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USATEC ltr, 14 Dec 1970.

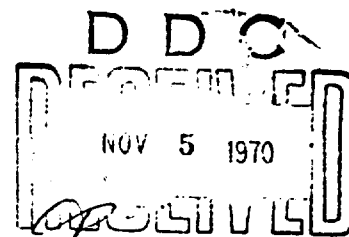
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3 August 1970

Materiel Test Procedure 3-2-531
Aberdeen Proving Ground

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

VULNERABILITY OF WEAPONS



1. OBJECTIVE

The objective of this MTP is to provide procedures for assessing the vulnerability of weapons to enemy action.

2. BACKGROUND

Weapons employed in combat are often exposed to enemy attack, particularly from small arms projectiles and from counter battery fire. While it would be unreasonable to expect a weapon to withstand a direct impact or near miss from an artillery projectile, the weapon should be able to withstand fragment hits and small arms impacts. This is particularly true with regard to the influence of such impacts on safety: after the impact it still should be safe to fire an HE projectile through the weapon without a catastrophic result.

Some weapons (many self-propelled artillery weapons, for instance) are designed with integral armor protection. With such materiel the QMR may state a level protection. Generally, however, the vulnerability of weapons is not covered by QMR's; thus, vulnerability tests of weapons are normally conducted only when special directions are provided.

3. REQUIRED EQUIPMENT

The equipment required to conduct a vulnerability test of a weapon is the same as that used in armor tests described in MTP 2-2-710. This includes facilities for loading ammunition and measuring projectile velocities as well as appropriate ranges and guns for firing projectiles and fragment simulators.

4. REFERENCES

- A. MTP 2-2-617, Vehicular Vulnerability to Conventional Weapons Attack.
- B. MTP 2-2-710, Vehicular Armor.
- C. MTP 2-2-711, Armor Weldments.
- D. MTP 2-2-715, Vehicle Vulnerability to Attack by Kinetic-Energy Projectiles.
- E. MTP 4-2-816, Photographic Instrumentation for Trajectory Data.
- F. AMC Pamphlet 706-170, Engineering Design Handbook, (C) Armor and Its Application to Vehicles (U), December 1961 (To be replaced by AMCP 706-170, (C) Armor and Its Applications (U), 1970.

5. SCOPE

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5.1 SUMMARY

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This MTP covers tests of weapons to include:

- a. Vulnerability of Armored, Self-Propelled Weapon Systems - To determine the ability of armored, self-propelled weapon systems to resist enemy action.
- b. Vulnerability of Gun Tubes - To determine whether a HE projectile can be safely fired through a gun tube after the tube has been hit by enemy action.
- c. Vulnerability of Weapon Components - To determine the vulnerability of certain components or ancillary equipment not part of a normal vulnerability test.
- d. Area of Vulnerability - To determine the projected area of the weapon that is vulnerable to a certain attack (e.g., cables or dials).

5.2 LIMITATIONS

This MTP does not apply to the vulnerability of small arms such as rifles, pistols, and machineguns.

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Review of Test Directives

For armored, self-propelled weapons the QMR may provide all of the guidance on vulnerability testing that the test director requires. In any event, vulnerability studies of armored, self-propelled weapons are considered essential. If inadequate guidance is provided, the test director may be required to seek clarification from the U. S. Army Combat Developments Command or confer with the U. S. Army Test and Evaluation Command, the Weapons Command, or the Project Manager's Office, as well as to avail himself of local knowledge and experience.

For weapons other than armored, self-propelled weapons the QMR is not likely to stipulate any requirements for invulnerability. If there are such requirements, special instructions will usually be provided. If the test director feels, however, that a vulnerability test of portions of a weapon system should be made because of the uniqueness of the design, the intended employment of the weapon, safety considerations, or any other sound reason, he should incorporate such a test in the test plan, making contacts in advance with higher command or the commodity command, as appropriate.

