AD NUMBER

AD875670

LIMITATION CHANGES

TO:

Approved for public release; distribution is unlimited.

FROM:

Distribution authorized to U.S. Gov't. agencies and their contractors; Critical Technology; 28 JUL 1970. Other requests shall be referred to Army Test and Evaluation Command, Attn: AMSTE-TS, Aberdeen Proving Ground, MD 21005. This document contains export-controlled technical data.

AUTHORITY

USATEC ltr, 14 Dec 1970

28 July 1970

Materiel Test Procedure 9-2-212
General Equipment Test Activity

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

TOOL SETS

1. OBJECTIVE*

This document provides test methodology and testing techniques to determine the technical performance and safety characteristics of tool sets and equipment as described in Qualitative Materiel Requirements (QMR), Small Development Requirements (SDR), and Technical Characteristics (TC), and to determine the item's suitability for service tests.

2. BACKGROUND

An essential part of any support operation is the maintenance and refurbishment of diesel and gasoline engines, a facility to accomplish the welding and painting of metal and other surfaces, and tools and materials necessary to accomplish repair and replacement work on tubing networks, such as hydraulic lines, oxygen lines, etc. To complament the issue of standard tools are shop sets; these are normally mounted on a truck or semitrailer to enable them to be brought to the equipment to be repaired in the field. These equipment sets are self-sufficient in that power requirements are met by power sources which are an integral part of the carrier unit. This affords a high degree of mobility and enables repair work to be performed rapidly in isolated areas.

These portable units contain the following:

a. Cutting and Welding Equipment.
b. Engine Repair Equipment.
c. Tubing Repair Equipment.
d. Thread Repair Equipment.
e. Standard Tools.
f. Special Tools, such as glass cutters, hot plates, paint spray outfits, etc.
g. Instruments, such as dividers, tachometers, torque wrenches, etc.
h. Materials and Supplies.

3. REQUIRED EQUIPMENT

a. Thread Gauges.
b. Inside Calipers.
c. Outside Calipers.
d. Ruler
e. Straightedge.

*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 QMRs, SDRs, TCs, and any other applicable documents.

BLANK PAGE

f. Dial Indicator.
g. Durometer.
h. Depth Micrometer.
i. Temperature Measuring Devices.
j. Weighing Scales.
k. Hand Tools.
l. Magnetic Particle Inspection Set.
m. Calorimeter Beakers.
n. Wattmeter.
o. Stopwatch.
p. 75 Watt Bulbs.
q. Bevel Protractor.

4. REFERENCES

A. Army Regulation AR 70-10, Research and Development: Test and Evaluation During Research and Development of Materiel.
B. Army Regulation AR 70-38, Research and Development: Research, Development, Test and Evaluation of Materiel for Extreme Climatic Conditions.
C. AMCP 706-134, Engineering Design Handbook, Maintainability Guide for Design.
D. USATECOM Regulation 385-6, Verification of Safety of Materiel During Testing.
E. USATECOM Regulation 700-1, Value Engineering.
F. USATECOM Regulation 70-23, Equipment Performance Reports (EPR's).
G. USAGETA (HEDGE), Human Factors Evaluation Data for General Equipment.
H. MIL-STD-129, Marking for Shipment and Storage.
I. MIL-STD-130, Identification Marking of U. S. Military Property.
J. MIL-STD-810, Environmental Test Methods.
K. Federal Test Method Standard No. 151, Metals; Test Methods.
L. MIL-H-13859, Honing Unit, Cylindrical Bore, Portable.
M. MIL-L-18947, Lappers, Poppet Valve, Hand Powered.
N. MIL-M-11472, Magnetic-Particle Inspection, Process, for Ferromagnetic Materials.
O. MIL-P-116, Preservation, Methods of.
P. MIL-R-6223, Removing and Mounting Kit, Tire, Type S-5.
Q. MIL-S-15297, Spray Outfit, Paint Portable.
R. MIL-T-704, Treatment and Painting of Metal.
S. MIL-T-21309, Tools for Inserting and Extracting Helical Coil Wire Screw Thread Inserts.
T. W-G-690, Grinding Kit, Valve Seat, Electric.
U. W-S-570, Soldering Iron, Electric.
V. OO-G-686, Grinding Machine, Valve Face.
W. WW-H-636, Hot Plates.
X. GGG-A-576, Anvil, Blacksmiths.
Y. GGG-C-430, Cleaner, Valve Stem Guide.
Z. GGG-C-00555, Compressor, Piston Ring, Band-Type.
AA. GGG-G-17, Gages.

