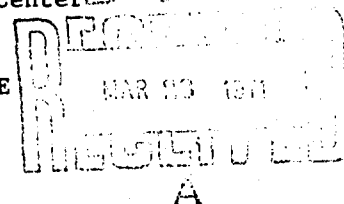


28 January 1971

Materiel Test Procedure 3-4-003
Tropic Test CenterU. S. ARMY TEST AND EVALUATION COMMAND
COMMON TROPIC ENVIRONMENTAL TEST PROCEDURE

ARMAMENT AND INDIVIDUAL WEAPONS

1. OBJECTIVE

This document provides test methodology and testing techniques for determining the capability of armament and individual weapons to withstand exposure to, and function effectively within, tropic environments. A principal purpose is to compare data obtained from dynamic tests, (tactical deployment and firing) and static tests (storage).

2. BACKGROUND

a. Army worldwide operations create a need for developing and testing new equipment. This creates a need for determining whether or not armament and individual weapons and accessories (hereinafter called test items) will meet specified performance requirements when they are exposed to natural wet-warm or wet-hot tropic environment conditions. Testing under these conditions is generally not conducted until data from simulated environmental tests provide reasonable assurance that the test item will function satisfactorily when subjected to such tropic environmental conditions.

b. There are four main classifications of armament and individual weapons, namely; (1) individual small arms (not crew-served), (2) light and medium weight crew-served weapons, (3) towed weapons, and (4) self-propelled weapons.

c. Non-crew-served small arms weapons are ordinarily carried by the individual soldier during tactical deployment. Some crew-served weapons are carried by the crew during tactical deployment, while others are vehicle carried. As indicated by the name, towed weapons will be towed, while self-propelled weapons will be driven over the terrain during tactical deployment.

d. The mode of tactical deployment has some bearing on the kind of exposure to which the particular test item will be subjected. For example, an individual weapon will be subject to water immersion when a stream is forded, and to contact with mud and vegetation. A self-propelled weapon will be subject to vibrations and to shocks, especially when the vehicle is used to batter down trees in a forest, and to heavy impact with impeding vegetation such as tree branches or lianas. All classes of weapons will be exposed to tropical rains, high humidity, and solar radiation in open areas.

e. A comprehensive dynamic environmental test should include the above described exposures, as well as the firing tests conducted at a firing range. It is assumed in this MTP that the ammunition used during firing tests contains no defects. Live ammunition will be utilized to the greatest practicable extent consistent with safety requirements. Since mechanical and/or chemical damage may result when ammunition is transported with the weapon during tactical deployment, the above assumption makes it often necessary to prescribe the use of dummy ammunition during the dynamic tactical deployment test in order to simulate actual battle-ready conditions as closely as possible. For example, it may be necessary from a mechanical balance standpoint, because of safety, to have a dummy round in place in the breech of a tank main

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gun, as well as dummy rounds stowed in ammunition racks inside the tank. Similarly, it may be necessary to simulate the weight of the ammunition carried by an individual soldier, by having him carry dummy rounds.

1. See MTP 2-4-003, Appendix A, for details regarding the environmental characteristics of those areas in the Panama Canal Zone, and in the Rio Hato Training Area, which are available for testing, major problems associated with tropic areas, a description of fungus-inert and fungus-susceptible materials, the corrosion-resistant properties of metals, and the major environmental effects caused by exposure to the Panama Canal Zone climate.

3. REQUIRED EQUIPMENT

One or more of the following items and/or facilities may be required to obtain data during the various evaluations:

- a. Facilities and measuring and recording devices listed under paragraph 3. "REQUIRED EQUIPMENT" in MTP 2-4-003, as applicable.
- b. Reference or comparison items, as required.
- c. Facilities and measuring and recording devices as listed in the applicable Commodity Item MTP.
- d. Suitable transport vehicles for non-vehicle-mounted test items.

4. REFERENCES

- A. AR 70-38, Research, Development Test and Evaluation of Materiel for Extreme Climatic Conditions.
- B. USAMC Regulation 385-12, Verification of Safety of Materiel from Development Through Testing Production and Supply to Disposition.
- C. USAMC Regulation 385-224, AMC Safety Manual.
- D. USAMC Pamphlet 702-3, Reliability Handbook.
- E. USAMC Pamphlet 706-134, Maintainability Guide for Design.
- F. USATECOM Regulation 70-23, Equipment Performance Reports.
- G. USATECOM Regulation 385-6, Verification of Safety of Materiel During Testing.
- H. USATECOM Regulation 700-1, Value Engineering.
- I. USATECOM Regulation 750-15, Maintenance Evaluation During Testing.
- J. USAGETA Document, Human Factors Evaluation Data for General Equipment (HEDGE) Guidebook Supplement.
- K. MIL-HDBK 472, Maintainability Prediction.
- L. MIL-STD-794B, Part and Equipment, Procedures for Packaging and Packing of.
- M. MIL-STD-1472A, Human Engineering Design Criteria for Military Systems, Equipment and Facilities.
- N. MTP 2-4-003, Tropic Environment Test of Wheeled and Tracked Vehicles.
- O. MTP 3-3-500, Preoperational Inspection and Physical Characteristics.
- P. MTP 3-3-517, Infantry Weapons and Ammunition Safety.
- Q. MTP 3-3-521, Human Factors Engineering.

- R. MTP 4-4-003, Tropic Environmental Test of Ammunition and Explosives.
- S. MTP 8-4-004, Long Term Surveillance/Environmental Testing of CBR Munitions, Weapons, and Equipment.
- T. Specific Volume 3 MTP for the Commodity Item for Evaluation.
- U. FM 31-35, Jungle Operations.
- V. TM 743-200, Storage and Materials Handling.

