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Materiel Test Procedure 10-2-030
General Equipment Test Activity

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

DRAFTING EQUIPMENT

1. OBJECTIVE

This document provides test methods and techniques for determining the technical performance and safety characteristics of drafting equipment and its associated tools and equipment as described in Qualitative Material Requirements (QMR's), Small Development Requirements (SDR's), and Technical Characteristics (TC's) and the suitability of the test item for service testing.

2. BACKGROUND

A requirement exists for drafting equipment which is used in general drafting practice, data plotting, and map compilation. Drafting equipment includes ruling pens, triangles, templates, curves, T-squares, compasses, protractors, erasing shields, dividers, rulers, and drafting machines. A combination of smaller instruments usually is combined in a small case called a drafting instrument set. Drafting instrument sets are further subdivided into three classes depending on the use. These are general purpose pocket sets, field sets, and office sets. Drafting machines are devices which attach rigidly to a table and conveniently aid in drawing or measuring lines drawn horizontally, vertically, or at an angle.

3. REQUIRED EQUIPMENT

- a. Scales.
- b. Machinists Steel or Black Granite Straight Edge.
- c. Measuring Magnifier or Pocket Comparator to 1/1000".
- d. Calibrated Standard Ruler accurate to $\pm 1/64$ inch.
- e. Drawing Ink, black, Pencils, Erasers, Chalkbags.
- f. Calibrated Standard Protractor or equivalent instrument capable of angle measurement from 0 to 90 degrees, in 10 degree increments, accurate to at least ± 10 minutes of arc.
- g. Drawing Paper conforming to Federal Specification UU-P-223C.
- h. Tracing Cloth conforming to Federal Specification CCC-C-531E.
- i. Matte-Surface Plastic sheet conforming to Federal Specification L-P-519B.
- j. Rockwell Hardness Tester.
- k. Environmental Test Chamber (-65°F to +115°F. R.H. to 100%)
- l. Drop Test Facility.
- m. Light Source.
- n. Thickness Gage.

4. REFERENCES

- A. USATECOM Regulation 385-6, Safety Release.
- B. USATECOM Regulation 700-1, Value Engineering.
- C. USATECOM Regulation 705-4, Equipment Performance Report.

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- D. Federal Specification L-P-519B, Plastic Sheet, Tracing, Glazed and Matte Finish.
- E. Federal Specification UU-P-223C, Paper, Drawing.
- F. Federal Specification CCC-C-531E, Cloth, Tracing.
- G. Federal Test Method Standard 406, Plastics: Methods of Testing.
- H. Federal Standard FED-STD-151, Metals, Test Methods.
- I. USAGETA Document, Human Factors Evaluation Data for General Equipment (HEDGE).
- J. MTP 10-2-500, Physical Characteristics.
- K. MTP 10-2-501, Operator Training and Familiarization.
- L. MTP 10-2-503, Transportability.
- M. MTP 10-2-505, Human Factors Evaluation.
- N. MTP 10-2-507, Maintenance Evaluation.

5. SCOPE

5.1 SUMMARY

This materiel test procedure describes the following procedures to be used in evaluating the technical performance and safety of drafting equipment.

a. Preparation for Test - A pre-test inspection to determine the condition of the test item upon arrival, a determination of the test item's physical characteristics, and operator training and familiarization requirements.

b. Performance - An evaluation to determine accuracy of angle and length markings and functional suitability of drawing pens, compasses, drawing pencils, etc.

c. Material Evaluation - An evaluation of the accelerated aging and flammability characteristics of plastic components and a determination of the Rockwell hardness for metal components.

d. Environmental Storage - An evaluation of the test item's ability to withstand storage under extreme conditions of temperature.

e. Transportability - An evaluation of the test item's ability to withstand the shock which might be incurred during normal handling and transport.

f. Safety - An evaluation to determine whether the test item contains any hazards.

g. Maintainability and Reliability Evaluation - That portion of the test which is concerned with the following: verification and appraisal of failures; determination and appraisal of maintenance characteristics and requirements; appraisal of design-for-maintainability; appraisal of the maintenance test package; and, calculation of indicators which express the effects of the preceding aspects.

h. Human Factors Evaluation - An evaluation of the man-item relationship during operation and maintenance of the test item to include adequacy of markings, ease of adjustments, portability and transportability.

i. Value Analysis - A determination of non-functional, costly, or "nice-to-have" features of the test item as described in USATECOM Regulation 700-1.

