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Materiel Test Procedure 7-3-054
U. S. Army Aviation Test Board

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

AIRCRAFT REFUELING/DEFUELING SYSTEMS

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1. OBJECTIVE

This document provides guidelines for developing test methods and techniques necessary to determine the degree to which installed aircraft refueling/defueling systems and their auxiliary equipment and associated tools and test equipment (maintenance package) meet the requirements stated in Materiel Need (MN) and their suitability for Army use.

2. BACKGROUND

Refueling and defueling systems have been developed for tactical Army aircraft in accordance with the requirements dictated by mission and operational environment.

Refueling operations (ground to air) are designed to insure a minimum of ground time within the limits of safety and to increase the operating range of the aircraft. Both operations require positive aircraft movement control, safe and standardized refueling techniques, and close coordination between refueling personnel and the aircrew.

Defueling operations, the removal of fuel from the aircraft tanks are required to: perform maintenance on the fuel system, check and calibrate quantity indicating mechanisms, verify aircraft weight and balance, and to prepare aircraft for shipment or storage.

New refueling and defueling systems are constantly being developed and existing systems modified to support new and changed military concepts. Such refueling and defueling systems shall be subject to a period of service testing to determine their suitability for Army use.

3. REQUIRED SUPPORT

3.1 FACILITIES

- a. Suitable operational airfield(s) and test sites.
- b. Air and land space to conduct tests.

3.2 EQUIPMENT

- a. Measuring tools for determining system dimensions and weight.
- b. Photographic equipment.
- c. Appropriate number and types of test bed aircraft, vehicles and equipment.
- d. Avionics and electronic maintenance support - as required.
- e. Standard petroleum handling equipment.
- f. Equipment required by referenced MTPs.

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MTP 7-3-054
1 July 1971

3.3 PERSONNEL

Personnel in appropriate numbers, of the proper MOS and with special training as required.

4. REFERENCES

- A. Army Regulation 385-16, Safety: Safety for Systems, Associated Subsystems, and Equipment.
- B. Army Regulation 750-6, Maintenance of Supplies and Equipment: Maintenance Support Planning.
- C. USATECOM Regulation 70-23, Research and Development: Equipment Performance Reports (EPRs).
- D. USATECOM Regulation 70-24, Research and Development: Documenting Test Plans and Reports.
- E. USATECOM Regulation 108-1, Photographic Coverage. (As implemented by USAAVNTBD Memo 108-1).
- F. USATECOM Regulation 385-6, Safety: Verification of Safety of Materiel During Testing.
- G. USATECOM Regulation 700-1, Quality Assurance: Value Engineering.
- H. USATECOM Regulation 750-15, Maintenance of Supplies and Equipment: Maintenance Evaluation During Testing.
- I. MIL-STD-129, Marking for Shipment and Storage.
- J. MIL-STD-130, Identification Marking of US Military Property.
- K. MIL-STD-882, System Safety Program for Systems and Associated Subsystems and Equipment: Requirements for.
- L. MTP 6-3-501, Pretest Inspection for Service Test.
- M. MTP 6-3-502, Personnel Training Requirements.
- N. MTP 6-3-506, Durability.
- O. MTP 6-3-509, Effects of Weather.
- P. MTP 7-3-500, Physical Characteristics.
- Q. MTP 7-3-506, Safety.
- R. MTP 7-3-507, Maintenance (Maintainability/Availability).
- S. MTP 7-3-508, Reliability.
- T. MTP 7-3-509, Compatibility with Related Equipment.
- U. MTP 7-3-510, Human Factors.
- V. MTP 7-3-514, Adequacy of Technical Manuals.
- W. MTP 7-3-519, Photographic Coverage.
- X. MN for aircraft refueling/defueling systems.

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5. SCOPE

5.1 SUMMARY

This materiel test procedure describes tests for evaluating the refueling/defueling systems incident to aircraft operation and maintenance. During ground and flight operations the refueling/defueling system will be evaluated by test operators with skills representative of those normally assigned to operate such equipment. The suitability of aircraft refueling/defueling systems will be evaluated against the requirements established in applicable MN or other approved documents.

5.1.1 Preparation for Test

This section provides guidance for test project planning to determine the facility, equipment requirements, and training for test personnel familiarization.

