REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
26 April 2004	Final	

4. TITLE AND SUBTITLE
Test Operations Procedure (TOP)
10-2-021 General Performance Tests of Combat Uniforms and Protective Clothing

5a. CONTRACT NUMBER
5b. GRANT NUMBER
5c. PROGRAM ELEMENT NUMBER

6. AUTHORS

5d. PROJECT NUMBER
5e. TASK NUMBER
5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Test Technology Core (CSTE-DTC-AT-WC-F)
US Army Aberdeen Test Center
Aberdeen Proving Ground, MD 21005-5059

8. PERFORMING ORGANIZATION REPORT NUMBER
TOP 10-2-021

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Technology Management Division (CSTE-DTC-TT-M)
US Army Developmental Test Command
314 Longs Corner Road
Aberdeen Proving Ground, MD 21005-5055

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
Same as item 8

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited.

13. SUPPLEMENTARY NOTES
Defense Technical Information Center (DTIC), AD No.: ADA423072
This TOP supersedes TOP 10-2-021, 16 February 1973 (DTIC AD No.: AD763001).

14. ABSTRACT
This TOP provides guidance for planning performance and durability tests of combat uniforms, nuclear, biological, chemical (NBC) protective clothing, and other types of clothing worn by the soldier. Items covered include, but are not limited to, uniforms, caps, undergarments, over garments, clothing liners, hoods, masks, gloves, socks and boots. Tests include laboratory analyses, functional performance over special design or wear test courses described in the appendixes, and field testing. This TOP does not include chemical, ballistic, or other protection testing, but does provide the procedures for "conditioning" the "used" items for these tests as a follow-on to verify performance after SAR durability testing. This TOP does not address natural environments testing of clothing.

15. SUBJECT TERMS
Protective Clothing; Sizing and Fitting; Donning and Doffing; Accelerated Wear Test Courses; Water Immersion; Transportability and Packaging; Human Factors Engineering (HFE); Mission Performance; Reliability and Durability; Safety Release

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	B. ABSTRACT	C. THIS PAGE			19b. TELEPHONE NUMBER *(include area code)*
Unclassified	Unclassified	Unclassified		37	

U.S. ARMY DEVELOPMENTAL TEST COMMAND
TEST OPERATIONS PROCEDURE

*Test Operations Procedure (TOP) 10-2-021 26 April 2004
AD No.: ADA423072

GENERAL PERFORMANCE TESTS OF COMBAT UNIFORMS AND PROTECTIVE CLOTHING

*This TOP supersedes TOP 10-2-021 dated 16 February 1973, (DTIC AD No.: AD763001)

1. SCOPE. This TOP provides guidance for planning performance and durability tests of combat uniforms, nuclear, biological, chemical (NBC) protective clothing, and other types of clothing worn by the soldier. Items covered include, but are not limited to, uniforms, caps, undergarments, over garments, clothing liners, hoods, masks, gloves, socks and boots. Tests include laboratory analyses, functional performance over special design or wear test courses described in the appendixes, and field testing. This TOP does not include chemical, ballistic, or other protection testing, but does provide the procedures for "conditioning" the "used" items for these tests as a follow-on to verify performance after durability testing. This TOP does not address natural environments testing of clothing.

2. FACILITIES AND INSTRUMENTATION. Facilities and instrumentation required are defined in the documents listed in Appendix E, References. Special test courses and their uses are described in Appendix C, Impregnating Procedure For Boots; Appendix C, Accelerated Wear Test Courses; and Appendix D, Handwear Test Courses.

3. REQUIRED TEST CONDITIONS.

3.1 Test Planning.

3.1.1 Development of detailed test plans requires review of the applicable test planning and requirements documents such as the Test and Evaluation Master Plan (TEMP), System Evaluation Plan (SEP), Event Design Plan (EDP), Operational Requirements Document (ORD), and specifications as available and appropriate, and background information, such as references from preceding development and test phases and similar studies which required selection of appropriate samples, methods, test sequences, facilities, and test equipment. Testing may be tailored or modified to suit the acquisition program or special test items.

3.1.2 Safety and health issues must be given prime consideration in test planning. Review all applicable/available safety documents such as Safety Assessment Reports (SAR) and Health Hazard Assessments (HHA) to determine if any safety or health issues require special tests. For any tests involving military personnel not assigned as testers, a Safety Release (SR) and Human Use Committee (HUC) approval are required.

3.1.3 Test planning should include determination of exact wear/use configuration of each test item, in conjunction with all compatible items to be used/worn with the test item.

3.2 Preparation for Test. Test preparations include preparing the test courses (if applicable), and selection, examination, anthropometric measurement and characterization, and training of test participants (if applicable). Planning may require certain preliminary activities that should be included in the test plan, such as the following:

a. Identification and Coding. Prior to the issuance of test articles or prototypes to the test participants, test articles need to be assigned a unique Test Item Control Number (TICN). The TICNs can be generated during test preparation as sequential alphanumeric numbers that

correspond directly and identify the specific test articles submitted by the manufacturers, or can be the manufacturer's serial number. The TICN database, once created, will be easily assimilated into the overall test database to permit easy access to the individual records of each test item. The TICNs will serve as the vehicle to quickly retrieve specific data corresponding to the test article, demographic/anthropometric data on the test participant, data collection information or Test Incident Reports (TIRs). The TICNs must be marked or attached to the test articles in a permanent process. The TICNs must be able to be used to track the test articles from the initial receipt from the manufacturer through all Developmental Tests (DTs) and should be structured based on utility for multiple DTs and Operational Tests (OTs) when applicable. An overarching TICN assignment plan will often be developed to facilitate data integration when there are multiple test sites.

b. Medical. Medical examinations (e.g., condition of those portions of the body where treated materials come in contact with the skin, or physicals if there is a requirement that the participant is physically able to perform the tasks required) or surveillance, such as for heat stress or cold injury, of test participants may be a requirement for testing some clothing items. If a medical examination is necessary for test participants this will be done prior to starting the test. A medical record will be maintained on each participant if applicable to the test program.

c. Training and Familiarization. Test participants must be trained regarding the test items, mission scenarios, and test conditions to include the following:

(1) Description of test courses and physical activities required during actual wearing/use of the test items.

(2) Demonstration of and training on the test item and discussion of special characteristics and differences of comparative items to include safety aspects and proper methods of donning, doffing, and wearing/use of the items along with any associated items of equipment to be concurrently worn and those of the test environment and mission activities.

(3) Identification of appropriate test personnel and processes through which participants should report any safety or health related issues.

d. Demographic/Anthropometric Characterization. Prior to test initiation demographic data including date of birth (DOB), rank, month of service (MOS), handedness and any other pertinent data should be collected from each participant. Anthropometric measurement should be taken for relevant body dimensions to assign percentile rankings to all test participants.

e. ARs 40-38 (ref 10), Clinical Investigation Program, and 70-25 (ref 11), Use of Volunteers as Subjects of Research should be reviewed and followed as appropriate when using human test subjects.

3.3 Physical Characteristics.

a. Characteristics and conditions of test items at test start and throughout testing are a key part of the database. Dimensional measurements of combat uniforms and protective clothing are made to the nearest 0.3 cm (1/8 in.) unless specified differently by the requirement document. Detailed descriptions are recorded on methods for fastening apparel (hook and pile, drawstrings, buttons, etc.) and provisions for ventilator/filter ports. For items undergoing laundering or other treatment, characteristics are recorded before and after treatment, and effects such as weight change, shrinkage, texture or color change and expansion are noted. Weight is measured in either ounces or grams and is usually measured for Size Medium items as a minimum. If measured for multiple sizes and configurations, the measures should be reported separately. Test item inspection should also include conditions of materials, quality of construction and packaging, effects of shipment, and interfaces.

b. Depending on the specific requirements applicable to the test item, select appropriate laboratory tests for physical and material characteristics from the numerous available listings and methods. These include but are not limited to: Federal Test Method Standard (FTMS) (ref 2) No. 191A, American Society for Testing and Materials (ASTM) (ref 3), section 7, American Association of Textile Colorists and Chemists (AATCC) (ref 4). Examples of physical characteristics that may be tested include porosity, abrasion, electrostatic discharge, electrical resistivity, laundering, tearing (grab break, strip tear, seam tear), ball bursting, insulation, mildew-resistance, colorfastness, reflecting, and flame-resistance. The procedures for these laboratory tests are not repeated in this TOP but should be dictated by the program requirements, and the purpose and limitations of the test methods.

3.4 Presentation of Data. Data will be presented in graphical, tabular, pictorial and/or narrative form as appropriate.

4. TEST PROCEDURES.

4.1 Safety and Health Evaluation. Safety must be considered throughout the test program. Any hazards or potential hazards identified during the test program are noted and the hazard risk classified in accordance with AR 385-16 (ref 5). If there are specific safety and/or health issues or concerns identified in requirements documents, or considered necessary by the test agency a Safety Subtest should be incorporated in the Test Plan and front-loaded in the test program.

a. Method.