AB. GGG-P-781, Puller and Puller Kit, Mechanical, and Mechanical Puller Attachments.
AC. TM 5-4940-200-12, Shop Equipment, Contact Maintenance, Truck Mounted, Set. No. 3.
AD. TM 5-4940-209-12, Shop Equipment: General Purpose Repair, Semitrailer Mounted, Set. No. 1.
AE. MTP 7-2-057, Tools(Aviation).
AF. MTP 9-2-166, Air Compressors.
AG. MTP 9-2-167, Tools, Hand, Pneumatic.
AH. MTP 9-2-202, Hoists, Chain and Wire Rope.
AI. MTP 9-2-205, Drilling Machines.
AJ. MTP 9-2-207, Lathes.
AK. MTP 9-2-213, Welding Equipment Machines.
AL. MTP 9-2-286, Power Generators.
AM. MTP 9-3-512, Compatibility.
AN. MTP 9-4-001, Desert Environmental Test of Construct, Support and Service Equipment.
AO. MTP 9-4-003, Tropical Environmental Test of Construct, Support and Service Equipment.
AP. MTP 9-4-004, Arctic Environmental Test of Construction Equipment.
AQ. MTP 10-2-500, Physical Characteristics.
AR. MTP 10-2-501, Operator Training and Familiarization.
AS. MTP 10-2-503, Surface Transportability. (General Supplies and Equipment).
AT. MTP 10-2-505, Human Factors Evaluation.
AU. MTP 10-2-507, Maintenance Evaluation.
AV. MTP 10-2-508, Safety.
AW. MTP 10-2-511, Quality Assurance.
AX. MTP 10-2-512, Reliability.

5. SCOPE

5.1 SUMMARY

This procedure describes the preparation for the methods of evaluating the technical characteristics of tool sets 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 item upon arrival. Also, to ensure that the test item is complete and functionally operational and to provide operator training and familiarization procedures.

b. Engine Repair Equipment Test -

1) Cylinder Head Repair Test - A series of tests to determine the adequacy of the test item to remove, repair, and replace cylinder head components (i.e., valves, valve springs, seats).
2) Block Repair Test - A series of tests to determine the adequacy of the test item to recondition or replace the cylinder bores of an engine block.

3) Piston and Ring Test - A series of tests to determine the adequacy of the test item to recondition piston ring grooves, install rings on the piston, and place the piston and ring assembly into the block.

c. Tubing Repair Test - A series of tests to determine the adequacy of the test item to fabricate and/or repair lengths of tubing and couplings.

d. Thread Repair Test - A series of tests to determine the adequacy of the test item to repair damaged threads on bolts, studs, etc. and to repair/replace damaged tapped threads.

e. Cutting and Welding Test - A series of tests to determine the adequacy of the test item to cut, weld, and braze metals of varying thicknesses and composition.

f. Special Tools and Instruments Test - A series of tests to determine that special function tools adequately perform their intended task.

g. Climatic Tests - Performance testing of the test item 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 70-38. The following evaluations are required:

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 transportation.

k. Maintenance - An evaluation to determine and appraise the test item's maintenance characteristics and requirements, a verification and appraisal of its malfunctions, an evaluation of the test item's associated publications and other common and special support elements (maintenance test package), an appraisal of the test item's 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 appropriate preceding aspects.

l. Compatibility Evaluation - A determination of the components of the test item to be easily installed on a mobile fixture, to be properly secured for transport, to be readily accessible for use, and to be operationally compatible with the mobile fixture.

m. Safety - An evaluation to determine the test item compliance with safety requirements and to confirm the test item's safety characteristics during conduct of all tests.

n. 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.

o. 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, reliability, quality, maintainability, or safety.

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

5.2 LIMITATIONS

None.

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 and the following:

a. Visually inspect the packaged test item and record the following:

1) Evidence of damage incurred during transport or storage.
2) Exterior identification markings not in accordance with MIL-STD-129 or other governing documents.

b. Unpack and remove all traces of protective transport/storage materials. When this has been accomplished, visually inspect the test item and record evidence of the following:

1) Interior markings of shipment not in accordance with MIL-STD-129 or other governing documents.
2) Evidence of defects in test item materials and construction, treatment and finish, and/or workmanship.

6.1.2 Inventory Check

a. Conduct an inventory against the Basic Issue Items 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 Inspection and Preliminary Operation

a. Perform preliminary operations, inspections, and adjustments in accordance with 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 following provides, in part, the guidelines necessary for this type of pretest determination.

1) Electrically driven 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 9-2-168.

6.1.4 Physical Characteristics

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

1) Valve seat grinding stones:

a) Cutting angle of face.
b) Minimum diameter of face.
c) Maximum diameter of face.

2) Minimum and maximum diameter of the cylinder hone.
3) Piston ring cleaner blade thickness and range (diameter).
4) Piston ring compressor maximum and minimum diameter.
5) Boring machine maximum and minimum diameter.
6) Valve spring tension tester maximum spring height capacity.
7) Cutting and flaring tool kit maximum and minimum.
8) Gear puller; range of jaws or attachment points.
9) Riveter kit; size of jaws (opening, depth).
10) Hot plate; diameter of work (heating) surface.