5. SCOPE

This MTP is intended to be used as a guide in conjunction with the MTP for the specific commodity item(s) undergoing service tests. Reference is made to other MTP's for the actual test procedures to be followed in assessing test item physical condition, technical characteristics, and operating performance. The primary intention of this MTP is to specify the environmental conditions under which such testing is to be performed, collect data relating test item performance to continued tropic exposure, and evaluate the data collected to determine the suitability of the test item for use in the tropics.

5.1 SUMMARY

This Materiel Test Procedure describes the following tests to be conducted on armament and individual weapons and their accessories.

5.1.1 Preparation for Test

This section provides guidance for test project planning, including a description of the facilities, documentation, calibration, test scheduling, and equipment required, test personnel training and familiarization, statistical planning, and the preparation of an appropriate mission scenario.

5.1.2 Test Conduct

- a. Initial Inspection and Operation - A determination of the condition of the test item upon its arrival at the test site, and an assessment of its performance characteristics before it has been exposed for any appreciable length of time to the tropic environment in which it will be used.
- b. Operational Performance - An evaluation to determine the capability of the test item to perform its intended mission. This test is conducted during both dry and rain seasons when the test schedule permits.
- c. Short Term Storage - A determination of any deterioration in the test item occurring during and after short term storage.
- d. Surveillance (Long Term Storage) - A determination of any deterioration in the test item occurring during and after long term storage, when properly packed and packaged for storage in a tropic environment.
- e. Maintenance Evaluation - An evaluation to determine the maintenance characteristics of the test item and the suitability of the maintenance test package in a humid tropic environment.

f. Safety - An evaluation to determine the safety characteristics and possible hazards to which the test item is exposed.

g. Human Factors - An evaluation to determine those design and performance characteristics affecting the test item user which are peculiar to the tropic environment.

h. Security from Detection - An evaluation to determine the capability of the test item to avoid detection when stored or operated in a humid tropic environment.

i. Value Analysis - An evaluation directed at analyzing the primary function and features of the test item for the purpose of cost reduction without compromising performance, reliability, quality, maintainability or safety.

5.2 LIMITATIONS

a. The material presented in this MTP is limited to field testing. Guidance for testing equipment in simulated environments or other induced wet-warm or wet-hot conditions has been intentionally omitted.

b. Procedures outlined in this MTP do not constitute detailed test plans. A test plan for tropic environmental testing of an item may be prepared using the guidance given in this MTP, but each test activity preparing environmental test plans must make its own judgment as to the applicability of each procedure, and must determine how best to obtain the required data from each item under test.

c. These procedures are limited to tests on armament and individual weapons which require exposure to those combinations of weather and terrain conditions, described in Appendix A of MTP 2-4-003, which are available in the Panama Canal Zone or in the Rio Hato Training Area. It is assumed that these test items have been subjected to, and successfully passed, those test which are unaffected by ambient weather or terrain conditions, or which can be appropriately made in a temperate climate.

d. Consult MTP 4-4-003 for the tropic environmental tests to be conducted on ammunition.

e. To reduce the number of variables to a minimum, all test items must be chosen from the same production lot, and they must be so identified, when more than one test item is involved.

6. PROCEDURES

6.1 PREPARATION FOR TEST

NOTE: The quantity of test items received for test should be greater than the quantity specified in the statistical plan, except when it is known that the shipment contains no non-repairable items.

6.1.1 Test Project Planning

The test project officer and other designated personnel must:

- a. Conduct a thorough study of stated requirements as contained in QMR, SDR, TC, and the test directive to insure that complete and suitable test criteria are selected.
- b. Review all instructional material issued with the test item by the manufacturer and reports of previous tests conducted on similar equipment.
- c. Prepare a detailed test schedule showing proposed time periods allotted for each test. Ensure that cross country testing is scheduled for test courses with both cleared and uncleared terrain in wet-warm and wet-hot environments. These environments and test courses are defined in paragraph 3 and Appendix A of MTP 2-4-003. Testing should be scheduled to take place in the peak of the wet season (October through November) and in the dry season (January through March). Wherever applicable, testing should also be conducted in areas that expose the test item to salt-air and salt-spray.
- d. Prepare record forms and test logs for systematic entry of data, chronology of test, and evaluation in the final analysis of the test item's suitability for use in the tropics.
- e. Review the safety release. Tabulate the safety precautions that must be followed to insure safe operation of the test item(s); include all applicable safety Standing Operating Procedures (SOP's).
- f. Verify that test facilities, equipment, and accessories are available, operational and properly calibrated. Power sources, when used, shall be checked to ensure correct outputs.
- g. Final arrangements for supporting or participating agencies, activities and facilities shall be made.
- h. Operating instructions for test instruments to be used during test conduct should be obtained and made available to test personnel.
- i. Short term storage should last not less than 6 months, and should include both dry and wet seasons. It is advisable to start all testing during the dry season, because best performance is usually obtained at that time, and this performance can then be used as a standard against which wet season performance can be compared.

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j. Plan the use of photographic techniques where necessary to record and document test results.

6.1.2 Test Personnel Training and Familiarization

a. Evaluate the adequacy of all draft technical manuals and safety instructions used by the test personnel. This evaluation shall continue throughout the course of the test.

b. When a reference item is used for comparison purposes follow procedures described in paragraph a. and instruct personnel in accordance with Table I.