(1) Select appropriate tests to address safety and/or health issues. Examples might include flammability, toxicity, or abrasiveness.

(2) Review the SAR and SR if applicable to be sure that approved test procedures are adequate according to information provided by the SAR/SR.

(3) Review all appropriate safety regulations to ensure that they adequately cover potential hazards to test personnel.

b. Data Required.

(1) Results of the applicable safety tests.

(2) A table of actual and potential safety hazards.

(3) Classifications and health hazards identified during the test program with associated test conditions.

(4) Recommended corrective and/or health actions (if applicable) in accordance with Army Regulation (AR) 385-16.

4.2 Sizing and Fitting for Upper and Lower Torso Garments. Combat and protective clothing components have labels attached, which indicate fitting of garment sizes by range of body measurements (anthropometrics). The following procedure is typical for clothing to determine whether the test item can be properly sized and fitted according to requirement documents. The materiel developer or designated representative will provide the fitting procedures and support and may train the test team to perform fitting.

a. Method.

(1) Process test participants through a series of measurement and fitting stations for appropriate anthropometric measurements as dictated by the garment instructions. These may include height, weight, chest, arm length, waist, hips, and inseam. Additional anthropometric measurements may be needed to characterize fit or adjustability problems unique to the test item.

(2) Use the measurements in conjunction with the clothing prediction chart (app A, tables A-1 and A-2), fit the participants with and without the appropriate environmental clothing or compatible items to be worn.

(3) If an acceptable fit is not obtained with the predicted size, select alternative try-ons until an acceptable fit is attained, or it is determined that the individual cannot be fitted within the available sizes. Document the size initially predicted and the final best fitting size, for discussion of sizing directions and impact on sizing tariff. Document any differences in sizes needed to accommodate environmental clothing or other compatibility items.

(4) Rate each participant for acceptability (for example: good, fair, poor) of fit for the final fitted size. Ratings should be done for length and breadth at torso, arms, shoulders, waist, rise and legs, to the fullest extent possible as applicable to the test item. Use TOP 1-2-610 (ref 12), Human Factors Engineering, Test Procedure 5.18, as a guide for developing rating questionnaires.

(5) Photograph the test item on a selected participant (front, side, and rear) if required to show some peculiar-fitting characteristic.

b. Data Required. Collected data will include body dimensions, record of clothing ensembles tried and worn, predicted and fitted sizes, and reasons for unacceptable fittings with narrative descriptions and/or photographs of improper fitting occurrences.

4.3 Donning and Doffing. The objective is to evaluate the ease with which the test item can be donned and doffed and to determine the time required to don and doff the system. Doffing shall be analyzed in terms of emergency doffing as well as doffing for body eliminations. Closures shall be analyzed with respect to the ease of opening and closing with bare hands and while wearing appropriate handwear, and during daytime and darkness. The potential of the closures to degrade the protective characteristics of the ensemble should be considered. Multiple series of donning and doffing tests may be necessary to address multiple configurations. When testing multi-layer items characterize each step of the donning and doffing process.

a. Method. The test plan must specify the environmental clothing components to be worn and the prescribed donning and doffing sequences to be followed.

(1) A minimum of five test participants or a sufficient sample size to support adequate statistical analysis will be selected to perform don/doff procedures. All test participants will be trained on the proper procedures as provided by the manufacturer or material developer and should be given the opportunity to practice and demonstrate proficiency. As a minimum, each test participant will don and doff the test items three times to ensure adequate proficiency is achieved.

(2) Repeat procedures, as necessary to provide statistical confidence in the test results. Usually the mean don and doff times are calculated for comparison to required times. Compare don/doff times and ratings under various conditions and configurations to identify problem areas.

b. Data Required.

(1) Identity of the clothing systems used.

(2) Summary of averaged timed data for donning and doffing the test items; per sample study sheet in Appendix B, Table B-1.

(3) Subjective comments by participants.

(4) Observer comments on ease of donning and doffing, adequacy of fit, operability of closures, and problems encountered.

c. Analytical Plan. Recorded times for each element and comments are summarized and evaluated in respect to level of compliance with the requirements documents.

4.4 Leakage.

a. Method. If the test items are to be used in outdoor rainy or wet environments and if the ability to resist moisture penetration is a concern or a primary mission of the item (such as rainwear), measure the test-item leakage/integrity at selected points throughout the test. The leakage resistance characteristics should be measured when items are new, after initial inspection, after specific environmental subtests and/or field wear, after traversals over an accelerated-wear course, and after repairs have been made requiring retest. See also paragraph 4.10 below.

(1) For chemical biological protective masks, special leakage tests are required using gas-mask leakage and air-resistance testers. See TOP 8-2-110 (ref 7). Hoods may be tested by means of light penetration in the following manner:

(a) Examine the hood over a light of 32 foot-candle intensity with the light located no farther than 30 cm from the area to be examined and the observer no farther than 60 cm.

(b) Examine seams and joints from at least two angles.

(c) Subject areas indicating or suspected of containing holes to pneumatic or hydrostatic pressure of at least 13.8 kPa (2 psi) for 60 seconds.

(2) Test impermeable gloves for leakage by pressurizing the gloves, using a fixture to permit sealing at the cuff, and inflating and immersing in a soap solution, looking for bubbles.

(3) Test impermeable boots in a similar manner, using a boot top plug clamped in place and connected to a suitable air supply.

(4) Test permeable or semipermeable items by using controlled rain exposures and/or immersion. Items containing internal electronics must be tested for water leakage in order to verify the safety of the item against electric shock.

b. Data Required. Record the following:

(1) Amount of pressure applied.

(2) Location of leaks and defects on all test items.

4.5 Water Exposure (Boots). Boots may be designed as waterproof or the waterproofing may be applied in accordance with instructions furnished with the test items.

a. Method. A standard boot such as the current rain boot should be included in the test for comparison.

(1) Test participants, some wearing developmental or treated boots and some wearing the standard boot, traverse the mud and water trough of the footwear course (app C, fig. C-2) for a stipulated number of traversals.

(2) Depending on requirements, traversals may be conducted on the controlled-rain course (app C, fig. C-3).

b. Data Required. At the completion of each exposure period, comparative and specific data are obtained, to include:

(1) Type of exposure.

(2) Number of traversals.

(3) Water retention or absorption by weights.

(4) Source and amounts of leakage.

(5) Effects of water on boot construction or performance.

(6) Comparative performance of the boots.

(7) Subjective comments by the test participants.

4.6 Infrared Reflectance. This test is used for those items, which are specified to meet minimum levels of reflectance of infrared light sources and to determine the level of infrared reflectance of the clothing items. Percentage reflectance, usually in the 0.8- to 1.0-micron range, will be as stated in the requirements documents.

a. Method.

(1) Select both new and used or laundered items for the test, depending on the requirements. Currently worn systems may be used as baseline comparisons for the test item if dictated by program requirements or as a means of evaluation.

(2) Select locations or areas for measurements based on clothing configuration, to include multiple readings on both front and back of the items but on the outer surfaces only.

(3) Make measurement using a spectrophotometer and the procedures provided for the instrument.

b. Data Required.

(1) Collected data will include readings for each location and condition of the items measured.

(2) Averaged measurements for each test item to derive the overall percentage for each clothing item.

(3) Whenever possible, make comparisons with control items or standards.

4.7 Electrostatic Discharge/Decay. The purpose of this testing is to determine if the clothing items are safe for use during electrostatically sensitive operations. Tests to indicate the electrostatic discharge, decay or resistance of clothing items may be required in accordance with program requirements documents. Several test methods are available and vary as to purpose, instrumentation needed, and test sample type. Table 1 briefly describes commonly used methods and their purpose. Methods are not; however, limited to those listed.

TABLE 1. ELECTROSTATIC TEST METHODS

Standard	Method	Title
FTMS No. 191A	5931	Electrostatic Decay of Fabrics
ESD Association Standard for the Protection of Electrostatic Discharge Susceptible Items (ref 8)	ESD-DS11.12-1996	Volume Resistance Measurement of Static Dissipate Planner Materials
	ESD-STM-2.1-1997	Garments
American Association of Textile Chemists and Colorists Volume 72	76-1995	Electrical Resistively of Fabric
American Standard Test Methods (ASTM)	ASTM D-257-91	Direct Current (DC) Resistance or Conductance of Insulating Materials

The purpose for each test method varies and a general overview is as follows:

a. FTMS No. 191A, Method 5931. This method is intended for determining the time it takes for a charge on a fabric surface to decay to an electrostatically safe level. This method is appropriate for the use on material, which may or may not contain conductive fibers or have been treated with an antistat finish. The ultimate purpose is to determine which materials are safe for wear during electrostatic sensitive operations.

b. ESD-DS11.12-1996. This standard defines a direct current measurement to determine the volume resistance of static dissipative, planar material, without regard to its conduction mechanism. This test method is not intended for conductive or insulative materials as defined in Electronics Industry Association (EIA) 541 (ref 9).

c. ESD-STM-2.1-1997. This standard defines the methods for resistance measurement of garments which are designed for the control of electrostatic discharge. The resistance measurement taken from sleeve to sleeve and any other two points on the garment system is used to verify the electrical integrity of the seam and material used in the manufacture of the garment.

d. ASTM D-257-91. These test methods cover DC procedures for the determination of DC insulation resistance, volume resistance, volume resistivity, surface resisitivity of electrical insulating materials, or the corresponding conductances and conductivities. These methods are suitable for use in measuring the electrical resistivity/conductivity of moderately conductive materials.

