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

AIRCRAFT GUIDED MISSILE SUBSYSTEMS

1. OBJECTIVE

This procedure provides guidance for conducting engineering type tests of aircraft guided missile subsystems to determine the degree to which they meet the applicable MN or TC's and whether they are safe and suitable for Army use. An aircraft guided missile subsystem includes the launcher, the guidance and controls, and the missile, which is launched and/or controlled by Army aircraft (primarily helicopters).

2. BACKGROUND

Army deployment of guided missiles from helicopters has consisted of the SS-11 antitank missile fired from the UH-1 series utility helicopter (Fig 1). The SS-11 missile, a French antitank development of the mid-1950's, incorporates a two-strand wire guidance link that is unwound from the missile wire bobbins during the missile flight. Electrical command signals are sent along the guidance wire to the missile in flight. The missile pilot (gunner) originates the signals by manipulation of the missile guidance set "joy stick" from within the aircraft. An antioscillation (stabilized) sight is available for helicopter use with the SS-11 missile. The sight, guidance equipment, and missile firing controls are installed at the copilot position of the UH-1 helicopter.

Contemporary antitank guided missile systems that are being adopted for use on high-speed attack helicopters do not require the gunner to continuously estimate the spatial location and direction of motion of the in-flight missile relative to the target as is required with the SS-11 missile. The missile position error relative to the gunner's line of sight is automatically and continuously monitored by missile guidance equipment mounted on the aircraft, and electrical signals required to correct the missile flight to the gunner's line of sight are transmitted to the missile until target impact is achieved. The missile gunner, using the aircraft-mounted sighting equipment, is required to continuously track the target from the time of missile launching until the missile flight is completed.

3. REQUIRED EQUIPMENT

An aircraft of the type that will be used with the air-to-ground missile system being tested and accessories for mounting the weapon system, including a suitable weapon sight.

Environmental test chambers, gages, photographic equipment, etc., for physical measurements and environmental tests as specified in paragraph 6.2.

Instrumented test range large enough to permit testing of the missile systems under all required conditions of employment. A typical layout is illustrated in Figure 2.

Figure 1. SS-11 Missile (Painted White) Mounted on a UH-1 Helicopter. The external stores assembly and missile mounting pylon are shown above the missile.

Legend for Use of Instrumentation

Hawk velocimeter: Missile velocity-time profile.
Tracking cameras: Helicopter position and velocity at time of missile launch; missile position vs time.
35-mm High-speed cameras: Missile terminal flight (velocity and attitude), and target miss distance.
Telemetry receiving station: Recording of real-time telemetry signals during missile flight (when missile includes a telemetry package).

