AD NUMBER

AD876190

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AUTHORITY

USATEC ltr, 14 Dec 1970

1 July 1970

Materiel Test Procedure 4-2-503*
Aberdeen Proving Ground

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

SAFETY EVALUATION - CLOSE SUPPORT ROCKETS AND MISSILES

1. OBJECTIVE

The objective of this MTP is to provide tests to determine whether close support rockets and missiles are safe for service testing as required by USATECOM Regulation 385-6. If the item is proven safe, a Safety Release is issued by USATECOM. Safety evaluations are part of both the engineering test and the initial production test.

2. BACKGROUND

In this MTP the term "rocket" applies primarily to artillery rockets up to approximately 6 inches in diameter and to shoulder-held, bazooka-type, antitank rockets; the term "missile" refers to antitank guided missiles or shoulder-fired, surface-to-air guided missiles. These rockets and missiles may be employed from ground, shoulder, ground vehicle, or aircraft launcher. The term "hazardous failure" as used herein refers to any malfunctioning of the system that may result in injury to the user.

Basic components of close support rockets are the propulsion unit, the warhead, and the fuze section. Close support missiles have the same basic components plus a guidance system. The rocket and missile systems include launchers, power equipment, fire control devices, and - for missiles - guidance equipment.

3. REQUIRED EQUIPMENT

a. Standard Firing Range.
b. Range Facilities.
c. Environmental Test Chamber Facilities (-50°F to +160°F).
d. Launcher or Launching Facility applicable to item under test.
e. Witness Panels of Insulating Wallboard or other suitable material.
f. Photographic Equipment.
g. Equipment and Facilities required by referenced MTP's.

4. REFERENCES

A. AR 70-38, Research, Development, Test and Evaluation of Materiel for Extreme Climatic Conditions.
B. MIL-STD-331, Fuze and Fuze Components, Environmental and Perforance Tests For.
C. MIL-STD-810, Environmental Test Methods.
D. USAMC Regulation 385-12, Verification of Safety of Materiel From Development Through Testing, Production, and Supply to Disposition.
E. USAMC Regulation 700-34, Release of End Items for Issue.
F. USATECOM Regulation 385-6, Verification of Safety of Materiel

*Supersedes Interim Pamphlet 40-40.

During Testing.
G. MTP 2-2-614, Toxic Hazards Test for Vehicles.
H. MTP 3-1-002, Confidence Intervals and Sample Size.
I. MTP 3-2-056, Rocket Launchers (Ground-to-Ground).
J. MTP 3-2-615, Radio Frequency Radiation Hazards to Electro-Explosive Devices.
K. MTP 3-2-811, Noise and Blast Measurement.
L. MTP 3-2-823, Range Firing of Close Support Rockets and Missiles.
M. MTP 3-2-824, Flight Tests of Antitank Missiles.
N. MTP 4-2-015, Close Support Rockets and Missiles.
O. MTP 4-2-055, Fuzes.
P. MTP 4-2-601, Drop Tower Tests for Munitions.
Q. MTP 4-2-602, Rough Handling Tests.
R. MTP 4-2-804, Laboratory Vibration Tests.
S. MTP 4-2-806, Impact Sensitivity of Fuzes.
T. MTP 4-2-813, Arena Tests of High-Explosive Fragmentation Munitions.
U. MTP 4-2-820, Humidity Tests.
V. MTP 4-2-826, Solar Radiation Tests.

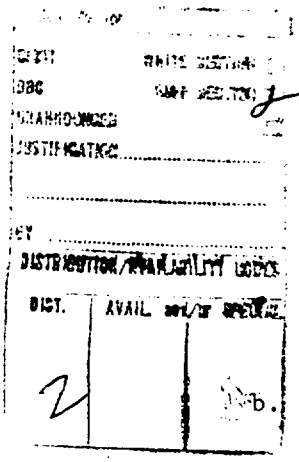
5. SCOPE

5.1 SUMMARY

This pamphlet provides guidelines for the safety evaluation of close support rockets and missiles including environmental exposure schedules and suggested test sample sizes. The subtests described herein include:

a. Environmental Testing - Consisting of:

