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Materiel Test Procedure 5-3-101
U.S. Army Aviation Test Board

US ARMY TEST AND EVALUATION COMMAND
COMMODITY SERVICE TEST PROCEDURE

MISSILE, AIR-TO-GROUND

1. OBJECTIVE

This document provides existing test methods and techniques to determine the degree to which air-to-ground missiles and allied aircraft equipment meet the requirements specified by the Qualitative Materiel Requirement (QMR), Small Development Requirements (SDR), Technical Characteristics (TC's), and whether or not the air-to-ground missile and maintenance test packages are suitable for Army use.

2. BACKGROUND

There are continuing requirements for the development of new and improved aircraft-mounted, point and area target weapon subsystems which utilize air-to-ground guided missiles. These subsystems are needed to increase the maximum effective target engagement range in order to grant a standoff capability to the launching aircraft and thereby reduce its vulnerability to small arms fire and anti-aircraft defenses.

These missiles are required to possess low susceptibility to countermeasures through favorable time-of-flight characteristics and secure in-flight guidance systems. Launches may be required from ranges of 500 meters to over 3,500 meters, from aircraft operating at nap-of-the-earth altitudes to heights greater than 5,000 feet, and from hover positions to airspeeds approaching the never-to-exceed velocity. Targets will vary from moving tanks and strongly fortified bunkers to road blocks and other point and small area targets.

The missile service test must duplicate or realistically simulate conditions of intended use to include the utilization of typical aviation unit personnel, maintenance facilities, and available field storage provisions. Additionally, the missile service test must be conducted under the stress of flight envelopes commonly encountered when launched from the aircraft against simulated tactical targets. Also, the missile service test should be conducted under environmental conditions similar to those found in the theaters of intended use.

3. REQUIRED EQUIPMENT AND FACILITIES

- a. Measuring tools and scales for determining missile dimensions and weight.
- b. Appropriate aircraft for flight testing.
- c. Aircraft for observations, utility, reconnaissance, and photography.

- d. Aerial camera(s) and film.
- e. Ground handling equipment as required for missile loading.
- f. Suitable targets.
- g. Communications equipment and operators (radio and telephone).
- h. POL supplies.
- i. Meteorological equipment.
- j. Timers and/or stopwatches.
- k. Automatic, high-speed target camera(s).
- l. Suitable firing ranges.
- m. Suitable operational airfield(s)
- n. Personnel of appropriate MOS and skill level(s).
- o. Missile in the quantity required for QMR/SDR specified

sample size.

- p. Storage facilities.
- q. Equipment to measure levels of toxic gases in the pilot

compartment atmosphere.

4. REFERENCES

- A. Army Regulation 385-16, Safety: Safety for Systems, Associated Subsystems, and Equipment.
- B. USATECOM Regulation 70-23, Research and Development: Equipment Performance Reports (EPRs).
- C. USATECOM Regulation 70-24, Research and Development: Documenting Test Plans and Reports. (As implemented by USAAVNTBD Pamphlet 705-1)
- D. USATECOM Regulation 385-6, Safety: Verification of Safety of Materiel During Testing.
- E. USATECOM Regulation 700-1, Quality Assurance: Value Engineering.
- F. USATECOM Regulation 750-15, Maintenance of Supplies and Equipment: Maintenance Evaluation During Testing. (As implemented by USAAVNTBD Memo 750-2).
- G. MIL-STD-129, Marking for Shipment and Storage.
- H. MIL-STD-704, Electric Power, Aircraft Characteristics and Utilization of.
- I. MIL-STD-882, System Safety Program for Systems and Associated Subsystems and Equipment: Requirements For.
- J. TM 55-405-9, Army Aviation Maintenance Engineering Manual, Weight and Balance.
- K. MTP 7-3-015(H), Aircraft Armament.
- L. FM 1-40, Attack Helicopter Gunnery.
- M. FM 1-110, Attack Helicopter Employment.

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5. SCOPE

5.1 SUMMARY

The evaluation of air-to-ground missile effectiveness against point and area targets is only one element of the overall service test

requirements for subsystems of this type. Additional elements of the service test must address maintenance considerations, safety aspects, limitations involved in employment, compatibility with the user and appropriate aircraft and adequacy of the equipment from the human factors standpoint.

To quantitatively evaluate these elements, service tests are conducted under operational conditions by personnel representative of those who will be involved in actual missile launch operations. It will be the objective of the service test to record the observations of supervisory test personnel together with the measurements of important missile performance parameters. Test personnel will be interviewed, their observations and recommendations recorded and correlated with the still and motion pictures taken during testing.

The data collected during the service test will be reviewed to obtain numerical indicators which characterize the equipment's performance. Tabulations, charts, and other graphic displays will be employed to present these indicators. Evaluation of the data will include comparisons with the numerical values of desired performance criteria and with the performance indicators obtained from the use of other armament subsystems in similar mission roles.

5.1.1 Preparation for Test

This section provides guidance for test project planning, facility and equipment requirements, preparation for test personnel training and familiarization, and target area preparations.