6.2 TEST CONDUCT

NOTE: All material malfunctions shall be reported in accordance with USATECOM Regulation 70-23.

6.2.1 Engine Repair Equipment Test

NOTE: Personnel should wear goggles and observe all safety precautions when operating machinery. When applying power to

grinding wheels, personnel should stand to the side of the machine to prevent injury in event of wheel breakage.

6.2.1.1 Cylinder Head

a. Subject jaws of valve spring compressor to a (spreading) force of 400 pounds for 10 minutes. Measure distortion of frame and deflection of jaws from their vertical centers.

b. Disassemble 10 cylinder heads by compressing valve springs with proper tool and removing spring keepers. Determine and record the amount of force required to compress each valve spring.

c. Measure maximum and minimum face diameter and cutting angle of seat grinding stone.

d. Insert pilot shaft in valve bore and reface valve seats. Seat width should be the maximum for the specific cylinder head without sinking valves. Measure valve seat angle.

e. Repeat c. Inspect stone face for clogging or wear as indicated by irregularity or concaveness of the cutting surface.

f. Measure inner and outer seat edges with a dial indicator to determine concentricity and roundness. Measure and record seat width at 6 points, 60° apart, with outside calipers.

g. Insert dummy shaft into valve grinding machine and set to an indicated 45° face cut. Determine actual cutting angle with bevel protractor. Repeat test for angles of 30°, 35°, 44°, 55°. Determine range of cutting angles.

h. Place valves in grinding machine and verify straightness with dial indicator. Reface according to operating instructions.

i. Measure and record valve face width and verify roundness with dial indicator.

j. Operate the valve guide bore cleaning tool to lightly hone the valve bores. Inspect the bore for any glaze (varnish) or residue left by the test item. Inspect bore surface for smooth hone pattern. Inspect test item for wear, clogged surfaces, or other deformation, and record any discrepancies.

k. Place lapping compound on valve seats and hand lap valves to heads per operating instructions.

l. Inspect valve/seat for scratches or other indications of uneven mating, and record any discrepancies.

6.2.1.2 Block

6.2.1.2.1 Nonreplaceable Bores - Boring machines used to recondition nonreplaceable bores should be evaluated in accordance with MTP 9-2-167.

6.2.1.2.2 Replaceable Bores - Perform the following:

a. Configure the test item with a test fixture to simulate actual removal.

b. Measure the maximum force the test item is capable of producing up to the distortion value of the cylinder sleeve. Retain pressure for 10 minutes, release for 5 minutes.

c. Repeat test cycle for 10 hours.

d. Inspect test item for distortion, surface cracks, or signs of wear, and record any discrepancies. Subject test item to magnetic particle inspection for stress cracks.

e. Remove cylinder sleeves from a suitable empty block per operating instructions.

f. Insert new bore sleeves per operating instructions; inspect for scratches, gouges, or machine marks left from removal/installation equipment, and record any damage to machines or materials.

g. Verify that the bore is perpendicular to the cylinder head surface.

6.2.1.2.3 All Blocks - Perform the following:

a. Hone cylinders per operating instructions.

NOTE: If the equipment used does not have an automatic depth stop or other indicating device, observe that the honing stone does not exit the block at the bottom of the bore and that no moving parts come in contact with the block or bore except the hone itself.

b. Inspect bore surface for proper "cross-hatch" pattern. Inspect hone for wear or clogging of stone surface.

6.2.1.3 Pistons and Rings

a. Mount the piston ring cleaner on piston and clean ring grooves and lands. Inspect ring grooves for scratches, gouges, twisting, or any other deformation caused by the ring cleaner.

b. Install rings on pistons with ring expander; observe that the expander does not "spring" or break rings. Coat assembly with light engine oil and attach ring compressor.

c. Install piston and ring assemblies in empty block. Observe that the rings do not catch on the block bore edge and that the piston/ring assemblies install smoothly and without binding.

6.2.2 Tubing Repair Equipment

a. Select one sample of each size tubing the flaring tool is capable of handling; the sample being of sufficient length to allow 10 cuts and splices with at least 6" between each splice.

b. Cut and flare each sample at 10 locations. Inspect each flare for burrs, cracks, draw marks or any other indication of improper flaring.

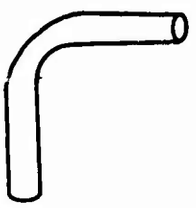
c. Splice each cut with materials and tools provided.

d. Plug one end of each sample line and subject line to the proof pressure of the tubing, and record the pressure.

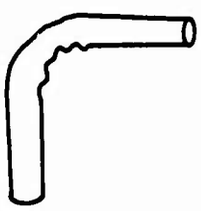
e. Inspect cutting and flaring tools for cracks, dulling edges or signs of deformation and record any indications of damage to the test item.

f. Perform five 90° bends and five 180° bends in one unused sample of each size tubing; bends should be in accordance with Figure 1.