1) High Temperature Storage and Operating Test - To determine the ability of the test item to withstand storage at extreme high temperatures.
2) Low Temperature Storage and Operating Test - To determine the ability of the test item to withstand storage at extreme low temperatures.
3) Transportation - Vibration Tests - To determine safety of the test item under a wide variety of transportation conditions.
4) Rough Handling Tests - To determine the ability of the test item to withstand the effect of transport and handling under expected battlefield conditions.
5) Forty-Foot Drop Test - To determine the ability of the test item to withstand shipboard backing accident without detonating.
6) Electromagnetic Radiation Initiation Hazard Test - To determine if the test item is safe from being initiated by r-f radiation.



b. Test Firing Tests consisting of:

1) Performance after Environmental Exposure - To determine safety of test item for firing after exposure to extreme

environment.

2) Fuze Safety Tests - To determine safety of test item safety devices against premature detonation.
3) Fragmentation Hazards - To determine hazards to the gunner, or personnel adjacent to the firing position.

5.2 LIMITATIONS

Due to the variety of guided missiles and rockets and the complexity of the test operations, this MTP provides only general guidelines. These must be adapted in accordance with the performance requirements of specific items and components being tested, taking into account the envisioned manufacture-to-launch environment. Additional information concerning the methods of testing close support rockets and missiles is found in MTP 4-2-015.

6. PROCEDURES

6.1 PREPARATION FOR TEST

In designing the test the test director must consider sample size requirements for statistical analyses, the use of increased-severity testing to minimize sample sizes, and techniques appropriate for detecting incipient failures. Knowledge of the rocket or missile design and of results of previous tests of the item or similar items provides a basis for making the determinations. Application of engineering judgment is most important.

6.1.1 Review of Data

In preparation for the test the test director reviews all data pertaining to the test item (AMC Technical Committee Minutes, Notes on Development-Type Materiel, manufacturers' handbooks and drawings, reports from development and engineer design tests, and similar material). Review of the Safety Statement provided by the developer (AMC Regulation 385-12) is mandatory. The test director examines the weapon or system thoroughly and assembles the following information:

a. Possible modes of failure and extent to which the components have proven safe and reliable when a part of other successful rocket and missile designs. Both static and dynamic firing data should be assembled.

b. Data from all tests, such as engineer design, conducted to date on the subject missile that provide support of verification of the safety of the item.

c. Any changes made in the rocket or missile system after the previous tests were conducted.

If review of data from previous tests indicates satisfactory performance of the item, and the item conforms with a proven design, a relatively limited test program may be conducted; if not, the test plan must be expanded in those phases considered critical.

Reference to the documents reviewed and to any novel design features

must be given in the test plan and in the test report.

6.1.2 Statistical Sample

Statistical techniques are used when designing a test to provide assurance of not more than a specified rate of failure. Confidence tables show, for example, that if a sample of 300 rounds is fired without a failure, one can state with 95 percent confidence that the population is not more than 1 percent defective. This percentage is totally unacceptable for hazardous failure that would result in injury to personnel. In fact, even if 30,000 rounds were fired without failure there would still be only 95 percent confidence of no more than one failure in 10,000 rounds. Engineering judgment must therefore also be applied.

A sample of 320 rounds, equal amounts fired at maximum and minimum temperatures, is economically feasible for most close support rockets. In the case of missiles, however, a 320-round sample is impractical because of the relatively high cost of each item. A small sample fired under extreme environmental conditions can contribute significantly toward a valid engineering judgment. MTP 3-1-002 provides additional information on sample size.

6.1.3 Increased-Severity Testing

One technique used to obtain an economical sample size is to test under conditions of increased severity. The likelihood of malfunctions arising from shock or structural failure is increased by testing under conditions representative of the upper extremes encountered in the field. Thus, if testing at -50° and 145°F is successful, satisfactory performance at less severe temperatures would be expected with greater confidence than the sample size alone would have indicated.

