6 December 1967 3967 Materiel Test Procedure 5-2-511
White Sands Missile Range

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

FIRE CONTROL OPERATIONS

1. OBJECTIVE

The objective of this procedure is to evaluate the live firing of a surface to air missile against a real target.

2. BACKGROUND

Fire Control operations involve those steps that a given defense system must perform to acquire, track, and destroy a hostile target. The integration of the missile, launch equipment, radars, and computer into a compatable functioning system requires that these components be interconnected in their final configuration and that the system be evaluated as a completely functioning entity.

3. REQUIRED EQUIPMENT

a. Test range appropriate to the limits of the systems designed performance

b. Range tracking facilities of sufficient accuracy to measure the flight performance of the missile and target to an order of ten greater than the system specifications

c. Launch facilities appropriate to the system

d. Targets of sufficient performance to fully exercise the system under test to the limit of its designed parameters. These could include but are not limited to drones, tow targets, and re-entry vehicles.

e. Instrumentation and telemetry as appropriate to acquire and record the information necessary to fully evaluate the system performance

f. Range safety equipment

g. Computation facilities

4. REFERENCES

A. Jerger, J.J., System Preliminary Design, D. Van Nostrand Co., Inc., Princeton, N.J., 1960.

B. Locke, A.S., Guidance, D. Van Nostrand Co., Inc., Princeton, N.J., 1955.

C. Wrigley, Walter, and Hovorka, Fire Control Principles, McGraw-Hill Book Co., New York, New York, 1959.

D. USATECOM Reg. Number 705-7, Research and Development of Materiel.

E. Ar 320-5, Dictionary of Army Terms.

F. Chamber's Technical Dictionary, Third Edition Revised, MacMillan Company, New York, New York, 1962.

G. The International Dictionary of Physics and Electronics, Second Edition, D. Van Nostrand Co., Inc., Princeton, N.J., 1961.

5. SCOPE

5.1 SUMMARY

This Materiel Test Procedure describes the following systems tests to be conducted on a surface to air missile system.

a. Target acquisition: Evaluate the ability of the acquisition subsystem to acquire and identify a hostile target both with and without the presence of ECM and to transfer this target to the tracking subsystem.

b. Target tracking: Evaluate the ability of the system to track targets accurately in order that an intercept point can be predicted.

c. Target Interception: Evaluate the missile's ability to intercept and destroy the target.

5.2 LIMITATIONS

The tests in this Materiel Test Procedure are limited in scope to those items or components directly utilized during a fire mission, and to their ability to function as an integrated system. It is not a test to evaluate the individual components or subsystems, the performance of the system under environmental extremes, and system functions other than those involved in firing. Tests of this type can be run by referring to appropriate MTP's, Military Specification and MDP's.

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Pre-Scheduling Conditions

a. Experienced technicians, engineers, and range operations personnel should be available to conduct this test.

b. All safety conditions as specified by range regulations, should be observed during this test. As the test involves handling of ammunition components, and since actual firing operations are involved, no personnel who are not trained and equipped to handle these components should be allowed in the launch area during a test.

c. Appropriate range documentation must be prepared prior to the test, and all arrangements for targets, instrumentation, and other range facilities should be made prior to the test.

d. It is assumed that the system to be tested is in an operable condition, and that all pre-operational tests and checks have been completed and passed.

6.1.2 Pre-Testing Conditions

a. Secure and prepare or make arrangements for all required targets. These should be capable of exercising the system parameters to the limits of their designed capabilities.

b. All documentation that describes operating instructions, specifications, and systems capabilities, such as MPD's, QMR's, and Mil Specs, and TM's should be available prior to the test.

c. The system must be in a ready to fire condition prior to the start of the test.

d. All range equipment and facilities utilized in the test must be in an operable condition.

6.2 TEST CONDUCT

6.2.1 Target Acquisition

This test establishes that any system under test is able to recognize and acquire the target, and when applicable, discriminate between it and false targets. It also establishes that the accuracy of detection permits the target data to be inserted into the weapon system fire control network with minimum delay. Once the weapon system recognizes the target and accepts it for an engagement, the target acquisition sequence is considered to be completed.

a. Determine the minimum and maximum detection ranges of the system by flying a suitable target at the system per MTP 5-2-528.

b. Observe and record the range at which the target is first detected and the range at which it is too close to the acquisition system to be detected.

c. By a similar procedure determine the minimum and maximum altitude of detection.

d. Using at least two targets flying within at least twenty feet of each other, fly them at the system until they can be detected as two separate targets.

e. Observe and record the range at which these targets can be differentiated per MTP 5-2-518.

f. Using a target equipped with electronic counter measures (ECM) equipment determine the ability of the system to discriminate a real target in an ECM environment per MTP 5-2-528.

g. Record the ranges, type of ECM and pertinent operational data from the system, at the time of target discrimination.

h. Using a target or aircraft equipped with IFF determine, the ability to differentiate between friendly and enemy targets.

i. Measure and record the ability of the system to interrogate the target and to receive a response from it.

j. Fly the maximum number of targets that the system capabilities are rated to handle per MTP 5-2-518.

k. Repeat this test for various combinations of altitude and direction.

l. Record the number of targets detected and their positions for each combination.

m. Repeat the previous tests at least ten times, to obtain a standard deviation for the data obtained.