6.1.2 Pretest Inspection

For purposes of economy select a weapon, or weapon system as applicable, which has been subjected to considerable use and:

- a. Record the nomenclature of the item under test.

- b. Assure that the weapon is in satisfactory firing condition, firing it if applicable.
- c. Record any operating problems associated with the weapon.
- d. Record muzzle velocity from previous firings.

6.2 TEST CONDUCT

6.2.1 Vulnerability of Armored, Self-Propelled Weapon Systems

A vulnerability study is usually required of all armored vehicles including armored, self-propelled weapon systems to determine their ability to resist enemy action. The steps are as follows:

- a. Study reference 4F for background information.
- b. Plan vulnerability study in accordance with MTP 2-2-617, with supplementary details in MTP's 2-2-710, 2-2-711, and 2-2-715, selecting as appropriate from the following list of study areas.
 - 1) Bullet splash from small arms projectiles
 - 2) Immobilization of components
 - 3) Shock produced by ballistic attack
 - 4) High-explosive blast
 - 5) Air attack
 - 6) Penetration by kinetic-energy projectiles
 - 7) Welded joint weaknesses
 - 8) Fuel fires
 - 9) Special types of attacks
- c. Conduct studies in accordance with MTP 2-2-617.

6.2.2 Vulnerability of Gun Tubes

This test is a safety test to determine whether an HE projectile can be safely fired through a gun tube after the tube has been hit by enemy action. Examples of such tests that have been considered necessary in the past are the damage tests to the 106-mm recoilless rifles mounted on the ONTOS vehicle and damage tests to the 105-mm self-propelled howitzer M108. Steps in conducting such a test are as follows:

- a. Select AP projectiles (not over 20-mm) that, when fired at the tube from the direct flank, will result, as a minimum in a protection type (MTP 2-2-710) complete penetration of one wall of the tube.
- b. Plan sequence of testing to start with light damage and progress to more severe damage.
- c. Fire one projectile at the gun tube at a velocity to effect a complete penetration. Record projectile nomenclature, velocity, effect, and location of impact.
- d. Photograph damage.
- e. Set up high-speed photographic equipment to view the tube under test, and the projectile as it emerges from the tube, in accordance with MTP 4-2-816.

f. Taking appropriate precautions for possible prematures, fire an HE projectile, or a thinner-walled HEAT projectile if applicable, through the gun tube under study.

g. Record visible results and results obtained from reading the film.

h. Repeat the above procedures at least twice with the same tube, and with other tubes as required.

NOTE: A test of the vulnerability of tank gun tubes to attack by HEAT Projectiles is an infrequently used variation of this test. Such tests may include complete and partial penetrations of the gun tube as well the lodging of the follow-on plug (from the copper liner of the shaped charge) crosswise in the bore to form an obstruction. Each time the tube is damaged, an HE projectile is fired through it to see whether a premature will occur.

6.2.3 Vulnerability of Weapon Components

The vulnerability of certain components or ancillary equipment may be of concern and not be part of a normal vulnerability test. Only those items that, if struck, could cause the weapon to be useless or dangerous are of concern; for instance, exposed cables, equilibrators, and recoil cylinders. The test is conducted in the following steps:

a. Fire a projectile specified in the directive at one of the components under study, and record projectile nomenclature, velocity, location of impact, attack direction, and visible damage.

b. Traverse, elevate, and otherwise exercise the weapon under study to determine the effects of the projectile impact. Record the effects.

c. Only if necessary, fire the weapon under study and determine damage effects, such as failure to return to battery, etc.

d. Repeat above against other components as required.

e. When the weapon has been rendered unusable, determine the area that was vulnerable to the attack.