5.1.2 Test Conduct

The tests and evaluations are arranged in a logical sequence to provide step-by-step analysis of the missile and subsystem's suitability to meet required effectiveness criteria in the typical aviation combat environment. These tests are as follows:

a. Inspection and Physical Characteristics -- This section provides procedures for determining the physical characteristics and condition of the subsystem as received by the Aviation Test Board.

b. Installation Requirements -- A determination of the equipment's installation characteristics and the tools, number of personnel, skill levels, time, and facilities required to adequately install, align, and checkout the equipment in selected Army aircraft.

c. Weight and Balance -- A determination of the effect of allied equipment and missile load on aircraft balance and gross takeoff weight.

d. Operational Performance -- An evaluation of the equipment's performance characteristics, including the following:

- 1) Guidance and Trajectory Efficiency.
- 2) Terminal Effectiveness.
- 3) Night Effectiveness.

e. Handling Requirements -- Evaluation of the missile from the standpoint of determining special handling or storage provision required to achieve the desired performance and reliability.

f. Maintenance -- Evaluations in which maintenance actions resulting from testing are noted and reported. Personnel required, tools and equipment, availability of repair parts, suitability of maintenance instructions, and mean time to repair are evaluated and recorded. Recommendations are solicited to reduce incidences of recurrent, unscheduled maintenance and to simplify maintenance requirements, as appropriate.

g. Personnel and Training Requirements -- An evaluation to determine the number of personnel of specific skill levels and proficiency required to prepare, maintain, and employ the subsystem under simulated combat conditions.

h. Human Factors -- An evaluation of the man equipment interface to determine the adequacy of equipment design and performance characteristics related to the physical and psychological effects of the subsystem's use on flight and ground personnel.

i. Safety -- An evaluation of subsystem safety characteristics and possible hazards while the equipment is being ground handled, loaded, armed, employed, maintained, and unloaded, if applicable. Also, to provide safety confirmation for the subsystem, if appropriate.

5.1.3 Test Data

This section details the data to be collected and recorded while completing the procedures of 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 intended to be used as a basic guide during the preparation of test plans for guided missile subsystems. Suitability for Army use criteria and attendant test procedures shall be determined in response to specific QMR, SDR, or TC requirements.

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Test Project Planning

The project officer should consult reference 4.C. for guidance with respect to plans and reports of tests. Certain planning information specifically applicable to air-to-ground missiles is provided by the following paragraphs.

6.1.1.1 Test Criteria

The project officer shall select test criteria which will adequately satisfy the officially stated objectives for service testing the missile and subsystem. Perform as a minimum, the following actions:

- a. Review the test directive.
- b. Study the QMR, SDR, or TC's.
- c. Review authorized sources of criteria such as --
 - 1) Designated test directive references.
 - 2) Commodity technical specifications, or drafts thereof.
 - 3) Special instructions and references accompanying the test directive.
- d. Review authorized criteria inputs from cooperating agencies.
- e. Prepare a listing of air-to-ground missile test criteria, which states in a logical sequence the parameters against which service test data may be compared to determine whether or not the objectives for the service test have been realized. At the same time, prepare a similar listing of requirements documents criteria which --
 - 1) Are beyond the state-of-art to test.
 - 2) Are beyond the mission of the Aviation Test Board charter.

Coordinate items 1) and 2) with appropriate levels of command and prepare the test plan using this document for test procedural guidance.

6.1.1.2 Required Equipment, Facilities and Personnel

Schedule for the use of items that require long lead times such as appropriate test sites of varying terrain and climatic conditions, installation and maintenance areas, etc. In addition, schedule for the items listed under section 3., Required Equipment and Facilities, and for special consultants, e.g., armament specialists, etc., or other personnel required during the service test.

6.1.1.3 Test Conditions

a. Aircraft, flight personnel, and associated equipment used during the conduct of the service test will be authorized under the aviation

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unit(s) table of organization and equipment (TOE).

b. Personnel with the appropriate MOS will perform ground handling, aircraft loading, pre-flight maintenance, and checkout of aircraft allied equipment using typical aviation unit ground support equipment, tools, and other equipment required for maintenance of subsystem under test.

c. Mission length will be based on actual mission times and provisions will be made for maintenance and nominal turnaround intervals.

d. In addition to missile firing missions, evaluate aircraft missions in which missile subsystem components and allied equipment are installed but are not required for mission, e.g. cargo, personnel transport, etc. Evaluate the installation of the missile subsystem for effects on aircraft's overall performance in conducting all required missions.

e. Use a scenario of operations for each mission configuration adjusted to remain within the authorized arrival and departure corridors of the airfield used for the service test. Provide mission planners with flight operations data similar to that illustrated below.

- 1) Mission type, e.g. fire support, antitank operation, etc.
- 2) Flight duration.
- 3) Mission loading, e.g., maximum gross weight to include flight personnel, and weight of maximum number of missiles that can be carried.
- 4) Percent of mission time per flight phase.
- 5) Number of landings.
- 6) Severe flight maneuvers.
- 7) Operating conditions, e.g., night, type of weather, etc.
- 8) Firing data, i.e., maximum effective range, minimum safe range, optimum range, etc.

f. Consult MTP 7-3-015, Aircraft Armament, for other considerations which may be applicable to air-to-ground missile service tests.

