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Materiel Test Procedure 7-2-057
General Equipment Test Activity

U.S. ARMY TEST AND EVALUATION COMMAND
COMMODITY ENGINEERING TEST PROCEDURE

TOOLS, AVIATION



1. OBJECTIVE

This document provides test methodology and testing techniques necessary to determine the technical performance and safety characteristics of aviation tools and associated accessories as described in Materiel Need (MN) and to determine the item suitability for service tests.

2. BACKGROUND

The efficiency of the flight line mechanic is determined to a great extent by the variety and condition of aviation tools available for specific maintenance or repair tasks.

Since Army tactical aviation is generally undertaken in support of mobile ground forces, the airfields which provide maintenance and service for the aircraft or helicopters are often of pioneer or hasty construction and the customary shop facilities are absent. Under these conditions, successful aircraft maintenance and repair for maintaining an adequate aircraft turnaround will depend on the flight line mechanic's ability and flexibility granted by aviation tools. Therefore, manually or power operated hand tools are needed which are lightweight, strong, but not bulky, resist rust and corrosion, accurately fit standard aircraft fasteners, and are otherwise suitable for work with typical aircraft alloys of magnesium, titanium, monel, copper, aluminum, and inconel as well as the various forms of aircraft steel. The Army flight line mechanic so equipped will be able to perform routine repairs and maintenance in addition to battle damage repair in the absence of power presses and other shop machines common to permanently established airfields.

The required aviation tool types are identified and briefly described by the following paragraphs:

1. Measuring Tools: The outcome of many repair tasks depends upon the accuracy of measurement and layout made by the repairman. Therefore, the calipers, rules, micrometers, dividers, gages, and layout tools must be of the required accuracy and provide adequate precision under the less than ideal conditions of the field.

2. Holding Tools: This group includes cleco fasteners, C-clamps, vises, vise grips, pliers, and other devices designed to hold sheet metal or other stock while being worked.

3. Striking Tools: These tools, e.g., hammers and mallets, are used by the repairman to form, set up, and attach metal work. Also, hammers may be used for light bumping, special bumping, or dinging, as applicable.

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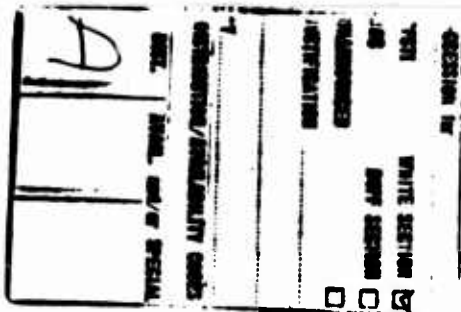
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4. Cutting Tools: The most frequently used tools of this group are: hand shears, aviation snips, straight snips, hand and breast drills, twist drills, taps and dies, reamers, countersinks, files, chisels, and hacksaws.

5. Punches: These tools are used to cut metal, locate centers, start points for drilling, punch holes, transfer hole locations and remove rivets, bolts, or pins.

6. Screwdrivers: These tools are classified by blade length-design and are made for loosening or tightening screws or screwhead bolts.

7. Wrenches: The open-end, box-end, combination, socket, and adjustable wrench are the most common of this group required for routine airframe and engine maintenance and repair.

3. REQUIRED EQUIPMENT

3.1 General Equipment

- a. Steel rule, 0-18 inches.
- b. Tape measure, 0-6 feet.
- c. Still camera, film, flashbulbs.
- d. Motion picture camera and film.
- e. Weighing scales, 0-100 pounds.
- f. Weighing scales, 0-200 grams.
- g. Reference hand tools. (comparison)
- h. Temperature measuring devices.

3.2 Calibration Equipment

- a. Eighty-one block set of gage blocks.
- b. Gage block holder and dial comparator.
- c. Micrometer caliper standard. (outside)
- d. Micrometer caliper standard. (inside)
- e. Toolmaker's microscope.
- f. Optical contour comparator.

3.3 Test Jigs and Testing Machines

- a. Rockwell hardness tester, 0-120 Brinell and 0-62 Rockwell C.
- b. Tensile testing machine, 0-60,000psi
- c. Torsion Test mandrels equivalent to existing aircraft fasteners.
- d. Torsional Moment test apparatus.
- e. Bending moment test mandrels.
- f. Bending moment test apparatus.

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- g. Compression testing machine.
- h. Shear testing machine.
- i. Automatic cycling machine for unique test item endurance test requirements.

3.4 Test Facilities

- a. Physical property determination laboratory.
- b. Chemical analysis laboratory.
- c. Corrosion testing facility.
- d. Sand and dust test facility.

4. REFERENCES

- A. Army Regulation 70-38 Research and Development: Research, Development, Test and Evaluation of Material for Extreme Climatic Conditions.
- B. USAMC Pamphlet 706-134 Engineering Design Handbook: Maintainability Guide for Design.
- C. USATECOM Regulation 70-23 Research and Development: Equipment Performance Reports (EPRs).
- D. USATECOM Regulation 385-6 Safety: Verification of Safety of Materiel During Testing.
- E. USATECOM Regulation 700-1 Value Engineering.
- F. USATECOM Regulation 750-15 Maintenance of Supplies and Equipment: Maintenance Evaluation During Testing.
- G. USAGETA Document Human Factors Evaluation Data for General Equipment (HEDGE).
- H. FED-STD-101 Preservation, Packaging, and Packing Materials, Test Procedures.
- I. FED-STD-141 Paint, Varnish, Lacquer, and Related Materials: Methods of Inspection, Sampling and Testing.
- J. FED-STD-151 Metals; Test Methods.
- K. MIL-STD-129 Marking for Shipment and Storage.
- L. MIL-STD-130 Identification Marking of US Military Property.
- M. MIL-STD-453 Inspection Radiographic.
- N. MIL-STD-810 Environmental Test Methods.
- O. MIL-T-16243 Tools, Nonsparking.
- P. NN-H-106 Handles: Wood, Miscellaneous (for) Tools.
- Q. GGG-S-121 Screwdriver and Screw Starter, Hand.
- R. GGG-T-106 Tape, Measuring, (General Use).
- S. GGG-W-631 Wrenches, Adjustable; Open-End, Auto, and Monkey.
- T. GGG-W-665 Wrench, Spanner.
- U. GGG-G-17 Gages.
- V. MTP 7-4-001 Desert Environmental Testing, Aviation Equipment.
- W. MTP 7-4-008 Arctic Environmental Test Aviation Spt Eqpt. (GRD HDLG, MAINT, SPT, ETC.).
- X. MTP 7-2-155 Motors, Electrical.