5.2 LIMITATIONS

This MTP is limited to general purpose drafting equipment including drafting instrument sets, templates, ruler, T-squares, and drafting machines. Automatic or electrically powered equipment are not included.

6. PROCEDURES

6.1.1 Pre-Test Inspection

Upon receipt of the test item package, the following procedures shall be performed:

- a. Visually inspect the test item package and record the following:
 - 1) Evidence of package damage or deterioration
 - 2) Identification markings including:
 - a) Manufacturer
 - b) Number and date of contract
 - c) Date of manufacture
 - d) All other pertinent markings
- b. Weigh and measure the test item package and record the following:
 - 1) Weight
 - 2) Overall length, width and height, or diameter
 - 3) Cubage
- c. Unpack the test item and record the type and adequacy of packing material in the shipping container.
- d. Inventory and visually inspect all items in the package and record the following:
 - 1) Identification of item
 - 2) Evidence of defects in:
 - a) Manufacturing
 - b) Material
 - c) Workmanship
 - 3) For drafting instrument set cases, record:
 - a) Torn or defective covering or lining
 - b) Improper snap fastener operations
 - c) Instruments not fitting snugly in case
 - d) Instruments contacting one another
 - 4) For drafting instruments, record:
 - a) Missing or damaged parts.
 - b) Whether all metal components are free of surface irregularities and roughness, and properly finished.

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- c) Whether plastic components are free of cracks, chips, warping, or surface roughness or irregularities.
 - d) Hardness of lead provided (2H, 4H, etc).
- 5) For maintenance package, record:
- a) Missing or incomplete manuals
 - b) Missing or incomplete repair parts or accessories

6.1.2 Physical Characteristics

Subject the test item/test item components to the applicable sections of MTP 10-2-500 and the following:

- a. Weigh and measure the test item and record the following:
 - 1) Weight
 - 2) Length, width and height, or diameter
- b. When applicable, measure and record the minimum and maximum extension of adjustable instruments such as dividers, compasses, or ruling pens.
- c. Measure the angles of such implements as T-squares, triangles, and the fixed 90 degree angles on drafting machines and verify their accuracy.

NOTE: Reject any instruments having angle measurements beyond the specified tolerance.

6.1.3 Operator Training and Familiarization

Members of the test team shall be oriented in accordance with MTP 10-2-501 and the applicable data recorded; and the following:

- a. Test personnel will be oriented in the test objectives, procedures, and operating and maintenance procedures for the test item.
- b. Test personnel shall be issued copies of the draft technical manuals. The adequacy of the manuals for training purposes will be assessed.
- c. Test personnel shall be instructed in test item safety hazards, if any.
- d. Record any difficulties.

6.1.4 Preparation

Remove all preservatives and check for proper operation of the test item and any components.

6.2 TEST CONDUCT

NOTE: All equipment failures during the test shall be reported in accordance with USATECOM Regulation 705-4.

6.2.1 Performance

6.2.1.1 Marking Accuracy

Perform the following:

- a. For all components with a linear distance scale (rulers, drafting machine, etc.) draw a series of short lines at the major divisions at least every 1/2 inch.
- b. Record the distance between each line segment as measured by the standard ruler.
- c. For all components with an angular scale (protractors, drafting machine angle indicator), draw a series of angles from 0 to 90 degrees in 10 degree increments.
- d. Record the angle as measured with the standard protractor.