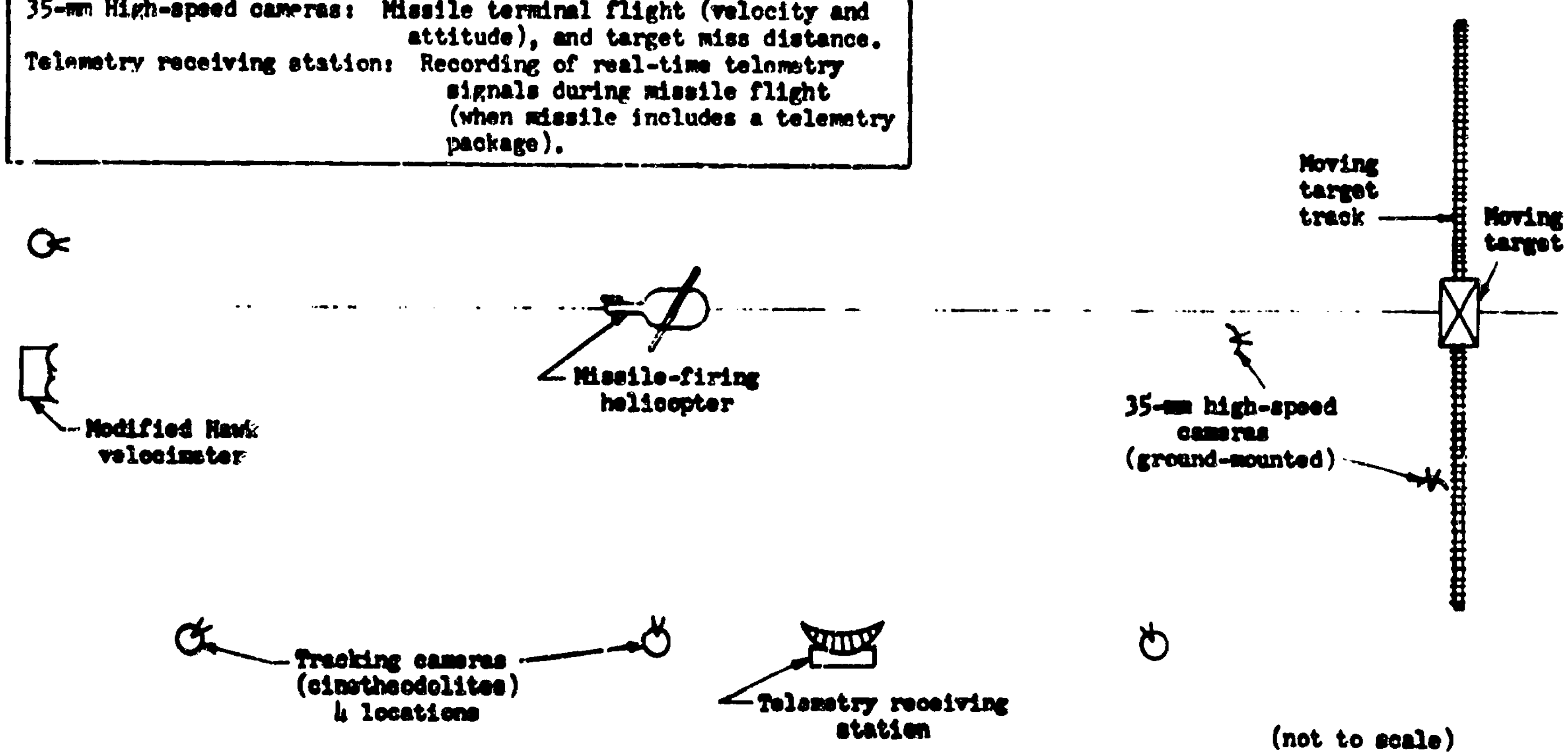

Figure 2. Ground Instrumentation Layout for Air-to-Ground Missile Firing Tests.

4. REFERENCES

A. AR 70-38, Research, Development, Test, and Evaluation of Materiel for Extreme Climatic Conditions.
B. USATECOM Regulation 70-23, Equipment Performance Reports (EPR's).
C. USATECOM Regulation 385-6, Verification of Safety of Materiel During Testing.
D. USATECOM Regulation 750-15, Maintenance Evaluation During Testing.
E. MIL-STD-810B, Environmental Test Methods.
F. MTP 2-1-004, Telemetry.
G. MTP 2-2-613, Broadband Radio Interference Testing of Vehicles and Electrical Equipment - Noncommunication.
H. MTP 2-2-614, Toxic Hazards Test for Vehicles.
I. MTP 2-2-815, Rain and Freezing Rain.
J. MTP 3-1-002, Confidence Intervals and Sample Size.
K. MTP 3-1-003, Meteorological Data.
L. MTP 3-2-503, Safety Evaluation of Fire Control System Electrical and Electronic Equipment.
M. MTP 3-2-618, Electrical Power Measurements for Weapon Subsystems.
N. MTP 3-2-706, Night Vision Devices.
O. MTP 3-2-811, Noise and Blast Measurements.
P. MTP 3-2-824, Flight Tests of Antitank Missiles.
Q. MTP 3-2-825, Location of Impact or Airburst Positions.
R. MTP 4-1-005, The Doppler Velocimeter.
S. MTP 4-2-015, Close Support Rockets and Missiles.
T. MTP 4-2-503, Safety Evaluation, Close Support Rockets and Missiles.
U. MTP 4-2-602, Rough Handling Tests.
V. MTP 4-2-804, Laboratory Vibration Tests.
W. MTP 4-2-813, Arena Tests of HE Fragmentation Munitions.
X. MTP 4-2-816, Photographic Instrumentation for Trajectory Data.
Y. MTP 4-2-818, Testing for Fungus Resistance.
Z. MTP 4-2-819, Sand and Dust Testing of Ammunition.
AA. MTP 4-2-820, Humidity Tests.
AB. MTP 4-2-824, Penetration Tests of HEAT Warheads for Close Support Rockets and Missiles.
AC. MTP 5-1-031, Cinetheodolites.
AD. MTP 6-2-508, Electromagnetic Vulnerability.
AE. MTP 7-1-004, Army Aircraft Armament.
AF. MTP 7-2-009, Rocket Subsystems, Aircraft.
AG. MTP 7-2-014, Multiple Armament Subsystems, Aircraft.
AH. MTP 7-2-501, Safety Evaluation of Aircraft Armament.
AI. MTP 7-2-502, Fire Control Systems for Army Aircraft.
AJ. MTP 7-2-503, Air-to-Ground Accuracy and Dispersion.
AK. MTP 7-2-504, Maintenance Evaluation of Aircraft Weapons.
AL. MTP 7-2-505, Human Factors in Aircraft Weaponry.

5. SCOPE

5.1 SUMMARY

The emphasis in this MTP is on subsystem evaluation. A total subsystem evaluation, however, encompasses evaluations of all subsystem components which may be covered in other MTPs. Table I lists all possible subsystem tests and indicates where details on each can be found.

5.2 LIMITATIONS

Operating features of an airborne guided missile weapon system are numerous. This MTP does not include the detailed test techniques required for all of these features; MTPs containing more details are referenced in paragraph 6.

6. PROCEDURES

6.1 PREPARATION FOR TEST

Ammunition components (missiles) are inspected upon receipt, for damage incurred during transit and for compliance with applicable specifications.

Radiographs of the test item are made for comparison with post-vibration inspection (para 6.2.4.4).

Other weapon system equipment (missile launchers, fire control equipment including interlocks with other weapons installed on the aircraft, missile guidance and control equipment, rangefinding and sighting equipment, etc.) is installed on the applicable aircraft and operated (nonfiring) in accordance with the installation and operating instructions to assure initial operability and compatibility.

An instrumented test range (Fig 2) is necessary for the conduct of missile firings in order to obtain data on helicopter position at the time of missile launch, missile position and velocity profile during flight, and other test data as required. Instrumentation locations are determined by precise engineering survey before the start of the test.