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- Y. MTP 9-2-167 Tools, Hand Pneumatic.
- Z. MTP 10-2-500 Physical Characteristics.
- AA. MTP 10-2-501 Operator Training and Familiarization
- AB. MTP 10-2-503 Surface Transportability (General Supplies and Equipment).
- AC. MTP 10-2-505 Human Factors Evaluation.
- AD. MTP 10-2-507 Maintenance Evaluation.
- AE. MTP 10-2-508 Safety.
- AF. MTP 10-2-511 Quality Assurance.

5. SCOPE

5.1 SUMMARY

This procedure describes the preparation for the methods of evaluating the technical characteristics of aviation tools and their suitability for service testing. The required tests are summarized as follows:

- a. Preparation for Test - A determination of the condition and physical characteristics of the test upon arrival. Also, to ensure that the test item is complete and functionally operational, and to provide operator training and familiarization procedures.
- b. Linear Measuring Tool Tests - A series of tests for determining the accuracy and repeatability of measurements made with aviation applicable direct - and indirect-reading measuring tools.
- c. Torsional Moment Tests - A series of tests for the determination of test item design adequacy as indicated by resistance to damage or permanent set when exposed to twisting forces.
- d. Bending Moment Tests - A series of tests for the determination of test item design adequacy as indicated by resistance to damage or permanent set when subjected to bending forces.
- e. Compression Test - A test to determine adequacy of test item design as indicated by resistance to damage when exposed to compression forces.
- f. Shear Test - A test to determine adequacy of test item design as indicated by resistance to damage when subjected to shear stresses.
- g. Climatic Extremes Tests - Performance testing of the test item(s) under arctic and desert conditions.
- h. Intermediate Climatic Tests - Laboratory testing of test item ability to resist the effects of the extremes of the Intermediate Climate as defined by AR 705-15. The following evaluations are required:

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- 1) Corrosion Tests.
 - a) Salt Spray Test.
 - b) Synthetic Sea-Water Spray Test.
 - c) Intergranular-Corrosion Test for Corrosion Resistant Austenitic Steels.
 - d) Intergranular-Corrosion Test for Aluminum Alloys.
 - e) Mercurous-Nitrate Test for Copper Alloys.
- 2) Sand and Dust Test.

i. Endurance Test - A determination of test item durability characteristics and ability to retain acceptable performance and accuracy levels over a desired or expected lifetime.

j. Transportability - An evaluation to determine test item ability to withstand the forces it will experience during normal handling and transportation.

k. Maintenance and Reliability Evaluation - An evaluation to determine and appraise the maintenance characteristics and requirements of the test item, a verification and appraisal of its malfunctions, an evaluation of the test item associated publications and other common and special support elements (maintenance test package), an appraisal of the test item design for maintainability (AMCP 706-134: accessibility, ease of maintenance, standardization, and interchangeability), an evaluation of component and system durability and reliability, and the calculation of indicators which express the effects of the preceding aspects.

l. Safety - An evaluation to determine the safety characteristics and possible hazards of the test item.

m. Human Factors Evaluation - An evaluation to determine the adequacy of the design and performance characteristics of the test item and associated equipment in terms of conformance to accepted human factors engineering design criteria.

n. Value Analysis - An evaluation directed at analyzing the primary function and features of the test item for the purpose of reducing the cost of the test item without compromising performance and safety characteristics.

o. Quality Assurance - A review to determine and evaluate defects in material and workmanship.

5.2 LIMITATIONS

This MTP is intended to be used as a basic guide in preparing actual test plans for the subject equipment. Specific criteria and test procedures must be determined only after careful appraisal of pertinent MN and any other applicable documents.

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6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Initial Inspection

Upon receipt of the test item at the test site, perform applicable procedures of MTP 10-2-500.

6.1.2 Inventory Check

a. Conduct an inventory against the Basic Issue Item List (BIIL). Record evidence of the following:

- 1) Missing literature or instructions for use.
- 2) Shortages in kit contents.
- 3) Improper content.

b. Submit an Equipment Performance Report (EPR) for each noted shortage or discrepancy.

6.1.3 Division of Aviation Tools into Testing Groups

To provide a tractable system for testing a wide variety of aviation tools, place test items processing similar characteristics into common groups.

- NOTES:
1. The selection of group identifiers is arbitrary and is required principally for convenience in stating test procedures and in maintaining test records.
 2. For the purpose of this document, the following listed divisions of aviation tools have been accomplished. Hereafter, engineering tests will reference these groups and will specify appropriate tests for dominant characteristics for items of each group.
 3. See Appendix A for drawings which illustrate existing aviation tools representative of the groups listed below.

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GROUP I: MEASURING TOOLS

GROUP IA - RULES AND TAPES.
GROUP IB - CALIPERS
GROUP IC - GAUGES
GROUP ID - DIVIDERS

GROUP II: HOLDING TOOLS

GROUP IIA - SHEET METAL HOLDERS
GROUP IIB - PLIERS

GROUP III: STRIKING TOOLS

GROUP IIIA - HAMMERS
GROUP IIIB - MALLETS

GROUP IV: CUTTING TOOLS

GROUP IVA - SHEARS AND SNIPS
GROUP IVB - MANUALLY POWERED DRILLS
GROUP IVC - ELECTRICALLY POWERED DRILLS
GROUP IVD - PNEUMATIC POWERED DRILLS
GROUP IVE - TAPS AND DIES
GROUP IVF - REAMERS
GROUP IVG - FILES
GROUP IVH - SAWS
GROUP IVI - CHISELS

GROUP V: PUNCHES

GROUP VI: SCREWDRIVERS

GROUP VII: WRENCHES

6.1.4 Inspection and Preliminary Operation

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a. Perform preliminary operations, inspections, and adjustments in accordance with MTP 10-2-500, draft technical manuals, or other governing documents and regulations.

b. Examine test item nomenclature, warning, and instructional data plates for conformance with MIL-STD-130 and other applicable governing documents. Record evidence of errors, omissions, and/or deleted plates or labels.

c. Inspect, examine, and determine the extent to which test item(s) conform to the standards and criteria of pre-engineering tests. The list below provides, in part, the guidelines necessary for this type of pretest determination.