6.2.1.2 Straightedge Devices

Perform the following for all components having straight edges (including drafting machines):

- a. Using a machinists steel or black granite straight edge as a standard, invert test straight edge on it so that two straight edges (test and standard) are opposing.
- b. Place light source behind juncture of two edges and observe for gaps between mating edges.
- c. Where light gaps show, measure variation with thickness gage.

6.2.1.3 Curves and Templates

- a. Draw typical curves or make template symbols, using both ink pen and pencil.
- b. Observe and record the overall ease of utilizing the curve or template and functional suitability for performing the intended tasks.
- c. Ensure that all template symbols are utilized and record any special problems associated with particular symbols.

6.2.1.4 Pens

6.2.1.4.1 Ruling Pens - Perform the following:

- a. Record the length, nominal or specified line widths obtainable, manufacturer, and model number, when applicable, for each pen tested.
- b. Move the adjustment screw to verify freedom of movement and proper adjustment of the pen nibs and record any deficiencies.
- c. Fill the pen with ink, compatible with the surface being used.
- d. Draw a series of lines varying from maximum to minimum width on the following types of surface:

- 1) Drawing paper conforming to Federal Specification UU-P-223C.
- 2) Tracing cloth conforming to Federal Specification CCC-C-531E.
- 3) Matte-surface plastic sheet conforming to Federal Specification L-P-519B.

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NOTE: All surfaces shall be clean, free of grease, and dry, prior to test.

e. Allow the ink to dry, examine the drawn lines and surface, and record the following:

- 1) Minimum and maximum line width obtainable (measured with a measuring magnifier).
- 2) Irregularities or breaks in lines.
- 3) Sharpness and clarity of lines.
- 4) Evidence of pen point cutting into the drawing.
- 5) Ease of using pen.
- 6) Type of ink utilized.
- 7) Type of surface utilized.
- 8) Test personnel comments on overall functional suitability of pens.

6.2.1.4.2 Non-adjustable Pens - Perform the following for each pen:

- a. Record the length, nominal line width, manufacturer and model number, when applicable, for each pen tested.
- b. Fill the pen with ink compatible with the surface being used.
- c. Draw several lines on each type of surface specified in step c of paragraph 6.2.1.4.1.
- d. Allow the ink to dry, examine the drawn lines and surface and record the following:

- 1) Average width of lines drawn as measured with a measuring magnifier.
- 2) Data required in steps 2 through 8 of paragraph 6.2.1.4.1e.

6.2.1.5 Compasses and Bow Instruments with Pen Attachments

Perform the following:

- a. Record the nominal instrument size, nominal or specified minimum and maximum circle diameters obtainable with and without an extension bar, and line widths available with pen attachments.
- b. If the compass is equipped with adjustable pen nib, move the adjustment screws to verify freedom of movement and proper adjustment and record any deficiencies.
- c. Adjust the test instrument, to varying diameters, with and without an extension bar and record the ease of adjusting and the maximum and minimum diameters obtainable.
- d. Utilize each compass to draw at least three circles with diameters ranging from minimum to maximum on each of the surfaces specified in step c of paragraph 6.2.1.4.1.
- e. If the compass is equipped with a variable pen nib repeat step b using a maximum, minimum and intermediate line width for each diameter of circle drawn.

f. Allow the ink to dry, examine the drawn lines and surface, and record the following for each circle drawn:

- 1) Circle diameter.
- 2) Irregularities or breaks in lines.
- 3) Sharpness and clarity of lines.
- 4) Type of ink utilized.
- 5) Type of surface utilized.
- 6) Ease of adjusting instrument for varying diameters.
- 7) Evidence of pen point cutting into drawing surface.
- 8) Line widths obtainable as measured with a measuring magnifier.
- 9) Test personnel comments on overall functional suitability of the instrument.