4.8 Launderability. This test is performed to determine the ability of the material to withstand cleaning without losing or degrading material strength or characteristics.

a. Method.

(1) Cycle the test items for cleaning or laundering after designated periods of field wear over the test courses, or after appropriate soiling by laboratory techniques. Generally for hygiene purposes, suits are worn for a maximum of 7 days before being laundered for field use. Usually appropriate field laundering procedures are required to be used to allow evaluation of durability and launderability in conjunction with each other. It is important to adhere to the exact field laundering procedures to include load size, type washer, types of detergent and additives, water and drying temperatures, and washing and drying times. Any required deviations from standard procedures for laundering must be coordinated with the test sponsor and thoroughly documented.

(2) Check instructions provided with the test items to determine any limitations.

(3) Select the applicable system of cleaning from test system logistic support documents, training manuals, packaged instructions, or other appropriate guides.

(4) After laundering, selected performance tests should be conducted to check retention of protective and other physical characteristics, such as weight, dimensions, and chemical agent resistance (if applicable).

b. Data Required. Record the following:

(1) Ease and adequacy of laundering methods.

(2) Results of pre- and post-laundry visual inspection of each test item. Baseline performance results (pre-laundering) should be compared to post-laundering performance results for each test item/candidate. Photographs are recommended to document any anomalies found in the garments after laundering.

(3) Problems encountered.

4.9 Storage. This is performed to determine the ability of the test item to withstand high- and low-temperature storage. Storage tests are divided into two categories, short term and long term. The latter type is used to fully evaluate the requirement (3, 5, or 10 years) and is not usually a part of the DT where knowledge of the item's suitability is required within a period of approximately 6 months. Only short-term storage is considered here.

a. Method. There are two types of storage tests: uncontrolled and controlled. Storage testing should be considered for both in packaging and outside of packaging, depending on the individual item. Nominally, storage in uncontrolled extreme climatic conditions is planned for 3 months to identify problems.

(1) Make a review to determine whether any standard controlled tests on storage are specified. If no standard tests are specified, use the following as controlled storage tests:

(2) Using a minimum of nine samples, subject three to the highest temperature condition specified in the requirements documents and three to the lowest temperature, with temperatures and duration's in accordance with Table 2. Store the remaining three samples as control items in a temperature environment of 22 $\pm$ 5 °C with relative humidity of 50 $\pm$ 5 percent. Then store all nine samples for 2 hours at 22 $\pm$ 5 °C with a relative humidity of 50 $\pm$ 5 percent followed by tests to determine effects on quality. These tests should be made for quality of those performance characteristics that are most likely to be affected by the environment (e.g., leakage on BC protective items, TOP 8-2-511 (ref 13)).

TABLE 2. ENVIRONMENTAL CONDITIONS FOR STORAGE

Climatic Category (AR 70-38)	Temperature, °C	Relative Humidity, %	Hours
Hot-dry	71	≤ 5	4
Basic hot	63	≤10	4
Basic cold	-33	Saturation	6
Cold	-46	Saturation	6
Severe cold	-51	Saturation	6

(3) In uncontrolled storage tests, test items are stored in extreme natural environments, with inspections and functional or other item specific checks before and after storage.

b. Data Required.

(1) For each chamber condition, record the conditions, test items involved, damage incurred, and results of tests conducted before and after storage.

(2) Tabulated results are photographed as necessary and evaluated against the stated criteria.

4.10 Water Immersion. This test is used when the test items, either unpackaged or in waterproof packaging, are required to resist immersion in water.

a. Method.

(1) Adjust water depth and temperature in accordance with the requirement stated in the applicable acquisition document (specification, evaluation plan or ORD), or use MIL-STD 810F (ref 6) as a guide.

(2) Immerse the test item at the predetermined depth for the prescribed period.

(3) Observe the item for bubbling, and make notes of the length of item until bubbling occurs and points at which leakage is apparent.

(4) Analyze results with respect to presence of leakage and its impact on the ability of the item to perform its mission.

b. Data Required. Record the following:

(1) Depth of water over item.

(2) Temperature of water.

(3) Immersion time until occurrence of bubbling.

(4) Total immersion time.

(5) Type of waterproofing used.

(6) Extent of water damage (heavy, moderate, slight, or none).

4.11 Transportability and Packaging. If rough handling tests are required, use MIL-STD-810F, Method 514 as a guide.

4.12 Human Factors Engineering (HFE). HFE characteristics are tested using military participants or appropriate personnel doing mission representative tasks. This testing can be done in conjunction with the accelerated wear tests, field use, and other tests in which test participants use the items, observing reactions and soliciting responses from the test participants. Controlled HFE tests may include donning/doffing (para 4.3), Range of Motion, compatibility with other CIE and functionality during various mission tasks. Qualified HFE personnel shall conduct or directly supervise tests, which deal with personnel/test-items compatibility and results shall be recorded with HFE data. Questionnaires should be carefully structured in accordance with TOP 1-2-610 and tailored to the specific test item and its function. When multiple test sites are involved, questionnaires and data forms should be standardized across test sites to facilitate integration of data.

4.13 Mission Performance/Suitability. Suitability subtests for specifically mission-oriented characteristics may be designed using military personnel in actual wear/use situations to subject the test item to repetitive or periodic exposure in the particular simulated field environment or conditions required. Such tests may be supplemented with photography and telemetry devices as required to monitor the characteristic under test. Examples of particular mission performance include the ability of load-carrying equipment to be reconfigured to carry the full range of loads, the ability of an entrenching tool to dig various kinds of soil, the ability of an individual shelter or poncho to withstand rain or snow. Attention should be paid to defining the multiple configurations to be tested and the associated items of equipment and compatibility items to be used/worn while accomplishing each mission activity.

4.14 Durability. Durability is a special case of passive reliability, which is applicable to CIE. For NBC clothing and general CIE, requirements are frequently stated in terms of a wear life throughout which the item must be reliable and durable. The items are required to retain the mission performance characteristics and protective capabilities (if applicable) over the wear life.

Durability testing requires use by military personnel conducting simulated mission activities to stress the items over the length of the wear life. This testing is developmental in nature because the number of hours of cumulative wear/use must be structured and tracked to ensure that all items are treated identically both within a candidate, between candidates, and between candidates and standard items, if required.

There are two types of developmental durability tests. One is to obtain controlled durability data in terms of traversals of stations in a wear course for quantitative comparisons. A common procedure has been to use a sample size of eight to twelve military personnel to characterize performance on structured durability wear courses. The second method is field durability testing in which test items are worn by military personnel in mission scenarios while the developmental test team tracks all wear hours and histories of each item. A sample size of one platoon (25 to 30 test participants) has been commonly used in this type of testing. Testing should initiate with extra test participants (20 percent higher than the required number of participants) to allow for attrition over the length of the test. In some cases, higher sample sizes may be required in order to provide sufficient numbers of items for follow-on chemical or ballistic protection testing of worn items. Both types of tests can be used to compare candidates to each other and to standard items and should include the standard items tested side by side whenever possible. The relative durability courses can also address mobility over obstacles and timed traversals for quantitative performance comparisons. These tests are usually run to failure. The field durability testing is particularly important for items which are required to provide chemical or ballistic protection after wear. The field durability test is run for a set number of cumulative wear hours at which time the items are withdrawn and provided to DT laboratories for further testing. Formulating an appropriate database to track all durability data and wear histories is critical to support the follow on DT laboratory testing.

4.14.1 Relative Durability and Mobility.

a. General. Tests to establish quantitative data to characterize the durability of some items may be conducted on special test courses designed to accelerate wear characteristics and to provide basic comparison data that complement laboratory analyses. For suits, standard mobility/transportability courses can be used. These courses are described in Appendix C for combat and protective garments, and Appendix D for handwear (see also section 4.15). These courses should be analyzed for each test program relative to the missions of the systems under test and tailored accordingly. There are no data that relate accelerated wear on these test courses to field wear; thus, caution must be used in interpreting data.

b. Method.

(1) Prepare the test course as indicated in Appendix C. The course may be tailored according to the specific system under test and its unique requirements and operating environments. Deviations should be documented in the test plan and coordinated across the T&E community to ensure concurrence and accurate representation of specific missions.