PERFECT BEND



FLATTENED BEND



WRINKLED BEND

KINKED BEND

Figure 1. Acceptable and Unacceptable Tubing Bends

6.2.3 Thread Repair Equipment

a. Select at random, 50 different bolts from the complement of shop materials and flatten a portion of the threads on each bolt with a mallet or similar device.

b. Mount each bolt in a vice and renew damaged threads with the thread set provided.

c. Compare original (undamaged) portions of bolt to those portions straightened, using a thread measuring set.

d. Flatten a portion of the threads of 50 different size tapped steel holes with a drift punch and mallet or other suitable means.

e. Retap threaded holes with equipment provided.

f. Compare straightened threads with undamaged portions.

g. Inspect threading set for evidence of damage, wear, or dulling of cutting edges and record any discrepancies.

h. Install 2 thread inserts of each available size into suitable tapped steel with the installation kit provided. Verify flatness of surface surrounding bolt hole with straightedge.

i. Insert proper size bolt into each tapped hole and torque to maximum bolt value. Allow test items to remain torqued for 30 minutes. Release torque. Repeat test for 10 hours at 30 minute increments.

j. Remove bolt and inspect thread inserts for distortion, damage or failure. Inspect surface surrounding hole to determine that the screw insert did not distort the block area or shift the cinching devices (if applicable).

k. Remove screw inserts from block with tools provided. Inspect blade of removing tool for nicks, cracks, or dulling. Inspect tapped hole for gouges or scratches made by the insert or removing tool.

6.2.4 Cutting and Welding Equipment

a. Cutting and welding equipment should be evaluated in accordance with MTP 9-2-213.

b. Record applicable data of MTP 9-2-213.

6.2.5 Special Tools

6.2.5.1 Anvils and Metal-Working Dollies

a. Determine and record surface hardness of work areas with a durometer or other suitable instrument.

b. Drop a 50 pound steel ball of at least 20% more surface hardness on anvil work area from a height of 10 feet. Perform 10 drops and examine the anvil surface for distortion, stress cracks, or chipping after each drop.

c. Perform a similar test on sheet-metal dollies; dropping the steel ball from a height of 5 feet.

6.2.5.2 Riveter Kit

a. Reface 10 clutch discs and 50 brake shoes with equipment provided. Determine the pressure applied to install each rivet.

b. Inspect each rivet for proper fit in hole, head shape, and lack of burrs or other irregularities.

c. Measure and record the distance between the rivet face and the surface of surrounding material with a depth micrometer.

6.2.5.3 Grease Gun

a. Load the gun with suitable POL material in accordance with operating instructions.

b. Affix a pressure measuring device to the end of the gun and operate the pressure lever for 50 cycles. Repeat the test for each adapter fitting supplied with the gun and record the test pressure.

c. Inspect the gun and adapters for signs of leakage or deformation.

6.2.5.4 Hydraulic Presses

a. Operate the press to install and remove 10 bearings or collars on suitable fixtures (i.e., axle shafts, etc.) which require the maximum pressure capacity of the press.

b. Repeat the test for each size adapter supplied with the equipment.

c. With suitable measuring device determine and record maximum pressure capability of the press.

d. Inspect the press for hydraulic leaks or frame distortion.

6.2.5.5 Paint Spray Outfit

a. Assemble the paint spray outfit to its operating configuration and load with paint.

b. Adjust the compressor to operating pressure and spray 10 test panels, operating the spray nozzle through its entire range of adjustments. Make one pass on each panel.

c. Clean gun and reload with paint. Repeat b.

d. Disassemble and clean nozzle and gun in accordance with operating instructions. Inspect components for wear, deformation, or paint that was not removed during normal cleaning procedures and recording any instances of damage or wear.

e. Inspect paint panels for adequate one-pass coverage. Note range of paint coverage in relation to nozzle adjustments. Inspect panels for runs, sags, etc.

6.2.5.6 Puller Sets

a. Configure the test item to simulate actual usage with a hydraulic press.

b. Perform the following cyclic test five (5) times:

1) Apply 1½ times the design pressure to the test item and hold for 5 minutes.
2) Release pressure for one minute.

c. Inspect each component for wear, deformation or indications of stress cracks using the magnetic particle inspection process or similar method.

6.2.5.7 Hot Plate

a. Mount the test item on a vibration test facility and perform test in accordance with MIL-STD-810, Method 514.

b. Perform a shock test in accordance with MIL-STD-810, Method 816.

c. Mount a hot plate on a level surface and place a standard calorimeter beaker on the heating surface. Insulate the beaker and the beaker/hot-plate union for minimum heat loss. Attach wattmeter to measure power input to the hot plate. Fill beaker with 5 pounds of water and place a thermometer in the water such that it is readable from outside of the beaker. Stabilize temperature of test apparatus at 50°F.

d. Operate the test item at its maximum output until a water temperature of 180°F is reached; measure and record the time required to attain this temperature. During this time, record the wattmeter readings at 3 minute intervals.

e. Determine the efficiency of the hot plate, using the following formula:

$$\text{Efficiency} = \frac{0.19 \text{ Kwhr.}}{WT}$$

where: W = average wattmeter reading in Kw.
T = time required for temperature change in hours.