6.1.2 Personnel Training and Familiarization

Personnel selected for the test team shall be familiarized with subsystem installation characteristics, capabilities, restrictions and mission profiles to be used for subsystem evaluation. Proceed as follows:

6.1.2.1 General Familiarization

Prepare a training program which takes into consideration the team's experience, training on similar equipment, and familiarization with employment procedures. Also, observe the following guide lines:

- 1) Use appropriate training circulars and the draft technical manual(s) to augment training.

- 2) Familiarize appropriate team members with the aircraft and special test equipment and/or tools designated or required for use with the subsystem.
- 3) Familiarize test team members with QMR, SDR, or TC's requirements, service test objectives, and the detailed plan of test.
- 4) Flight, armorer, and aircraft servicing personnel, as appropriate, shall perform functional operations required to load, arm, employ, maintain and unload the subsystem, as directed by the project officer.

6.1.2.2 Preflight Briefing

Brief aircrews accordingly:

a. Mission: State mission objective(s), e.g., missile attack delivering direct fire on simulated enemy machinegun emplacements, bunkers, tanks, etc. Other considerations include:

- 1) Provide desired munitions delivery technique(s), such as:
 - a) Running fire, including recommended altitude, e.g., nap-of-the-earth flight.
 - b) Hovering fire, recommendation concerning terrain and available cover to avoid being silhouetted against sky, etc.
 - c) Stationary fire, including disadvantages due to loss of mobility. Stress need for concealment and a well-planned exit route.
- 2) The following "time" information shall also be provided:
 - a) Desired time on target.
 - b) Desired time for results.
 - c) Time at which attack is no longer of value.

b. Meteorological Information: Provide data concerning safety-of-flight in the target area and those parameters useful for enhancing the effectiveness of weapon utilization, e.g., windspeed and direction, visibility, etc., predictions for the target area.

c. Control: Provide data on selected method of aircraft control to the target area(s), e.g., radar vector, etc., indicate availability of ground observers and provide call signs and radio frequencies.

6.1.3 Target Area Preparation

a. Qualified observers will be assigned to protected stations near the target area(s) in accordance with range safety regulations. The observers shall be provided with motion picture cameras for photographing

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the aircraft during missile launch runs. Remote cameras in the target area will be situated to focus on designated targets to obtain impact effects, as appropriate.

b. Point and small area targets will approximate those of the "enemy" in regard to size, color, and form. Where material destroying warheads are employed, targets must exhibit realistic physical characteristics including hardness, thickness, and obliquity. Terrain contour will dictate target placement, and the concentration of targets within a given area shall be representative of the "enemy" positions being simulated.

c. Appropriate observation and chase aircraft will be stationed in the target area and shall orbit at altitudes which will not interfere with the service test aircraft mission profile. The observation aircraft will contain qualified observers who shall record with cameras, as appropriate, the missile launch sequence and guidance phases.

6.2 TEST CONDUCT

6.2.1 Arrival Inspection and Physical Characteristics

Determine the missile and subsystem's arrival condition and physical characteristics.

6.2.1.1 Arrival Inspection

a. Inspect shipping containers for evidence of damage and photograph.

b. Measure the shipping container's dimensions. Record a description of the container employed. Weigh each container.

c. Examine container markings for compliance with appropriate requirements of MIL-STD-129 or other governing documents. Record container markings which identify contents and indicate quantity.

d. Unpack the missile and subsystem components and inventory contents against the Basic Issue Item List (BIIL) and external markings identifying contents. Submit Equipment Performance Reports (EPRs) where differences are found to exist.

e. Check the inventory list against the maintenance support plan and/or other authorized source to determine whether or not a complete maintenance test package has been received.

f. Confirm suitability of missile and subsystem components for test as demonstrated by freedom of the equipment from damage. Any damage noted shall be photographed and reported by EPR.

6.2.1.2 Physical Characteristics

Determine the missile's and allied equipment's physical characteristics by performing the following:

- a. Weigh each major component.
- b. Measure the dimensions of each major component.

NOTE: Consult Appendix A, Accuracy of Measurement and weight, for guidance with respect to selecting the most appropriate measuring tool or scale.

c. Measure the volume of irregular and complex shaped components by using the displacement method (immersion-proof items) or for nonimmersion-proof items by computing the volume of the smallest parallelepiped which will hold the component.

- d. Photograph each major component.

6.2.2 Installation Requirements

Determine the suitability of the missile subsystem for installation on selected Army aircraft from the standpoint of installation ease, personnel requirements, special tool and ground support equipment/facility requirements, and the degree to which established aircraft characteristics related to clearances, maintenance, loading, and refueling are altered or compromised. Perform the following:

a. Utilize personnel of the appropriate MOS and skill levels to perform installation of the equipment including any required mounting modifications. Use tools and ground support equipment which are authorized by the simulated unit's Table of Organization and Equipment (TOE) and facilities commonly available in the theater of operations. Remove the equipment, modifications, as applicable, and restore the aircraft to its original configuration. Repeat the installation and removal of the equipment to determine:

- 1) Optimum number of personnel required with the appropriate MOS and the appropriate skill level.
- 2) Special training requirements of allied equipment.
- 3) Tools and equipment requirements.
- 4) Minimum shop facilities required under varying environmental conditions.