NOTE: The instrumentation setup may vary according to the data requirements, launch and flight characteristics of the missile, and availability of instrumentation. For example, if tracking cameras capable of following the missile throughout its flight are not available, ground-mounted ballistic cameras can be used to obtain missile position data. All instrumentation uses a common time base. Additional information on the use of photographic equipment and other types of range instrumentation is presented in MTPs 4-1-005, 4-2-816, and 5-1-031.

Table I - Subtests for Evaluating Major Components of a Missile Subsystem

Subtest	Missile	Control and Guidance	Launcher	Complete Subsystem
Physical Characteristics	MTP 4-2-015	para 6.2.1	para 6.2.1	para 6.2.1
Safety Evaluation	MTP 4-2-503	para 6.2.2	para 6.2.2	para 6.2.2
Firing System Operation	NA	para 6.2.3	para 6.2.3	para 6.2.3
Environmental Tests	MTP 4-2-503 4-2-015	para 6.2.4	para 6.2.4	para 6.2.4
Operational Vibration and Static Loading	para 6.2.4.4	para 6.2.4.4	para 6.2.4.4	para 6.2.4.4
HEAT Warhead Effectiveness	MTP 4-2-824	NA	NA	MTP 4-2-824
HE Warhead Effectiveness	MTP 4-2-813	NA	NA	MTP 4-2-813
Noise and Blast	MTP 3-2-811	NA	NA	MTP 3-2-811
Toxic Gas	MTP 7-2-505	NA.	NA	MTP 7-2-505
Electronic Counter Countermeasures (ECCM)	MTP 6-2-508	MTP 6-2-508	NA	MTP 6-2-508
Radio Frequency Radiation Initiation	MTP 3-2-615	NA	NA	MTP 3-2-615
Radio Frequency Interference	NA	NA	NA	MTP 2-2-613
Ground Firing Tests	MTP 4-2-015 3-2-825	para 6.2.5	para 6.2.5	para 6.2.5
Airborne Firing Tests	para 6.2.6	para 6.2.6	para 6.2.6	para.6.2.6
Airborne Tracking Tests	NA	para 6.2.7	NA	para 6.2.7
Maintenance Evaluation	NA	para 6.2.8	para 6.2.8	para 6.2.8
Human Factors Evaluation	para 6.2.9	para 6.2.9	para 6.2.9	para 6.2.9 MTP 7-2-505
Reliability and Endurance	MTP 4-2-015	para 6.2.10	para 6.2.10	para 6.2.10

In addition to the ground-based photographic equipment, instrumentation should be installed on the aircraft to record the gunner's aiming point and missile position with respect to the gunner's line of sight throughout the missile flight. A small camera mounted on the gunner's sight may be adequate for this purpose. Magnetic-tape-recording instrumentation should be installed on the aircraft to monitor the missile guidance and control signals, error signals, and other hardline data during firing, obtainable from the guidance and control equipment mounted on the aircraft.

The maintenance test package, provided by the commodity command in advance of testing, is examined (para 6.2.8 and USATECOM Reg 750-15) and, if not in conformance with the list provided, reported by an Equipment Performance Report (EPR) in accordance with USATECOM Regulation 70-23.

All instrumentation is identified and the locations recorded for use in determining range firing data.

6.2 TEST CONDUCT

a. The subtests described herein are conducted as required and applicable with full consideration being given to prior data on tests of components. Sufficient environmental test data may be available on the ammunition components (guided missiles) that only limited environmental treatments of these items (i.e., treatments that apply especially to the helicopter installation) will be necessary. This is often the case when an infantry-type antitank weapon system is adapted for deployment from helicopters.

b. Missile firing tests are planned to satisfy multiple test objectives when possible, and the total number of missiles for a test program is held to the minimum required.

c. All tests, including especially those mentioned in paragraph 6.2.2, are monitored for evidence of a malfunction or type of failure that might result in a hazard to the aircraft or crew.

d. Any damage occurring to the weapon system hardware or aircraft during testing is photographed. Throughout the test, the appropriate manuals are evaluated for completeness and accuracy.

6.2.1 Physical Characteristics

The missile armament subsystem is disassembled into its major components. These components are weighed and measured (exterior dimensions), and a characteristics photograph is made (MTP 7-1-004). Particular attention is paid to the missile launcher or launcher cluster. Critical dimensions of the launcher (including those which control proper fit of the missile to the launcher) are identified, measured, and compared with the applicable engineering drawings. If the missile is launched from a reusable tube, stargage measurements of internal diameter are made throughout the tube and straightness and alignment of the tubes are determined. These measurements are repeated at the end of the test firing program to determine durability. The complete guided missile subsystem (fully loaded) is installed to the applicable aircraft, and weight and balance determinations are made at maximum gross weight (with full crew and fuel) and at 20 minutes fuel supply.

6.2.2 Safety Evaluation

Safety tests are planned and conducted concurrently with the suitability tests to: assure that no safety hazards exist in any possible mode of operation; determine safety precautions necessary during loading, aircraft flight, and firing procedures; and provide information on danger areas created by missile firing tests. Also of significance are: the ability of the helicopter airframe structure to withstand the forces created by missile launch; the effects of exhaust gas, overpressure, and any secondary debris caused by missile launch upon the aircraft; and the possibility of aircraft damage caused by missile warhead functioning at the minimum fuze arming distance.