6.2.2 Materials Evaluation

6.2.2.1 Accelerated Aging (Plastics)

Perform the following on all plastic components:

a. Successively subject the component to 24 hours at each of the following test conditions:

- 1) Temperature 140°F. Relative Humidity 85 to 90 percent.
- 2) Temperature 140°F. Relative Humidity less than 10 percent.
- 3) Temperature 32°F. Relative Humidity 95 to 100 percent.

b. At the completion of each temperature test, perform the following:

- 1) Inspect the test item and record evidence of warping, cracking, or other damages to the plastic material.
- 2) Subject the test item to the applicable performance tests of paragraph 6.2.1 and record significant deficiencies in performance resulting from aging tests, if any.

6.2.2.2 Flammability (Plastics)

Perform the flammability test specified in Federal Test Method Standard 406, method 2021 and record the following:

- a. Whether material is considered flammable
- b. Burning rate, if applicable
- c. Possible safety hazards due to burning

6.2.2.3 Rockwell Hardness (Metals)

Determine and record the Rockwell hardness of metal components such as the metal portions of drafting machines, pen nibs, compasses, etc. in accordance with FED-STD-151. Method 243, Hardness Scale C.

6.2.3 Environmental Storage

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6.2.3.1 High Temperature Storage

- a. Subject the test item, in its normal storage or transit condition, to 48 hours at a temperature of 155°F at the appropriate humidity.
- b. Remove the test item from the test chamber and allow it to return to room temperature.
- c. Inspect the test item and record any damages.
- d. Repeat the performance tests of paragraph 6.2.1 and record any significant deficiencies in performance resulting from the high temperature storage.

6.2.3.2 Low Temperature Storage

- a. Subject the test item, in its normal storage or transit condition, to 72 hours at a temperature of -65°F.
- b. Remove the test item from the test chamber and allow it to return to room temperature.
- c. Inspect the test item and record any damages.
- d. Repeat the performance tests of paragraph 6.2.1 and record any significant deficiencies in performance resulting from the low temperature storage.

6.2.4 Transportability

Subject the test item to the applicable sections of MTP 10-2-503 and the following:

- a. Visually inspect the test item and record the type of, and location of any defects or damages, such as cracks, chips or punctures.
- b. Package the test item in a normal shipping case.
- c. Drop the test item package on all edges and faces from a height of 5 feet onto a concrete floor. Record any damages to the test item package.
- d. Remove the test item from the shipping case, inspect for, and record any damages.
- e. Repeat the performance tests of paragraph 6.2.1 and record any significant deficiencies in performance.

6.2.5 Safety

Perform the following throughout all testing:

- a. Observe normal safety precautions when utilizing the test item.
- b. Record any safety hazards, cause of the hazard, and steps taken to alleviate the hazard.
- c. Issue a safety release in accordance with USATECOM Regulation 385-6.

6.2.6 Maintainability and Reliability Evaluation

NOTE: Missing, inappropriate, or incomplete maintenance packages will be reported on AMSTE form 1025 in accordance with USATECOM Regulations 705-4.

Evaluate the maintenance-related factors of the test item as described in MTP 10-2-507 with emphasis on the following:

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

6.2.7 Human Factors Evaluation

a. Determine the adequacy of the design and performance characteristics of the test item in terms of conformance to appropriate human factors engineering design criteria as outlined in USAGETA document, Human Factors Evaluation Data for General Equipment (HEDGE), and as described in the applicable sections of MTP 10-2-505.

b. Prepare a checklist which shall consider the following general items and tasks:

NOTE: Task/item checklists shall be constructed which allow space for test personnel comments regarding satisfactory or unsatisfactory compliance with the design criteria associated with each task.

1) Operability, including:

NOTE: Observe and record any special problems encountered by left handed personnel.

- a) Carrying case, if provided.
- b) Reading of labels.
- c) Alignment guides/controls.
- d) Securing devices.
- e) Accuracy and suitability of scales/markings in terms of user ability to discriminate between mappings and accurately read the scales.

2) Maintainability, including:

- a) Tools and special equipment
- b) Operating components
- c) Manuals

3) Transportability, including:

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- a) Packaging
- b) Handling

6.2.8 Value Analysis

During operation and maintenance of the test item test and supervisory personnel will observe and record any design features that can be eliminated, modified, or reduced in cost without affecting the technical performance, durability, or safety characteristics of the test item.