6.1.3 Statistical Plan

6.1.3.1 General

a. Unless it is known, or unless it can be reasonably assumed, that the time to failure of the test item follows an exponential or other known distribution, cross country mission reliability should be expressed as a probability of success, using the "attributes" approach (binomial distribution), wherein the mission (or "experiment"), if satisfactorily completed, is called a success, and if the mission (or "experiment") is not satisfactorily completed, it is called a failure.

b. When the "attributes" approach is used, the preciseness of the probability figure obtained increases as the number of "experiments" increases. For example, if only one "experiment", or mission is conducted, and no failure occurs, a probability of success of 10%, at a lower 90% confidence level, is the best that can be claimed when the "experiment" is repeated with the same, or another identical, test item. If, however, five identical "experiments" are successfully completed, the probability of success becomes 63.1% at a lower 90% confidence level when another identical "experiment" is made. Therefore, when the "attributes" approach is used in reliability determinations, the number of identical "experiments", or missions (NxT) should be made as large as possible. The decision regarding the number of test items, N, to use, and the number of identical experiments, T, to make, should form an essential part of every statistical plan.

c. To obtain the maximum amount of useful information, use the same test personnel in both the wet season and in the dry season.

d. When a reference item is used for comparison purposes, follow the same test procedures as those followed with the test item.

e. Follow the instructions in AMCP 702-3 when calculating test item reliability and unless otherwise specified, use a lower confidence level of 90% in these calculations.

TABLE I
Personnel Instructions

Personnel	To be instructed in
All	<ul style="list-style-type: none"> a. The purpose of the test. b. The characteristics of the test item. c. The characteristics of the reference item, if any. d. The kind of data to be obtained. e. The terrain(s) in which testing is to be conducted. f. The health precautions to be observed in the terrain(s) required for test conduct.
Test and reference item operators	<ul style="list-style-type: none"> a. The test item (and reference item, when used) operating characteristics and limitations. b. The expected test item performance. c. The safety precautions to be observed. d. The kind and extent of all maintenance actions to be taken under all specified environmental conditions. e. All operating procedures to be followed under all environmental and terrain conditions. f. The procedures to be followed when filling out checklists and questionnaires, and their purpose.
Test evaluators	<ul style="list-style-type: none"> a. The purpose and use of all checklists and questionnaires, and the methods to be used in their evaluation. b. The calculations to be made in evaluating test data.
Topographical analysis support	<ul style="list-style-type: none"> a. Physical terrain features to be measured, including water velocity and terrain slopes. b. Vegetation features to be noted and described.

TABLE I (Cont'd)

Personnel	To be instructed in
Maintenance support	<ul style="list-style-type: none"> a. The scheduled maintenance requirements to be met. b. The procedures, equipment and material to be used to make emergency repairs and unscheduled maintenance. c. The kind of recovery vehicle to be used. d. The recovery procedures to be used. e. The maintenance records to be written.
Meteorological support (TTC Reg. 705-4)	<ul style="list-style-type: none"> a. The terrain areas which will be used. b. The calendar dates of all tests. c. The readings to be taken.
General support	<ul style="list-style-type: none"> a. Storage, handling, layout, spacing, pest control, fire protection, security, and inspection procedures to be followed. b. Required organizational maintenance to be performed, including cleaning, and microbiological inspection. c. The calendar dates of all inspections.
Explosive ordnance disposal personnel	<ul style="list-style-type: none"> a. The terrain areas which will be used. b. The calendar dates of all tests. c. The disposal of any test ammunition considered to be unsafe.

6.1.3.2 Combat Mission

NOTE: A combat mission shall require one traversal of a cross country course, unless otherwise specified.

Perform the following:

- a. Verify that, at the beginning of each mission, the weapon has been restored to its initial pretrial condition with respect to all of those features which are considered to be important from a reliability standpoint.
- b. Assign each weapon to the particular individuals or crews who will be operating it.
- c. Select a minimum of two crews, or a minimum of two groups of infantrymen, as applicable, from an infantry, artillery or tank company, or elements thereof.
- d. Using a block design procedure such as that described in Appendix A, determine which of these crews or groups will be used to fire the weapons, and describe the cross country course over which the weapon will be carried.
- e. Determine, in detail, what constitutes a weapon failure.
- f. When a reference item is to be used for comparison purposes, follow the procedures described under steps c. or d. above for the reference item personnel.
- g. Unless otherwise specified, the total number of experiments to be conducted over each of the specified test courses shall be as shown in Table II:

- 1) N = number of test items.
- 2) T = number of missions over each test course.
- 3) $N \times T$ = number of experiments.

TABLE II
Minimum Number of Experiments

Test Item	Number of Experiments ($=N \times T$)
Individual and crew-served weapons	50 Minimum
Towed and self-propelled weapons	5 Minimum

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In planning a tactical scenario, include that information required by the five paragraph field order and the following:

a. A tank-infantry task force is organized for one of the following reasons:

- 1) To cover greater distances in less time than dismounted patrols.
- 2) To operate in contaminated areas too dangerous for dismounted patrols.
- 3) To provide greater fire power.

b. Organize the task force into elements by assigning infantry men to tanks and maintain squad or fire team integrity as far as possible.

c. Appoint one man to be in command of each vehicle.

d. Insure that tanks are in good mechanical condition, combat loaded and properly supplied with fuel and oil. Combat vehicle drivers and other attached men must be as thoroughly prepared for a mission as a regular task force member.

e. A tank-infantry task force moves by one of three methods:

- 1) Continuous movement.
- 2) Successive bounds.
- 3) Alternate bounds.

Plan to use the methods of movement best suited for the anticipated tactical situation.

f. Security is provided for by requiring each vehicle commander to assign each passenger a direction to observe. This provides visual contact with vehicles to the front and rear and some security from surprise attack.

g. Actions to take at danger areas and on contact with the enemy must be planned and covered in detail during the mission briefing of all task force personnel. A clear statement of whether or not tank elements can engage in decisive combat should be covered in this briefing.

h. Selection of areas for conducting operations must include terrain and vegetation conditions for which the test item was designed. Unless otherwise specified, each course should not be less than 6.44 kilometers (4 miles) long.

i. Command, control, logistical, and administrative matters will be contained in the five paragraph field order. Sketch maps and/or overlays will be appended to the operations order.