(2) Station observer/recorders at various locations along the course to ensure that the participants properly traverse the course and observe effects on the test items and participants. A minimum of 8 to12 participants clad in the test item and other predetermined clothing articles/ equipment, should participate in testing.

(3) At the completion of each traversal and after each obstacle, as appropriate, observers inspect each test item. If an item incurs a failure after a traversal, it may be removed from the test and the number of traversals until failure is calculated. The test director, based on established failure criteria and in coordination with the T&E principals, makes the decision for withdrawal of any test item from the test and must document the rationale. On withdrawal of an item because of failure, it may be subjected to required analyses such as the leakage or agent-penetration test.

(4) A test director shall remove a test participant from the test if the need is obvious or if there is any safety issue (e.g., broken ankle, physical collapse, etc.). A test participant who complains of discomfort should be given the opportunity to rest and may require medical examination. A qualified medical doctor should provide a signed statement of cause of any test-induced injuries to be entered in the individual's medical record.

(5) At the completion of each day's testing, each participant should be interviewed to gain additional insight into any difficulties or issues regarding the test item. All comments should be recorded for use in the system analysis. The questionnaire should include data for evaluation of the worn apparel with respect to fit, comfort, freedom of movement, heavy abrasive action, and stress or strain. Questionnaires should also indicate difficulties encountered as a direct result of uniform design, such as buttons or pockets snagging on objects which may inhibit or throw the participant off balance. Also, an inspection for failures of test items will be recorded.

(6) Repeat the above procedures as necessary to obtain the required statistical significance of data or determine the effects of adding a rifle or other field equipment to the participant's pack.

(7) Analyze failure modes and rates specific to each test item/candidate. Perform summary statistics on number of traversals to failure. Whenever possible, include a standard item in the test to establish baseline comparison.

b. Data Required. Record the following:

(1) Ambient temperatures (maximum, minimum, average), relative humidity, precipitation, and wind direction and speed (including gusts) at appropriate intervals throughout the testing.

(2) Identity of test items and clothing systems worn and equipment carried.

(3) Test hours and number of course traversals.

(4) Reasons for participant's withdrawal or removal.

(5) Failure data including descriptions, locations, and causes, number of traversals at failure occurrence.

(6) Photographic coverage of test incidents.

(7) Questionnaire data from participants and observed data from observers.

c. Analytical Plan. Data are averaged for item performance, summarized, and evaluated for statistical significance at the 5th and 95th percentile levels. Compare computed narrative and subjective determinations against any existing database and the specified requirements.

4.14.2 Field Durability Testing. Field Durability Developmental Testing (FDDT) consists of field wear by military personnel while conducting suitable mission activities based on the program mission profile, Concept of Operation, or Operational Requirements Documents (ORD) and input from the appropriate user/combat developer community representatives.

a. Proponents or user community representatives should provide detailed information on the definition of a "wear day" (hours per day of wear) in actual field use situations for the proposed test item including specific activities and test item configurations to be worn. The wear day definition will be used to plan the total length of time required to accumulate the total wear life required in conjunction with the military personnel unit schedule considerations. If possible, consideration should be given to testing an interim and/or extended wear time as a separate set of samples in order to fully characterize the performance of the items at several points.

b. Every effort should be made to inspect the items daily and to document the time of occurrence and associated conditions for each test incident. Photographs and videos should be used to the fullest extent possible to document the condition of each test item over the wear life.

c. For NBC items, the FDDT must be planned to support follow-on chemical testing after wear. It is important that a homogeneous set of identically treated test items be obtained in the FDDT, so that accurate characterization of performance can be made at the required wear life. This approach is also useful for ballistic protective items.

(1) Method. For NBC items size, fit, and train 30 test participants for each test candidate and standard item to be worn. For non-NBC items or special cases, a lower sample size may be used. Set up the database to include each test participant identification (ID) number and the TICNs, cross-referenced to each other. Set up mission cycles with the military test personnel unit to include down time for laundry, maintenance, and unit leave. If multiple test participant groups are used, the various candidates and standard items must be equally assigned over all groups to ensure identical treatment. Inspect test items daily and provide a current on-going tally of wear hours accumulated and mission profiles for each item. This is important so that when items are approaching the end of the wear time they can be withdrawn at the correct time.

(2) Data required.

(a) Anthropometric and demographic data on all test participants, size of all clothing items worn.

(b) Condition of test items at test start and daily throughout test, especially before and after laundering, repair, or specific test mission.

(c) Documentation of any rips or tears in inner or outer layer(s) of each test item to include time, size, and location of rip/tear; associated cause; repair action taken and degree of success; and any effect on mission performance. Documentation of incidences of petroleum, oils, and lubricants (POL) exposure or other battlefield contaminants should also be documented.

(d) Initial scoring classification of test incidents as no-test, nonmission essential functions, or mission essential function failures in accordance with Failure Definition/Scoring Criteria (FD/SC) provided by the combat developer.

(3) Analytical plan. Calculate the proportion of test items accomplishing the wear life without a mission essential function failure and a non-mission essential function failure. Calculate the mean expected wear life, expected time to first failure for each type of failure, and compare candidates and standard items in terms of wear life and failure modes. Analyze failure modes to recommend fixes and/or to identify limitations in use. Provide the wear histories and time of first failures to support the follow-on chemical and/or ballistic testing when applicable.

4.15 Handwear Testing. Handwear used in military applications is designed for various mission specific purposes, and the design must also provide the basic handwear requirements of protection, comfort and tactility. The performance requirements of the individual must be given first priority. For instance, a mitten will provide the most comfort in cold conditions but will often negate actions required by the wearer to perform assigned tasks. Handwear testing is designed to evaluate the functionality and suitability of the test item under specific mission representative conditions and provide the program evaluator with qualified values. Durability

testing of handwear is performed to assess the durability characteristics of the test glove against other test candidates or an existing baseline system. Types of handwear covered by this procedure include but are not limited to NBC protective, wet weather, cold weather, and various work types including chemical and petroleum handlers.

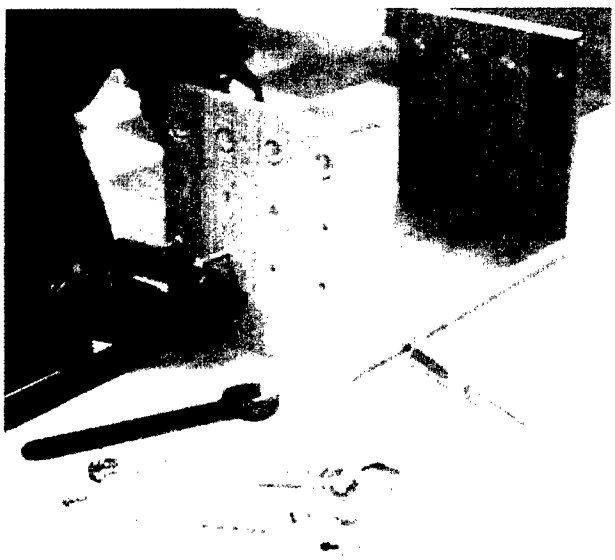
4.15.1 Procedures.

a. Initial Inspection and Coding. Procedures in paragraph 3.2a should be used for handwear. Measurements of thickness are made with a caliper gauge at points where maximum wear is expected. Each pair of gloves is weighed to the nearest 0.005 kg (0.01 lb). Any defective workmanship is documented with photographs.

b. Relative Durability for Handwear. Tests to establish quantitative data as to the relative durability of the test items as compared to a baseline system or other test candidate glove systems, can be conducted on specially designed test courses. These courses can be designed and arranged to measure design and accelerate wear characteristics based on the intended mission use of the glove, and to provide basic comparison data that augment laboratory analysis. The use of a designed wear test course enables repeatability of test conditions between test item candidates and users.

(1) Durability test course design for Handwear. Durability testing to be conducted on a controlled test course should be designed with the intended mission of the handwear test item in mind. Test item proponents or user representatives should be consulted during course design to allow durability exposure to stations which closely replicate the intended mission. The standard handwear course described in Appendix D, Table D-1, and Figure D-1 at the U.S. Army Aberdeen Test Center (ATC) provides overall moderate to severe abrasion and seam strain for more rugged or general purpose work gloves and aviator gloves. Table D-2. Aviator/Aircrew Durability Course, Table D-2, provides a course design specific for aviator gloves.

Durability testing using the designed handwear course can be used in conjunction with the field exercises to augment durability test duration or performed as a standalone test. A minimum of six stations should be chosen for the durability course. Individual stations can be selected from the examples shown in Appendix D, Tables D-1 and D-2 or designed specifically for the test candidate. Once suitable test course stations have been selected or developed, the complete course will be evaluated to determine the correlation between actual field wear (hours per day) and one traversal of the course, if possible. The number of test participants should be based on the planned statistical analysis and number of stations, and test items. If candidates are to be compared to a baseline system or there are more than one candidates, a counter balanced test design should be used to eliminate bias.