- 1) Electrically driven aviation hand tools, such as drills, etc., should be evaluated in accordance with MTP 9-2-155.
- 2) Pneumatic hand tools should be evaluated in accordance with provisions of MTP 9-2-167.
- 3) General guidelines for wrench selection and evaluation are provided by GGG-W-631, GGG-W-636, and GGG-W-665.
- 4) Evaluation criteria for screwdrivers may be found in GGG-S-121.
- 5) Measuring tapes, gauges, and other measuring tools may be evaluated in accordance with GGG-T-106 and GGG-G-17.
- 6) Wooden tool handles should be in accordance with the provisions of NN-H-106.
- 7) Nonsparking tools should conform, in general, with requirements of MIL-T-16243.

6.1.5 Physical Characteristics

a. Perform applicable dimensional and physical specification determinations found in MTP 10-2-500 for all classifications and types of aviation tools. Record data required by MTP 10-2-500 and the following:

- 1) Chisels:
 - a) Width of stock.
 - b) Length overall.
 - c) Width of cutting edge.
 - d) Angle at cutting edge.
 - e) Thickness of cutting edge (nominal).
 - f) Length of taper (nominal).
- 2) Hammers and mallets:

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- a) Weight.
- b) Handle length.
- c) Head description, e.g., circular, etc.
- d) Head surface, e.g., slightly convex, etc.

3) Screwdrivers:

- a) Width of blade.
- b) Thickness of blade.
- c) Length of handle.
- d) Length of tang in handle.
- e) Other shape characteristics.

4) Wrenches (Open End):

- a) Milled openings, head(s).
- b) Length, overall.
- c) Thickness of head (maximum).
- d) Weight.

5) Wrenches (Box):

- a) Wrench opening, small end.
- b) Wrench opening, large end.
- c) Outside diameter of head, small end.
- d) Outside diameter of head, large end.
- e) Thickness of head(s).
- f) Overall length.

b. Perform 6.2.2.3.3, Metals (Material Characteristics) of MTP 10-2-500 for all classifications and types of aviation tools. Record data required by the specified procedure(s) of MTP 10-2-500.

NOTE: Where radiographic inspection of aviation tool material is required, consult MIL-STD-453 for general recommendations regarding X-Ray techniques and radiation protection to testing personnel.

c. Measure, as applicable, and record the following data:

1) Group I: Measuring tools.

- a) Test item type.
- b) Scale precision (number of graduations per unit of measurement used).
- c) Direct- or indirect-reading.

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- 2) Group III: Striking tools.
 - a) Test item type.
 - b) Characteristics of rubber material used in certain types of mallets determined in accordance with 6.2.2.3.2, Rubber, of MTP 10-2-500.
 - c) Characteristics of wood handle material used in certain types of hammers and mallets determined in accordance with 6.2.2.3.6, Wood, of MTP 10-2-500.

d. Conduct a chemical analysis of the material(s) used for the manufacture of nonsparking type aviation tools. Record the chemical composition, including:

- 1) Beryllium.
- 2) Cobalt.
- 3) Silicon.
- 4) Nickel.
- 5) Aluminum.
- 6) Tin.
- 7) Lead.
- 8) Zinc.
- 9) Chromium.
- 10) Copper.

NOTE: Nonsparking hand tools are generally made of copper and aluminum alloys which present a low sparking hazard for use in areas where flammable gases and explosives are present.

6.1.6 Scribing Reference Lines

Scribe straight lines centrally along both sides of the test item handle, blade, body, etc., continuing across jaws, openings, etc. to that permanent set of the test item can be detected following application of compression, tension, torsion, bending, and/or shear forces. Proceed as follows:

- a. Hold the test item securely in a definite position on a vertical face plate attached to a horizontal face plate.
- b. Use a surface gauge to scribe straight lines on the test item.
- c. Measure the jaw openings of any open-ended type test item and record these dimensions for each predetermined reference point.

6.1.7 Operator Training and Familiarization

Test personnel shall receive training and familiarization in accordance with applicable procedures of MTP 10-2-501.

6.2 TEST CONDUCT

NOTE: All material malfunctions shall be reported in accordance with USATECOM Regulation 705-4.

6.2.1 Linear Measuring Tool Tests

6.2.1.1 Direct-Reading Tool Test

Determine the accuracy of line-graduated test item scales in measuring objects.

a. Allow the test item(s) to attain temperature equilization with the measurement standard and/or other objects such as test item supports.

b. Measure and record test area temperature. Precautions should be taken to reduce thermal expansion effects from heat radiation from laboratory lights, heating components, sunlight, and people.

NOTE: Manual handling may introduce thermal expansion errors. For example, human temperature is approximately 30 degrees (F) higher than the standard measurement temperature of 68 degree F. and could cause an error in one inch of steel up to 0.0002 inches.

c. Use a measurement standard proportional to the accuracy objective of the test item and determine and record the magnitude of test item cumulative scale error. Also, record the identification of the measurement standard used and the date of certified calibration.

NOTE: Direct-reading test items are end- or line-matching devices, since an end and a line, or two lines, must be aligned with the extremities of the object being measured in order to obtain the desired reading. Thus, the accuracy of the resulting reading is a function of the alignment and the magnitude of the smallest scale division. Rule and tape scales ordinarily are not used for

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accuracies greater than 1/64 inch in the case of fractional dimensions or 0.01 inch for decimal dimensions.

6.2.1.2 Indirect-Reading Tool Test

Determine the accuracy of transferring the size of the dimension being measured to a direct-reading scale.