1. See Appendix C for a typical scenario.

6.1.4 Unit Test

a. The unit test will describe the tests to be conducted under simulated field conditions by personnel who would use the equipment in the field. The mission scenario (refer to Appendix C) will describe the test areas and operations that will be used for evaluating the use of the test item.

b. Unit missions, where possible, will include both defensive and offensive operations as they apply to the type of item being tested, i.e., an individual hand-held item will be evaluated as a defensive weapon for a battalion perimeter, and then as a part of an attack force securing an enemy position.

c. The mission scenario should include, as a minimum, the following:

- 1) Details of test item prime function(s) to be completed in each condition of environment and terrain.
- 2) Sketch map, or overlay, of the test area(s) and a description of the environment(s) to be found therein.

6.2 TEST CONDUCT

- NOTE:
1. Ensure that a safety release statement has been received from USATECOM before making any tests.
 2. Observe all specified safety requirements at all times.
 3. Performance assessment shall be accomplished by observers equipped with the means of recording visual, aural, and judgmental observation and related time factors. Observer activities shall not interfere with, or influence, in any manner, the functions of the test item or operators. Subtests shall be conducted concurrently or in conjunction with other subtests whenever possible, so that the time taken to collect the required data will be minimized. Testing shall be conducted under all meteorological conditions prevailing during the test period.
 4. When the test item meets specified operational tests during the course of an assigned mission, the test item performance is defined as being a mission success.

6.2.1 General Requirements

- a. Conduct all tests under prevailing weather conditions.
- b. When a reference or comparison item is used, subject it to the same tests as those applied to the test item.

c. When the test item will be exposed to the shock, vibration, vegetation, terrain and weather conditions encountered during a cross country mission, observe the following:

- 1) Travel over the test course during daytime and nighttime unless safety requires only daytime testing.
- 2) Travel over grass lands during both dry and wet seasons.
- 3) Verify that the test course includes the terrain and vegetation conditions which the test item was designed to withstand.
- 4) When a reference or comparison item is to be carried cross country, take it over a course parallel to that taken by the test item, and trail it behind the test item a sufficient distance to avoid the danger of it becoming damaged by the same terrain feature which has damaged the test item.

d. Note the ambient temperature, relative humidity, wind speed and direction for each test.

e. Conduct all initial inspections, maintenance actions, and operations as specified in the applicable draft technical manuals.

f. At the end of each operational test, ask the test personnel to fill out a questionnaire giving their opinion regarding the performance of their own test item and its relative merits or demerits as compared to the comparison item, when a comparison item is used.

g. The test officer shall ensure that a safety statement pertaining to the item undergoing test has been received from headquarters, USATECOM and is understood before the test is started. The safety statement includes information pertaining to operational limitations and specific hazards peculiar to the test item.

- 1) Test and subtest plans and procedures shall be prepared to ensure performance in the safest manner consistent with conduct of the USATECOM evaluation. The cardinal principle is to limit exposure of a minimum of personnel, for a minimum time, to a minimum amount of hazardous material consistent with safe and efficient operations. Plans shall include safety procedures, precautions, protection, and emergency procedures, as necessary. Technical information on the hazards and safety characteristics of the test item as provided by the safety statement and other pertinent information, shall be included. Such information shall include evaluation of potential hazards, analysis of risks, limitations, and precautions including special test equipment and techniques that should be incorporated in test plans and procedures.
- 2) A specific individual shall be charged with responsibility

for safety. He shall be familiar with the construction and operation of the test item and its critical components, shall have full knowledge of the hazards and safety aspects of the test, and shall review test procedures for evaluation of hazards and recommend control measures.

- 3) All personnel who participate in or observe the tests shall be briefed on the hazards involved and the precaution required to ensure proper test methods and procedures.
- 4) Observe all of the safety precautions specified in AMCR 385-224, the draft technical manual and the applicable Volume 3 Commodity Item MTP.
- 5) Any test ammunition or explosive considered to be unsafe shall be disposed of by explosive ordnance disposal (EOD) personnel.

6.2.2 Initial Inspection

Perform the following immediately upon receipt at the test site:

- a. Inspect and record the condition and identification marking of all packages and packing and their conformance to MIL-STD-794B for overseas shipment for Level A or Level B, as applicable.
- b. Weigh and measure the individual package(s) for each packaged test item component, or a sample package, if identical components are contained in several packages. Unless otherwise specified, the minimum sample size shall be as shown in Table III.
- c. Unpack and remove all preservative coatings on test item(s) and inspect all surfaces for proper painting and other protective coatings. Take color photographs of all surfaces displaying roughness, corrosion or microbiological growths.
- d. Verify completeness of the test item, associated components, and maintenance test package as specified in the Basic Issue Item List (BIIL), and file an Equipment Performance Report for any damages or omissions, if required.
- e. Determine the physical characteristics of the test item(s) in accordance with the appropriate procedures in the applicable Volume 3 MTP and in MTP 3-3-500.
- f. Conduct an operator preparational inspection in accordance with MTP 3-3-500 and the draft technical manual, and repair or replace all test items or test item components which do not pass this inspection.

6.2.3 Initial Operation

- a. Assemble and/or emplace or position the test item in the physical environment in which it will be used.

TABLE III
Minimum Sample Size

Number of Items	Minimum Sample Size
1-4	all
5	4
6	4
7	5
8	5
9	6
10	6
11-15	7
16-40	8

b. Operate or exercise the test item as described in the applicable Volume 3 MTP, including firing tests, in all specified modes and ranges of use, under the applicable meteorological conditions, and determine its effectiveness.

