from Timed Measurements

a. Mean (average). (Here, as above, the mode or median may be more accurate measures)

b. Standard Deviation.

6.1.3 Summary Data from Maintenance/Reliability Data. Specialized means.

6.1.4 Statistical Inference with Questionnaire Data. When comparing two groups' mean performance, t-tests will be used. T-tests will be useful in analyzing data obtained during any tests in which the in-service equipment is being compared with the one being tested. For example, donning/doffing times for vests can be compared using the standard and new test equipment.

6.1.5 Statistical Inference with Time Measurement Data. One-sided tolerance tests will be performed to determine with a given degree of confidence (e.g., 90%) what proportion of the user population can perform the task under the established criterion time.

6.2 Conventional Symbols and Usage. These are necessary in understanding the formulas explained in the next section.

S=Subject (Test Participant)

N_1=Number of subjects in sample 1

N_2=Number of subjects in sample 2

X=An individual score

$\bar{X}$=Mean

Σ=Summation

$\sqrt{\ }$=Square root

ΣX_1^2=Square the individual scores (sample 1) and then add them together.

$(\Sigma X_1)^2$=Add the scores (sample 1) and then square the total.

6.3 Description of Analytical Techniques

6.3.1 Range = X_{high} minus X_{low}

6.3.2 Mean $(\bar{X}) = \frac{\sum_{i=1}^{N} X}{N}$

6.3.3 Standard Deviation: $SD = \sqrt{\frac{\sum_{i=1}^{N}(X_i - \bar{X})^2}{N-1}}$

6.3.4 T-test. A -test will be required to determine the level of statistical significance between the means x for two independent groups. Performing the test will yield a "significance level," which indicates the probability that the difference is due to chance.

Formula:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{(N_1-1)\ SD_1^2 + (N_2-1)\ SD_2^2}{N_1 + N_2 - 2}}\ \sqrt{\frac{1}{N_1} + \frac{1}{N_2}}}$$

6.3.5 One Sided Tolerance Limits

$$X_u = \bar{x} + K_s$$

or

$$X_L = \bar{x} - K_s$$

See para 2-5.3 AMCP 706-110, Engineering Design Handbook Experimental Statistics, Section 1, Basic Concepts and Analysis of Measurement Data

6.3.6 Formulas for Maintainability, Reliability, and Availability

6.3.6.1 Maintainability. Two formulas typically are used here:

a. Mean Time to Repair (MTTR) = $\frac{\text{Total Repair Time}}{\text{No. of Repairs}}$

b. Corrective Maintenance Man-Hours per Utilization Hour (Cmm/Uh)=

$$\frac{\text{Total Corrective Maintenance Man-Hours}}{\text{Total Hours of Use}}$$

6.3.6.2 Reliability. The following is used:

Mean Time Between Failures (MTBF) = $\frac{\text{Accumulated Test Time}}{\text{No. of System Failures}}$

6.3.6.3 Availability. The following formula is used:

$$\text{Availability} = \frac{\text{MTBF}}{\text{MTBF} + \text{MTTR}}$$

Recommended changes to this publication should be forwarded to Commander, U.S. Army Test and Evaluation Command, ATTN: AMSTE-TC-M, Aberdeen Proving Ground, MD 21005-5055. Technical information may be obtained from the preparing activity: Commander, U.S. Army Aviation Development Test Activity, ATTN: STEBG-MP-P, Fort Rucker, AL 36362-5276. Additional copies are available from the Defense Technical Information Center, Cameron Station, Alexandria, VA 22034-6145. This document is identified by the accession number (AD No.) printed on the first page.

(SAMPLE)
APPENDIX A
SAFETY CHECKLIST

Detailed Design Considerations	Yes	No	N/A	Comments
1. Vest or contents do not interfere with flight control manipulation.				
2. Reach and/or view of instruments, displays, or emergency equipment is not blocked.				
3. Sharp/pointed objects (i.e., knives, needles, fish hooks, etc) cannot cause injury to wearer.				
4. Hoist harness materials and design are able to safely support the wearer.				
5. Hoist harness design is such that the wearer cannot fall out regardless of body position.				
6. Vest and contents will not cause or aggravate injury during a crash or while being hoisted.				
7. Vest does not compromise the effectiveness of the aircraft restraint harness.				
8. Vest does not compromise the effectiveness of NBC protective clothing and gear.				
9. Vest does not hinder emergency egress.				
10. Fasteners, closures, and configuration of the survival equipment insure that it will not loosen or fall off during flight operations.				