5.1.2 Test Conduct

The tests and evaluations are arranged in a logical sequence to provide a step-by-step analysis of the suitability of refueling/defueling systems to perform their prime functions of reducing to a minimum the ground time required for fueling, increasing the range of the aircraft through air refueling, and rendering the aircraft safe for maintenance, storage and shipment through defueling operations. The specific tests to be performed, and their intended objectives, are listed below:

a. Initial Inspection - To determine the condition and completeness of the aircraft refueling/defueling system(s).

b. Operational Performance - To determine the adequacy and suitability of aircraft refueling/defueling systems to provide safe standardized refueling/defueling techniques and to establish conformance with design requirements.

c. Durability - To evaluate the time in service, failure potential of components and durability of the aircraft refueling/defueling systems during operation.

d. Effects of Weather - To determine the capabilities and limitations imposed upon the operation of the aircraft refueling/defueling system due to the extremes of weather.

e. Maintenance Evaluation - To determine the maintenance/maintainability requirements of aircraft refueling/defueling systems and the adequacy of the maintenance test package (tools and test equipment, equipment technical manuals, and repair parts).

f. Maintainability - An evaluation to determine adequacy of design characteristics which is expressed as the probability that an item will be retained in or restored to a specified condition within a given period of time, when maintenance is performed in accordance with prescribed procedures and resources.

g. Reliability - An evaluation to determine the probability that the test item will perform its intended function for a specified interval under stated conditions.

h. Achieved Availability - To evaluate the probability that aircraft refueling/defueling systems, when used under stated conditions in an ideal support environment will operate satisfactorily at any given time.

MTP 7-3-054
1 July 1971

i. Safety - To identify and examine hazardous characteristics of the refueling/defueling system.

j. Human Factors - To determine if the aircraft refueling/defueling system is designed so as to comply with accepted human factors engineering principles.

k. Personnel Training Requirements - To evaluate the scope and effectiveness of pretest training associated with operating and maintaining aircraft refueling/defueling systems and the requirement, if any, for additional training.

l. Compatibility with Related Equipment - A determination of the suitability of aircraft refueling/defueling systems for operation with related equipment in various configurations.

5.1.3 Test Data

This section details the data to be collected and recorded while completing the test procedures in section 6.2, Test Conduct.

5.1.4 Data Reduction and Presentation

This section provides instructions for evaluating and displaying the data recorded during testing.

5.2 LIMITATIONS

This MTP is not intended to cover service testing of refueling/defueling equipment external to the aircraft system used during the refueling/defueling operation.

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Test Planning

Formulate a plan of test utilizing reference 4.D and the following general procedures:

a. Review

- 1) The test directive.
- 2) The MN.
- 3) Other applicable sources of criteria.
- 4) Instructional material available from the manufacturer.
- 5) All reports of previous tests conducted on like types of equipment.

b. Prepare a detailed test schedule showing proposed time periods allotted for each test listed in paragraph 5.1.2. Ensure that a sufficient number of samples of all measurements are taken to provide statistical confidence in the final data.

c. Prepare necessary forms for entry of test data.

d. Develop adequate safety measures to provide essential safety for personnel and equipment. Ensure that these measures are observed throughout the test. Safety Release or Confirmation will be obtained in accordance with reference 4.F.

e. Plan to utilize photographic techniques where possible to record and document standard and test configurations and test results. (See reference 4.E and 4.W).

6.1.2 Required Support

a. Review the support requirements of section 3.

b. Select and schedule suitable operational areas at representative locations. Ensure availability of maintenance support facilities, special test equipment, repair parts, and personnel.

c. Ensure that all required support aircraft and vehicles have been scheduled.

d. Coordinate with supporting and participating agencies, activities, and facilities.

6.1.3 Personnel

Ensure that service personnel, with the appropriate MOS and skill levels for the operation and maintenance of aircraft refueling/defueling systems are adequately trained as prescribed in reference 4.M. Include the following:

a. Procedures to be followed and the data to be collected during test conduct.

b. Known hazards and safety precautions associated with the test procedures, test equipment, and aircraft refueling/defueling systems.

6.2 TEST CONDUCT

NOTE: Various subtests shall be conducted concurrently whenever possible, so that the time needed to collect the required data will be minimized.