(See Appendix A.)

f. Configure the test item with a beaker such that cold water can be constantly circulated over the work surface.

g. Operate the test item for 10 hours, taking wattmeter readings every 30 minutes.

h. Repeat steps (c, d, e).

6.2.5.8 Tire Remover Kit

a. Assemble the tire remover so that it is in its operating configuration. Verify that the tire work surface is flat and perpendicular to the retaining shaft.

b. Subject the outer edge of the flat work surface to a vertical pressure equal to twice the weight of the maximum tire/wheel capacity for 30 minutes. Repeat the test at points 90°, 180°, and 270° from initial test point. After each test, determine that no permanent set or warpage has been induced into the work surface.

c. Mount the maximum size tire/rim configuration on the test item and remove tire per operating instructions. Reinstall tire on rim and inflate to operating pressure. Repeat test for 50 cycles. For each cycle observe that the test item does not pinch or bind the tire and that all components operate smoothly.

d. Remove tire and examine for cord or tire bead breakage, cuts, or any abrasions. Inspect tire rim for warpage, deformation, machine marks, or any indication of excess pressure from the removing kits, and record any discrepancies.

e. Operate the hydraulic system (if applicable), at 1½ times rated

capacity for 30 minutes. Inspect for hydraulic leaks or component warpage.

6.2.5.9 Battery Charger

Perform the following:

a. Perform a shock test in accordance with MIL-STD-810, Method 516.
b. Perform a vibration test in accordance with MIL-STD-810, Method 514.
c. Set the test item for fast charging a 24 volt battery and install three 75 watt bulbs and an ammeter in series in the circuit.
d. Operate the test item in this configuration for one week, and record the readings every 4 hours.
e. Insert a partially-charged 24 volt battery into the circuit in place of the bulbs and observe that the charging rate diminishes as the battery approaches full charge. Verify that the charger cut-off device is activated when the battery reaches a fully-charged state (if applicable).

NOTE: If the temperature rise of the battery exceeds 15°F above the surrounding air temperature, reduce charging rate.

6.2.5.10 Soldering Iron

a. Perform a shock test in accordance with MIL-STD-810, Method 516.
b. Configure the test item to record power consumption and tip temperature with suitable measuring instruments.
c. Operate the iron, measuring the time required to reach its maximum tip temperature and the power (watts) being consumed. Record wattage and elapsed time in 50° increments until the maximum temperature is reached. Allow test item to naturally cool to room temperature.
d. Repeat the test 200 times.

6.2.5.11 Brake Cylinder Grinding Hone

a. Mount an empty slave cylinder or suitable fixture of drilled mild steel in a fixed position. Hone cylinder per operating instructions.
b. Inspect the bore for a smooth finish pattern, which is absent of scratches, gouges, or other irregularities.
c. Repeat honing operation for 50 hours. Inspect hone for clogging, dulling of cutting edges, waviness of hone surface, or other signs of wear.

6.2.5.12 Inner Tube Repair Kits

a. Select 2 samples of each size and shape tire patch provided and mount on square inner tube sections which are at least 3" larger in length and width than the patch. Subject each vulcanized patch to the following:

1) Torsion - With one edge of the patch held stationary, perform 300 cycles of twisting the opposite edge to an angle of 45°, returning to level, then twisting to 45° in the opposite direction.

2) Tension - With one edge of the patch held stationary, stretch the test patch to 125% of its original length. Allow tension to remain for 5 minutes. Repeat the test 3 times, rotating the test patch 90° in the same direction after each test. Repeat entire test cycle 25 times.

b. Examine test patches for evidence of deterioration or failure.

c. Examine test items for warpage, bending, or other signs of failure.

d. Record any evidence of patch failure or test item wear or distortion.

6.2.6 Standard Tools

6.2.6.1 Standard Hand Tools Should be Evaluated in Accordance with MTP 7-2-057.

6.2.6.2 Engine Lathes Should be Evaluated in Accordance with MTP 9-2-208.

6.2.6.3 Drilling Machines Should be Evaluated in Accordance with MTP 9-2-205.

6.2.6.4 Chain Hoists Should be Evaluated in Accordance with MTP 9-2-202.

6.2.6.5 Power Generators Should be Evaluated in Accordance with MTP 9-2-286.

6.2.6.6 Air Compressors Should be Evaluated in Accordance with MTP 9-2-166.

6.2.6.7 Measuring Equipment, such as Torque Wrenches, Generator and Voltage Regulator Sets, Tachometers, and Multimeters, Should be Evaluated in Accordance with MTP 7-2-057.