YES = Adequate NO = Inadequate N/A = Not Applicable

(SAMPLE)
APPENDIX B, PART 1
EMERGENCY EGRESS TIME (SEC)

Name_____ DATE_____

AIRCRAFT	CLOTHING CONFIGURATION 1	5
OH-58		
Pilot		
Copilot		
Pass		
UH-1		
Pilot		
Copilot		
Pass		
UH-60		
Pilot		
Copilot		
Pass		
CH-47		
Pilot		
Copilot		
Pass		
AH-1		
Pilot		
Copilot		
U-21		
Pilot		
Copilot		
Pass		
OTHER		

(SAMPLE)
APPENDIX B, PART 2
FIT/RANGE OF ADJUSTMENT WORK SHEET

VEST SIZE	RANGE OF ADJUSTMENT	AVIATOR POPULATION FIT*

Problems Noted:	Related anthropometric measurement(s):	
	DATA	PERCENTILE*

*Based on anthropometric data in TR 72-52-CE, Anthropometry of U.S. Army Aviators - 1970

(SAMPLE)
APPENDIX C, PART 1
COMFORT AND USE QUESTIONNAIRE

Name/Rank_____ DATE_____

Type of use_____ Land
_____ Water

---

1. Rate the overall ease of donning the test item.

6	5	4	3	2	1
Excellent	Very Good	Good	Adequate	Barely Adequate	Poor

Comments_____

---

2. Rate the overall ease of adjusting the test item.

6	5	4	3	2	1
Excellent	Very Good	Good	Adequate	Barely Adequate	Poor

Comments_____

---

3. Rate the overall comfort of the test item.

6	5	4	3	2	1
Excellent	Very Good	Good	Adequate	Barely Adequate	Poor

Comments_____

---

4. Rate the fit of the test item.

6	5	4	3	2	1
Excellent	Very Good	Good	Adequate	Barely Adequate	Poor

Comments _____

_____

5. Did you have any problems with the closures/fasteners of the test item?

Yes ___ No____

If yes, explain _____

_____

6. Did you have any problems, donning, doffing, or adjusting the test item while wearing gloves?

Yes ___ No____

If yes, explain _____

_____

7. When wearing NBC protective gear, did you have any survival test item-related problems?

Yes ___ No____

If yes, explain _____

_____

8. Did the test item retain body heat to the point of making you uncomfortable?

Yes____ No____

If yes, under what conditions were you uncomfortable?_____

_____

9. Rate the ease of visual identification of items in the test item.

6	5	4	3	2	1
Excellent	Very Good	Good	Adequate	Barely Adequate	Poor

Comments_____

_____

10. Rate the ease of tactile identification of items in the test item.

6	5	4	3	2	1
Excellent	Very Good	Good	Adequate	Barely Adequate	Poor

Comments_____

_____

11. Rate the overall accessibility of items in the test item.

6	5	4	3	2	1
Excellent	Very Good	Good	Adequate	Barely Adequate	Poor

Comments_____

_____

12. Were items easily accessible with either hand?

Yes____ No____

If no, explain_____

_____

13. Rate the comfort of the test item while being hoisted.

6	5	4	3	2	1
Excellent	Very Good	Good	Adequate	Barely Adequate	Poor

Comments_____

_____

14. Rate the ease of opening the survival packets.

One Hand:

6	5	4	3	2	1
Excellent	Very Good	Good	Adequate	Barely Adequate	Poor

Two Hands:

6	5	4	3	2	1
Excellent	Very Good	Good	Adequate	Barely Adequate	Poor

Comments_____

_____

15. During the in-water test, did the vest interfere with the inflation of your water wings?

Yes____ No____ N/A____

If yes, explain_____

_____

(SAMPLE)
APPENDIX C, PART 2
COMFORT AND CREWSTATION COMPATIBILITY QUESTIONNAIRE

Name/Rank_____ DATE_____

Duty Position: ___ Pilot ___ Flight Engineer

___ Copilot ___ Passenger

___ Crewchief

Aircraft Type: ___ OH-58 ___ CH-47

___ UH-1 ___ AH-1

___ UH-60 ___ AH-64

___ U-21

DID YOU WEAR BODY ARMOR? Yes___ No___ FLIGHT TIME_____

---

1. Rate the overall ease of donning the test item.

6	5	4	3	2	1
Excellent	Very Good	Good	Adequate	Barely Adequate	Poor

Comments_____

---

2. Rate the overall ease of adjusting the test item.

6	5	4	3	2	1
Excellent	Very Good	Good	Adequate	Barely Adequate	Poor

Comments_____

---

3. Rate the overall comfort of the test item.

6	5	4	3	2	1
Excellent	Very Good	Good	Adequate	Barely Adequate	Poor

Comments _____

_____

4. Rate the ease of normal ingress (entry) into the cockpit while wearing the test item.

6	5	4	3	2	1
Excellent	Very Good	Good	Adequate	Barely Adequate	Poor

Comments _____

_____

5.Rate the ease of normal egress (exit) from the cockpit while wearing the test item.

6	5	4	3	2	1
Excellent	Very Good	Good	Adequate	Barely Adequate	Poor

Comments _____

_____

6. Did the test item interfere with helicopter flight safety?

Yes____ No____

If yes, how was flight safety compromised? _____

_____

7. Did the test item limit access to aircraft controls, displays, or other equipment?

Yes____ No____

If yes, explain_____

_____

8. Did the test item interfere with the use of the restraint harness?

Yes____ NO____

If yes, explain_____

_____

9. Rate the fit of the test item.

6	5	4	3	2	1
Excellent	Very Good	Good	Adequate	Barely Adequate	Poor

Comments_____

_____

10. Did you have any problems with the closures/fasteners of the test item?

Yes____ No____

If yes, explain_____

_____

11. Did you have any problems donning, doffing, or adjusting the test item while wearing gloves?

Yes____ No____

If yes, explain_____

_____

12. When wearing NBC protective gear, did you have any survival test item-related problems?

Yes____ No____ N/A____

If yes, explain_____

_____

13. Did the survival test item cause any restrictions in flight control movement?

Yes____ No____

If yes, during which flight maneuver?_____

_____

14. Did the test item contribute to seat discomfort (i.e., force you to sit in an uncomfortable position, degrade lumbar support, etc.)

Yes____ No____

If yes, what made you uncomfortable?_____

_____

If yes, how long were you flying before becoming uncomfortable?_____

_____

15. Did the test item cause any discomfort due to:

fit?	Yes____	No____
location of pockets?	Yes____	No____
bulk of contents?	Yes____	No____
heat retention?	Yes____	No____
weight of test item and contents?	Yes____	No____

If yes to any of the above, explain_____

_____

APPENDIX D

FOOTNOTE REFERENCES

1. TECOM Pamphlet 602-1 Vol 1, Questionnaire and Interview Design Subjective Testing Techniques, US Army Test and Evaluation Command, 1975

2. TR 72-52-CE, Anthropometry of U.S. Army Aviators, 1970

3. AMCP 706-203, Engineering Design Handbook, Helicopter Engineering, Part one, Preliminary Design, August 1974

4. AMCR 700-15, Integrated Logistics Support (ILS), 26 November 1979

5. Test Operations Procedure 7-3-507, Integrated Logistics Supportability (Aviation Materiel), 1 September 1983

6. Test Operations Procedure 7-3-508, Reliability (Aviation Materiel), 28 July 1977

7. Test Operations Procedure 7-4-008, Artic Environmental Test of Aviation Support Equipment, 23 July 1970

8. Test Operations Procedure 1-1-006, Desert Environmental Considerations, 10 August 1972

9. Test Operations Procedure 7-4-005, Aviation Equipment and Aircraft Armament, 29 January 1971

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