MTP 7-3-054
1 July 1971

6.2.1 Initial Inspection

6.2.1.1 Visual Inspection

Perform the following:

a. An inventory check against the Basic Issue Item List (BIIL). Submit an Equipment Performance Report (EPR) for shortages or discrepancies in accordance with the provisions of reference 4.C.

b. Inspection procedures required by reference 4.L to include the following:

- 1) Visual inspection for defects.
- 2) Removal of all preservatives and foreign materials.
- 3) Check for completeness of assembly.
- 4) Inclusion of maintenance support package.

6.2.1.2 Physical Characteristics

Determine the physical characteristics of the aircraft refueling/defueling systems equipment according to the procedures of reference 4.P. Photograph the equipment (reference paragraph 4.W).

6.2.2 Operational Performance

a. Ground Fueling Operations

Fuel aircraft using acceptable methods. Evaluate the operation of the system from the viewpoints of safety, efficiency and minimum refueling time.

b. Aerial Refueling

Perform aerial refueling operations if applicable to the system installed in the aircraft. Evaluate the operation of the system from the viewpoint of safety, efficiency and increased capabilities of the aircraft to perform mission requirements.

c. Fuel Jettison System

Operate fuel jettison system, if applicable, and evaluate the efficiency and safety of performance.

d. Defueling Operations

Defuel the aircraft using acceptable methods. Determine the degree to which all evidence of fuel and related fumes can be eliminated from the system and the effectiveness of the purging system if applicable.

6.2.3 Durability

Monitor the durability of the aircraft refueling/defueling system in accordance with the applicable procedures of reference 4.N.

6.2.4 Effects of Weather

Operate the aircraft refueling/defueling system under all conditions of existing weather as described in the procedures of reference 4.O.

6.2.5 Maintenance Evaluation

Perform the maintenance requirements as detailed in references 4.H and 4.R. Utilize personnel possessing the appropriate MOS and skill levels, tools and test equipment, technical manuals, and repair parts for the prescribed level of maintenance. Record all maintenance actions required for retaining equipment in, or restoring it to, specified conditions on the Maintenance Analysis Chart described in reference 4.H.

a. Tools and Test Equipment

Evaluate the use of common and special tools and test equipment to determine whether they are suitable and needed for the intended purpose and prescribed maintenance level. Perform the applicable procedures of reference 4.H and 4.R. Record all relevant findings in the Special Tool Analysis Chart described in reference 4.H.

b. Technical Manuals

Evaluate the content and adequacy of the equipment technical manuals for their intended maintenance levels as specified in reference 4.H and 4.V. Record all pertinent data and comments in the Maintenance Package Literature Chart described in reference 4.H.

c. Repair Parts

Evaluate the adequacy and quantity of repair parts provided for all levels of maintenance in accordance with the procedures of references 4.H and 4.R. Record all pertinent data and comments in the Parts Analysis Chart described in reference 4.H.

6.2.6 Maintainability

Assess the maintainability characteristics of the aircraft refueling/defueling system in accordance with references 4.H and 4.R to evaluate the following:

a. The degree to which the equipment meets the maintainability design requirements specified by the MN or other established criteria.

- b. Whether the time required for individual maintenance operations is considered excessive based on previous experience with similar equipment.
- c. The ease of access to facilitate inspection, test, repair and replacement.
- d. The maximum utilization of interchangeable components.
- e. The maximum utilization of common tools for maintenance operations.
- f. The degree to which major components are designed for removal as individual units.
- g. The existence of conditions which will adversely affect the conduct of maintenance operations or generate excessive maintenance requirements.

6.2.7 Reliability

Beginning with the initial checkout of the aircraft refueling/defueling system assess the reliability characteristics of the system in accordance with reference 4.S. Make maximum use of the data collected and recorded on the special analysis chart used in evaluating the maintenance test package as described in reference 4.H.

6.2.8 Achieved Availability

To evaluate the achieved availability of the aircraft refueling/defueling system, ensure that sufficient data is recorded on the special analysis charts described in references 4.H and 4.R to be able to determine the two factors, mean-time-between-maintenance (MTBM) and mean active maintenance downtime (\bar{M}) resulting from both preventive and corrective maintenance actions. At the completion of service testing, extract and summarize this data and compute achieved availability (A_a) using the following formula:

$$A_a = \frac{MTBM}{MTBM + \bar{M}} \quad (\text{references 4.H and 4.R})$$

6.2.9 Safety

- a. Monitor all hazards associated with aircraft refueling defueling systems in accordance with reference 4.Q.
- b. Provide Safety Confirmation in accordance with the provisions of reference 4.F.
- c. In addition to data required by reference 4.Q, record comments concerning the following:

- 1) Analysis to establish that no identifiable hazards are present during testing or operation of the aircraft refueling/defueling system.
- 2) Evaluation of any hazards, including air pollution, associated with operation and maintenance of aircraft refueling/defueling systems.