6.1.4 Inspection for Incipient Failure

Another method of enhancing the assurance of safety is to inspect test items for incipient failures. Rocket or missile failures are most likely to occur at launch or during the rocket motor burning part of the trajectory; for example, separations may occur between the rocket motor and rocket warhead in the initial phase of flight. A means to compensate for these unknowns is to obtain detailed inspection information before, during, and after testing when such data can provide indication of incipient failure as described in paragraph 6.2.2.1.

6.1.5 Component Parts Check

a. Inspect component parts of safety evaluation sample
b. Determine and record damage to test item parts due to transport
c. Record all defects found on test item components

NOTE: Damaged missiles are not normally used in the performance test (MTP 4-2-015).

6.1.6 Rounds for Concurrent or Joint Engineering and Service Tests

When engineering and service tests are to be conducted concurrently or jointly, a preliminary safety evaluation is performed by the engineering test agency to permit issuance of a preliminary Safety Release governing the service test safety precautions. Rounds used for this preliminary safety evaluation should be from the same lot (or lots) that is set aside for the service test; this is essential so that the preliminary safety evaluation will be meaningful as regards the possibility of hazards to be avoided during the service test.

6.1.7 Safety Evaluation of Initial Production Items

The procedures in this MTP are basically designed as part of the engineering test. However, safety subtests are also included as part of the initial production test to determine whether the production process results in a product that is equally as safe as the design item. The justification for such a test is covered by USAMC Regulation 700-34.

The engineering safety test procedure conducted during the engineering test is essentially repeated, but the items selected for testing must be representative of the production process. The test should be conducted on the first production lot of a manufacturer, also after any significant change in the production process that would require reexamination of test item safety.

6.1.8 Flight Danger Area

Information concerning the flight danger area required for missile firing is obtained by making a theoretical determination of the missile trajectory and impact coordinates resulting from the application of a maximum guidance signal to which the missile is capable of responding (minimum turning radius). Record the results of this determination. If engineering judgment dictates, special test firings may verify the flight danger area determination (see paragraph 6.2.2.4).

6.2 TEST CONDUCT

The following information will be recorded for each subtest:

a. Item and lot identification
b. Number of samples tested
c. Specific environmental and time records
d. Any limitations to the safety of the test item

6.2.1 Environmental Testing

Close support rockets and missiles must be safe to fire without the occurrence of unsafe incidents after exposure to extreme environments. Of the environmental tests, the most important in determining the safety of the test item are the extreme temperature storage and firing tests and those that pertain to transportation and handling.

Environmental tests are frequently conducted sequentially, in order

to more closely simulate the stockpile-to-battlefield sequence and, sometimes, to reduce the required sample sizes. A typical environmental sequence for a smaller caliber rocket system, requiring 320 rounds, is shown in Figure 1. The actual sample size required for a test item depends upon many factors, such as test item size and complexity, previous test history, etc., as discussed in Appendix A of MTP 4-2-015.

6.2.1.1 High Temperature Storage and Operating Test

a. Subject packaged test item to 7 days of cycled exposure as described in the high temperature-low humidity schedule of MTP 4-2-820.
b. Inspect and record effect of the exposure on the test item package.
c. Unpack test item, inspect and record the effect of the exposure on the test item.
d. Recondition test item to the required high temperature operating condition (discussed in MTP 4-2-015 or MTP 4-2-826).
e. Fire test item and record data as described in paragraph 6.2.2.