NOTE: Missile (ammunition) safety tests are specified in MTP 4-2-503. In addition to the missile safety tests, the tests shown in Table II must be applied to the entire guided missile weapon system before the system can be considered operationally safe and before the airborne firing tests (para 6.2.6) are conducted.

Table II - Weapon System Safety Tests

Test	Paragraph
System operating characteristics	6.2.3
Environmental treatments, including extreme temperature storage, temperature shock, operational vibration, static loading, rain and freezing rain, and salt spray	6.2.4
Ground firing at temperature extremes	6.2.5

Analytical studies are of value in assessing the safety hazards associated with missile firing from helicopters when based upon actual test results. The nature of hazards to the launch aircraft or to occupants caused by a warhead function at the minimum fuze arming distance may be investigated analytically provided that the rearward fragmentation pattern of the tactical missile warhead when functioned on the missile is known. The degree of protection offered by the aircraft skin, vulnerability of the aircraft engine and other critical components to damage by fragments, etc., are factors that must be taken into consideration in a "computer study" of this type of hazard.

The size of the danger area caused by a missile firing may also be established by computer techniques when adequate data are available regarding (a) missile performance under all required operating conditions and (b) system failure modes which may contribute to the size of the danger area. Sufficient testing is specified herein to develop the required information. Further discussion of the computer analysis techniques involved is outside the scope of this MTP.

6.2.3 Firing System Operating Characteristics

The missile-firing subsystem is installed on the appropriate aircraft and operated (nonfiring), while on the ground, to determine the following characteristics:

a. Warmup time (electrical).

b. Electrical compatibility of the weapon subsystem equipment with the electrical power supply and avionics equipment of the aircraft (MTP 3-2-618) during periods of steady-state and peak electrical power loadings. Recording instrumentation (oscillograph or magnetic tape) is used to determine electrical power usage.

c. Ease of identifying functions on the missile selection and arming panel and ease of operation. Events such as completion of system warmup, missile firing circuit in safe or arm position, etc., must be clearly displayed. Schematic drawings of the electrical firing circuit are studied to assure that a positive interruption and proper grounding of the firing circuit occurs whenever the weapon system is not in the "armed" position. Accuracy of control panel switching positions is determined by electrical measurement.

d. Adequacy of self-contained operational check capability. Complex missile-firing equipment should include self-test features capable of conducting a go-no-go test on the missile launching, sighting, and guidance equipment. System operation and boresight calibration are monitored, although to a lesser extent than is possible when using ground support equipment. The capability of identifying failed components with the self-test is limited. The self-test is primarily intended to show whether the system is properly installed and in operating condition suitable for conducting missile firings. The functions performed by the self-test should be determined and examined for completeness.

NOTE: System self-tests should be performed after completion of installation procedures prior to missile firings, and before and after exposure to environmental treatments. Following environmental treatment involving the self-test equipment, or any indication of possible improper operation of the self-test (such as a "no-go" indication), the self-test equipment should be checked. Special equipment such as ground support equipment or specialized instrumentation should be used to verify proper operation of the self-test.

e. Proper fit of weapon subsystem installed to the aircraft. Dummy missiles are loaded into the launchers for this check.

Other checkouts of electrical, mechanical, and optical equipment are made in accordance with applicable operating procedures and with test procedures detailed in pertinent MTPs (see para 4, References).

6.2.4 Environmental Tests

Environmental conditioning and firing tests are conducted as required to demonstrate weapon system safety, operability, and compatibility during or following exposure to various simulated environments. Sequential environment treatment of system components is often preferred, not only to reduce total test hardware requirements but to provide closer simulation of the stockpile-to-battlefield environmental sequence. A typical sequential environmental treatment series is shown in Table III.

NOTES: 1. Failed components are repaired or replaced as necessary to continue the sequential testing, and such repairs or replacements are documented in the test report.

Table III - Sequential Environmental Tests

Low Temperature Sequence (One Complete Weapon System)	High Temperature Sequence (One Complete Weapon System)
Storage and operation at low temperature (para 6.2.4.1)	Storage at high temperature (para 6.2.4.1)
Temperature shock test (para 6.2.4.2)	Operation at high temperature (para 6.2.4.1)
Operational vibration at the low operating temperature (para 6.2.4.4)	Temperature shock test (para 6.2.4.2)
Freezing rain test (externally mounted components only) (para 6.2.4.3)	Operational vibration at the high operating temperature (para 6.2.4.4)
	Static loading test (para 6.2.4.4)
	Sand and dust test (externally mounted components only) (para 6.2.4.2)
Also impose the following tests on this weapon system:	Also impose the following tests on this weapon system:
Rain test (external components only) (para 6.2.4.3)	High humidity test (para 6.2.4.2)
Salt spray test (para 6.2.4.2)	Fungus test (para 6.2.4.2)

2. If the guided missile to be utilized is part of an infantry-type (ground mounted) weapon system, acceptable data for some environmental tests may already be available. Procedures for environmental testing of guided missiles are specified in MTPs 4-2-015 and 4-2-503.
3. Requirements for climatic tests are usually stated in terms of item ability to perform satisfactorily in certain climates defined in AR 70-38.
4. Proper weapon system operation after exposure to environmental tests may be adequately determined by nonfiring operational checks, depending upon the weapon system design and previous test history. In this case operational checks may be substituted for missile firings following each environmental exposure.