6.2.7 Climatic Extremes Tests

Performance testing of each test item type under arctic and desert conditions should be performed in accordance with MTP's 9-4-001, and 9-4-004. Additional guidance may be obtained from MTP 9-4-003.

6.2.8 Intermediate Climatic Tests

Subject the test item(s) to climatic conditions representative of the Intermediate Climate as defined by AR 70-38. Use procedures and applicable tests contained in MIL-STD-810 or Federal Test Method Standard No. 151, as applicable.

6.2.8.1 Corrosion Tests

6.2.8.1.1 Salt Spray Test - Determine the test item(s) ability to resist corrosion when subjected to a fine mist of 5 percent sodium chloride solution at a temperature of 95°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.

6.2.8.1.2 Synthetic Sea-Water Spray Test - Determine the test item(s) ability to resist corrosion when subjected to a fine mist of synthetic sea water at a temperature of 75°F. This test is applicable for tools made of certain types of steel which are subject to localized pitting attack. Perform in accordance with Method 812 of Federal Test Method no. 151.

6.2.8.1.3 Intergranular-Corrosion Test for Corrosion Resistant Austenitic Steels - Determine the test item(s) ability to resist corrosion when subjected to an acidified copper-sulphate solution following a sensitized, descaling, and immersion procedure. This test is applicable for 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.

6.2.8.1.4 Intergranular-Corrosion Test for Aluminum Alloys - Determine the susceptibility of aluminum alloy test items to intergranular corrosion. Perform the test according to Method 822 of Federal Test Standard No. 151.

6.2.8.1.5 Mercurous-Nitrate Test for Copper Alloys - Determine the susceptibility of copper alloy test items (such as non-sparking tools) to fail in use or storage due to stress-corrosion cracking. Perform the test according to Method 831 of Federal Test Standard No. 151.

6.2.8.2 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 tools scales

6.2.9 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 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.

6.2.10 Transportability

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

6.2.11 Maintenance

Evaluate the maintenance-related factors of the test item as described in MTP 10-2-507, MTP 10-2-512, and the applicable portions of AMC Pamphlet 706-134 with emphasis on the following:

a. Organizational (O), Direct Support (F), and General Support (H) maintenance requirements.
b. Operator through General Support Maintenance Literature, if applicable.
c. Repair Parts.
d. Calibration standards and facilities.
e. Test and handling equipment.
f. Maintenance facilities.
g. Personnel skill requirements.
h. Maintainability.
i. Reliability.
j. Availability.

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

In evaluating the above listed factors, perform the following:

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

6.2.12 Compatibility Evaluation

This equipment is normally mounted on a mobile fixture to facilitate in-the-field repairs. An evaluation should be made to ensure compatibility between the test items and the transporting device. Perform the applicable portions of MTP 9-3-512 and the following:

a. Determine the power requirements of each test item requiring external power from the mobile device. Correlate these requirements with the power sources available at the mobile device.
b. Determine physical compatibility by setting up and operating

each test item that requires external power from the mobile device in accordance with operating instructions supplied.

6.2.13 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:

a. Perform the applicable sections of MTP 10-2-508.

b. 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.

c. 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 QMR 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.

d. 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.

6.2.14 Human Factors Evaluation

Determine the degree to which the design and performance of the test item(s) 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. Consult MTP 10-2-505 for guidance in developing the overall evaluation and 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 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, and the following:

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.

4) Accessibility.

a) Mount all appropriate test items on the applicable mobile device (i.e., semitrailer or truck) in the manner and position described in the draft manual.
b) Determine accessibility by assuming a requirement for each item, in turn, that is contained in the mobile unit, and remove that item from its location. For each item, note any difficulties such as having to remove other equipment in order to gain access to the test item. As each item is evaluated, return it to its original position.

6.2.15 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.

6.2.16 Quality Assurance

Determine the quality of the test item as described in the applicable section of MTP 10-2-511.

6.3 TEST DATA

6.3.1 Initial Inspection

Record the following:

a. Evidence of damage incurred by the test item during transport or storage.

b. Exterior test item identification markings not in accordance with MIL-STD-129 or other governing documents.

c. Interior test item markings not in accordance with MIL-STD-129 or other governing documents.

d. Evidence of defects in test item materials and construction, treatment and finish, and/or workmanship.

6.3.2 Inventory Check

Record the following:

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

6.3.3 Physical Characteristics

Record the physical specifications and dimensional data required by applicable procedures of MTP 10-2-500.

6.3.4 Engine Repair Equipment Test

6.3.4.1 Cylinder Head

Record the following:

a. Force required to compress springs.
b. Valve seat width.

c. Valve face width.
d. Any indication of an out-of-round or off-center condition.
e. Damage to the test item.