NOTE: It is preferable to perform initial operation tests during the January-February-March dry season because best performance is most likely to occur then. This will then provide a performance standard against which all other operational tests can be compared.

6.2.4 Operational Test

Perform tests during the dry season, which normally starts in January and ends in mid-April; and during the rainy season, which normally starts in mid-April and ends in December.

a. Perform the tests described in paragraph 6.2.3.b, for a sufficient number of missions to obtain a suitably precise measure of the test item's probability of mission success, (see paragraph 6.1.3). When specified, these tests shall include subjecting the test item to the applicable portions of MTP 3-3-521, including the shock, vibration, weather, water immersion and vegetation conditions encountered during cross country missions.

b. During cross country mission operations, verify that no terrain conditions or obstacles exceed the limits allowed for the test course, and measure the water velocities and depths at all stream and river crossings.

6.2.5 Security from Detection

NOTE: This subtest will be conducted only when specifically requested in the test directive.

a. Position test item in designated test site.

b. Use natural material, nets, tarpaulins, and any other prescribed camouflage material to conceal test item. Place material about site as required to enhance concealment qualities.

c. Make ground and aerial observations of concealed item at various times of the day and at various distances.

d. Repeat foregoing steps in each test site of interest.

6.2.6 Short Term Storage

Storage of the test item and/or components shall be consistent with normal practice for the commodity class of the test item as supplemented by the applicable information in the draft technical manual.

a. Place the test item and/or components in the area designated for short term storage. Unless otherwise specified, minimum use of preservatives should be made.

b. Periodically inspect the test item for performance degradation and for any evidence of corrosion or microbiological growths. Sample and analyze any growths detected. Unless otherwise specified, make these tests only on a sample quantity of test items as specified in Table III.

c. At the completion of the storage period, repeat the procedures of paragraph 6.2.3 to determine if any damaging effects have been induced in the test item by storage.

6.2.7 Surveillance (Long Term Storage) Test

NOTE: Unless otherwise specified, the requirements of MTP 8-4-004 shall be met throughout this test.

Perform and record the following:

a. Unless otherwise specified, store all items in their normal long-term storage containers as specified in the draft technical manual.

b. Determine the kind of inspections to be made on the test items during the total storage period. Unless otherwise specified, the number of inspections to be made shall be eight, and the "cycle number" dates when these occur shall be as specified in Figure 1, MTP 8-4-004.

c. Determine at which "cycle number" dates (month, day and hour) the specified number of test items are to be operated or exercised. Unless otherwise specified, the number of test items to be operated or exercised at each specified "cycle number" operating date shall be not less than the value of N determined as described under paragraph 6.1.3.1.

d. Store the test items in the specified environment, using the applicable procedure described in TM 743-200, unless otherwise specified. Note the particular half month, and the day and hour in which this storage takes place and denote this as the "cycle No.1" date.

e. At each of the "cycle number" dates, perform the following on each test item in the test group:

- 1) Visually examine it, and take color photographs of all corrosion and fungus growth areas.
- 2) Make a microbiological analysis of all materials which display evidence of microbiological attack.
- 3) Perform all specified operator maintenance and repairs needed.
- 4) When an operational test is to be made, transport the specified number of test items (see item c. above) to the operating site, perform the operational test described in paragraph 6.2.3 and determine to what extent the operating characteristics of the test items have deteriorated during the storage period.

6.2.8 Maintenance Evaluation

NOTE: Perform the following on those test items for which operator maintenance is prescribed.

Data expressing system maintenance factors is collected in preparing for and completing active testing. If, at the completion of testing, very little maintenance has been performed, representative samples of the maintenance procedures in the applicable Volume 3 MTP and the draft technical manual should be completed to determine the ease in performing these actions with emphasis on the following:

- 1) Organizational (O), Direct Support (F), and General Support (H) maintenance requirements.
- 2) Operator through General Support Maintenance Literature.
- 3) Repair parts.
- 4) Tools.
- 5) Test and handling equipment.
- 6) Calibration and maintenance facilities.

6.2.9 Safety

- a. Do not begin testing until a safety release is received from higher headquarters.
- b. Observe the proper safety precautions during testing, and record any conditions that might present a safety hazard, the cause of the hazard, and the steps which were taken to alleviate the hazard.
- c. Observe and record all of the applicable precautions specified in the following documents:
 - 1) The test item maintenance packages.
 - 2) AMCR 385-224.
 - 3) FM 31-35.
 - 4) MTP 3-3-517.
 - 5) Applicable portions of the specific commodity item Volume 3 MTP.
 - 6) Applicable portions of Appendix A (Questionnaires).
 - 7) Applicable portions of Appendix B (Checklists).
- d. After completing all testing, prepare a safety confirmation for inclusion in the final report if the test item was determined safe for use. If the test item was found to be unsafe, a detailed explanation should be provided.

6.2.10 Human Factors Evaluation

Develop task/item checklists reflecting the human factors design considerations for the test item. These checklists will allow test supervisory personnel to compare test item features against appropriate criteria and record comments to evaluate the suitability of the man-item interface with particular emphasis on operations under adverse weather conditions. Detailed criteria and human factors considerations for each task may be derived from USAGETA document, Human Factors Evaluation Data for General Equipment (HEDGE) Guidebook Supplement. Consult Appendix B, MTP 3-3-521 and MIL-STD-1472A, for guidance in preparing a suitable checklist.