Hand Tool Dexterity

Cinder Block Stack

Chain Pull

(2) Test performance. Observers/recorders should monitor each test participant throughout the traversal of each station to ensure that proper procedures are used and to observe effects on the test items and participants. An agreed quantity of test participants should be determined which will support statistical analysis by the program evaluator. Quantity of test item candidates may also dictate sample size. A minimum of five test participants is recommended for handwear course testing.

At the completion of each station and again at the end of course traversal, observers will inspect each test item. If an item incurs damage, photographs and appropriate measurements will be taken. A determination of failure should be made based on the agreed upon failure criteria. If a failure occurs the test director will make the determination to remove the test item and traversals until failure calculated and rationale provided.

At the end of each test day, each test participant should be interviewed and comments recorded regarding fit, comfort, tactility, stress or strain, and should indicate difficulties encountered as a result of the handwear design.

(3) Data required.

(a) Ambient temperatures (maximum, minimum, average), relative humidity, precipitation, and wind direction and speed (including gusts) at appropriate intervals throughout the testing.

(b) Identity of test items and clothing systems worn and equipment carried.

(c) Test hours and number of course traversals.

(d) Reasons for participant's withdrawal or removal.

(e) Failure data including descriptions, station, wear time, and causes, number of traversals at failure occurrence. Analyze failure modes and rates specific to each test item/candidate. Perform summary statistics on number of traversals to failure. Whenever possible, include a standard item in the test to establish a baseline comparison.

(f) Questionnaire data, including participant hand preference, from participants and observed data from observers.

(4) Analytical plan. Data are averaged for item performance, summarized, and evaluated for statistical significance at the 5th and 95th percentile levels. Compare computed narrative and subjective determinations against any existing database and the specified requirements.

c. Field Durability for Handwear.

(1) Test design. Durability testing using a controlled field exercise should be designed using the appropriate MOS intended for ultimate fielding whenever possible. Procedures from paragraph 4.14.2 apply to handwear testing. If actual field training exercises cannot be utilized, the test director along with military unit participant leaders, will design a controlled field exercise to obtain the desired durability duration for the handwear candidates. The exercises will

be designed considering the durability requirement from the appropriate program documents, program evaluators and the "wear day" definition. If applicable, the same exercise should be performed using the baseline handwear system for comparison purposes. Test participants will be monitored for wear duration, missions during wear, and system failures during the exercise. A typical data form for data collection during handwear tests is shown in Appendix D, Figure D-1. After completion of the exercise, all test participants should be provided a questionnaire to evaluate the adequacy of the systems worn.

(2) Data required.

(a) Anthropometric and demographic data on all test participants, size of all clothing items worn, hand preference.

(b) Condition of test items at test start and daily throughout test, especially before and after laundering, repair, or specific test mission.

(c) Documentation of any rips or tears in inner or outer layer(s) of each test item to include time, size, and location of rip/tear; associated cause; and any effect on mission performance. Documentation of incidences of POL exposure or other battlefield contaminants should also be documented.

(d) Initial scoring classification of test incidents as no-test, nonmission essential functions, or mission essential function failures in accordance with FD/SC provided by the combat developer.

(3) Analytical plan. Calculate the proportion of test items accomplishing the wear life without a mission essential function failure and a nonmission essential function failure. Calculate the mean expected wear life, expected time to first failure for each type of failure, and compare candidates and standard items in terms of wear life and failure modes. Analyze failure modes to recommend fixes and/or to identify limitations in use. Provide the wear histories and time of first failures to support the follow-on chemical or protective property testing when applicable.

d. Electrostatic Discharge/Decay for handwear. Paragraph 4.7 contains guidance for evaluation of electrostatic characteristics for clothing. Since values for acceptable items are nebulous, the inclusion of a control item that is currently in use is highly desirable. Handwear with resistivity values of 10 ohms per square or less is presently considered acceptable. As defined in FTMS No. 191A, Method 5931:

$$\text{Resistivity in ohms per square} = \frac{\text{measured resistance in ohms X width of specimen}}{\text{Distance between electrodes}}$$

e. Resistance to POL Products. Wet each of five samples with 5 mL of gasoline and 5 mL of diesel fuel No. 2 at separate material locations. The excess is shaken off and the glove hung to dry. Appropriate laboratory tests such as elongation, leakage, and abrasion are conducted on these samples and on an equal number of gloves that have not been treated. Statistical comparisons of data from treated gloves to untreated gloves can be used to determine whether significant changes have occurred. The test officer should analyze these changes in terms of potential mission impact.

f. Handwear Storage. Testing under extreme temperature conditions is conducted using procedure of paragraph 4.9.

g. Handwear Human Factors. The human factors portion of testing should include observations of mission tasks during field durability operations to determine the compatibility of each glove candidate with other worn or used items. Whenever possible, each test participant should perform the tasks barehanded or with baseline handwear as a means of comparison. Tests of tactility and dexterity can be designed based on the intended use of the glove. Some examples of standard military tasks to assess dexterity include mission-oriented protective posture (MOPP) exchange procedures, use and disassembly of various weapons, use of radio controls, vehicle or generator operation, etc. Before each test and use of each candidate, each participant should be verified to have a properly fitting glove. Any instances of inadequate fit should be documented for later analysis of impact on wearer ability to perform tasks or determination of fitting the wearer with another size.

Testing of handwear used in more tactile operations requires assessments with higher dexterity tasks. Some suggested general purpose tasks to assess tactility include splicing wire, knot tying, turning valves, writing, typing, fastening clothing, picking up screws/washers, and use of hand tools. Some standardized tests developed for the assessment of dexterity and tactility can be utilized and include hand tool dexterity, Minnesota Dexterity and various other small task test kits. Each test participant should perform these tasks a minimum of three times each with each glove candidate for averaging. Each test participant should be observed by the human factors personnel to note any difficulties encountered during task performance or irritation to the wearer. Questionnaires directly pertaining to all tasks performed should be administered to each test participant at the conclusion of each handwear candidate testing. Data should include participant hand preference.

h. Handwear Leakage. Procedures in paragraph 4.4 should be utilized for handwear testing. Handwear may be tested for leakage by pressurizing the gloves, using a fixture to permit sealing at the cuffs, inflating and immersing in a soap solution and observing for air leakage.

APPENDIX A. SIZE AND FIT

TABLE A-1. CLOTHING PREDICTION CHART (UPPER TORSO)

Size	Measurement	Short		Regular		Long	
		Standard, cm	Measured	Standard, cm	Measured	Standard, cm	Measured
X-small	Chest	Up to 83.8		Up to 83.8		Up to 83.8	
	Height	Up to 170.2		170.2 to 180.3		180.3 and up	
	Arm	Up to 78.7		78.7 to 81.3		81.3 and up	
Small	Chest	83.8 to 94.0		83.8 to 94.0		83.8 to 94.0	
	Height	Up to 170.2		170.2 to 180.3		180.3 and up	
	Arm	Up to 78.8		78.7 to 81.3		81.3 and up	
Medium	Chest	94.0 to 104.1		94.0 to 104.1		94.0 to 104.1	
	Height	Up to 170.2		170.2 to 180.3		180.3 and up	
	Arm	Up to 81.3		81.3 to 83.8		83.8 and up	
Large	Chest	104.1 to 114.3		104.1 to 114.3		104.1 to 114.3	
	Height	Up to 170.2		170.2 to 180.3		180.3 and up	
	Arm	Up to 83.8		83.8 to 86.4		86.4 and up	
X-large	Chest	114.3 and up		114.3 and up		114.3 and up	
	Height	Up to 170.2		170.2 to 180.3		180.3 and up	
	Arm	Up to 83.8		83.3 to 86.4		86.4 and up	

Note: For some apparel, other data may be pertinent (e.g., weight, neck size) and chart should be prepared accordingly.

TABLE A-2. CLOTHING PREDICTION CHART (LOWER TORSO)

Size	Measurement	Short		Regular		Long	
		Standard, cm	Measured	Standard, cm	Measured	Standard, cm	Measured
X-small	Waist	Up to 68.6		Up to 68.6		Up to 68.6	
	Inseam	Up to 74.9		74.9 to 82.6		Over 82.6	
	Height	Up to 170.2		170.2 to 180.3		180.3 and up	
Small	Waist	68.6 to 78.7		68.6 to 78.7		68.6 to 78.7	
	Inseam	Up to 74.9		74.9 to 82.6		Over 82.6	
	Height	Up to 170.2		170.2 to 180.3		180.3 and up	
Medium	Waist	78.7 to 88.9		78.7 to 88.9		78.7 to 88.9	
	Inseam	Up to 74.9		74.9 to 82.6		Over 82.6	
	Height	Up to 170.2		170.2 to 180.3		180.3 and up	
Large	Waist	88.9 to 99.1		88.9 to 99.1		88.9 to 99.1	
	Inseam	Up to 74.9		74.9 to 82.6		Over 82.6	
	Height	Up to 170.2		170.2 to 180.3		180.3 and up	
X-large	Waist	99.1 to 109.2		99.1 to 109.2		99.1 to 109.2	
	Inseam	Up to 74.9		74.9 to 82.6		Over 82.6	
	Height	Up to 170.2		170.2 to 180.3		180.3 and up	

Note: For some apparel, other data may be pertinent (e.g., weight, neck size) and chart should be prepared accordingly.