b. Measure available clearances between the ground, aircraft skin, and appendages resulting from the installation of the equipment with the aircraft empty and loaded to maximum gross weight.

c. With the aircraft's engine operating at the ground and flight speed required for accessories, operate electrical or bleed-air powered subsystem equipment throughout all modes. Ensure that the equipment has

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been suitably installed and will not adversely alter the operation of other aircraft subsystems. Determine adequacy of power-on jettison or quick release devices, if appropriate. Determine adequacy of aircraft checklist and compatibility of existing checklist with missile system activation and operation.

d. Conduct scheduled aircraft inspections and routine maintenance noting any restriction in access to hatches, jackpoints, control rigging, inspection plates, etc., and other compartments or areas required for maintenance operations. Evaluate any changes to maintenance procedures caused by installation of the equipment.

e. Refuel the aircraft at a POL area similar to that used in the theater simulated. Determine any refueling restrictions caused by equipment components, any hazardous conditions encountered, and any change in specified refueling procedures, including any increase in refueling time.

f. Boresight and harmonize each launcher and align the subsystem, as applicable.

g. Verify stability and magnitude of missile guidance signals for each launcher. Detect the presence or absence and sequence of ignition voltages. Perform check for stray voltages on each launcher before loading missiles. Verify arming and safety provisions.

6.2.3 Weight and Balance

Compute aircraft center of gravity (c.g.) location resulting from the addition of the equipment and personnel or accessories required to employ the subsystem from the aircraft. Proceed in accordance with TM 55-405-9 and the following:

a. Establish for each mission profile a specific "mission configuration" which includes the number of crewmen, avionics, weapons, sights, etc., and the specified amount of fuel and other expendables necessary for the mission.

b. Compute aircraft weight and balance for each mission profile configuration using appropriate aircraft operator's manual.

c. Locate the c.g. on the applicable aircraft operator's manual c.g. fore and aft limit chart.

d. Where the c.g. location determined during the preceding steps is shifted outside the established fore or aft limits, compute ballast, weight, and location required to return the c.g. to an acceptable value considering full/minimum expendables loading combinations. Provisions should be made to placard the aircraft to alert crew of ballast location and weight requirement.

6.2.4 Compatibility

During the preparation for and conduct of selected mission profiles, evaluate the adequacy of the subsystem in terms of compatibility with armorer personnel, flight personnel, and the aircraft. Proceed as follows:

- a. Takeoff, maneuver, hover, autorotate, if applicable, aircraft at slow cruise, maximum velocity, and within established limitations. Instruct flight personnel to determine operating conditions at which aircraft performance is changed or degraded due to the missile subsystem. Photograph appropriate proceedings.
- b. Engage appropriate point or small area targets from various slant ranges, altitudes, attitudes, and airspeeds from initial ranges between 300 and 3,500 meters, unless otherwise specified. Instruct flight personnel to determine from the vantage point of the aircraft, the optimum delivery technique for launch. All flight personnel will be instructed to determine any interference with routine flight procedures/tasks or emergency procedures caused by subsystem components or procedures for their use.
- c. During firing runs, photograph debris and note possible hazards to the firing aircraft or hazards to aircraft within the attacking formation, if applicable.
- d. Evaluate effect of missile launch on aircraft's instruments.
- e. Evaluate placement of fire controls including trigger(s), sight optics, missile control stick, and missile selector panel.
- f. Evaluate utility and ease of using gunner's sighting station including reticle intensity, field of view, pointing and tracking ease, night effectiveness, and freedom from excessive vibration.
- g. Determine compatibility of subsystem components such as electrical connectors with aircraft fixtures.
- h. Following the completion of each mission, service aircraft, reload expendables and missiles and perform necessary maintenance on the missile subsystem. Utilize recommended procedures, various numbers of properly trained personnel, and tools. Time each specific operation and total elapsed time to determine minimum turnaround time.
- i. Measure levels of toxic gases in the pilot compartment during all phases of employment to include firing from static, hover and running with doors, windows and ventilators opened or closed in all possible combinations of normal operation.

6.2.5 Guidance and Trajectory Efficiency

- a. Static Firing: Operate the aircraft on the ground and

and engage point or small area targets. Perform the following:

- 1) Increase the separation between the target and aircraft weapon in increments of 500 meters, or less, and engage the point target at each new range increment. Continue increasing target-weapon separation until the percentage of missile hits is equal to the value specified to be the minimum acceptable range for effective engagement.
- 2) Continue to increase the separation between the target and aircraft until one of the following events occur, as applicable:
 - a) Missile maximum range is reached as signified by a low, predetermined percentage of hits, e.g., 2 or 3 percent, or:
 - b) Missile maximum range is reached as signified by inability to yield the specified terminal effects, e.g., penetration of required or minimum thickness of armor plating, etc., as applicable, or:
 - c) Missile impacts obstacle-free and level terrain.
- 3) Dispersion Patterns: Determine for each set of three to six missiles launched at each range increment the following:
 - a) The center of impact expressed in terms of horizontal distance (X) and vertical distance (Y) from the aiming point.
 - b) The distance of each round from the center of impact expressed in terms of X and Y.
 - c) The mean horizontal radius.
 - d) The mean vertical radius.
- 4) Evaluate the accuracy of the missile system with respect to the aiming point.
- 5) Evaluate the missile system and rank the precision of the results achieved in respect to dispersion of hits measured from the point of impact. Also, evaluate the following:
 - a) Accuracy and adequacy of boresight and alignment procedures.
 - b) Suitability of jettison mechanism for the guidance wire, as applicable.
 - c) Operational status of installed subsystem.

b. Hover Firing: Maintain the aircraft in hover flight at the range determined to be the maximum effective engagement range from an appropriate point target. Launch three to six missiles at this range; if unable to attain the effective launches specified for this range, decrease the range between target until the specified percentage of hits is attained.