6.2.4 Area of Vulnerability

In certain test programs the directive may require that the projected area of the weapon that is vulnerable to a certain attack be determined. In much of the study - e.g., in evaluating the vulnerability of cables or dials - it will not be necessary to fire projectiles to determine whether the attack will knock out the particular component making the weapon inoperable. The steps are as follows:

a. From the direction of attack specified, determine the projected area of each component that can obviously be knocked out by the attack projectile and incapacitate the weapon. Record results.

b. For questionable areas, fire the attack projectile recording the location of impact and visible damage.

c. Following b, exercise the weapon to determine it is still operable. Fire the weapon only if absolutely essential. Record results.

d. From a, b, and c tabulate the total projected area of the weapon that, if subjected to the attack specified, will render the weapon inoperable. Compare this with the total projected area of the weapon.

6.3 TEST DATA

6.3.1 Preparation for Test

Record the following:

- a. Nomenclature of test item
- b. Operating problems associated with the test item
- c. Muzzle velocity as determined from previous firings

6.3.2 Test Conduct

6.3.2.1 Vulnerability of Armored, Self-Propelled Weapon Systems

Record the data requirements of applicable sections of MTP 2-2-617.

6.3.2.2 Vulnerability of Gun Tubes

a. Record the following:

- 1) Nomenclature of projectile
- 2) Velocity of projectile
- 3) Effect of fire on test item
- 4) Location of impact
- 5) Visible results
- 6) Results of test obtained from reading film

b. Retain all photographs.

6.3.2.3 Vulnerability of Weapon Components

Record the following:

- a. Nomenclature of projectile
- b. Projectile velocity
- c. Location of impact
- d. Attack direction
- e. Visible damage
- f. Effect of impact on test item
- g. Results of test firing if required
- h. The area of the test item vulnerable to attack

6.3.2.4 Area of Vulnerability

Record the following:

- a. The projected area of vulnerability

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- b. Direction of attack
- c. For attack fires:
 - 1) Type, model, and caliber of projectile
 - 2) Location of impact
 - 3) Visible damage
 - 4) Direction of attack
- d. Results of test firing if required

6.4 DATA REDUCTION AND PRESENTATION

A comparison between weapons is applicable when adequate data exist. Photographs are taken to picture significant information.

6.4.1 Vulnerability of Armored, Self-Propelled Weapon Systems

Data reduction and presentation will be as specified in applicable section of MTP 2-2-617.

6.4.2 Area of Vulnerability

From the data obtained during testing tabulate the total projected area of the weapon that, if subjected to the attack specified, would render the weapon inoperable. Compare this with the total projected area of the weapon.

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3 August 1970

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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 -----	
3. REPORT TITLE U. S. Army Test and Evaluation Command Materiel Test Procedure 3-2-531, Common Engineering Test Procedure, - "Vulnerability of Weapons."			
4. DESCRIPTIVE NOTES (Type of report and, inclusive dates) Final			
5. AUTHOR(S) (First name, middle initial, last name) -----			
6. REPORT DATE 3 August 1970		7a. TOTAL NO. OF PAGES 8	7b. NO. OF REFS 6
8a. CONTRACT OR GRANT NO. DA-18-001-AMC-1045(R)		9a. ORIGINATOR'S REPORT NUMBER(S) MTP 3-2-531	
b. PROJECT NO. AMCR 310-6		9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) -----	
c. d.			
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11. SUPPLEMENTARY NOTES -----		12. SPONSORING MILITARY ACTIVITY Headquarters US Army Test and Evaluation Command Aberdeen Proving Ground, Maryland 21005	
13. ABSTRACT This Engineering Test Procedure describes test methods and techniques for assessing the Vulnerability of Artillery, Recoilless Rifle and Tank Gun Weapons. Vulnerability to direct projectile impact and fragment hits. The evaluation is related to criteria expressed in applicable Qualitative Materiel Requirements (QMR), Small Development Requirements (SDR), Technical Characteristics (TC), or other appropriate design requirements and specifications.			

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0101-807-6811

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3 August 1970

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KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Engineering Test						
Vulnerability of Weapons (to projectile fragment impact) Artillery, Recoilless Rifle and Tank Guns						
Test Procedures						
Test Methods and Techniques						

DD FORM 1473 (BACK)

1 NOV 65

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Security Classification

A-31400