6.3.4.2 Block

Record the data required by MTP 9-2-167 and the following:

a. Bore diameter measurements.
b. Any scratches, gouges, or other machine marks.
c. Any out-of-alignment condition, i.e., bores not perpendicular to block face.

6.3.5 Tubing Repair Equipment Test

Record the following:

a. Proof pressure of tubing.
b. Time required to perform each splicing operation.
c. Any indication of failure of the splice, fittings, or test item.

6.3.6 Thread Repair Equipment Test

Record the following:

a. Breakage of bolts or tools during test.
b. Threads which did not conform to approximate original dimensions and shape after thread renewal process.
c. Any thread cutting edges which show wear, dulling or deformation.

6.3.7 Cutting and Welding Equipment Test

Record the data required by MTP 9-2-213.

6.3.8 Standard Tools Test

Record the following data as required by the appropriate MTP:

a. Hand tools - MTP 7-2-057.
b. Lathes - MTP 9-2-207.
c. Drilling machines - MTP 9-2-205.
d. Chain hoists - MTP 9-2-202.
e. Power generators - MTP 9-2-286.
f. Air compressors - MTP 9-2-166.
g. Measuring equipment - MTP 7-2-057.

6.3.9 Special Tools Test

6.3.9.1 Anvils and Metal-Working Dollies

Record the following data:

a. Surface hardness of each work area.
b. Condition of work area after each drop.
c. Any indication of wear or deformation such as chipping, cracking, warpage, etc.

6.3.9.2 Riveter Kit

Record the following data:

a. Time required to install each rivet.
b. Distance between rivet face and surrounding material.
c. Any indication of improper installation, such as loose rivets, burrs, flashing, etc., or failure of the test item.

6.3.9.3 Grease Gun

Record the following:

a. Time required to load gun.
b. Test pressure of gun and accessories.
c. Indication of leakage or deformation of the test item(s).

6.3.9.4 Hydraulic Press

Record the following:

a. Rated press capacity.
b. Measured test capacity.
c. Time required to press and remove each bearing or collar.
d. Indication of leakage, warping, or other deformation.

6.3.9.5 Paint Spray Outfit

Record the following:

a. Time required to assemble the test item to operating configuration.
b. Degree of coverage in relation to nozzle adjustments.
c. Internal areas of test item components which contained paint residue after normal cleaning operations.
d. Indications of irregular spray, such as runs, sags, blotches, etc.

6.3.9.6 Puller Set

Record the following:

a. Maximum pressure applied to each test item.
b. Evidence of distortion or failure.

6.3.9.7 Hot Plate

Record the following:

a. Time required for temperature change.
b. Calculated efficiency.
c. Average power consumption.

6.3.9.8 Tire Remover Kit

Record the following:

a. Pressure applied to work surface.
b. Time required to mount/remove each tire.
c. Evidence of damage to the tire/rim caused by the test item.
d. Evidence of failure of the test item.
e. Maximum pressure applied to the hydraulic portion of the test item (if applicable).

6.3.9.9 Battery Charger

Record the following:

a. Average power reading over one-week period.
b. Verification that charger output does not exceed battery charging requirements.
c. Indication that the automatic cut-off device (if applicable) operates satisfactorily.

6.3.9.10 Soldering Iron

Record the following:

a. Manner in which drop test was performed.
b. Indications of drop test failure.
c. Maximum temperature attained and elapsed time required.
d. Time required to reach maximum temperature in 50°F increments during 200 cycle tests.
e. Power consumption at maximum working temperature.

6.3.9.11 Brake Cylinder Grinding Hone

Record the following:

a. Evidence of gouging or scratching of the test block by the test item.
b. Clogging or dulling of the hone surface.
c. Uneven wear of the test item as evidenced by waviness or concaveness of the hone surface.

6.3.9.12 Inner Tube Repair Kit

Record the following:

a. Evidence of failure of the test patches.
b. Evidence of distortion or wear of the test item.

6.3.10 Climatic Extremes Tests

Record data required by applicable procedures of MTP's 9-4-001, 9-4-004, and 9-4-003.

6.3.11 Salt Spray Test

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

6.3.12 Synthetic Sea-Water Spray Test

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

6.3.13 Intergranular-Corrosion Test for Corrosion Resistant Austenitic Steels

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

6.3.14 Intergranular-Corrosion Test for Aluminum Alloys

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

6.3.15 Mercurous-Nitrate Test for Copper Alloys

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

6.3.16 Sand and Dust Test

Record the following:

a. Data required by applicable procedures of MIL-STD-810, Method 410.
b. Data obtained from the post test 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.

6.3.17 Endurance Test

Record the following:

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

endurance test.

b. Identification of test fixtures, obtained for test, which are unique properties of the test item.

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

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.

6.3.18 Transportability

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

6.3.19 Maintenance

Record data collected as described in the applicable section of MTP 10-2-507 and MTP 10-2-512.