- a. Allow the test item(s) to attain temperature equilization with the measurement standard and/or other objects such as test item supports.
- b. Measure and record test area temperature.
- c. Obtain measurement standards such as the gauge blocks of various dimensions.

NOTES: 1. Gauge blocks are produced to three grades with respect to accuracy:

- AA, or Master-Grade Gauge Blocks are accurate to ± 0.000002 inch per inch of length for blocks over one inch in length.
- A, or inspection, or Reference Gauge Blocks are similarly accurate to ± 0.000004 inch.
- B, or Working Gauge Blocks are similarly accurate to ± 0.000008 inch.

2. An 81-block set of gauge blocks can be combined in over 120,000 combinations of lengths in increments of 0.0001 inches from 0.1001 to over 25 inches.

d. Use the test item to obtain a measurement of a dimension known to a high degree of accuracy at the existing temperature. Record the error, citing the standard identification and date of certified calibration.

NOTE: To obtain a measurement with these instruments, first adjust the test item legs so that contact with the desired portions of the object is "just" established. The test item is then held against a scale and the distance between the leg points are read from the scale. In this

operation a considerable amount of care and experience is required to get the proper "feel" of the test item against the object being measured a matter of contact pressure.

6.2.1.3 Measurement Precision and Repeatability Test.

Determine the adequacy of test item scale design and the quality of components which affect obtaining the desired accuracy when repeated measurements of the same dimension are made.

a. Repeat procedural steps a. and b. of 6.2.1.1. Record data required.

b. Use the test item to measure predetermined dimension(s) of ten different objects. Measure the desired dimension of each object at least ten times, but not in succession, e.g., measure the items in a random sequence. Record the dimensional data taken for each object.

NOTE: Preceding tests (6.2.1.1. and 6.2.1.2) have been performed to determine the accuracy of test item scales under laboratory conditions. These measurements can be considered as the determination of the permanent error associated with the test item, or bias. The measurement precision test is then a determination of how well a human under ordinary conditions can read the test item scale or otherwise use the test item to obtain desired measurements. The variations in a series of measurements of a given dimension are an indication of the maximum extent of random error likely to be associated with the test item. The combination of bias and random errors for a given test item will constitute its overall characteristic.

6.2.2 Torsional Moment Tests

Determine test item design adequacy as indicated by resistance to damage or permanent set when exposed to twisting forces resulting from the application of torque common to ordinary usage of the tool.

6.2.2.1 Torsion Test for Heavy Hand Tools.

a. Set up mandrels containing slots representative of the aircraft fasteners or other objects for which the test item is intended for use. The following considerations are important in the selection and use of the mandrels for this test:

- 1) The mandrels should possess slots equivalent to

existing aircraft structural screws, machine screws, self-tapping screws, and internal wrenching bolts.

- 2) The size of the mandrel opening should be equal to the specified tool size within a minus tolerance of 0.001 inch, or as otherwise specified. A plus tolerance should not be permitted.
- 3) The mandrels used should be hardened to show a Rockwell hardness number of C40 to C46, or as otherwise specified.
- 4) The depth of the internal mandrel slot(s) should be no greater than the thickness of the end of the test item blade plus the tolerance permitted.

b. Prepare the test item for the test according to 6.1.6, as applicable.

c. Insert the test item blade into the mandrel slot, supporting the test item such that it is perpendicular to the plane of the top surface of the mandrel. Also, constrain the test item to prevent the test item blade from leaving the mandrel slot when the torsional moment is applied.

d. Attach an arm, bar, or clamp to the test item near the middle of the natural grip of the handle such that the torsional force will be applied substantially at right angles to the axis of the test item.

e. Apply the specified force through a spring balance near the end of the arm, bar, or clamp which was attached during step d. The force is applied at right angles to the axis of the test item and is applied in right- and left-hand directions alternately. Compute the torsional moment by multiplying the force, in pounds for example, by the arm, in inches for example e.g., fifteen-pound load applied 10 inches from axis of the tool is equal to 150 inch-pounds, etc. Record the force applied, the direction, i.e., left-hand, right-hand, and the total number of applications.

f. Following application of the torsional moment(s), examine the test item and record evidence of the following:

- 1) Blade or tool arm failure.
- 2) Permanent set due to torsional forces.

6.2.2.2 Torsion Test for Light Tools

a. Set up a torsion moment test apparatus equivalent to that illustrated by Figure 1. The principal requirements of the apparatus are:

- 1) The apparatus consists essentially of a pivoted beam, the pivot axis of which contains a slot accessible from the outside and is suitable for receiving the test item blade.

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- 2) A counterweight for balancing the beam.
- 3) A weight hanger and set of calibrated weights.

b. Place the empty weight hanger at the required distance from the center of the pivot axis (center of slot). Adjust the counter weight to balance the beam. Record the distance.

c. Place the required dead weight on the weight hanger. Record the value of dead weight.

d. Insert the test item blade in the pivot slot.

NOTE: The depth of the slot should be no greater than the thickness of the end of the test item blade plus allowable tolerance.

e. Apply torsional forces required to lift the dead weight attached to the beam arm. Switch the test item blade alternately so that left- and right-hand torsional forces are effectively applied. Record the number of times the weight was lifted.

f. Following application of the torsional moment(s), examine the test item and record evidence of the following:

- 1) Blade or tool arm failure.
- 2) Permanent set due to torsional forces.

6.2.3 Bending Moment Tests

Determine test item design adequacy as indicated by resistance to damage or permanent set when subjected to bending forces common to ordinary usage of the tool.

NOTE: Bending is a combination of tension and compression. The inside of the bent object is under compression and the outside curve is under tension.

6.2.3.1 Bending Test for Light Tools

a. Set up a bending moment test apparatus equivalent to that illustrated by Figure 2.

b. Prepare the test item for test as specified by 6.1.6, if applicable.