6.3 TEST DATA

6.3.1 Preparation for Test

6.3.1.1 Pre-Test Inspection

Record the following:

- a. Evidence of package damage or deterioration
- b. Identification markings including:
 - 1) Manufacturer
 - 2) Number and date of contract
 - 3) Date of manufacture
 - 4) All other pertinent markings
- c. For test item shipping package:
 - 1) Weight, in lbs.
 - 2) Length, width and height or diameter, in feet and inches
 - 3) Cubage, in ft³
- d. Type and adequacy of packing material
- e. For test item and major components:
 - 1) Identification of item, name and serial number
 - 2) Evidence of defects in:
 - a) Manufacturing
 - b) Material
 - c) Workmanship
 - 3) For drafting instrument set cases:
 - a) Torn or defective covering or lining
 - b) Improper snap fastener operation
 - c) Instruments not fitting snugly in case
 - d) Instruments contacting one another
 - 4) For drafting instruments:

- a) Missing or damaged parts.
- b) Whether all metal components are free of surface irregularities, roughness, and are properly finished.
- c) Whether plastic components are free of cracks, chips, warping, or surface roughness or irregularities.
- d) Hardness of lead provided (2H, 4H, etc.).

6.3.1.2 Physical Characteristics

Record the following for each test item/test item component:

- a. Item under test (compass, drafting instrument set case, etc.).
- b. Data collected as described in MTP 10-2-500.
- c. Weight, in pounds and ounces.
- d. Length, width and height or diameter, in feet and inches.
- e. If applicable, minimum and maximum extension of adjustable instruments such as dividers, compasses, or ruling pens.
- f. Angles, in degrees, of such instruments as T-squares, triangles, and the fixed 90 degree angles on drafting machines.
- g. Instruments rejected for out-of-tolerance angle measurements, if applicable.

6.3.1.3 Operator Training and Familiarization

Record the following:

- a. Data collected as described in the applicable sections of MTP 10-2-501.
- b. Adequacy of manuals for training purposes.

6.3.2 Test Conduct

6.3.2.1 Performance

6.3.2.1.1 Marking Accuracy -

Record the following:

- a. Test item nomenclature (ruler, drafting machine, etc.)
- b. For components with linear distance scale:
 - 1) Distance between line segments as drawn from the test item scale.
 - 2) Distance between line segments as measured by the standard ruler.
- c. For components with an angular scale:
 - 1) Angle as drawn from the test item scale
 - 2) Angle as measured by the standard protractor

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6.3.2.1.2 Straightedge Devices -

Record the following:

- a. Type of straightedge device under test
- b. For each light gap:
 - 1) Location
 - 2) Thickness gage reading

6.3.2.1.3 Curves and Templates -

Record the following:

- a. Identification of device under test
- b. Ease of use
- c. Overall functional suitability of device
- d. Special problems associated with use of any template symbol

6.3.2.1.4 Pens -

Record the following for each pen tested, as applicable:

- a. Type of pen (ruling, non-adjustable)
- b. For test item identification:
 - 1) Length
 - 2) Nominal line width(s), in inches
 - 3) Manufacturer
 - 4) Model number
- c. For ruling pens:
 - 1) Deficiencies in operation of pen nib adjustment screw
 - 2) Minimum and maximum line widths obtainable, in inches
- d. Average width of lines drawn for non-adjustable pens
- e. For all pens:
 - 1) Type of surface utilized.
 - 2) Type of ink utilized.
 - 3) Irregularities or breaks in lines.
 - 4) Sharpness and clarity of lines.
 - 5) Evidence of pen point cutting into the drawing surface.
 - 6) Ease of using pen.
 - 7) Test personnel comments on overall functional suitability of pens.