TABLE A-3. TYPICAL SUMMARY OF OVERGARMENT FITTING DATA (FITTED SIZES - ENVIRONMENTAL CLOTHING VERSUS OVERGARMENTS)

No. Fitted: Environmental Clothing Sizes		Overgarment Fitted Sizes														
		Hot-Weather Uniform				Cold-Wet Uniform						Cold-Dry Uniform				
		XXS	XS	S	Total	XXS	XS	S	M	L	Total	XS	S	M	L	Total
X-small	6	6	-	-	6	6	-	-	-	-	6	6	-	-	-	6
Small	63	62	1	-	63	50	12	1	-	-	63	46	16	1	-	63
Medium	84	71	12	1	84	1	67	16	-	-	84	-	41	43	-	84
Large	23	7	15	1	23	-	3	17	3	-	23	-	1	12	10	23
X-large	4	-	-	4	4	-	-	-	3	1	4	-	-	-	4	4
Total	180	146	28	6	180	57	82	34	6	1	180	52	58	56	14	180
X-small	1	1	-	-	1	1	-	-	-	-	1	1	-	-	-	1
Small	68	68	-	-	68	36	31	1	-	-	68	11	56	1	-	68
Medium	76	47	29	-	76	2	29	44	1	-	76	-	13	62	1	76
Large	26	4	16	6	26	-	3	13	10	-	26	-	-	6	20	26
X-large	9	-	2	7	9	-	-	1	5	3	9	-	-	-	9	9
Total	180	120	47	13	180	39	63	59	16	3	180	12	69	69	30	180

APPENDIX B. DONNING AND DOFFING TEST DATA

TABLE B-1. TYPICAL DONNING AND DOFFING TIME STUDY DATA

Tasks	Average Time to Perform Tasks, min			
	Hot-Weather Uniform		Cold-Wet Uniform With Insulated Gloves	Cold-Dry Uniform With Mittens
	Without Gloves	With Vesi Gloves		
Donning Sequence				
Don mask and hood	0.185	0.219	0.199	0.439
Don BDU trousers	0.858	0.879	1.593	2.507
Don BDU jacket	0.286	0.601	0.695	1.826
Pull hood flap, secure jacket closure and hood straps	0.864	1.094	1.471	3.555
Total	2.193	2.793	3.958	8.327
Doffing Sequence				
Release hood straps and open jacket neck closure	0.188	0.206	0.213	0.415
Doff OG jacket	0.186	0.280	0.584	0.288
Doff OG trousers	0.416	0.403	0.759	0.830
Doff mask and hood	0.109	0.096	0.666	0.078
Total	0.899	0.985	1.622	1.612

APPENDIX C. ACCELERATED WEAR TEST COURSES

Clothing tests courses, also called accelerated wear courses provide the means to compress anticipated service life/time of an item or a material into shorter testing periods. Testing is characterized by judicious repetition of use under conditions approximating or stressing beyond, normal conditions. Several characteristics are evaluated simultaneously (e.g., abrasion resistance, snag resistance, wear pattern, and water repellence). Comparative performance and correlation with expected field use are possible through study of wear effects. Facilities at ATC include the mobility/portability, confidence course, footwear course, and the rain course. Other courses may be assembled with selected obstacles as required to test specific features of materials. Descriptions of representative courses are as follows:

a. Standard Mobility/Transportability Course. Standard courses (fig. C-1) are located at most military installations or training centers, including Aberdeen Proving Ground (APG). These provide a field performance course to measure the durability of the garment, the effect of personal clothing and equipment, and military personnel's ability to maneuver, i.e., run, jump, crawl or climb as might be required under realistic operational scenarios. The course may consist of ladders, debarkation nets, hurdles, rope swing, overhead ladder, etc. A typical test course design consists of seven event's selected to adequately evaluate the clothing being tested. The course is designed so that the end point of one event is the starting point of the next. Garment wear times, traversed times along with instances of difficulties should be documented.

b. Footwear Course. The 268-meter (1/6-mi) footwear course, shown in Figure C-2, consists of abrasive surfaces, water and mud troughs and various obstacles for testing footwear. The abrasive surfaces include crushed quartz, chipped and cubed granite, cinders, sand, gravel, slag, and smooth and rough concrete. Additional surfaces, such as logs, stones, and metal may be incorporated in adjustable incline planes for testing footwear traction.

c. Rain Course. The rain course (fig. C-3), used for testing the adequacy of garments against the effects of wet weather, is designed to simulate natural rainfall that the soldier would encounter in performance of duty. The course can produce man-made rain from a slight drizzle to a downpour. High pressure shower heads projecting from parapets 9-meters (30-ft) high produce simulated rainfall of varying intensities from 2.5 to 76 mm (0.1 to 3.0 in.) per hour. The course is divided into a dynamic course and a static course, each covering an area of 26 by 15 meters (86 by 50 ft).

(1) The dynamic course has two tracks: An obstacle track 85 meters (278 ft) long and a clear track of 91 meters (300 ft). On the obstacle track, personnel wearing test clothing or gear will cross obstacles and obstructions simulating a dozen combat situations. The clear track is designed for testing water resistance of individual clothing.

(2) The static course, consisting of the center portion of the course, clear of obstacles, is designed to test stationary items that may be subjected to controlled rain for short or extended periods

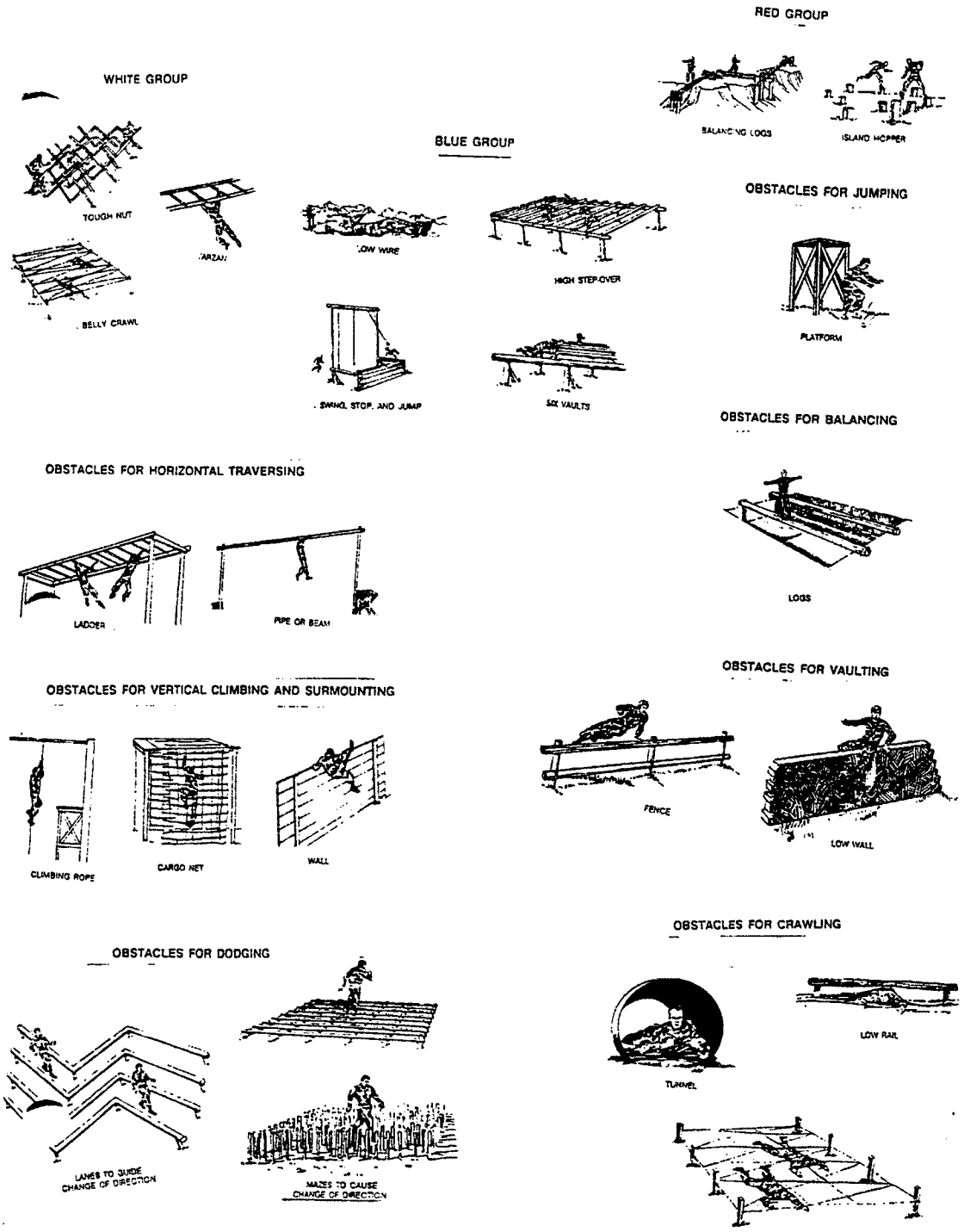


Figure C-1. Obstacle courses.