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c. Introduce the test item into the test apparatus in a manner similar to that shown by Figure 2.

d. Rigidly clamp the test item at a point near the middle of the natural grip of the tool handle or area of the tool which is normally grasped for use.

e. Place a calibrated weight on the weight hanger of the apparatus. Place the weight hanger at a distance, D, which when multiplied by the total weight equals that force in ounce/pound-inches specified for the test item. See Figure 2. Record the weight of the weight hanger and calibrated weight, the distance D, and the stop distance, D.

f. Repeat step e. performing the test with a 150 percent overload force, if applicable. Record data required by step e.

g. Visually inspect the test item and record evidence of the permanent damage or set. Record the findings of this inspection.

6.2.3.2 Bending Test for Heavy Hand Tools.

a. Set up mandrels for test item openings which are representative of the types and classifications of aviation fastener or other objects for which the test item is intended for use. The following considerations are important in the selection and use of the mandrels for this test:

- 1) The mandrels should be square, hexagonal, or shaped equivalent to existing aviation fasteners.
- 2) The size of the mandrel should be equal to the specified tool opening size within a plus tolerance of 0.001 inch, or as otherwise specified. A minus tolerance should not be permitted.
- 3) The mandrels used should be hardened to show a Rockwell hardness number of C40 to C46, or as otherwise specified.

NOTE: Mandrels for test items with adjustable openings should be sized for the mid-point opening value and maximum test item opening.

b. Prepare the test item for test according to 6.1.6, as applicable.

c. Attach the test item to the appropriate mandrel such that the plane of the tool is perpendicular to local vertical.

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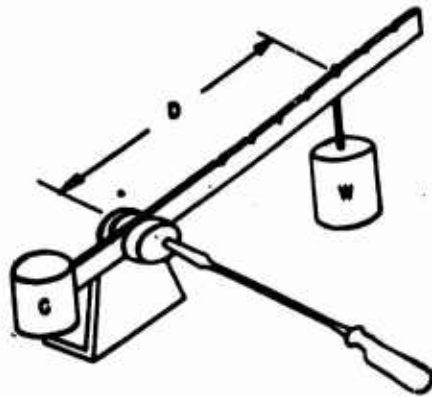


FIGURE 1: TYPICAL APPARATUS FOR TORSIONAL MOMENT TEST

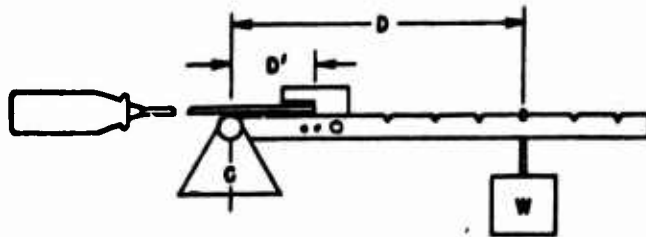


FIGURE 2: TYPICAL APPARATUS FOR BENDING MOMENT TEST

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NOTE: Unlike actual usage of the tool, the mandrel represents only a suitable device for fitting the test item opening so that the tool is properly supported and a realistic reaction against the bending moment load is provided.

d. Apply the specified bending moment load to the test item at the center of the natural hand grip on the handle, or as far away from the tool opening as practicable.

NOTE: The bending moment load may be applied by an appropriate testing machine or by recently calibrated dead weights.

e. Continue the application of the bending moment load for not less than one minute or more than five minutes, unless otherwise specified. Record the force applied, i.e., total dead weight applied and the length of time the load was applied.

f. Measure and record the effective lever arm through which the bending moment load acts.

NOTE: The length of the effective lever arm is defined as the shortest distance between two vertical lines passing, respectively, through the point of load application and the center of the mandrel fitting the test item opening.

g. Repeat steps d., e., and f, for specified overload values. Record data required by these steps.

h. After application of the testing load(s), place the test item on the gage jig (See 6.1.6). Compare the scribed marks on the test item to the scribed marks on the jig. Any permanent deformation of the test item will be indicated by a change in the alignment of these scribed marks made prior to application of the bending moment force. Record evidence of permanent deformation.

i. Measure open ended test item openings and compare to original dimensions. Record evidence of spreading test item jaws or enlargement of openings resulting from the effects of the application of the bending moment force(s).

6.2.4 Compression Test

Determine test item design adequacy as indicated by resistance to damage when exposed to compression forces common to ordinary usage.

- a. Prepare the test item for test in accordance with 6.1.6.
- b. Clamp the test item in a testing machine such that the test item working surface is at right angles to the impact test force or weight.
- c. Subject the test item to repeated blows of the testing machine drop weight or hammer. Record the magnitude of force (weight) used and number of blows performed.

NOTE: Compression is the resistance to pushing together or crushing produced by two forces pushing toward each other in a straight line.

- d. Following the application of compression forces, subject the test item to an examination. Record evidence of the following:
 - 1) Chips, cracks, or other damage to test item working surface.
 - 2) Distortion of the working surface as indicated by misplaced scribed lines.

6.2.5

Shear Test

Determine test item adequacy of design as indicated by resistance to damage when subjected to shear stresses common to ordinary usage.

- a. Prepare the test item for test in accordance with 6.1.6.

NOTE: This test is applicable to pliers and all forms of aviation snips and shears.
- b. Introduce the test item into the testing machine such that shear stress is exerted on those test item parts normally under shear in use. Record the method of set-up and identify the component which was stressed i.e., the pin which connects together a pair of pliers, etc.
- c. Apply shear stress as specified. Record the value of force used and duration of the test.
- d. Following application of shear stress, examine the test item and record evidence of the following:
 - 1) Damage to connecting pins, etc.
 - 2) Pliers, etc. sides loosened by application of force.

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- 3) Side cutters, etc. which do not perform as specified following application of shear force.

6.2.6 Climatic Extremes Tests

Performance testing of each test item type under arctic and desert conditions should be performed in accordance with MTP's 7-4-008 and 7-4-001. Additional guidance may be obtained from MTP 7-1-001.

6.2.7 Intermediate Climatic Tests

Subject the test item(s) to climatic conditions representative of the Intermediate Climate as defined by AR 705-15. Use procedures and applicable tests contained in MIL-STD-810 or Federal Test Method Standard No. 151, as applicable.