6.2.11 Value Analysis

- a. During the conduct of all tests, test personnel shall evaluate the test item from a value versus cost standpoint. Record all pertinent comments concerning features or components which can be eliminated or modified to accomplish cost reduction without impairment of performance, reliability, quality, maintainability, or safety. The applicable portions of USATECOM Regulation 700-1 shall be used for evaluation.
- b. Consideration shall be given to the topics listed below. Record appropriate comments for each topic.

1) Mission Capacity.

The test item should be capable of accomplishing the specified task with only a reasonable margin of excess capability. Excess capacity and unused capability normally results in unnecessary bulk, excessive weight and unwarranted costs.

2) Simplicity.

Unnecessarily complex components and systems, redundancy, and the use of unneeded parts will increase cost and maintenance efforts.

3) State-of-the-Art.

In many instances the use of recently developed, currently available, components and automated features will result in an overall product improvement and cost savings.

4) Standardization.

The use of identical parts and parts currently in the military system will reduce the overall logistics burden.

5) Materials and Methods of Construction.

Polished surfaces, overdone finishes, and the use of expensive materials will result in unnecessary costs if used inappropriately.

6) Tolerances.

Inadequate tolerances will result in difficulties and delays in accomplishing post arrival assembly, routine maintenance, servicing and repair.

6.3 TEST DATA

6.3.1 General Requirements

a. When measuring attributes, which are subject to small deviations, make at least two, and preferably four, different measurements under identical test conditions, and record each measurement, as well as the arithmetic mean of these measurements. Also, record the percentage accuracy of the measuring device used.

b. Indicate the accuracy of the measuring device employed when recording measurements which must be made accurately.

c. When progressive degradation is observed on any part, describe and/or photograph the degradation, and show the "before" and "after" condition together when recording.

d. When applicable, show a soil profile of the test course terrain in the test course performance record.

e. When two or more persons are asked to fill out a questionnaire giving their opinion regarding specified features in a particular test, show the scoring values used, and the scoring results obtained, in tabular form as described in Appendix A (Questionnaires). When an analysis of variance is used to test for the significance of the variation in the scoring results, state the results of this analysis.

6.3.2 Test Project Planning

Record the following:

- a. Detailed test schedule for each test.
- b. Types and lengths of all cross country test courses to be used.
- c. The record forms and test logs to be employed.
- d. Details of the safety release.
- e. All safety precautions to be followed, including applicable safety SOPs.
- f. Test facilities, equipment, accessories and their operating instructions available for use.
- g. Arrangements concluded with supporting or participating agencies.
- h. Month, day and hour of the start and finish of the short term and the long term (surveillance) storage periods.
- i. Photographic facilities to be used.

6.3.3 Test Personnel Training and Familiarization

Record the following:

- a. For all test personnel:
 - 1) MOS and skill level.
 - 2) Rank.
 - 3) Unit.
 - 4) Experience.
 - 5) Previous training.

b. Adequacy of draft technical manual for supporting personnel training.

c. Requirements for training aids.

d. Difficulties encountered in completing training program.

6.3.4 Statistical Plan

Record the following:

a. Whether or not the "attributes" approach is to be used in determining probability of mission success.

b. The number of identical "experiments" or missions (NxT) to be made.

c. The reference item to be used for comparison purposes.

d. The personnel to be used in the various tests.

6.3.5 User Test

Record the following:

a. The test areas and operations to be used for evaluating the use of the test item.

b. A sketch map, or photomap, of the test area(s) and a description of the environment to be found therein.

6.3.6 Initial Inspection

Record the following:

a. Conformance with specified packing, packaging, preserving, identification and marking criteria.

b. Any omissions of components or equipment, damage detected, and repairs made.

c. Physical characteristics of the test item as specified in the applicable Volume 3 Commodity Item MTP, and in MTP 3-3-500.

d. Missing or improper protective coatings on the test item, and photographs of roughness, corrosion or microbiological growths.

6.3.7 Initial Operation

Immediately after assembling and/or emplacing or positioning the

test item in the physical environment in which it will be used, record the performance characteristics obtained in all specified modes and ranges of operations under the applicable meteorological conditions.

6.3.8 Operational Test

Record the following:

- a. The performance characteristics described under paragraph 6.3.7 during the dry season and rainy season for all of the "experiments" or missions performed.
- b. The terrain conditions encountered, including water velocities at stream or river crossings.

6.3.9 Security from Detection

Record the following:

- a. Conditions of the terrain in which observations were made.
- b. Implements used to make observations (field glasses, aircraft, etc.).
- c. Distances from which test item observations were made.
- d. Time of day and sky conditions when observations were made.
- e. Type(s) of material used.
- f. Identity of illustrative photography.

6.3.10 Short Term Storage

Record the following:

- a. Condition of the test item(s) just prior to storage, and the storage preparations made, including (if applicable) the shipping containers used.
- b. Storage environment and daily meteorological conditions.
- c. Number of items involved.
- d. Method and duration of storage of each item, and the calendar dates of all inspections.
- e. Results of all inspections made.

- f. Maintenance and repairs made.
- g. Extent of deterioration of operating characteristics.

6.3.11 Surveillance

Record the following:

- a. The condition of the test items just prior to storage, and the storage preparations made, including all containers and packaging used.
- b. Storage environment and daily meteorological conditions.
- c. Number of items involved.
- d. Method and duration of storage of each item and the calendar dates of all inspections.
- e. Results of all inspections made.
- f. Maintenance and repairs made.
- g. Extent of deterioration of operating characteristics.