Determine dispersion patterns for each range increment.

c. Running Fire: Conduct missile launch runs at point targets under the following conditions:

- 1) Launch at the maximum effective range determined in step a. above or at a specified range for forward flight. Where effective engagement cannot be obtained or sustained, launched at decreased range increments until satisfactory engagement is achieved.
- 2) Fly the aircraft at indicated airspeeds (IAS) of 80, 100, and 120 knots, to velocity-never-exceed (V_{ne}) at absolute altitudes of nap-of-the-earth, 500 and 1000 feet, etc., as appropriate.
- 3) Engagement breakway will be made initially at the maximum value predicted for the "minimum safe range". Subsequent engagement breakways will be made at decreasing ranges until the aircraft commander indicates that time of flight is too short to command the missile to a correct course to hit the target.
- 4) Determine dispersion patterns for each change in major variable, e.g., altitude, initial engagement range, etc.

6.2.6 Terminal Effectiveness

Determine the destructive fire potential of the missile by conducting missile launches where the objective is to inflict a high casualty rate upon simulated enemy tanks, facilities, and equipment. Launch against point targets and small area targets such as fortified bunkers, tanks, etc. Evaluate the missile's capability to render effective terminal effects in terms of the following:

- a. Missile flight and guidance, e.g., accuracy and precision.
- b. Payload effect(s) on each target type, as applicable.
- c. Minimum safe launch range on ability to obtain satisfactory destructive effects against moving targets.

6.2.7 Operational Suitability

6.2.7.1 Daylight Effectiveness

Conduct flights and launch guided missiles using various types of warheads throughout the established flight envelope of each aircraft using various initial engagement ranges, line of sight rates, dive angles, altitudes, entry airspeeds and slant ranges to determine optimum delivery techniques. When missiles are launched at silhouettes and simulated vehicles dispersed to simulate small area targets, determine center of impact, dispersion pattern, and the damage inflicted on targets. Also investigate --

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- a. Missile subsystem utilization, suitability and overall ease of use by various members of the flight crew.
- b. Capability of flight personnel to control the missile effectively during flight time.
- c. Response characteristics as a function of launch range under various acquisition conditions.
- d. Optimum range for launch in respect to capability of target detection, acquisition, and tracking portion of the subsystem to provide real-time target information for missile guidance.
- e. Suitability of missile and guidance against moving targets.
- f. Launch hazards including launch debris, control and stability, and the ease of clearing hang-fires.

6.2.7.2 Night Effectiveness

Launch missiles from applicable aircraft in the performance of realistic night target engagement profiles in sufficient quantities to be operationally significant in accordance with paragraph 6.2.5, Guidance and Trajectory Efficiency. In addition, evaluate the following:

- a. Launch effects on flight personnel to include problem with night adaptation and back scatter.
- b. Ability of appropriate flight personnel to control guided missiles effectively by motor illumination, with and without missile guidance flares, and suitability of weapon sight at night when used with/without aircraft released flares.

6.2.8 Handling Requirements

Evaluate the missile's handling characteristics using typical operational ammunition carts, trailers, etc., and personnel of appropriate MOS. Identify any special handling requirements observed during the service test.

6.2.9 Maintenance

a. Determine the adequacy of the air-to-ground missile and allied equipment's maintenance characteristics and maintenance test package. Consult Reference 4.F and prepare a program which emphasizes the following:

- 1) Maintainability.
- 2) Reliability.
- 3) Tools and test equipment.
- 4) Technical manuscripts and manuals.

b. Include in the maintenance subtests the preparation of the following charts:

- 1) Maintenance and Reliability Analysis Chart.
- 2) Parts Analysis Chart.
- 3) Special Tool Analysis Chart.
- 4) Maintenance Package Literature Chart.

6.2.9.1 Maintainability

a. List and provide complete details of occurrences for scheduled maintenance without downtime and unscheduled maintenance with minimum downtime (minor adjustment).

b. List and provide complete details of occurrences for unscheduled maintenance involving excessive downtime and/or provide replacement or repair of components.

6.2.9.2 Reliability

6.2.9.2.1 Allied Equipment-

Reliability of allied equipment will be determined during the service test by performing the following:

- a. Maintain an accurate log of the accumulated operating time.
- b. For each unscheduled maintenance involving any loss of operating time, record the following:
 - 1) Conditions which indicated the malfunction.
 - 2) Component or feature involved and method used to determine cause.
 - 3) Damage caused to associated components of the subsystem due to the failure.
 - 4) Repair procedures followed, personnel, material, and tools required.
 - 5) Elapsed time since last malfunction, if any, accumulated operating time of failing component, and time to repair failure.

c. From the times recorded, calculate the mean time between failure (MTBF), the mean time to repair (MTTR), and the availability (A).