6.2.7.1 Corrosion Tests

6.2.7.1.1 Salt Spray Test -

Determine test item ability to resist corrosion when subjected to a fine mist of 5 percent sodium chloride solution at a temperature of 95 degrees F. This test is applicable for test item assemblies, metallic coatings, organic and inorganic coatings on metals, and many non-metallic materials. Perform in accordance with Method 811.1 of Federal Test Method Standard No. 151. Record details of test conduct and the effect of the test on the test item.

6.2.7.1.2 Synthetic Sea-Water Spray Test -

Determine test item ability to resist corrosion when subjected to a fine mist of synthetic sea water at a temperature of 75 degrees F. This test is applicable for aviation tools made of certain types of steel which are subject to localized pitting attack. Perform in accordance with Method 812 of Federal Test Method Standard No. 151.

6.2.7.1.3 Intergranular-Corrosion Test for Corrosion Resistant Austenitic Steels -

Determine test item ability to resist corrosion when subjected to an acidified copper-sulfate solution following a sensitized, descaling, and immersion procedure. This test is applicable for aviation tools made of stabilized extra-low-carbon, and annealed unstabilized steel. Perform in accordance with Method 821.1 of Federal Test Method Standard No. 151.

6.2.7.1.4 Intergranular-Corrosion Test for Aluminum Alloys -

Determine the susceptibility of aluminum alloy test items to intergranular corrosion. Perform according to Method 822 of Federal Test Standard No. 151.

6.2.7.1.5 Mercurous-Nitrate Test for Copper Alloys -

Determine the susceptibility of copper alloy test items (such as nonsparking tools) to fail in use or storage due to stress-corrosion cracking. Perform according to Method 831 of Federal Test Standard No. 151.

6.2.7.2 Sand and Dust Test

Perform the sand and dust test, Method 410 of MIL-STD-810, and record all test results. At the completion of the sand and dust test, examine and inspect each test item type for the effects of sand and dust, including the following:

- a. Abrasion to test item moving parts.
- b. Test item coatings damaged.
- c. Test item parts which were caused to bind by sand or dust.
- d. Damage to measuring tool(s) scale(s).

6.2.8 Endurance Test

a. Set up the test item in a normal operating configuration under standard ambient environmental conditions. Record actual values.

b. Obtain the necessary fixtures so that the test item may be automatically operated through a large number of cycles where repeatable conditions of force, etc., are obtainable during each cycle. Record the method of obtaining controlled endurance testing of each aviation tool.

c. Instrument the test item, where applicable, to obtain the following data:

- 1) Speed of rotation.
- 2) Temperature at the working surface.
- 3) Operating cycles.
- 4) Decreasing efficiency.
- 5) Loss of accuracy.
- 6) Test item failure.

d. Following the endurance test, repeat, as applicable, 6.2.1, 6.2.2, 6.2.3, 6.2.4, and 6.2.5. Record any change in test item performance.

6.2.9 Transportability

NOTE: The draft technical manual shall be reviewed or consulted for proper procedures for tying down, lifting

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and transporting the test item by various media. Any inadequacy of instructions should be reported by an EPR.

Perform the applicable portions of MTP 10-2-503.

6.2.10 Maintenance and Reliability Evaluation

a. Evaluate and appraise the maintenance/reliability-related factors of the test item as described in MTP 10-2-507 and AMC Pamphlet 706-134 with emphasis on the following:

- 1) Organizational (O), Direct Support (F), and General Support (H) maintenance requirements.
- 2) Operator through General Support Maintenance Literature, if applicable.
- 3) Repair parts.
- 4) Calibration standards and facilities.
- 5) Test and handling equipment.
- 6) Maintenance facilities.
- 7) Personnel skill requirements.
- 8) Maintainability.
- 9) Reliability.
- 10) Availability.

NOTE: Ensure that the data collected will permit the computations of M & R indicators such as MR, MTBF, MTTR.

b. In evaluating the above listed factors, perform the following:

- 1) Obtain copies of the manufacturer's mechanical and electrical drawings and the draft technical manual, as applicable.
- 2) Position the test item to permit a maintenance evaluation.

6.2.11 Safety

Throughout the conduct of all tests, the safety characteristics of the test item shall be observed in order to determine whether or not the test item is safe for its intended use. Toward this objective, the following principal points shall be stressed in addition to procedures of MTP 10-2-508.

a. Accident prevention principles and techniques shall be integrated into the design of service tests in accordance with the provisions of USATECOM Regulation 385-6, the draft technical manual and the Safety Release.

b. Performance tests and evaluations shall be designed and conducted to the extent that sufficient test data is accumulated to determine to what degree the test item complies with the specific safety requirements of the MN or other governing documents. Recorded safety test data will be in accordance with USATECOM Regulation 385-6 in regard to "Safety Confirmation" statements or recommendations.

c. During the conduct of all tests and inspections, test personnel shall record evidence of the following:

- 1) Non-operable safety features.
- 2) Inadequate warning plates or notices.
- 3) Inadequate safety features.
- 4) Opinions regarding the suitability of the test item from a safety viewpoint.
- 5) Recommendations to improve the safety characteristics of the test item either in design or from a procedural-usage point of view.

d. Throughout the performance and endurance, record test item susceptibility to chip or splinter when subjected to the various test forces.

e. Grade the test item as good, fair, or poor in regard to hand protection devices including guards, shields, etc.

6.2.12 Human Factors Evaluation

Determine the degree to which the design and performance of the test item satisfy accepted standards for human factors. The applicable portions of the HEDGE (Human Factors Evaluation Data for General Equipment) will be used for the test. In particular, checklists will be prepared for all tasks associated with the HEDGE Class IIIA test functions which rate the task from a human factors standpoint as either satisfactory or not satisfactory. Also, consult MTP 10-2-505 for guidance in developing the overall evaluation. Include the following:

a. For all tasks the following factors will be considered:

- 1) Adequacy of instructions to perform the task with the test item.
- 2) Mental and physical effort required to use the tool for a given task.
- 3) Design of the test item as it affects the aviation service or maintenance task.
- 4) Time required for the task.

b. Perform the following tasks for the HEDGE test functions given. The factors considered shall include but not be limited to those of Section a. above.