6.2.4.1 Performance at Temperature Extremes

Extreme-temperature tests are performed in accordance with the conditions specified in AR 70-38.

a. The preferred high temperature test method consists of attaching the weapon system to a suitable mount, or to a helicopter, and exposing it in a chamber to the temperature-solar radiation diurnal cycle given in AR 70-38 for either the intermediate-hot or hot-dry climate, whichever is specified.

The missile is exposed simultaneously with the weapon system, if required (6.2.4.2 below). If missile firing from within a conditioning unit is required and practical, the launcher is loaded then fired through a suitable opening in the test chamber.

If the chamber does not have this capability, the items are conditioned to an approximate equivalent temperature and firing is conducted outside the chamber. In this case the equivalent temperature (air temperature plus solar effects) may be assumed to be 145°F for intermediate hot climate or 165°F for hot-dry climate. Temperature soaking is for 24 hours or until temperature equilibrium is attained.

b. For low temperature tests the weapon subsystem, appropriately mounted, is conditioned at -50°F (cold climate) unless intermediate cold (-25°F) or other temperature is specified. Cold soaking of both weapon system and missiles is continued for 24 hours or until temperature equilibrium is attained. Firing is conducted from within the chamber if a suitable facility exists; otherwise, the weapon subsystem is moved outside and test fired.

c. Any difficulties and malfunctions occurring during the hot or cold tests are recorded. Operational data are recorded as applicable.

6.2.4.2 Sand and Dust, Temperature Shock, High Humidity, Salt Spray, and Fungus Tests

The weapon subsystem is exposed in environmental chambers to sand and dust (MTP 4-2-819), temperature shock (MIL-STD-810B), humidity (high humidity-temperature cycle of MTP 4-2-820), salt spary (MIL-STD-810B), and fungus (MTP 4-2-818) environments. Following each exposure to an environmental treatment the test item is inspected for damage, and firing tests are performed.

6.2.4.3 Rain and Freezing Rain

A rain test is performed in accordance with MTP 2-2-815. If a suitable test chamber is not available, the test item can be set up on a ground mount and test fired during a natural rainfall. The natural rainfall at the launch site may be supplemented by artificial means, during the prefiring exposure period and during the missile launch, to meet the requirements of the test. After the required exposure period, the test item is fired. Any misfires or other malfunctions occurring are noted and the causes determined.

MTP 2-2-815 also describes procedures for freezing rain. Expedient methods of removing the ice are appropriate for a simulation of ice forming while on the ground. Simulation of ice formation in the air must depend upon manipulation of the equipment from within the cockpit.

6.2.4.4 Operational Vibration and Static Loading Tests

Laboratory vibration tests are conducted to determine whether missiles and missile firing equipment (external and internal) are dynamically compatible and structurally capable of withstanding the forces associated with aircraft flight vibration. The launching equipment, with ammunition components (missiles) installed, is mounted on an electrodynamic vibrator to simulate, as closely as possible, the method of attachment to the aircraft. The control accelerometer should be mounted on the fixture hardpoint where the equipment is attached so as to properly describe the input vibration environment to the launcher. The dynamics of the equipment and transmissibility characteristics over the broad frequency range of interest should be determined for the various load configurations. A full complement of tactical missiles is vibration tested at both high temperature (+145° or +165° F) and low temperature (-25° and -50° F).

Ideally, the equipment should be vibrated to the periodic vibration spectrum and amplitudes associated with the particular helicopters on which it is flown, to determine its structural adequacy. Duration of the test should be commensurate with the designed life of the particular component in terms of the required number of missions to be flown. MTP 4-2-804 describes the worst-case flight environment for the Iroquois and Cobra aircraft.

Results of laboratory vibration of the missiles, launchers, their sighting devices, or their related electronics equipment should be interpreted on an individual basis. Specific knowledge of the transmissibility characteristics of an item and the periodic spectrum of the aircraft are invaluable in making these assessments. A sinusoidal dwell test at the natural resonant frequency of some poorly damped item will often cause extreme damage. A test item which appears to have failed a standard vibration test may have been especially designed to have a lightly damped resonant frequency in a portion of the spectrum that is not excited by the operational vibration input from the applicable aircraft. Following vibration, radiographs are taken of the missiles and compared to previous radiographs to determine whether any damage occurred during the test. Particular attention is paid to cracks which may have formed in the warhead and to whether the safe and arm device remained in the "safe" position after exposure to vibration testing. External visual examination and electrical checkout of the missile are made as appropriate. Operational checks and nondestructive metallurgical examination of major structural components of the missile launching components are performed after vibration.

Static loading tests of the equipment which mounts the missile to the launcher are made to demonstrate adequate structural integrity of the mount and physical restraint of ammunition components during aircraft maneuvering and landings. A procedure for conducting this type of test on aircraft rocket launchers, which is also adequate for missile launchers and mounts, is described in paragraph 6.2.3.5 of MTP 7-2-009.

6.2.5 Ground Firing Tests

Ground firing tests are conducted to demonstrate weapon system safety, compatibility with the aircraft, and operability during temperature extremes.