6.2.9.2.2 Missile Reliability-

Determine the reliability of the missile in terms of the mean rounds to stoppage (MRTS) during the firing tests of 6.2.7, Operational Suitability. Maintain appropriate records of the following factors:

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- a. Number of missiles launched.
- b. Failure to arm following launch.
- c. Net chargeable missile malfunctions.
- d. Number of motor duds, hang-fires, failure to jettison, etc.

6.2.9.3 Tools and Test Equipment

Determine whether or not common and special tools and test equipment are suitable for the intended purpose and maintenance level and if the special tools provided (or specified) are excessive.

6.2.9.4 Technical Manuscripts and Manuals (Maintenance Portions)

Perform the following:

- a. Review the maintenance literature and instructions for accuracy and completeness.
- b. Note the presence of lists of recommended repair parts, tools, test equipment, and procedures for alignment, calibration, and troubleshooting.

6.2.10 Personnel and Training Requirements

Use military personnel of various skill levels with appropriate MOS and background for the service test. Determine the proficiency required to install, operate, and maintain the missile and allied equipment and the effectiveness of paragraph 6.1.2, Personnel Training and Familiarization, with respect to formal, informal, or combination courses presented on the equipment. By using varied numbers of personnel for each required task, determine the optimum personnel requirements, including:

- a. Skill level.
- b. Number of personnel for each required task.
- c. Training requirements for installation personnel.
- d. Training requirements for armorer personnel.
- e. Training requirements for flight personnel.

6.2.11 Human Factors Evaluation

a. Human factors engineering evaluations shall be conducted simultaneously with all service test evaluations. The test plan shall be evaluated to ensure that ample opportunities are provided to evaluate the missile-man-aircraft interface suitability in the following areas:

- 1) Transport.
- 2) Handling.
- 3) Preparation of firing or launching.
- 4) Firing or launching.

b. In general, the following human factors suitability indicators shall be studied during the tests:

- 1) Ease of identifying missiles and missile components during daylight, darkness, and blackout conditions.
- 2) Ease of transporting, loading the launcher, etc., when wearing protective items of clothing such as gloves.
- 3) Any difficulties encountered under various lighting levels and other adverse conditions when attempting to mate missile components or to load.
- 4) Missile physical size, shape, weight, or other factors which increase difficulty in handling.
- 5) Psychological reactions of flight personnel to required ear plugs, protective clothing, or other items of personnel equipment necessary to reduce the physical effects of missile launch.
- 6) Compatibility of missile and loading/arming procedures with armorer personnel, flight personnel, and missile handlers.

6.2.12 Safety of Firing

NOTE: Safety confirmation shall comply with the requirements of USATECOM Regulation 385-6.

a. Throughout the service test, observe missile and allied equipment characteristics and identify those which presented a potential hazard or were directly or indirectly the cause of any hazard. Consult MIL-STD-882 during preparation of the service test.

b. Observe missile employment characteristics and identify those which were hazardous or were indirectly the cause of any hazard.

- 1) Handling: Throughout conduct of 6.2.7, Operational Suitability, evaluate missile handling characteristics and record the relative safety with which armorer or other loading personnel are able to perform required tasks. Rate the following in respect to safety:
 - a) Missile transporters.
 - b) Physical loading procedures.
 - c) Electrical connections required in loading process.
- 2) Flight Personnel Reaction to Launch Effects: Interview

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flight personnel individually following each firing run and attempt to identify any launch effects, including --

- a) Crew discomfort, potential injury, physical hazards, and psychological reactions due to noise level, blast overpressures, and/or vibration as evidenced by any crew member reporting chest pain, nose bleed, or other physical discomfort.
- b) Any hazards caused by pilot reaction to missile launch.
- c) Presence of any toxic gas in the crew compartment.
- d) Firing effects on aircraft stability resulting in control problem.

c. Determine all hazards that may be induced as a result of proper or improper functioning of the safeing, arming, and firing circuits and positioning of associated switches and controls with electrical power either on, off, or in transition between these points.

6.3 TEST DATA

6.3.1 Preparation for Test

6.3.1.1 Test Project Planning

6.3.1.1.1 Test Criteria --

Record criteria statements and requirements and indicate source.

6.3.1.1.2 Required Equipment, Facilities and Personnel --

Record the schedule of availability of principal equipment, facilities, and personnel.

6.3.1.1.3 Test Conditions --

Record the following:

- a. Aircraft nomenclature.
- b. Flight personnel.
- c. Ground handling personnel.
- d. Ground support equipment needed.
- e. Tools required.
- f. Maintenance fixtures, etc.

- g. Planned mission lengths.
- h. Identification of scenarios planned for service test.
- i. Considerations for testing obtained from MTP 7-3-015.