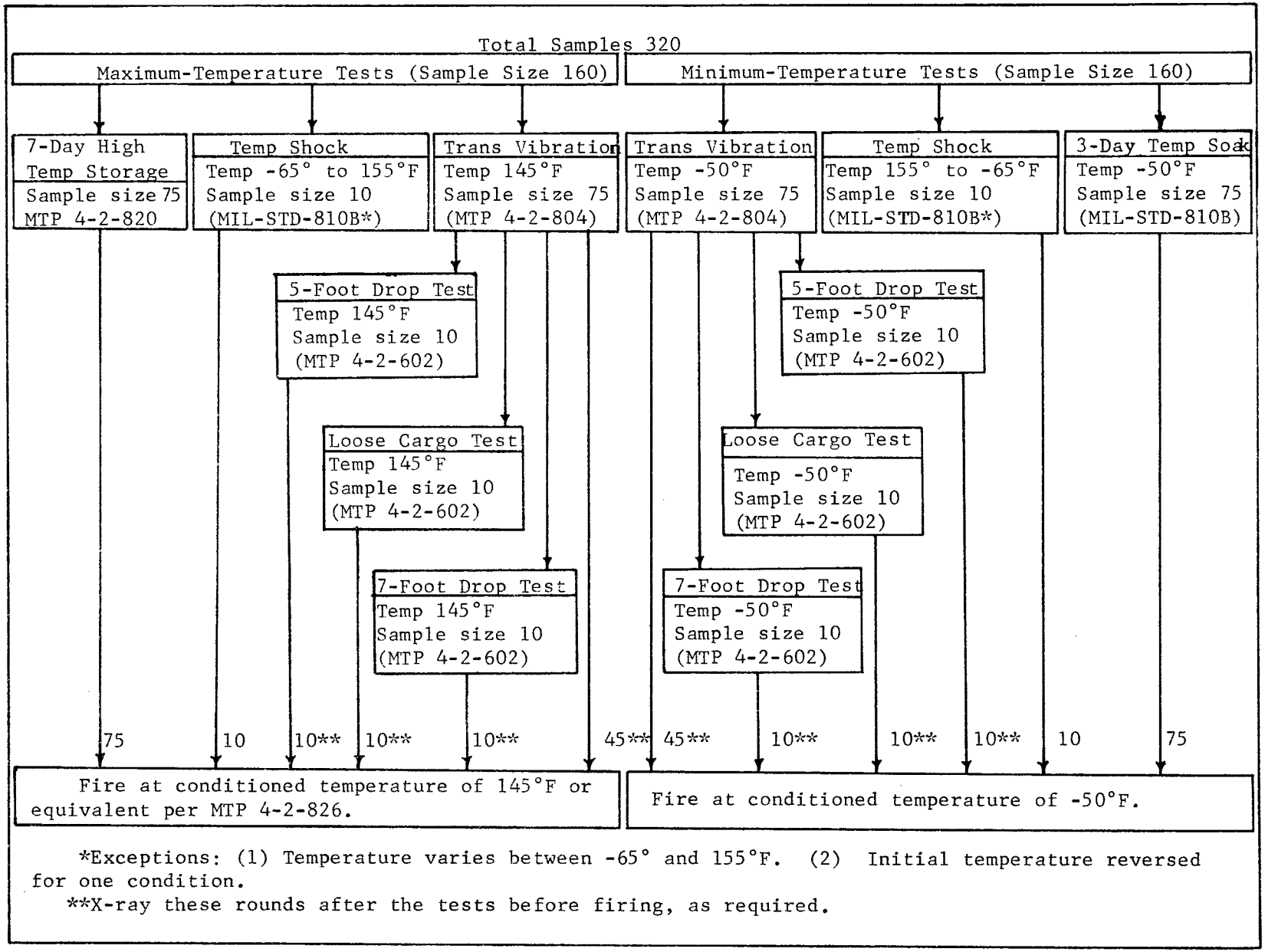
6.2.1.2 Low Temperature Storage and Operating Test

Most items are required to perform under the cold climatic conditions of AR 70-38. For test items that are required to meet only the intermediate conditions of AR 70-38, -50°F is an overtest for safety purposes only. If the items are safe to fire at -50°F but do not perform satisfactorily, a later test is conducted at -35°F to evaluate performance in accordance with MTP 4-2-015.

a. Expose an appropriate number of test items, in packages, to -50°F for 3 days.
b. Inspect and record the effect of the exposure on the test item package.
c. Determine and record the ability of the test item to withstand handling at low temperature.
d. Unpack test item, inspect and record the effect of the exposure on the test item.
e. Recondition the test item to -50°F.
f. Fire test item and record data as described in paragraph 6.2.2.