6.3.2.1.5 Compass and Bow Instruments with Pen Attachments -

Record the following:

- a. For test item identification:
 - 1) Nominal size of instrument.
 - 2) Nominal or specified minimum and maximum diameters obtainable with and without extension bar.
 - 3) Line widths available with pen attachments.
- b. Deficiencies in pen nib adjustment screw, if applicable.
- c. Ease of adjusting instrument for varying diameters.
- d. Maximum circle diameter obtainable, in inches:
 - 1) Without extension bar
 - 2) With extension bar
- e. Minimum circle diameter obtainable, in inches:
 - 1) Without extension bar
 - 2) With extension bar
- f. Line widths obtainable
- g. For each circle drawn:
 - 1) Type of surface utilized
 - 2) Circle diameter, in inches
 - 3) Line width used, if applicable
 - 4) Type of ink utilized
 - 5) Irregularities or breaks in line
 - 6) Sharpness and clarity of lines
 - 7) Evidence of pen point cutting into drawing surface
- h. Test personnel comments regarding overall functional suitability of the instrument.

6.3.2.2 Materials Evaluation

6.3.2.2.1 Accelerated Aging (Plastics) -

Record the following:

- a. Test conditions.
- b. Warping, cracking, or other damages to the plastic material.
- c. Applicable data as required by paragraph 6.2.1.
- d. Significant deficiencies in performance and/or overall effect on test item as a result of accelerated aging test.

6.3.2.2.2 Flammability (Plastics)

Record the data required by Federal Test Method Standard 406, method 2021 including:

- a. Whether material is considered flammable

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- b. Burning rate if applicable
- c. Possible safety hazards

6.3.2.2.3 Rockwell Hardness (Metals)

Record the Rockwell hardness value for each instrument tested.

6.3.2.3 Environmental Storage

6.3.2.3.1 High Temperature Storage -

Record the following:

- a. Damages to test item.
- b. Applicable data as required by paragraph 6.2.1.
- c. Significant deficiencies in performance and/or overall effect on test item as a result of exposure to high temperature.

6.3.2.3.2 Low Temperature Storage -

Record the following:

- a. Damages to test item.
- b. Applicable data as required by paragraph 6.2.1.
- c. Significant deficiencies in performance and/or overall effect on test item as a result of exposure to low temperature.

6.3.2.4 Transportability

Record data required by MTP 10-2-503 and the following:

- a. Type and location of any defects or damages prior to test.
- b. Damages to the test item after test.
- c. Applicable data as directed in paragraph 6.2.1.
- d. Significant deficiencies in performance and/or overall effect of test on the test item.

6.3.2.5 Safety

Record the following throughout the test:

- a. Normal safety precautions observed.
- b. Safety hazards observed, cause of hazard, and steps taken to alleviate the hazard.

6.3.2.6 Maintainability and Reliability Evaluation

Record data collected as described in the applicable sections of MTP 10-2-507.

6.3.2.7 Human Factors Evaluation

- a. Record data required by MTP 10-2-505.
- b. Complete the task/item checklists by rating satisfactory or unsatisfactory inclusion of the various design criteria in the test item.
- c. Record test personnel comments regarding adequacy of controls, adjustments, and indicators, and ease of operating, maintaining, and transport-test item.

6.3.2.8 Value Analysis

Record the following:

- a. Design features which can be eliminated, modified, or reduced in cost without affecting technical performance, durability, or safety of the test item.
- b. Test personnel comments.

6.4 DATA REDUCTION AND PRESENTATION

Data shall be summarized to reveal significant discrepancies between specified and observed performance and presented in chart, tabular, graphic, or narrative form as appropriate. When performance evaluation is repeated after exposing the test item to various stress conditions, the data shall be presented in a manner to reveal significant deficiencies in performance resulting from the test. A summary chart shall be prepared which lists specific requirements from the QMR's, SDR's, or other developmental criteria and reveals whether the test item has satisfactorily met the criteria. When a requirement has not been met, an analysis shall be made to determine reasons for the failure and appropriate suggestions for improvement rendered.