6.3.1.2 Personnel Training and Familiarization

Record the following:

- a. Outline of each course presented.
- b. Suitability of draft technical manuals and training circulars for training and familiarization purposes.
- c. For each assigned and attached test team member:
 - 1) MOS.
 - 2) Skill level and time held.
 - 3) Related past experience.
 - 4) Titles and dates of completion of all related training courses.
 - 5) Degree of proficiency attained.
- d. Details of preflight briefings prepared for flight personnel.

6.3.2 Test Conduct

6.3.2.1 Arrival Inspection and Physical Characteristics

6.3.2.1.1 Arrival Inspection-

Record the following:

- a. Description of damage to shipping container, if any.
- b. Dimensions of the shipping container, in inches.
- c. Weight of each shipping container, in pounds.
- d. Indication of compliance with applicable requirements of MIL-STD-129.
- e. Container markings, including:
 - 1) Identification of contents.
 - 2) Quantity of contents.
 - 3) Applicability data
- f. Evidence that contents in any way did not agree with data on outside of shipping container.

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- g. Results of inventory against the BILL.
- h. Number of EPRs submitted.

6.3.2.1.2 Physical Characteristics-

Record the following:

- a. Equipment major component weight, in pounds.
- b. Equipment major component dimensions, in inches.
- c. Volume of major components, in cubic inches.

6.3.2.2 Installation Requirements

Record the following:

a. Minimum and optimum number of personnel, identification of the various combinations of equipment, tools, and time required for installation and removal of equipment and modifications or related equipment(s) required to adapt the aircraft to the operational configuration.

b. Description of installation and attachments, to include modifications to the aircraft airframe and components.

c. Length of time required for the installation.

d. Time to boresight and harmonize.

e. Optimum number of personnel to align the equipment.

f. Equipment required for alignment.

g. Any change in aircraft maintenance procedures caused by equipment.

h. Difficulties, increased time, or procedural changes to aircraft servicing.

i. Extent of cargo or passenger space lost due to equipment installation.

j. Evidence of any restriction to personnel entering or leaving the aircraft due to equipment installation.

k. Stability and magnitude of guidance signals at each launcher.

6.3.2.3 Weight and Balance

Record the following:

- a. Weight and balance data for each aircraft and each aircraft configuration.
- b. Location of center of gravity with aircraft fully loaded and at minimum expendable level with equipment installed.
- c. Weight and location of ballast, if applicable.

6.3.2.4 Compatibility

Record the following:

- a. Initial time required to prepare the aircraft for the mission.
- b. Suitability of missile subsystem and associated equipment(s) for preparation for flight.
- c. Evidence that missile subsystem components installed in crew's compartment or other arrangements demanded too much space and/or interfered with or prevented adequate or proper operation of the aircraft.
- d. Any evidence of excessive aircraft trim changes as missiles were launched.
- e. Any indication that delivery technique of the missile imposed by aircraft construction was dangerous or otherwise unsuitable.
- f. Adequacy of the crew compartment arrangement for operation of launch controls.
- g. Adverse effects observed during separation of missiles from aircraft such as instrument vibration, etc.
- h. Debris striking the aircraft as a function of flight envelope.
- i. Time and number of personnel required for minimum turn-around.
- j. Suitability of special tools, test equipment, etc., required for missile system and associated equipments.

6.3.2.5 Guidance and Trajectory Efficiency

Record the following:

- a. Meteorological data to include the following as applicable:
 - 1) Windspeed, in knots.
 - 2) Wind direction true bearing.

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- 3) Temperature, in degrees F. or C., as desired.
- 4) Atmospheric pressure, in inches of Hg.
- 5) Visibility, in miles.
- 6) Relative humidity, in percent.
- 7) Presence of rain, snow, etc.

b. Static Firing

- 1) Maximum effective range from aircraft position
- 2) Launch effectiveness for each range at which target was engaged, in percent.
- 3) Accuracy and adequacy of boresight and alignment procedures.
- 4) Structural or skin damage to aircraft.
- 5) Maximum range, in meters.
- 6) Dispersion Patterns:
 - a) Center of impact in terms of horizontal (X) and vertical (Y) distances from the aiming point, in meters.
 - b) Distance of each round from the center of impact in terms of X and Y, in meters.
 - c) Mean horizontal radius, in meters
 - d) Mean vertical radius, in meters.

c. Hover Firing

- 1) Maximum effective engagement range, in meters.
- 2) Firing effectiveness for each range at which target was engaged, in percent.
- 3) Structural or skin damage to aircraft.
- 4) Maximum range, in meters.
- 5) Dispersion Patterns: See 5) above.
- 6) Number of missile launches under each condition.
- 7) Unusual flight characteristics or control movements.

d. Running Fire

- 1) Initial engagement range and effectiveness at that range in percent.
- 2) Engagement effectiveness for --
 - a) Each slant range.
 - b) Altitude.
 - c) Airspeed.
 - d) Attitude assumed during firing.
- 3) Optimum breakaway range from target.
- 4) Dispersion patterns: See step b.5).
- 5) Number of missiles launched for each condition.

6.3.2.6 Terminal Effectiveness

Record the following:

- a. Suitability of missile guidance responsiveness and target tracking in terms of accuracy and precision required to attain destructive effects specified.
- b. Suitability of individual missile payload on specific target types, as applicable.