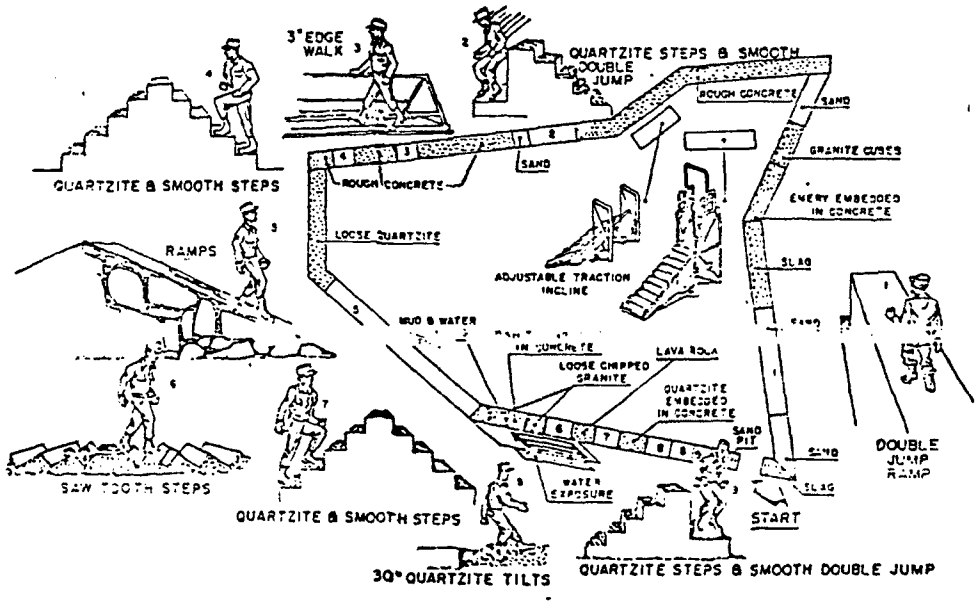


Figure C-2. Footwear course.

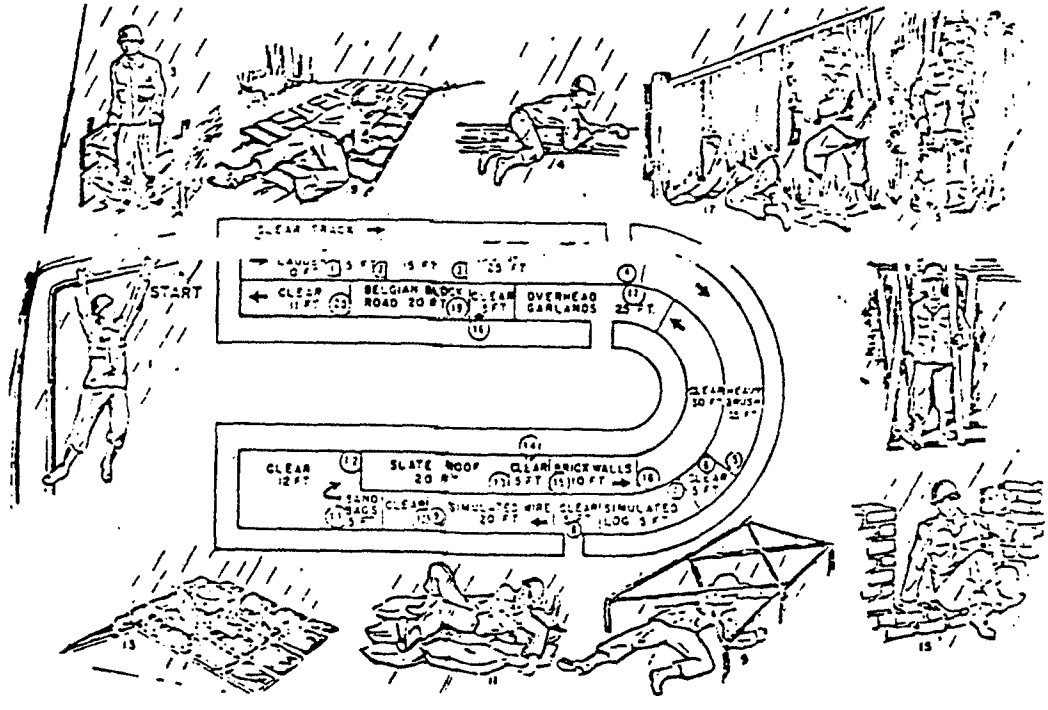
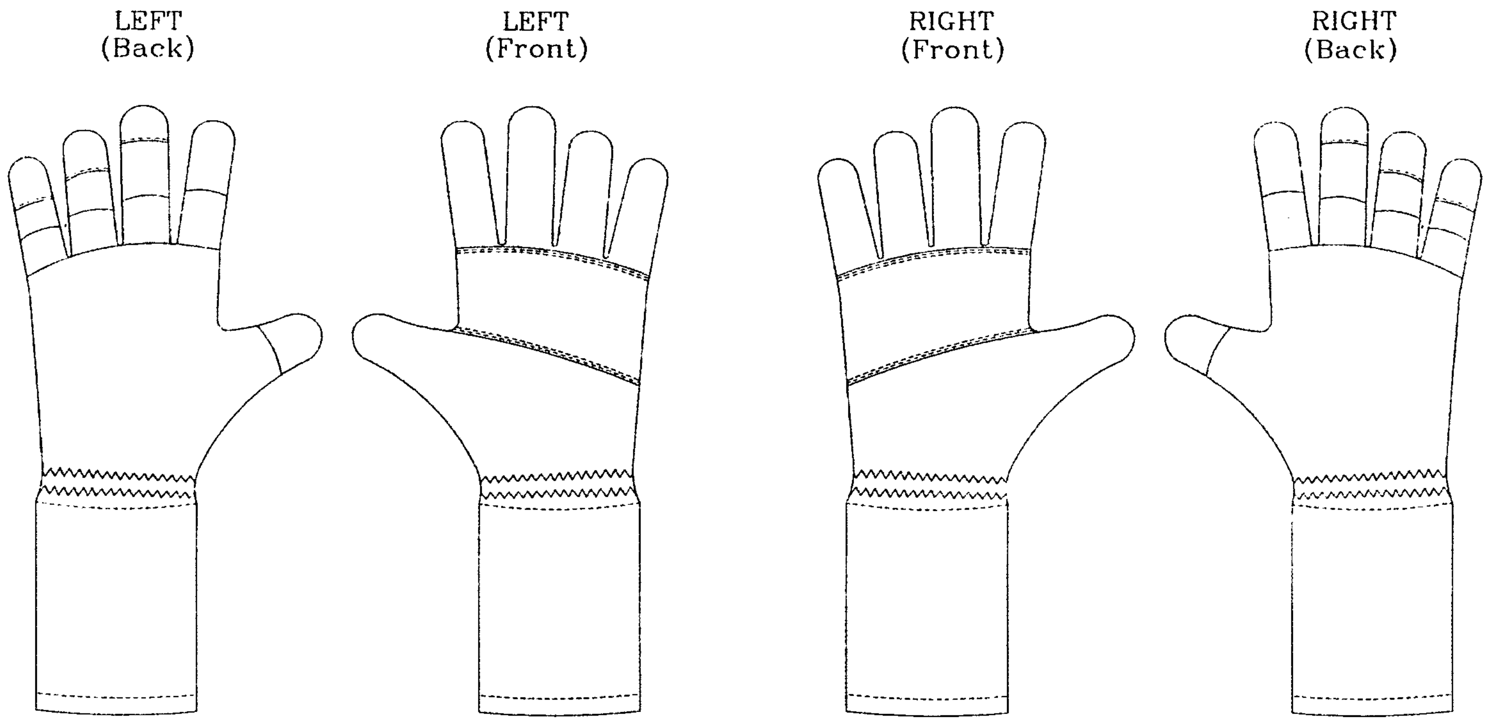


Figure C-3. Rain course.