6.2.5.1 Ground Firings for Weapon System Safety

Before aerial firings are conducted, ground firings are conducted to determine whether any hazards to the launching aircraft or occupants exist. The weapon system is installed to a helicopter positioned on a suitable firing pad. High-speed photographic instrumentation is set up and operated during firing to provide records of launch characteristics. Firing tests (approximately six missiles) are then conducted to demonstrate that:

a. Clearance between the missile launcher and the aircraft and associated equipment is adequate to prevent the missile from striking the aircraft during firing (including firing at the maximum launcher elevation possible considering the maximum dynamic droop of the helicopter rotor blade).

b. There will be no damage to the aircraft created by backblast gases or discarded material during launch. Particular attention must be paid to discarded material (closure plugs, etc.) that could strike the aircraft, with particular attention to the tail rotor and adjacent tail boom of helicopters.

Witness screens or collection boxes should be set up behind the launchers to determine the extent of any hazard created by the missile launch.

c. Launcher elevation limits are satisfactory. Used in conjunction with a standard mounting method, the launcher must be capable of elevation in accordance with the specified range capabilities of the weapon system without creating an installation safety hazard. Upper and lower elevation compatibility with safety requirements is determined.

> NOTE: Missile launchers may be designed to preset (fixed) at a specific quadrant elevation, or they may be slaved to the missile gunner's line of sight (elevation only) during target acquisition and prefiring operations, depending upon design requirements.

d. Sound pressure levels and toxic gas levels in the inhabited portions of the aircraft do not exceed safe limits during missile launch. Measurement techniques are described in MTP's 3-2-811 and 7-2-505.

6.2.5.2 Ground Firings at Temperature Extremes

Missile firings are conducted at high and low temperature extremes to verify weapon system operability and integrity at these temperatures. Test temperatures and testing procedures are specified in paragraph 6.2.4.1. High-speed motion picture cameras are used to document the missile launch and to determine missile launch velocity. Other test data are also taken if required, as specified in paragraphs 6.2.3 a and b and 6.2.5.1.

6.2.6 Airborne Firing Tests

Missile firing tests are conducted from an airborne helicopter to determine the integrity of the wire of a wire-guided missile and, in all cases, to determine weapon system capability (accuracy and hit probability) in all modes of operation and in such adverse natural environments as cross-winds and periods of reduced visibility. Missile test firings are usually heavily instrumented (para 6.1) so that the maximum amount of information may be realized from each test firing and that individual test item failures may be fully analyzed.

For all dynamic firing tests complete meteorological data at the test site, including cloud cover and visibility, surface winds, and winds aloft to the maximum altitude of the aircraft at missile launch and/or maximum ordinate of the missile during flight are recorded.

6.2.6.1 Wire Integrity Tests

When the guided missile used with the weapon system under test is linked with the guidance equipment on board the launching aircraft by a wire command link, tests are conducted to verify the integrity of the wire during aerodynamic loading and to determine the minimum terrain clearance required to prevent the guidance wire from snagging on obstacles on the ground. Procedures provided for discarding the guidance wire terminal from the aircraft once the missile flight is completed are also evaluated. A series of 22 missile flight tests designed to subject the wire command link to the extreme loading forces is shown in Table IV. The ground target should be located at or near the maximum weapon range. The use of moving targets should be considered for this test.

6.2.6.2 Accuracy Firing Tests

Missile firing tests are conducted from an airborne helicopter to determine the weapon system accuracy, reliability, and operability in all required modes of operation. The weapon system is properly installed on the appropriate helicopter. Tests are conducted on an instrumented test range (Fig. 2) by experienced and properly trained missile gunners. Twenty-five typical test conditions are shown in Table V. Each condition is executed by four gunners (total of 100 missiles).

This test should be conducted as an intergrated engineering test-operational service test (ET/OST) to satisfy both ET and OST requirements. Service board participation, including the provision of trained missile gunners, is compatible with ET objectives.

NOTE: The number of missiles required in a comprehensive test program depends in part on the required system operating characteristics. For example, the 25 test conditions shown in the table stress moving targets and aircraft maneuverability. For some applications, increased emphasis on short-range targets may be desired. Also, conduct of the wire integrity test series (6.2.6.1 above) will have satisfied some of the test requirements.

6.2.6.3 Airborne Firings During Adverse Environmental Conditions

Missile firing tests are conducted from an airborne helicopter to determine whether any reduction in weapon system capability occurs during operation in adverse natural environments. Typical test conditions are shown in Table VI.

6.2.7 <u>Airborne Tracking Tests (Nonfiring)</u>

Tracking tests are conducted to supplement data from the aerial firing tests regarding the ability of the missile gunner to sight and track tank-type targets. A suggested test schedule requires four trained gunners, each conducting the tracking (simulated firing) tests shown in

Table IV - Missile Flight Tests for Wire Integrity

Missile Flight Number	Aircraft Maneuver During missile Launch and Flight	Aircraft Airspeed	Aircraft Altitude (feet)
1	Straight, level flight	cruise	200
2	Straight, level flight	cruise	100
3	Hard bank (right)	cruise	100
4	Hard bank (right)	cruise	50
5	Hard bank (left)	cruise	100
6	Hard bank (right)	cruise	50
7	Straight, level flight	Maximum	100
8	Straight, level flight	Maximum	150
9	Hard bank (right)	Maximum	150
10	Hard bank (right)	Maximum	100
11	Hard bank (left)	Maximum	150
12	Hard bank (left)	Maximum	100
13	Straight, level flight	Maximum	50
14	Straight, level flight	Maximum	25
15	Hard bank (right)	Maximum	50
16	Hard bank (right)	Maximum	25
17	Hard bank (left)	Maximum	50
18	Hard bank (left)	Maximum	25
19	Hover	0	10
20	Hover	0	10
21	Evasive zig-zag	Maximum	400
22	Evasive zig-zag	Cruise	400