6.3.12 Maintenance Evaluation

Record the following:

- a. Scheduled maintenance:
 - 1) Description of test activity, environment, and meteorological factors associated with maintenance performed.
 - 2) Procedures and special tools (if any) required to complete maintenance actions; description of maintenance performed.
 - 3) Component or feature involved.
 - 4) Elapsed time since previous scheduled or unscheduled maintenance performed (whichever is shorter). Identity of previous maintenance performed (scheduled or unscheduled).
 - 5) Parts required, if any.
 - 6) Elapsed time required to complete maintenance actions.
 - 7) Difficulties in completing maintenance actions.
 - 8) Total scheduled maintenance time consumed in hours.
- b. Unscheduled maintenance:
 - 1) Description of test conduct, environment, and meteorological conditions under which maintenance requirements developed.

- 2) Procedures and special tools (if any) required to complete maintenance actions; description of maintenance performed.
- 3) Elapsed time since previous scheduled or unscheduled maintenance performed (whichever is shorter). Identity of previous maintenance performed.
- 4) Parts required, if any.
- 5) Difficulties in completing maintenance actions.
- 6) Component or feature involved and method used to determine it.
- 7) Damage caused to associated parts of the system by failure, if applicable.
- 8) Reason for maintenance required, if ascertainable.
- 9) Recommendations to prevent recurrence of maintenance requirements.
- 10) Elapsed time to identify and locate fault.
- 11) Elapsed time to rectify fault.
- 12) Total unscheduled maintenance times consumed in hours.

c. Time to complete related maintenance functions.

- 1) Supply delay time.
- 2) Administrative delay time.
- 3) Technical engineering investigations or inspections related to analysis of cause of failure or detection of suspected incipient failures.
- 4) Initial and final technical inspections.

d. For all maintenance performed:

- 1) The adequacy of the draft technical manual and maintenance information provided.
- 2) The adequacy of the OEM tools and repair parts.
- 3) The adequacy of the safety instructions.

e. Total operating time in hours.

f. Identify each maintenance action as either a chargeable or nonchargeable failure in accordance with definitions and illustrations provided in USATECOM Regulation 750-15:

- 1) Total number of chargeable failures.
- 2) Total number of nonchargeable failures.

6.3.13 Safety

Record the appropriate data as required by the specific Volume 3 MTP for the test item, MTP 3-3-517, AMCR 385-224, the maintenance package and the following:

- a. A tabulation of all safety features and/or devices:
 - 1) Type of feature/device.
 - 2) Purpose of the feature/device.
 - 3) Suitability of the feature/device.
 - 4) Adequacy of the feature/device.
 - 5) Proper operation of the feature/device.
- b. Adequacy of warning plates, instructions and markings in content, clarity, sufficiency and location.
- c. Any condition that did or might present a safety hazard, including cause and corrective action required to alleviate the condition.
- d. Presence and adequacy of fire fighting equipment and suitability of stowage and control location.
- e. Suggestions to improve safety features, safety measures and/or precautions.

6.3.14 Human Factors

Complete the task/item checklists by rating the inclusion of each design consideration as satisfactory or unsatisfactory.

6.3.15 Value Analysis

- a. Record appropriate comments for each of the topics listed below:

- 1) Mission Capacity.
- 2) Simplicity.
- 3) State-of-the
- 4) Standardization.
- 5) Materials and Methods of Construction.
- 6) Tolerances.

- b. When making recommendations for changes in test item features or components, record the following:

- 1) The feature or component under consideration.
- 2) Recommended change(s).
- 3) Reason(s) for recommended change(s).

6.4 DATA REDUCTION

6.4.1 General

Summarize all data using tabulations and/or charts as appropriate. Analyze and compare the data collected against specific criteria stated in

governing documents. Provide a narrative description of the degree of suitability of the test item for use in the tropics. If the item is not suitable for use in the tropics, provide a complete description (including test results) of why the item is so adjudged.

6.4.2 Questionnaires

When two or more persons are asked to fill out a questionnaire giving their opinion regarding specified features in a particular test, and an analysis of variance is used to test for the significance of the variation in the scoring results, perform this analysis as specified in Appendix A.

6.4.3 Checklists

Group the answers to all checklist questions under the applicable headings, such as safety, accessibility, and human factors, and arrange the answers in the order of their relative importance.

6.4.4 Maintenance Evaluation

Calculate the maintenance indicators as follows: Reference is made to USATECOM Regulation 750-15 for information as to the meaning and use of these indicators in assessing system maintenance.

- a. Mean Time Between Failures (MTBF).

$$\text{MTBF} = \frac{\text{Total operating time (in hours)}}{\text{Total number of chargeable system failures}}$$

- b. Mean Time Between Maintenance (MTBM).

$$\text{MTBM} = \frac{\text{Total operating time (in hours)}}{\text{Total number of scheduled and unscheduled maintenance actions performed}}$$

- c. Mean Active Maintenance Downtime (\bar{M}).

$$\bar{M} = \frac{\text{Total scheduled and unscheduled maintenance time (in hours)}}{\text{Total number of scheduled and unscheduled maintenance actions}}$$

- d. Mean Time to Repair (MTTR).

$$\text{MTTR} = \frac{\text{Total unscheduled maintenance time expended on chargeable failures (in hours)}}{\text{Total number of chargeable system failures}}$$

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e. Inherent Availability (A_i).

$$A_i = \frac{MTBF}{MTBF + MTTR}$$

f. Achieved Availability (A_a).

$$A_a = \frac{MTBM}{MTBM + M}$$

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APPENDIX A

Preparations and Use of Questionnaires

Follow the procedures described in Appendix B, MTP 2-4-003, substituting the words "convoy", "technicians", and "technician" for the words "drive", "test drivers" and "driver", respectively.

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APPENDIX B

Checklists

The following checklist questions are presented under two categories. The first category entitled "Tropic Environment Consideration", deals with those features which are emphasized in a tropic environment. The second category, entitled "General Considerations", deals with those features which are substantially independent of the kind of climate involved. Under this category, documents are referenced in which such general checklist questions can be found.