6.2.10 Human Factors Evaluation

A. Monitor and appraise human factors to identify design or operational features conducive to error and delay in mission accomplishment by user personnel in accordance with the procedures given in reference 4.U. Determine whether use of the aircraft refueling/defueling system equipment causes physical discomfort to the operator.

b. Prepare checklists for all tasks associated with all phases of operation and maintenance. These checklists shall be used to rate each task as satisfactory or unsatisfactory; include the following:

- 1) Communications quality of instructions as indicated by the ease of understanding technical manuals.
- 2) System design to the extent of personnel compatibility with instrument arrangement, controls, etc.
- 3) Minimum and optimum number of personnel for each action and the skill level(s) required.
- 4) Time(s) required.

6.2.11 Personnel Training Requirements

a. Monitor and evaluate all operator and organizational maintenance personnel training requirements in accordance with reference 4.M.

b. In addition to the data required by reference 4.M, record narrative comments concerning the following training factors:

- 1) Scope and effectiveness of pretest training.
- 2) Need for additional training in the same or different fields.

6.2.12 Compatibility with Related Equipment

Perform applicable sections of reference 4.T to determine any lack of compatibility that may exist between aircraft refueling/defueling systems and related refueling/defueling equipment.

6.3 TEST DATA

6.3.1 Preparation for Test

Data to be recorded prior to testing shall include, as a minimum, the following:

MTP 7-3-054
1 July 1971

- a. Test item nomenclature, serial number(s), manufacturer's name, and other pertinent data.
- b. Test equipment nomenclature, serial number(s), manufacturer's name, functional description, accuracy tolerances, calibration requirements and the data of last calibration.
- c. Detail of damages incurred prior to test start.

6.3.2 Test Conduct

a. Data originating in all tests and phases shall be recorded in the following forms, as appropriate.

- 1) Operators', observers', and test controllers' records and questionnaires.
- 2) Narrative comments and observations.
- 3) Maintenance records.
- 4) Photographs; still and movie.
- 5) Diagrams and sketches.

b. All data items shall be properly identified and annotated with respect to--

- 1) Test, subtest, test phase.
- 2) Source.
- 3) Time.
- 4) Pertinent correlative information.

c. Data to be recorded in addition to specific instructions given in succeeding paragraphs for each subtest shall include:

- 1) Sample size (number of measurement repetitions).
- 2) Instrument or measurement system mean accuracy tolerances.

6.3.2.1 Initial Inspection

6.3.2.1.1 Inventory Check and Visual Inspection

Record the following:

- a. Evidence of damage incurred prior to receipt.
- b. Exterior identification markings of the shipment in accordance with reference 4.I or other governing documents.
- c. Interior markings of shipment in accordance with reference 4.J or other governing documents.
- d. Physical condition.

e. The completeness of the shipment when items are compared against the BIL. Indicate also, the existence of materiel discrepancies in the shipment and the number of EPR's which were prepared.

6.3.2.1.2 Physical Characteristics

a. Record the physical characteristics of each major unit of the aircraft refueling/defueling system according to the procedures of reference 4.P.

b. Identify and retain all photographs taken.

6.3.2.2 Operational Performance

Record the following:

a. Ground Fueling Operations

- 1) Fueling system used (normal or rapid).
- 2) Maximum number of servicing adapters.
- 3) Refueling time (minutes).
- 4) Type of fuel reservoir, i.e., tank vehicle, collapsible fabric tank, etc.
- 5) Fuel flow (gpm).
- 6) Nozzle inlet pressure (psig).
- 7) Diameter of hose assemblies (inches).
- 8) Adequacy of refueling system.

b. Aerial Refueling

- 1) Fuselage pitch angle during refueling in light and heavy gross weight configuration.
- 2) Any hose interference and disconnect ability.
- 3) Determine aerial refueling speed altitude envelope and aircraft configuration.
- 4) Determine effect of flight to moderate air turbulence and moderate to heavy air turbulence on time required to accomplish hook-up.
- 5) Evaluate the adequacy of night lighting during a transition from twilight to dusk to full dark conditions.
- 6) Flow rates (gpm) during refueling.
- 7) Any difficulties encountered.
- 8) Evaluate increased capabilities resulting from air refueling.
- 9) System adequacy.

c. Fuel Jettison System

- 1) Average jettisoning rate.
- 2) Quantity of fuel which cannot be jettisoned (gallons).
- 3) Aircraft controllability during jettison operation.