6.2.1.3 Transportation-Vibration Tests

Laboratory vibration tests at -50°F and +145°F are conducted on rockets, missiles, and components to determine whether they can withstand the effects of transportation by land, sea, and air modes and will arrive at their destination in a safe and usable condition. When possible, the test items are packaged in the same manner as the production quantity is intended to be packed for shipment and storage. The test items and packing material are examined before and after vibration testing, so that any post-test damage found can be positively attributed to the test environment. In addition to inspection for component parts damage and damage to the packing material, items containing explosives are carefully examined for indications of explosive exudation or breakup of the explosive charge.



*Exceptions: (1) Temperature varies between -65° and 155°F. (2) Initial temperature reversed for one condition.

**X-ray these rounds after the tests before firing, as required.

Figure 1. Typical Environmental Test Sequence for Small Caliber Rocket System

a. Conduct tests at -50°F and +145°F, as described in MTP 4-2-804.
b. Fire test item (at either -50°F or 145°F depending upon vibration temperature used) and record data as described in paragraph 6.2.2.

6.2.1.4 Rough Handling Tests

Rocket and missile ammunition must be capable of withstanding the effects of being transported and handled under expected battlefield conditions, packaged and unpackaged, without degradation in safety and performance characteristics.

a. Conduct loose cargo test, 5-foot, and 7-foot drop tests as described in MTP 4-2-602 at -50°F and +145°F.
b. Fire test item (at either -50°F or 145°F depending upon rough handling temperature used) and record data as described in paragraph 6.2.2.

NOTE: Missiles, due to complexity of design, often have a limited capability to withstand the above treatments. Review of prior engineer design data, the QMR, and any design limitations imposed by the developer should be made prior to specifying rough handling tests. If the missile is not designed to meet standard rough handling tests, test conditions should be selected to demonstrate the maximum capability of the test item. The severity of the drop tests can be lessened by decreasing the height of drop and by varying the drop impact surface (e.g., gravel instead of armor plate). The test item must be carefully examined for visible damage after the drop, so that a correlation may be made between visible damage (dents, cracks, etc.) and degradations in test item safety and performance. Visible damage is particularly significant to the gunner in combat.

6.2.1.5 Forty-Foot Drop Tests

The 40-foot drop test simulates a shipboard loading accident. Performance is considered satisfactory when there is no burning and detonation and the item is safe to dispose of. A typical sample size is five. Conduct test as described in MTP 4-2-601.

6.2.1.6 Electromagnetic Radiation Initiation Hazards Test

This test is conducted when the fuze has electrical or electronic components. The test assures that r-f radiation will not initiate the fuze. Conduct the test as described in MTP 3-2-615.

6.2.1.7 Other Environmental Tests

Depending upon the design of the test item, additional environmental tests contained in MTP 4-2-015 may be made a part of the safety evaluation if, in the engineering judgment of the test director, such tests at this time are necessary.

6.2.2 Test Firing

6.2.2.1 Performance After Environmental Exposure

Environmentally treated rockets and missiles must be test-fired primarily to determine safety and secondarily to evaluate performance following exposure. Such ammunition is fired remotely, with all test personnel under protective cover, to avoid unnecessary exposure to a possible malfunction of the test item. Ammunition is fired at the appropriate low operating temperature of AR 70-38 and a high temperature of 145°F.

Special attention should be paid to inspection for incipient failures. Such information can be obtained by item measurement before firing, in-flight photographs for detection of breakup, and especially by inspection of recovered rounds.

Conduct firing as described in MTP 3-2-823 or MTP 3-2-824 as applicable and record data as specified.