6.2.1.1 Target Transfer Time

Once a target has been detected, target position data must be inserted into the fire control network of the weapon system. This step requires a transfer of data from the detecting equipment to the target tracking equipment. The

transfer is complete when the weapon system has acquired (locked on) the target.

a. Measure the time from detection to lock on of all detectable targets as per MTP 5-7-528.

b. Record any effects of electronic countermeasures on transfer time per MTP 5-2-528.

6.2.2 Target Tracking

If an intercept point is to be computed for a moving target, it is necessary to track the target. The requirement for accuracy depends on the type of guidance used by the missile weapon system. However, since target position is the origin of the elements needed to predict an intercept point, the accuracy with which the weapon system can determine this position must be known.

The physical means of tracking generally contains two sources of error. One is collimation error due to the inability of the tracker to pinpoint the target in space, and the lag in the dynamic response of the tracker. The second error is the readout error in the data transmission from the tracker to the later stages of the weapon system fire control network.

a. Track a target with the system while simultaneously tracking it with a tracking system of at least ten times greater accuracy.

b. Record the position of the target, as determined by the fire control system and the independent tracking system.

c. Repeat the test for all types of targets that the system is designed to combat.

d. Repeat the test at least ten times for each target.

e. Determine the errors introduced in the target data by the succeeding stages of the weapon system fire control network by utilizing the standard component evaluation procedures as set forth to applicable MTP's, such as MTP 5-2-527, MTP 5-2-529, MTP 5-2-531, etc.

6.2.3 Target Interception

This test evaluates the ability of the system to engage and destroy a hostile target.

a. Select targets as before, taking care that they are capable of exercising the system to the limits of its capabilities.

b. Equip the system to include the missile with instrumentation and telemetry as appropriate per MTP 5-1-028.

c. Trajectory measuring equipment is used to record the flight path of both the missile and target.

d. All standard range safety precautions should be taken.

e. The test may be run with a live or dummy warhead. If a dummy warhead is used, then the arming and detonation functions of the fuzing system should be instrumented, per MTP 5-2-608 and 609.

f. Launch and direct a target at the system in such a manner that

it simulates a hostile target.

g. Acquire, track and launch a missile at the target.

h. Observe and record the system performance from time of acquisition, until interception per MTP 5-2-611.

i. Repeat the test against all targets and situations that the system is designed to combat.

6.3 TEST DATA

Record on a suitable data sheet, the type, serial number, and nomenclature of the system being tested and the target used for each test. Record the locations, date, and time of the test. Record the nature of and the type of instrumentation used to gather the test data. Record all information about the system external conditions which may have an effect on system performance.

6.3.1 Target Acquisition

a. Record the speed, altitude, and direction of the target in km/sec, meters, and mils.

b. Record the maximum and minimum ranges of detection and the direction of the target in km and mils.

c. Record the minimum and maximum altitudes of detection in meters.

d. Record the type and characteristics of any electronic counter measures used.

e. Record the effects of ECM on the maximum and minimum ranges and altitudes in km and meters.

f. Record the number of targets used in each test.

6.3.1.1

Record the transfer time required for target transfer in microseconds.

6.3.2 Target Tracking

a. Record on a suitable graph or chart, the trajectory of the target as indicated by the independent tracking system.

b. Record similarly the trajectory of the target as indicated by the tracking system.

6.3.3 Target Interception

a. Record target information as before.

b. Record the trajectories of both the missile and the target on a suitable graph or chart.

c. Record the missile and ground support equipment functions in a format compatable with the system and the purposes of the test.

d. Record in seconds, the elapsed time from the time of acquisition to the time of intercept.

6.4 DATA REDUCTION AND PRESENTATION

Comprehensive test reports and records should be prepared in accordance with the formats specified in the applicable range documentation.

Data reduction and presentation will depend on the types and amount of data collected. Available data reduction techniques should be examined during test planning and the methods of data collection coordinated with the personnel who will eventually attempt to reduce the data.

Data from test support groups will be reduced to the degree specified by the test director. Target and missile position data will usually be referenced to the launcher or tracker, or both. Telemetry will be reduced to a real time record with timing and calibrations.

The results of investigations and tests presented in this MTP will be in the form of notes, photographs, charts, graphs, tables, or other such forms as may apply. Enter all test information, results, and data in the test log or folder including the number of starts on each test, dates, and running times, and all test equipment settings at which the tests were conducted. The test results should not be based upon a single test, but should be an average of a series of tests to reduce the possibility of erroneous conclusions. All test data and information will become a permanent record in the log. It is important that the log for each system is complete, accurate, and up-to-date, as these logs may be used for future studies. The information derived from these procedures may be reviewed by the appropriate authorities to determine the practicality of using the system tested for a particular usage.

Equipment evaluation usually will be limited to comparing the test results to the applicable specifications and/or the requirements imposed by the intended usage.