Table V - Accuracy Firing Tests

Test Cond. No.	Helicopter				Target[1]		Missile Type (Suggested)
	Airspeed	Altitude (feet)	Prefiring Maneuver	Postfiring Maneuver (During Missile Flight)	Speed (mph)[2] and Direction	Range[3]	
1	Hover	10	Hover	Hover	————	Maximum	Telemetry[4]
2	Hover	100	Hover	Hover	L-R	"	Tactical[5]
3	Hover	1000	Hover	Hover	R-L	"	"
4	Cruise	400	Straight, level flight	Straight, level flight	L-R	"	"
5	"	100	"	Straight, level flight	R-L	1/3 Max	"
6	"	400	"	30° to 45° bank left (no heading change)	L-R	2/3 Max	Telemetry
7	"	400	"	30° to 45° bank right	R-L	2/3 Max	"
8	"	1000	"	45° heading change, left	L-R	Maximum	Tactical
9	"	1000	"	45° heading change, right	R-L	"	"
10	Maximum permitted	400	"	45° heading change, 30° bank left	R-L	"	Telemetry
11	Maximum permitted	1000	"	45° heading change, 30° bank right	L-R	"	"
12	Cruise	400	"	Accelerating turn to left	R-L	"	Tactical
13	"	400	"	Accelerating turn to right	L-R	"	"
14	"	400	"	Ascend and bank 30° left	L-R	2/3 Max	"
15	"	400	"	Ascend and bank 30° right	R-L	2/3 Max	"
16	Maximum permitted	1500	"	Descend and bank 30° left	L-R	Maximum	"
17	"	1500	"	Descend and bank 30° right	R-L	"	"
18	"	400	Evasive zig zag	Evasive zig-zag	L-R	"	Telemetry
19	"	1500	Evasive zig zag	Evasive zig-zag	R-L	"	"
20	Cruise	3500	Straight, level flight	Straight, level flight	L-R	"	Tactical
21	Maximum	3500	Straight, level flight	Straight, level flight	R-L	"	"
22	Cruise	3500	Shallow dive	Shallow dive	R-L	"	Telemetry
23	Maximum	3500	Shallow dive	Shallow dive	L-R	2/3 Max	"
24	Cruise	400	Straight, level flight	Straight, level flight	L-R	500 m	"
25	Maximum	400	Straight, level flight	Straight, level flight	R-L	500 m	"

[1]Crossing target except stationary target for test condition 1.
[2]Speed 30 mph except for test conditions 1 (stationary) and 4 (5 mph)
[3]Maximum range to target indicates maximum weapon system range capability.
[4]Telemetry missile: Missile containing instrumentation that monitors the operating characteristics (prelaunch and in-flight) and telemeters this information to a ground receiving station (Fig 2) in real time. The information is recorded at the ground station for later compilation and post-flight analysis.
[5]Tactical missile: Configuration identical to that which will be issued to tactical units, except that an inert-loaded warhead may be substituted for the explosive-loaded warhead, if required for safety and operating conditions.

Table VI - Airborne Firing Tests Under Adverse Conditions

Missile Firing Number	Climatic Condition	Helicopter			Range to Target[1]
		Maneuver	Altitude (feet)	Airspeed	
1, 2 & 3	Firing through dust and/or smoke	Straight flight	200-400	Cruise	Maximum[2]
4 & 5	Firing through fog	Straight flight	200-400	Cruise	"
6 & 7	Firing through rain	Straight flight	200-400	Cruise	"
8 & 9	Firing through snow	Straight flight	200-400	Cruise	"
9 & 10	Firing in crosswinds	Hover	100	Hover	1/2 maximum[3]
11 & 12	Firing in crosswinds	Straight flight	200-400	Cruise	Maximum[3]
13, 14 & 15	Operation during dusk-dawn[4]	Straight flight	200-400	Cruise	Maximum[2]

[1]Crossing target used for all phases.

[2]Maximum range at which a missile gunner can identify and track a target.

[3]Maximum weapon system range capability.

[4]Operation during periods of reduced ambient light, using daytime optical equipment. Testing of night sighting devices is not considered in this MTP.

TABLE VII- TRACKING (Simulated Firing) TESTS

Tracking Test No.	Helicopter Maneuver	Helicopter Altitude (feet)	Helicopter Airspeed	Target Range	Target Maneuver
1	Hover	10	Hover	500 meters	Stationary
2	"	1000	"	Maximum	Stationary
3	"	10	"	500 meters	Crossing
4	"	1000	"	Maximum	Crossing
5	Straight flight	100	Cruise	500 meters	Stationary
6	"	400	Cruise	Maximum	Stationary
7	"	100	Max permitted	500 meters	Crossing
8	"	400	Max permitted	Maximum	Crossing
9	Evasive bank right	100	Cruise	500 meters	Stationary
10	"	400	Cruise	Maximum	Stationary
11	"	100	Max permitted	500 meters	Crossing
12	"	400	Max permitted	Maximum	Crossing
13	Evasive bank left	100	Cruise	500 meters	Stationary
14	"	400	Cruise	Maximum	Stationary
15	"	100	Max permitted	500 meters	Crossing
16	"	400	Max permitted	Maximum	Crossing
17	Slalom left and right	400	Cruise	Maximum	Stationary
18	Slalom left and right	400	Max permitted	"	Stationary
19	Straight flight	400	Cruise	"	Evasive-Crossing
20	Straight flight	400	Max permitted	"	Evasive-Crossing

Table VII. A lightweight boresight camera (gun camera) or other instrumentation technique that provides the required tracking error data is used to record the deviation of the gunner's aiming point from the target center as a function of time.