NOTE: **Test items that have been subjected to the 40-foot drop test are not test-fired because they are not required to be in operable condition after the drop.**

6.2.2.2 Fuze Safety Tests

Fuze arming and sensitivity tests are normally conducted when fuze or warhead components are under development during engineer design tests. If there are not sufficient data already available on fuze performance to assure safety:

a. Conduct arming distance test as described in MTP 4-2-055
b. Conduct impact sensitivity test as described in MTP 4-2-806

6.2.2.3 Fragmentation Hazards

Hazards to the gunner, or personnel adjacent to the firing position, from a fuze and warhead function at the minimum arming distance are determined (especially for direct-fire weapons). This test may be combined with the fuze arming distance tests.

a. Install witness panels made of insulating wallboard or other suitable materiel at an appropriate distance in front of the target.
b. Following the test firing inspect the witness panels and record penetration by fragments of the test item.

NOTE: If test results are inconclusive, of if additional information regarding warhead fragmentation that may be directed toward the firing position is desired, a static detonation (arena) test and analytical safety study is conducted in accordance with MTP 4-2-813.

6.2.2.4 Flight Danger Area

Flight danger area (paragraph 6.1.8) may be verified by special test firing as follows:

a. Apply maximum guidance signal to missile. Record type and level of signal.

b. Determine and record resultant missile trajectory and impact coordinates (minimum turning radius).

6.2.2.5 Supplementary Safety Tests

Other tests that may be conducted either as part of, or following the safety evaluation, as engineering judgment may dictate are:

a. Pendulum recoil test of MTP 3-2-056.
b. Noise and blast test of MTP 3-2-811.
c. Toxic gas measurements of MTP 2-2-614

6.3 TEST DATA

Test data will include item and lot identification, number of samples tested, specific environmental and time records, appropriate information from review of design data and metal parts check (par. 6.1), and other data required by the test reference documents. Any limitations to the safety of the test item (6.2.4 above) will also be recorded.

6.4 DATA REDUCTION AND PRESENTATION

Data will be obtained from all phases of the safety evaluation, and will be considered in preparing a recommendation for use of the test item. Test item failures, however minor, will be examined to determine whether they could contribute to unsafe operation under any and all possible conditions of use. The potential hazards to using and/or adjacent friendly personnel (e.g., functioning of short rounds) will be carefully considered. Any special protective equipment or operational limitations (such as the minimum range at which targets may safely be engaged without endangering friendly personnel from rearward-directed fragmentation) will be noted. Instrumentation data from the various subtests, such as rocket or missile motor thrust and pressure data from static motor firing tests, will be carefully reviewed to determine whether the performance of the item is within the anticipated and tolerable limits.

Results of the safety evaluation will be reported in accordance with USATECOM Regulation 385-6, including in the recommendation for Safety Release a description of any limitations to the safety of the test item.

UNCLASSIFIED

Security Classification

MTP 4-2-503
1 July 1970

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)
US Army Test and Evaluation Command (USATECOM)
Aberdeen Proving Ground, Maryland 21005

2a. REPORT SECURITY CLASSIFICATION
Unclassified

2b. GROUP
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3. REPORT TITLE
US Army Test and Evaluation Command Materiel Test Procedure 4-2-503, Common Engineering Test Procedure - "Safety Evaluation -"Close Support Rockets and Missiles."

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)
Final

5. AUTHOR(S) (First name, middle initial, last name)
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6. REPORT DATE
1 July 1970

7a. TOTAL NO. OF PAGES
11

7b. NO. OF REFS
22

8a. CONTRACT OR GRANT NO.
DA-18-001-AMC-1045(R)

b. PROJECT NO.
AMCR 310-6

c.

d.

9a. ORIGINATOR'S REPORT NUMBER(S)
MTP 4-2-503

9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

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11. SUPPLEMENTARY NOTES
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12. SPONSORING MILITARY ACTIVITY
Headquarters
US Army Test and Evaluation Command
Aberdeen Proving Ground, Maryland 21005

13. ABSTRACT
This Engineering Test Procedure provides guidance for determining whether close support rockets and missiles are safe for service testing.

DD FORM 1 NOV 68 1473 REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

UNCLASSIFIED

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
- Engineering Test						
- Test Procedure						
- Safety Test.						
- Rockets						
- Missiles						