6.3.20 Compatibility Evaluation

Record data required by applicable procedures of MTP 9-3-512 and the incompatibility between the available power of the mobile fixture and the power requirements of the test item.

6.3.21 Safety

Record the following:

a. Data required by procedures of MTP 10-2-508.
b. During all tests 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.

6.3.22 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.

c. Time required to obtain each item from the mobile fixture.
d. Items to which access was difficult.

6.3.23 Value Analysis

Record the following:

a. Non-functional, costly, or "nice-to-have" features of the test item.

b. Test personnel comments and opinions regarding features to be eliminated.

6.3.24 Quality Assurance

Record data collected as described in the applicable section of MTP 10-2-511.

6.4 DATA REDUCTION AND PRESENTATION

Data obtained during the conduct of engineering tests shall be summarized, tabulated, and displayed in a manner which will facilitate evaluation. Comparison tool test data will be displayed to facilitate comparison(s) with appropriate test item(s).

Physical characteristics test data will be evaluated as required by appropriate specification test methods for comparison with the technical performance characteristics specified by the SDR or other governing documentation.

Photographs, charts, and narrative descriptions of tests will be made available during the evaluation.

Recommendations should be provided in regard to the test item(s) suitability for service testing.

A Safety Release Recommendation shall be submitted in accordance with USATECOM Regulation 385-6 based on the data collected related to safety.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX A

HOT PLATE EFFICIENCY

The efficiency of the Hot Plate is the ratio of the energy transferred to the liquid to the energy supplied to the Hot Plate, and is expressed as:

$$\text{Efficiency} = \frac{0.19 \text{ Kwhr.}}{WT}$$

where: W = average wattmeter reading in Kw.
T = time required for temperature change, in hours.

The equation is derived using the following information:

5 lbs. of water
$\Delta T = 82°C - 10°C = 72°C$
Specific heat of water = /cal./gr. °C.

a. The number of calories required to raise 5 lbs. of water 72°C is:

$$(1 \text{ cal./gr. °C})(72°C)(5 \text{ lbs.})(453.6 \text{ gr./lb.}) = 163{,}296 \text{ cal.}$$

b. 1 Kwhr. = 860,000 cal.

c. The number of Kwhr. required $= \frac{163{,}296 \text{ cal.}}{860{,}000 \text{ cal/Kwhr.}} = 0.19$ Kwhr.

d. Efficiency $= \frac{\text{Power Required}}{\text{Power Supplied}} = 0.19$ Kwhr./WT.

UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R & D

Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1 ORIGINATING ACTIVITY (Corporate author) US Army Test and Evaluation Command (USATECOM) Aberdeen Proving Ground, Maryland 21005	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b GROUP ----------

3 REPORT TITLE

U. S. Army Test and Evaluation Command Materiel Test Procedure 9-2-212, Commodity Engineering Test Procedure, - "Tool Sets"

4 DESCRIPTIVE NOTES (Type of report and, inclusive dates)
Final

5 AUTHOR(S) (First name, middle initial, last name)
----

6 REPORT DATE 28 July 1970	7a. TOTAL NO. OF PAGES 30	7b. NO. OF REFS 50
8a. CONTRACT OR GRANT NO DA-18-001-AMC-1045(R) b. PROJECT NO AMCR 310-6 c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) MTP 9-2-212 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) ----------	

10 DISTRIBUTION STATEMENT
This document is subject to special export controls and each transmittal to foreign governments or foreign nationals,-WITH THE EXCEPTION OF AUSTRALIA, CANADA, AND UNITED KINGDOM,-may be made only with prior approval of HQ,USATECOM.

11 SUPPLEMENTARY NOTES ----------	12. SPONSORING MILITARY ACTIVITY Headquarters US Army Test and Evaluation Command Aberdeen Proving Ground, Maryland 21005

13 ABSTRACT

This Engineering Test Procedure describes test methods and techniques for evaluating the technical performance and characteristics of Tool Sets, and for determining their suitability to be subjected to further test for service use by the U. S. Army. It is intended for use in testing standard and special tool equipment (e.g. Engine Repair, Cutting/Welding, Tubing Repair, Thread Repair). The evaluation is related to criteria expressed in applicable Qualitative Materiel Requirements (QMR), Small Development Requirements (SDR), Technical Characteristics (TC), or other appropriate design requirements and specifications.

DD FORM 1 NOV 65 1473 (PAGE 1)
S/N 0101-807-6811

UNCLASSIFIED
Security Classification

A-31408

Preceding page blank

UNCLASSIFIED
Security Classification

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Engineering Test						
Tool Sets (Standard and Special)						
Test Procedures						
Test Methods and Techniques						

DD FORM 1 NOV 65 1473 (BACK)
S/N 0101-807-6821

UNCLASSIFIED
Security Classification