- 1) Operability.
 - a) Assemble and set up.
 - b) Prepare for use.
 - c) Activate/deactivate and perform prime function.
 - d) Comfort while using tool.
 - e) Difficulties encountered using test item with authorized protective clothing.
 - f) Ease of alignment.
 - g) Grips placed to exert optimum force.
 - h) Indicators and displays oriented toward operator during use of tool.
- 2) Maintainability.
 - a) Perform routine maintenance and calibration.
 - b) Detect malfunction and isolate and identify cause.
 - c) Remove defective component and replace or repair.
- 3) Transportability.
 - a) Prepare for transport.
 - b) Load/unload.

c. Record any inadequacies of test item design affecting ease of operation.

d. Record any recommendations to improve man-item effectiveness.

6.2.13 Value Analysis

Throughout all tests, the test item shall be examined for any unnecessary, costly, "nice-to-have" features as described in USATECOM Regulation 700-1. Perform the following:

a. During operation of the test item, observe for features which could be eliminated without compromising performance, reliability, durability, or safety.

b. Question test personnel regarding features of the test item which could be eliminated without decreasing the functional value of the test item or decreasing man-item effectiveness.

c. Record the following:

- 1) Nonfunctional, costly, or "nice-to-have" features of the test item.
- 2) Test personnel comments and opinions regarding features to be eliminated.

6.2.14 Quality Assurance

Throughout all tests, examine the test item for compliance with the quality requirements of the applicable MN and the provisions of MTP 10-2-511.

6.3 TEST DATA

6.3.1 Preparation for Test

6.3.1.1 Initial Inspection

Record the applicable data required by MTP 10-2-500.

6.3.1.2 Inventory Check

Record the following:

- a. Missing literature or instructions for use.
- b. Shortages in kit contents.
- c. Improper content.

6.3.1.3 Division of Aviation Tools into Testing Groups

Record the aviation tools by groups.

6.3.1.4 Inspection and Preliminary Operation

Record the applicable data required by MTP 9-2-155, MTP 9-2-167, MTP 10-2-500, GGG-G-17, GGG-T-106, GGG,W-661, GGG-W-636, GGG-W-665 and NN-H-106.

6.3.1.5 Physical Characteristics

Record the following:

a. Physical specification and dimensional data required by applicable procedures of MTP 10-2-500.

b. Chisel data:

- 1) Width of stock, in inches.
- 2) Length overall, in inches.
- 3) Width of cutting edge, in inches.
- 4) Angle at cutting edge, in degrees.
- 5) Thickness of cutting edge (nominal), in inches.
- 6) Length of taper (nominal), in inches.

c. Hammer data:

- 1) Weight, in ounces.
- 2) Handle length, in inches.
- 3) Head description, circular, etc.
- 4) Head surface description, slightly convex, etc.

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d. Screwdriver data:

- 1) Width of blade, in inches.
- 2) Thickness of blade, in inches.
- 3) Length of handle, in inches.
- 4) Length of tang in handle, in inches.
- 5) Other shape characteristics for designed purpose.

e. Wrenches (Open End) data:

- 1) Milled openings, heads, in inches.
- 2) Length, overall, in inches.
- 3) Thickness of head (maximum), in inches.
- 4) Weight, in ounces.

f. Wrenches (Box) data:

- 1) Wrench opening (small end), in inches.
- 2) Wrench opening (large end), in inches.
- 3) Outside diameter of head, small and large ends, in inches.
- 4) Thickness of heads, in inches.
- 5) Overall length, in inches.

g. Data required by 6.2.2.3.3 of MTP 10-2-500.

h. Group I: Measuring tools:

- 1) Test item type.
- 2) Scale precision (number of graduations per unit of measurement used).
- 3) Direct - or indirect-reading.

i. Group III: Striking tools:

- 1) Test item type.
- 2) Data required by 6.2.2.3.2 of MTP 10-2-500.
- 3) Data required by 6.2.2.3.6 of MTP 10-2-500.

j. Chemical content and concentration of nonsparking aviation tools.

6.3.1.6 Scribing Reference Lines

Record the dimensions of any open jawed test item prior to application of any test forces, in inches.

6.3.1.7 Operator Training and Familiarization

Record the following:

- a. Data required by applicable procedures of MTP 10-2-501.
- b. For each test team member:
 - 1) Name.
 - 2) Rank.
 - 3) Past experience.
 - 4) Extent of retraining, if required.
- c. Test director evaluation of group as test team.
- d. Adequacy of draft technical manuals for training purposes.

6.3.2 Test Conduct

6.3.2.1 Linear Measuring Tool Tests

6.3.2.1.1 Direct-Reading Tool Test -

Record the following:

- a. Test site temperature, in degrees F.
- b. Precautions undertaken to reduce variations in temperature which could cause errors in test readings.
- c. Cumulative scale error of test item scale. Identify measurement standard and date of last calibration.

6.3.2.1.2 Indirect-Reading Tool Test -

Record the following:

- a. Test site area temperature, in degrees F.
- b. Test item error.
- c. Identify measurement standard and date of last calibration.

6.3.2.1.3 Measurement Precision and Repeatability Test -

Record the following:

- a. Test site temperature, in degrees F.
- b. For each test object dimension:
 - 1) Length of dimension, in applicable units.
 - 2) Number of times each dimension was measured.
 - 3) Number of personnel performing a measurement round.

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6.3.2.2 Torsional Moment Tests

6.3.2.2.1 Torsion Test for Heavy Hand Tools -

Record the following:

- a. Size and tolerance of each mandrel used.
- b. Hardness number of each mandrel used.
- c. Depth of each mandrel slot.
- d. Highest torsional force test item withstood without damage or change in performance, in inch-pounds.
- e. Number of right- and left-hand applications of the test force.
- f. Following test:
 - 1) Blade or tool arm failure.
 - 2) Permanent set due to torsional forces.

6.3.2.2.2 Torsion Test for Light Tools -

Record the following:

- a. Identification of torsion apparatus used for test.
- b. Distance at which weight hanger was placed on the balanced beam, in inches.
- c. Highest weight value test item was able to lift without damage, in inch-pounds.
- d. Following application of torsional forces:
 - 1) Blade or tool arm failure.
 - 2) Permanent set.