I. TROPIC ENVIRONMENT CONSIDERATIONS

- a. Are adequate drain holes provided to drain off moisture inside closed-off areas, caused by condensation due to temperature changes when exposed to high humidity conditions?
- b. Are provisions such as shielding, insulation or warning labels provided when the temperature of surfaces with which personnel may come in contact exceeds 46.1°C. (115°F.)?
- c. Is adequate protection provided on the test item to protect personnel and equipment from overhanging limbs and lianas?
- d. Are provisions made on the test item to protect the operator/crew from the effects of prolonged exposure of the test item to the direct rays of the sun?
- e. Is a suitable medical kit provided for on-the-site treatment against poisonous plants, insects or animals?
- f. Is hermetic sealing used to keep out moisture whenever possible?
- g. Is contact between corrodible metal parts and anti-fungus-treated materials avoided whenever possible?
- h. Are drain holes provided, and are chassis and racks channeled to prevent moisture traps?
- i. Are reflecting surfaces used on equipment which must be maintained while exposed to the sun?
- j. Are materials used to the greatest extent possible for their non-corrosive and non-hygroscopic characteristics, as well as their ability to resist fungus growth?
- k. Are materials used which inhibit fungus growth rather than materials which include a fungicide, or which have received surface fungistatic or fungicidal treatment?

- l. Are metallic parts designed without recesses, cups or traps where liquids can accumulate, and are metals in contact chosen as close together as possible in the electromotive force series?
- m. Are exposed surfaces completely covered with some form of protective coating or surface plating?
- n. Are corrosion inhibitors or preservative materials used where necessary or possible?
- o. Are synthetic rubbers which are resistant to both microbiological and ozone deterioration used wherever possible?
- p. Are provisions made to determine the kind and extent of color facing encountered?

II. GENERAL CONSIDERATIONS

Consult the following documents for the indicated checklist subject:

A. MIL-HDBK-472

<u>Checklist Number</u>	<u>Subject</u>	<u>Pages</u>
A-1	Access (External)	A3-33
A-2	Latches and Fasteners (External)	A3-34,35
A-3	Latches and Fasteners (Internal)	A3-35,36
A-4	Access (Internal)	A3-36,37
A-5	Packaging	A3-37,38
A-6	Units-Parts (Failed)	A3-38
A-7	Visual Displays	A3-39
A-8	Fault and Operation In- dicators (Built-In Test Equipment	A3-39,40,41
A-9	Test Points (Availability)	A3-41
A-10	Test Points (Identification)	A3-42
A-11	Labeling	A3-42,43

A. MIL-HDBK-472 (Cont'd)

<u>Checklist Number</u>	<u>Subject</u>	<u>Pages</u>
A-12	Adjustments	A3-43,44
A-13	Testing (In Circuit)	A3-44,45
A-14	Protective Devices	A3-45,46
A-15	Safety (Personnel)	A3-46,47
B-2	Connectors	A3-48,49
B-4	Visual Contact (with other team members)	A3-50
B-5	Assistance (Operations Personnel)	A3-50,51
B-6	Assistance (Technical Personnel)	A3-51
B-7	Assistance (Supervisors or Contractor Personnel)	A3-51,52

B. AMCP 706-134

<u>Table No.</u>	<u>Subject</u>	<u>Pages</u>
5-2	Mechanical/Functional Checklist	5-3,4
9-11	Controls and Displays	9-29,30
12-2	Accessibility	12-10,11
13-4	Identification	13-9,10
14-1	Interchangeability	14-2
15-3	Safety	15-9,10,11
16-3	Servicing	16-9,10
21-1	Fasteners	21-12,13
23-2	Equipment Units	23-15,16,17

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B. AMCP 706-134 (Cont'd)

<u>Table No.</u>	<u>Subject</u>	<u>Pages</u>
23-3	Cabling and Connectors	23-25,26
23-4	Test Points	23-30,31
23-5	Test Equipment	23-34,35
27-2	Tank/Automotive Materiel	27-10,11,12

C. MIL-STD-1742 Human Engineering - Design Criteria For Military Systems, Equipment and Facilities

<u>Subject</u>	<u>Paragraph No.</u>
Labeling	5.5
Environment	5.8
Design for Maintainability	5.9
Small Systems and Equipment (including optical instruments)	5.11
Hazards and Safety	5.13
Man Transportability	5.14

APPENDIX C

Sample Scenario

Location: U. S. Army Tropic Test Center, Fort Clayton, Canal Zone
(79°57'30"W, 9°21'30"N)

Exposure: Tropical Tain Forest

Simulated Combat Scenario: A tank infantry team consisting of two officers, two platoon sergeants, 42 riflemen, and 5-M60A1 tanks, each with a four-man crew, has the mission of capturing a fortified position on Hill 801.

- A. Moving out from base camp by continuous movement, infantry troops dismount and cross stream enroute to Hill 801.
- B. Infantry elements are pinned down in stream.
- C. Tank elements fire on fortified position with main armament.
- D. Infantry squad pursues fleeing enemy.
- E. Infantry search and clear area of snipers.
- F. Tanks and infantry crossing stream by alternate bounds, deploy for assault on objective.
- G. Assault on Hill 801.
- H. Objective taken; tanks and infantry set up a perimeter defense.
- I. Infantry search and clear area, tanks provide covering fire with secondary armament.
- J. Infantry elements complete maneuver and return to Hill 801 and improve defensive positions.

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13. ABSTRACT Procedures are described for determining the capability of armament and individual weapons to function effectively during operation and storage in the tropic environment. A checklist of general considerations is included.			

DD FORM 1473

REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

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