APPENDIX D.
STANDARD HANDWEAR COURSE DESCRIPTION

Durability Tasks	Description/Reference
Turning windlass	The serrated handle is firmly gripped with the fingers wrapped palm down around the handle. The hands must be placed several inches from the ends and separated at the center so that they do not touch each other. The handle is rotated clockwise to raise the weight and counterclockwise to lower it.
Cinder block stack	The block is picked up with the hands firmly placed on the ends, thumbs inside the hole and fingers flat on the outside. With a slight toss, the hands are removed from the lift position, and the block is caught on the ends in both hands. Turn, walk to opposite side of station, and restack by removing fingers from the bottom and lowering with block held by palm pressure. Slide the flat palms up and away once the block has been stacked.
Smooth plank stack	Stand facing the end of the stack and pick up the planks one at a time. The planks are pulled with both hands placed on the nearest end until a center balance is obtained, which allows an easy lift. Turn and restack at right angles to the original stack. The process is reversed for returning planks to starting position.
Gravel shovel	Grasp the handle firmly thumbs down and with the hands separated for a comfortable shoveling position. A full shovel of gravel will be moved from one compartment to the other using only the hands and arms. Do not use the feet to dig into the gravel.
Barrel roll	With the barrel at the top of the ramp, place the hands palm in, thumbs up on the protruding end rim, and allow the barrel to slowly roll down to the wooden deck by maintaining a firm grip. The barrel is rolled to the top with an alternating right and left flat palm push.
Brick stack	Bricks are moved with both hands at the same time by grasping the bricks in the center with a firm thumb and finger grip. Stand in one place and move the bricks from one stack to another. A stack is 50 bricks: 2 rows, 4 high and 6 long with 2 on top. The new stack will resemble the old when completed.
Punching bag	Stand 6 inches short of a full arm's length and face bag. Draw the arm fully back, shoulder high, fist closed, knuckles up, and strike the bag with a full forward swing. Stop the swing of the bag with the other hand and repeat the process with alternating right and left arm punches.
Rope climb	Stand on ground and climb 13 feet of rope using hand-over-hand motion and legs (if necessary). Soldier will use hand-over-hand procedure to return to the start position.
Chain pull	Soldier will operate a chain hoist using hand-over-hand motion and will stop when the hoist has reached maximum height; the soldier will then return the chain hoist to the start position.



Glove TICN ______________

Left Glove No. ______________   Right Glove No. ______________

Traversals Prior to Failure

Left ______________

Right ______________

Wear Time Prior to Failure

Left ______________

Right ______________

Failure Identification:

O – Circle indicates area of failure and appropriate configuration.

H – Hole

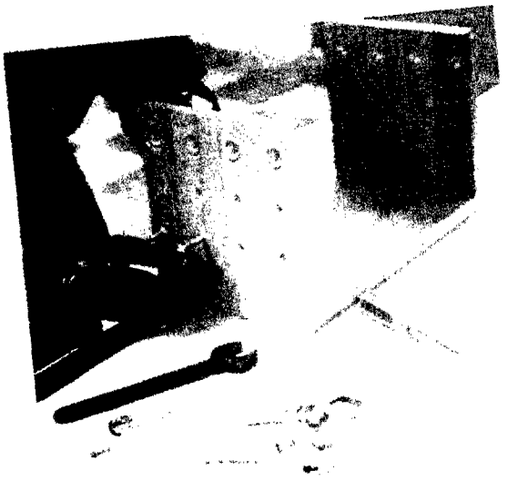
T – Tear

SF – Stitching/Seam Failure

Description: ____

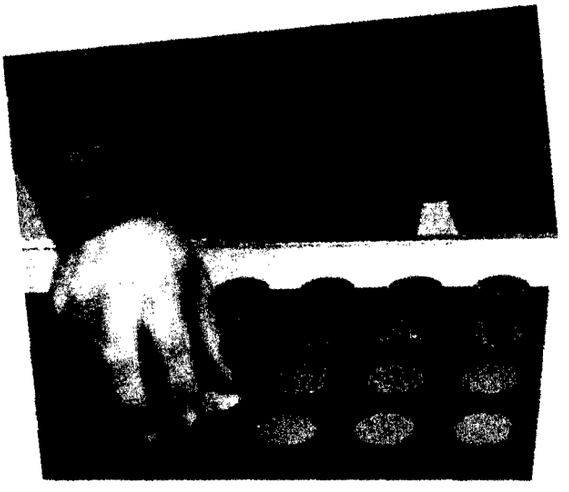
Figure D-1.

Keyboard



Hand Tool Dexterity

Minnesota Turning Test



Minnesota Displacement Test

Figure D-2. Dexterity tasks.

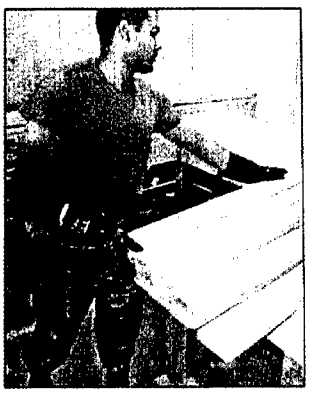
Windlass

Rope Climb

Chain Pull

Barrel Roll

Gravel Shovel



Plank Stack

Cinder Block Stack

Punching Bag

Brick Stack

Figure D-3. Durability stations.

TABLE D-2. AVIATOR/AIRCREW DURABILITY COURSE DESCRIPTION

Durability Tasks	Description/Reference	Simulation
Ladder climb	With the ladder extended, firmly grip each rung, climb the ladder to a height of 12 feet and return to the bottom.	Ladders/handle holds used during PMCS and ingress/egress of aircraft.
Barrel roll	With the barrel at the top of the ramp, place hands palm in, thumbs up on the protruding end rim, and allow the barrel to slowly roll down to the wooden deck by maintaining a firm grip. The barrel is rolled to the top with an alternating right and left flat palm push.	Palm abrasion associated with general equipment handling.
Control panel	Soldier will operate the cyclic stick (auto pilot, trigger, trim, radio/ICF), fuse panel for startup/shutdown procedures, VHF (changing the very high frequency radio in accordance to a predetermined sectional map flight pattern) and the Intercom Communications System (ICS) box for the outlined flight scenario.	Utilization of the cyclic stick, circuit breaker panel, VHF, and ICS controls during flight.
Net, cargo tie-down	Soldier will follow the procedures shown in the Air National Guard Palletizing and Cargo Netting Video.	Palletizing and cargo netting a load.
Smooth plank stack	Stand facing the end of the stack and pick up the planks one at a time. The planks are pulled with both hands placed on the nearest end until a center balance is obtained, which allows an easy lift. Turn and restack at right angles to the original stack. The process is reversed for returning planks to starting position.	Loading wooden cargo/ammunition boxes.
Lever pull	Soldier will grasp T-bar handle, set at a predetermined force, operating the lever in a series of five forward/reverse movements.	Use of power control quadrant control and various mechanical loading equipment controls.
Chain pull	Soldier will operate a chain hoist using hand-over-hand motion and stop when the hoist has reached the maximum height and the soldier will then return the chain hoist to the start position.	Seam stress for handling weapons and other various items of load.
Ammunition loading	Soldier will open/close, load/unload rounds into/from ammunition box.	Opening/closing, loading/unloading rounds into/from ammunition box while using weapon under fire.

APPENDIX E. REFERENCES

1. TOP 10-2-201, Combat Uniforms and Protective Equipment, 18 October 1985.
2. Federal Test Method Standard No. 191A, 21 June 1990.
3. American Society for Testing and Materials (ASTM), 1998.
4. American Association of Textiles Chemist and Colorists (AATCC), 1997.
5. Army Regulation (AR) 385-16, System Safety Engineering and Management, 3 May 1990.
6. MIL-STD-810F, Environmental Test Methods and Engineering Guidelines, 1 January 2000.
7. TOP 8-2-110, Masks, Protective, 1 August 1997.
8. ESD Association Standard for Protection of Electrostatic Discharge Susceptible Items, 1996/1997.
9. Electronics Industry Association 541, 1988.
10. Army Regulation (AR) 40-38, Clinical Investigation Program
11. Army Regulation (AR) 70-25, Use of Volunteers as Subjects of Research
12. TOP 1-2-610, Human Factors Engineering, Test Procedure 5.18, 30 May 1998.
13. TOP 8-2-511, Leak Test of Protective Equipment, 29 February 1968.

TOP 10-2-021
26 April 2004

Forward comments, recommended changes or any pertinent data which may be of use in improving this publication to the Technology Management Division (CSTE-DTC-TT-M), US Army Developmental Test Command, 314 Longs Corner Road, Aberdeen Proving Ground, MD 21005-5055. Technical information may be obtained from the preparing activity: Test Technology Core (CSTE-DTC-AT-WC-F), US Army Aberdeen Test Center, 400 Colleran Road, Aberdeen Proving Ground, MD 21005-5059. Additional copies of this TOP are available from the Defense Technical Information Center, 8725 John J. Kingman Rd., STE 0944, Fort Belvoir, VA 22060-6218. This document is identified by the accession number (AD No.) printed on the first page.