6.3.2.3 Bending Moment Tests

6.3.2.3.1 Bending Moment Test for Light Tools -

Record the following:

- a. Identification of test apparatus used.
- b. Highest force test item withstood without bending, in pounds.

test. c. Damage to test item observed during inspection following

6.3.2.3.2 Bending Test for Heavy Hand Tools -

Record the following:

- a. Size and tolerance of each mandrel used.
- b. Hardness number of each mandrel used.
- c. Mandrel head configuration, e.g., square, etc.
- d. Highest bending force test item withstood without damage.
- e. Lever arm length, in inches.
- f. Spreading of test item jaws, in inches.

6.3.2.4 Compression Test

Record the following:

- a. Number of blows test item withstood without damage.
- b. Magnitude of force (weight) of each blow, in pounds.
- c. Observed during inspection following test:
 - 1) Chips, cracks, or other damage to test item working surface.
 - 2) Distortions of the working surface as indicated by misplaced scribed lines.

6.3.2.5 Shear Test

Record the following:

- a. Method of shear test.
- b. Identification of test item part which was stressed (critical to operation).
- c. Magnitude of highest shear stress test item withstood without damage.
- d. Following test, during inspection:
 - 1) Damage to connecting pin, etc.
 - 2) Test item sides loosened by application of force(s).

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3) Side cutters, etc., which do not perform as specified.

6.3.2.6 Climatic Extremes Tests

Record data required by applicable procedures of MTPs
7-4-008 and 7-4-001.

6.3.2.7 Intermediate Climatic Tests

6.3.2.7.1 Corrosion Tests -

6.3.2.7.1.1 Salt Spray Test --

Record data required by Method 811.1 of Federal Test Method
Standard No. 151.

6.3.2.7.1.2 Synthetic Sea-Water Spray Test --

Record data required by Method 812 of Federal Test Method
Standard No. 151.

6.3.2.7.1.3 Intergranular-Corrosion Test for Corrosion Resistant

Austenitic Steels --

Record data required by Method 821.1 of Federal Test
Standard No. 151.

6.3.2.7.1.4 Intergranular-Corrosion Test for Aluminum Alloys --

Record the data required by Method 822 of Federal Test
Standard No. 151.

6.3.2.7.1.5 Mercurous-Nitrate Test for Copper Alloys --

Record the data required by Method 831 of Federal Test
Standard No. 151.

6.3.2.7.2 Sand and Dust Test -

Record the following:

a. Data required by applicable procedures of MIL-STD-810,
Method 410.

b. Following test and visual inspection:

- 1) Abrasion to test item moving parts.
- 2) Test item coatings damaged.
- 3) Test item parts which were caused to bind by sand or dust.

- 4) Damage to measuring tool scales.

6.3.2.8 Endurance Test

Record the following:

- a. Conditions under which test item is configured for the endurance test.

- b. Identification of test fixtures obtained for test of unique properties of the test item.

- c. The following "kinds" of data (specific requirements will depend upon test item use, and instrumentation required to test useful lifetime):

- 1) Speed of rotation.
- 2) Temperature at the working surface.
- 3) Operating cycles completed/running time.
- 4) Decreasing efficiency rate.
- 5) Loss of accuracy.
- 6) Test item failure data.

- d. Data resulting from re-testing to requirements of 6.2.1, 6.2.2, 6.2.3, 6.2.4, and 6.2.5, as applicable.

6.3.29 Transportability

Record data required by applicable procedures of MTP 10-2-503.

6.3.2.10 Maintenance and Reliability Evaluation

Record data as required by the applicable portions of MTP 10-2-507, 10-2-512, and the following:

- a. Maintenance literature which is not easily understood, incomplete or ineffective.

- b. Repair parts which are not proper type or are nonstandard.

- c. Ineffective or improperly specified tools.

- d. All applicable data as required to permit the computations as required by Appendix B, USATECOM Regulation 750-15.

6.3.2.11 Safety

Record the following:

- a. Data required by procedures of MTP 10-2-508.

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b. During all test and inspections:

- 1) Non-operable safety features.
- 2) Inadequate warning plates or notices.
- 3) Inadequate safety features.
- 4) Opinions regarding test item suitability from a safety viewpoint.
- 5) Recommendations to improve the safety characteristics of the test item either in design or from a procedural usage point of view.

c. Test item grade in regard to safety, e.g., good, fair,
or poor.

6.3.2.12 Human Factors Evaluation

Record the following:

- a. Data required by applicable procedures of MTP 10-2-505.
- b. Checklists for the following areas:

- 1) General
- 2) Operability
- 3) Maintainability
- 4) Transportability

6.3.2.13 Value Analysis

Record the following:

- a. Nonfunctional, costly, or "nice-to-have" features of the test item.
- b. Test personnel comments and opinions regarding features to be eliminated.

6.3.2.14 Quality Assurance

Record:

- a. Data required by MTP 10-2-511
- b. Comments as to any design shortcomings in the area of required quality.

6.4 DATA REDUCTION AND PRESENTATION

6.4.1 Data Reduction

Organize, analyze and summarize all raw data as specified in each of the MTPs referred to in paragraph 6.2. Use tabulations and charts as appropriate. Make a succinct, unbiased, and independent analysis of test data to show:

- a. The degree to which the test item meets stated requirements (test criteria) in MN or other approved documents.
- b. Deficiencies, shortcomings, and suggested improvements.

6.4.2 Data Presentation

Evaluate and present a complete data summary indicating the results and address the following:

- a. Item characteristics such as performance, reliability, durability and human factors engineering.
- b. Comparison of test item characteristics with those of a similar item or standard (control item). Show whether the test item offers a significant improvement (or not) over the control item or only a minimal and perhaps costly improvement.
- c. Safety characteristics and safety recommendation. All aspects of safety must be evaluated to determine if a safety recommendation can be given or must be withheld pending correction of any hazards found.
- d. Conclusions and recommendations on overall test objectives and the suitability of the test item for service testing.

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