In addition, tracking tests are conducted to determine the minimum permissible angle of incidence between the sun and the weapon system line of sight, without interference.

6.2.8 Maintenance Evaluation

Although the maintenance evaluation is a separate subtest of an ET or IPT, data for this evaluation are obtained throughout the entire test program. The maintenance evaluation covers the following subjects:

a. Data acquisition, i.e., timing of each maintenance action to obtain data for mean time between maintenance (MTBM), mean time to repair (MTTR), operational availability (A_o), and other factors.

b. Tools and test equipment.

c. Equipment publications.

. Repair parts.

e. Design for maintainability.

f. Safety aspects of maintenance operations.

g. Human factors aspects of maintenance operations.

h. Storage compartments and storage components.

i. Maintenance test package. (This includes elements of b, c, and d above. It is first evaluated upon receipt of the test item, but its evaluation continues throughout the entire test program.)

To plan and conduct a maintenance evaluation, USATECOM Regulation 750-15, MTP 7-2-504, and current guidance documents and policies must be consulted. Procedures for data reduction in connection with a above are included in these documents.

6.2.9 Human Factors Evaluation

Observations of the compatibility of the crew and weapon system are made during all aspects of testing. Typical areas of concern are: the ability of the gunner to properly guide the missile; the ease with which the control may be manipulated; ease of sighting and any obstructions to sighting; and the physical restrictions placed upon the gunner by (e.g.) reduced crew space, the presence of troublesome protrusions, or the wearing of protective clothing. Detailed guidelines may be found in MTP 7-2-505.

6.2.10 Reliability and Endurance

The data on failures and time to repair recorded for the maintenance evaluation (para 6.2.8) are also applicable to reliability and endurance.

6.2.10.1 Reliability

Requirements for reliability are expressed as mission reliability, overall reliability, or both.

a. Mission reliability expresses the probability that a certain mission (e.g., launching a full complement of missiles during a single helicopter flight) will be successfully accomplished with a certain confidence.

b. Overall reliability expresses the probability that the subsystem will perform a certain number of firings without a failure, with a certain confidence. It is concerned with mean time between failures (MTBF), mean rounds between failures (MRBF), and perhaps mean flying time between failures.

The test director must consult the latest guidance documents and reliability specialists with regard to sample sizes (MTP 3-1-002), the manner of acquiring data, and the manner of reducing data.

6.2.10.2 Endurance

Endurance is a general term used in connection with the life of the subsystem. Durability is a more specific term that can be used only in connection with the probability that the subsystem will fire a certain number of missiles before major overhaul is required. A confidence is associated with the probability. Since a durability evaluation requires a large sample of subsystems for testing and a large number of missiles for firing, it is unlikely that a durability requirement will be stated. If it is, it is even more unlikely that adequate subsystems and missiles will be available.

6.3 TEST DATA

The results of all tests, observations, and inspections are recorded as part of the test data.

6.4 DATA REDUCTION AND PRESENTATION

6.4.1 Safety Hazards

Any malfunction or other occurrence during the test program which could contribute to an unsafe condition is analyzed and reported immediately. Corrective measures required are determined, incorporated into the test item, and checked for satisfactoriness prior to the conduct of aerial firing tests.

6.4.2 Environmental Testing

Test item failures occurring during exposure to environmental treatments are: analyzed to determine the possible effects of each failure upon proper and safe weapon system operation, reported in accordance with established procedures, and corrected to the maximum extent possible.

6.4.3 Missile Firing Tests

The following information is reduced from instrumentation data obtained from airborne missile test firings (para 6.2.6):

a. Aircraft position (space coordinates) and velocity at the moment of missile launch (also pitch, roll and yaw data).

b. Missile position (space coordinates, including target hit data) and velocity profile during flight, as determined from the cinetheodolite and velocimeter records.

c. Time-correlated summary of on-board missile functions (motor pressure, gyro uncage and roll reference signals, battery voltages, error signals received, missile steering signals, etc.) as obtained from missile telemetry data.

Data obtained from missile guidance and control equipment are reduced and analyzed to determine proper operation and sequencing.

Data on malfunctions and flight test data are further analyzed and summarized to determine the capabilities of the weapon system to perform adequately in all required modes of operation. System limiting conditions are identified and reported. Data on malfunctions are analyzed to determine the effects on weapon system reliability. Weapon system accuracy data are analyzed to determine the probability of a single-shot target hit.

6.4.4 Tracking Tests

Target tracking data (from the firing and nonfiring tests) are reduced to determine the gunner's ability to sight and track a target under the required modes of employment.

The capability of the stabilized sight to provide a stable reference in all aircraft operating modes is evaluated. Gunner comments on sight stability and operation are summarized and reported, along with suggestions for improving the system to eliminate problem areas encountered.

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This procedure provides guidance for conducting engineering tests of aircraft guided missile subsystems, with re erences for the testing of subsystem components.

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