MTP 7-3-054
1 July 1971

- 4) Does fuel or fumes impinge or enter any portion of the aircraft?
- 5) System adequacy.

d. Defueling Operations

- 1) Method used to defuel aircraft.
- 2) Defueling time (minutes).
- 3) Fuel flow (gpm).
- 4) Fuel remaining in aircraft (gallons).
- 5) System adequacy.

6.3.2.3 Durability

Record data requirements of reference 4.N.

6.3.2.4 Effects of Weather

Record data required by applicable procedures of reference 4.0.

6.3.2.5 Maintenance Evaluation

Record data required by references 4.H and 4.R and complete the following forms:

- a. Maintenance Analysis Chart.
- b. Special Tools and Test Equipment Chart.
- c. Maintenance Package Literature Chart.
- d. Parts Analysis Chart.

6.3.2.6 Maintainability

Record applicable requirements of references 4.H and 4.R and comments on the following:

- a. Degree of accomplishment of the maintainability design requirements of the MN or other established criteria.
- b. Maintenance time required as compared to previous experience or similar equipment.
- c. Ease of access for inspection, test, repair and replacement.
- d. Utilization of interchangeable components.
- e. Utilization of common tools for maintenance.

1 July 1971

- f. Design of major components for removal as individual units.
- g. Conditions which will adversely affect maintenance operations.

6.3.2.7 Reliability

Record data required by reference 4.S.

6.3.2.8 Achieved Availability

Record the following:

- a. Mean-time-between-maintenance (MTBM).
- b. Mean active maintenance downtime (\bar{M}).
- c. Calculated value of achieved availability (A_a).

6.3.2.9 Safety

Record the following:

- a. Data in accordance with reference 4.Q.
- b. Comments concerning Safety Confirmation.
- c. Analysis of identifiable hazards associated with operation of the equipment.
- d. Evaluation of possible hazards including air pollution, associated with the operation and maintenance of the equipment.

6.3.2.10 Human Factors Evaluation

Record the following:

- a. Data in accordance with reference 4.U.
- b. Test phases on motion picture film.
- c. Times of accomplishment of phases in hours and minutes.
- d. Comments pertaining to the capability of average trained operator and maintenance personnel to operate and maintain aircraft refueling/defueling system equipment.

6.3.2.11 Personnel Training Requirements

- a. Record data in accordance with reference 4.M.

MTP 7-3-054
1 July 1971

b. Record comments concerning the scope and effectiveness of pretest training and any needs for additional training.

6.3.2.12 Compatibility with Related Equipment

Record data required by reference 4.T.

6.4 DATA REDUCTION AND PRESENTATION

6.4.1 Data Reduction

Processing of raw data shall, in general, consist of organizing, marking for identification and correlation, and grouping the test data according to subtest title. The criteria or specifications shall be noted on the test data presentation to facilitate analysis and comparison. Where necessary, test data measurement units shall be converted to be compatible with units given by test criteria or specifications.

6.4.2 Date Presentation

Presentation of test results shall consist of--

a. Composite documentation of the reduced and correlated data arranged by test phases in the general form of narrative description supported by diagrams, photographs, graphs, and tabular data.

b. The degree to which the aircraft refueling/defueling system provides safe and expeditious refueling and defueling of Army aircraft.

c. Supplements or annexes to the basic document, delineating the common service test factors which are of sufficient scope, importance and/or complexity to warrant separate treatment. Each supplement shall include the applicable supporting data.

d. A further analysis to determine the extent to which the aircraft refueling/defueling system under test exceeds the performance characteristics or otherwise provides distinct advantages over existing Army equipment providing the same requirements.

e. Recommendations as to the suitability of the aircraft refueling/defueling system and its maintenance test package for use by the Army.

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16

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