6.3.2.7 Operational Suitability

Record the following:

- a. General information concerning each operation --
 - 1) Identification of mission profiles conducted.
 - 2) Aircraft nomenclature.
 - 3) Aircraft gross weight on takeoff.
 - 4) Flight data:
 - a) Attitude.
 - b) Airspeed.
 - c) Windspeed and direction (estimated by aircrew).
 - d) Visibility conditions (from test aircraft).
 - 5) Control method to firing range; e.g., radar vector, etc.
 - 6) Meteorological conditions:
 - a) Temperature.
 - b) Windspeed and direction.
 - c) Visibility.
 - 7) Terrain features and target data:
 - a) Presence of trees, vegetation, etc.
 - b) Nature of ground cover.
 - c) Configuration of the surface including its relief.
 - d) Targets used.
- b. Daylight Operation --
 - 1) Missile subsystem utilization, suitability and overall ease of use by various members of the flight crew.
 - 2) Capability of flight personnel to control the missile effectively during flight time.
 - 3) Response characteristics as a function of launch range under various acquisition conditions.
 - 4) Optimum range for launch in respect to capability of

target detection, acquisition, and tracking portion of the subsystem to provide real-time target information for missile guidance.

- 5) Suitability of missile and guidance against moving targets.
- 6) Launch hazards including launch debris, control and stability, and the ease of clearing hang-fires.

c. Night Effectiveness --

- 1) Launch effects of flight personnel.
- 2) Missile guidance adequacy at night.
- 3) Appropriate information as indicated under section a. above.

6.3.2.8 Handling Requirements

Record the following:

- a. Suitability of each type of operational carrier such as ammunition carts, trailers, etc.
- b. Difficulties encountered.
- c. Any special handling requirements encountered.
- d. Number of personnel required for each operation.

6.3.2.9 Maintenance

Record the following"

- a. Maintainability:
 - 1) Maintenance operations performed.
 - 2) Personnel required, time, tools, etc.
 - 3) Elapsed time since last maintenance requirement.
- b. Reliability: Allied Equipment
 - 1) Total operating time of the system.
 - 2) Time since last failure.
 - 3) Time required to repair.
 - 4) MTBF.
 - 5) MTTR.
- c. Reliability: Missile Reliability.
 - 1) Number of missiles launched.
 - 2) Net chargeable missile malfunctions.
 - 3) Mean rounds to stoppage (MRTS).

d. Tools and Test Equipment:

- 1) Tools or test equipment required but not provided.
- 2) Excess tools provided.
- 3) Recommendations for changes to tools or test equipment allowances for system.

e. Technical Manuscripts and Manuals:

- 1) Procedures found to be inaccurate or incomplete.
- 2) Missing lists or procedures for specific maintenance tasks.

6.3.2.10 Personnel and Training Requirements

Record the following:

- a. Skill levels used to handle, load, and employ the missile during service tests.
- b. Number of personnel required for given tasks.
- c. Training requirements for armorer personnel.
- d. Training requirements for applicable flight personnel.

6.3.2.11 Human Factors

Record the following:

- a. Ease of identifying, loading, employing missiles under specified conditions.
- b. Any difficulties encountered under various lighting and adverse conditions when attempting to mate missile components, set fuzes, etc.
- c. Missile physical size, shape, or other factors which increase difficulty in handling, employing, etc.
- d. Observed psychological reactions of flight personnel to required ear plugs, protective clothing, or other items of personnel equipment necessary to reduce the physical effects of missile launches.
- e. Compatibility of missile and loading/arming procedures with armorer, flight, and missile handler personnel.

6.3.2.12 Safety of Firing

Record the following:

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a. Safety rating of missile in combination with available transporters or other flight line loading equipment.

b. Safety rating of storage/loading procedures.

c. Safety interface with aircraft of intended use.

6.4

DATA REDUCTION AND PRESENTATION

a. All data will be summarized using tabulation and/or charts as appropriate. Where photographs are used, positive identification will be ensured.

b. The data will be analyzed to determine to what degree the air-to-ground missile meets the requirements of QMR or TC.

c. The presentation shall conclude with a summarization of the suitability of the missile for Army use.

APPENDIX A

ACCURACY OF MEASUREMENT AND WEIGHT

1. For the missile, equipment or components thereof possessing approximate dimensions listed below, use a tool with the minimum accuracy indicated.
 - a. Up to 4 inches -- measurements will be to the nearest $\frac{1}{8}$ inch division.
 - b. From 4 inches to 3 feet -- measurements will be to the nearest $\frac{1}{4}$ inch.
 - c. Above 3 feet -- measurements will be to the nearest inch or tenth of a foot.

2. For the missile, equipment or components thereof possessing approximate weights listed below, use a scale with the minimum accuracy indicated.
 - a. Below 5 pounds -- weight will be to the nearest ounce (scale division $\frac{1}{4}$ ounce).
 - b. From 5 pounds to 30 pounds -- weight will be to the nearest $\frac{1}{4}$ pound.
 - c. From 30 pounds to 1,000 pounds -- weight will be to the nearest pound.

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Procedures are described to evaluate the operational effectiveness and carrier/missile compatibility of air to ground missile/rocket systems.

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