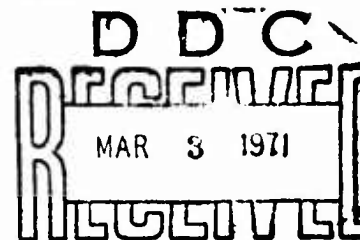


29 December 1970

Materiel Test Procedure 3-2-509
Aberdeen Proving Ground

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



1. OBJECTIVE

The objective of this MTP is to provide procedures for conducting tests of artillery cannon to determine their characteristics, and to assure that they comply with requirements stipulated in QMR's and other guidance documents.

2. BACKGROUND

A cannon is that portion of a gun or howitzer which consists of the gun tube, breech mechanism, firing mechanism, bore evacuator, and muzzle attachment. A cannon therefore does not include the carriage, mount, recoil system, fire control system, etc. A particular cannon could be adapted to several mounts for example.

Usually the cannon is tested at the same time as other portions of a particular weapon system.

Design changes in cannon can affect such things as: chamber pressure, muzzle velocity, accuracy and dispersion, rate-of-fire, bore evacuation, jump, obscuration, muzzle blast, service life, and effects of adverse weather conditions. Tests of cannon are principally concerned with these factors.

3. REQUIRED EQUIPMENT

- a. Appropriate Ranges, Facilities and Weapon Components
- b. Wind Machines capable of producing winds of 25 mph minimum
- c. Rain Facility for producing blowing rain
- d. Hot and Cold Chamber
- e. Freezing rain equipment for cold chamber
- f. A mud course for vehicles
- g. A dusty road
- h. Equipment for determining meteorological data
- i. High speed motion picture cameras and film
- j. Standard ammunition appropriate to the test item and inert rounds
- k. Equipment covered by referenced MTP's

4. REFERENCES

- A. AR 70-38, Research, Development, Test and Evaluation of Materiel for Extreme Climatic Conditions.
- B. AMCP 706-250, Guns Series, Guns - General.

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- C. AMCP 706-252, Guns Series, Gun Tubes.
- D. MIL-STD-810B, Environmental Test Methods.
- E. Naval Ordnance, U.S. Naval Institute, 1939
- F. Hayes, Maj. Gen. Thomas J., Elements of Ordnance, John Wiley and Sons, Inc., January 1938
- G. MTP 2-2-614, Toxic Hazards Test for Vehicles.
- H. MTP 2-2-800, Center of Gravity.
- I. MTP 2-2-815, Rain and Freezing Rain.
- J. MTP 3-1-006, Strain Measurement - Instrumental.
- K. MTP 3-2-510, Artillery Carriages and Mounts.
- L. MTP 3-2-600, Recoil and Equilibrator Systems.
- M. MTP 3-2-800, Inspection and Measurement of Cannon.
- N. MTP 3-2-805, Service Life and Safety Test for Gun Tubes.
- O. MTP 3-2-807, Materials Testing - Nondestructive Examination.
- P. MTP 3-2-809, Strain Measurement - Brittle Lazquer Method.
- Q. MTP 3-2-810, Weapon Pressure Instrumentation.
- R. MTP 3-2-811, Noise and Blast Measurements.
- S. MTP 3-2-816, Hop Firing.
- T. MTP 3-2-817, Jump Firing.
- U. MTP 4-2-802, Measurement of Projectile Seating.
- V. MTP 4-2-805, Projectile Velocity Measurements.
- W. MTP 4-2-829, Vertical Target Accuracy and Dispersion.

5. SCOPE

5.1 SUMMARY

This test pamphlet covers the firing and environmental testing of the cannon portion of guns and howitzers ranging from 40-mm to 280-mm. Test phases include:

- a. Prefiring inspection and measurement
- b. Prefiring functioning
- c. Ambient conditions firing tests, including:
 - 1) Proof firing tests.
 - 2) Basic firing tests.
 - 3) Cannon component tests.
 - 4) Rate-of-fire tests.
 - 5) Guidance on noting the particular test effects of blast, bore evacuation, and obscuration from flash and smoke.
- d. Extreme temperature firing tests
- e. Adverse weather condition tests, including:
 - 1) Headwind test
 - 2) Rain test
 - 3) Freezing rain test
 - 4) Mud test
 - 5) Sand and dust test

- f. Jump firing test
- g. Accuracy and dispersion tests
- h. Post-firing procedure

5.2 LIMITATIONS

This pamphlet does not cover safety evaluation or service life testing of artillery cannon, which subjects are covered by MTP 3-2-805. It also does not include the testing of carriages, mounts, recoil systems, and equilibrators systems which are covered in MTP's 3-2-510 and 3-2-600.

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Prefiring Inspection

- a. Inspect and measure the cannon under test as described in MTP 3-2-800 and MTP 3-2-807.
- b. Assemble the cannon to its recoil mechanism and gymnasticate it, as required.
- c. Assemble the cannon recoil mechanism to the test facility carriage and mount.
- d. Prepare the test weapon for firing, to include:
 - 1) Recoil and counterrecoil mechanism as described in MTP 3-2-600.
 - 2) Artillery carriage and mount as described in MTP 3-2-510.
- e. Mark components that are subjected to severe strain. Mount strain gages (MTP 3-1-006) or cover the surface of areas subject to severe strain with brittle lacquer (MTP 3-2-809).
- f. Photograph the test cannon, in both the traveling and firing positions, from various angles. Particular attention shall be paid to components of unusual design.

NOTE: Standard components used as facilities require only such routine examination as is necessary to assure compliance with inspection and safety procedures. The test site shall be checked for inherent hazards, the barricades shall be used when any possibility of danger from fractured parts or other hazards exists.

- g. Inspect, measure, photograph, prepare impressions, and magnaflux the test cannon and conduct magnetic particle or radiographic

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inspections on the test breech ring, breechblock, gun tube, bore evacuator chambers, and muzzle brakes as described in MTP 3-2-800.

h. Measure and record the data of steps b through i and m, n, and o, paragraph 6.1.2 below, as well as the type, model and serial numbers, and manufacturer of the cannon. Also record the model and serial numbers and description, as appropriate, of all the weapon system components or test facilities to which the cannon is mounted during the test.

6.1.2 Characteristics Data Sheet

A characteristics data sheet, suitable for the formal report and other uses, is assembled and printed. It consists of a photograph of the test item, reduced in size and combined, on a glossy 8- by 10-inch print, with all principal physical and performance characteristics of the weapon. Measurements are made to provide the following data on the characteristics data sheet.

- a. Type (built-up, monobloc, etc.) and model numbers.
- b. Total weight.
- c. Weight of removable components.
- d. Location of center of gravity of cannon with accessories (i.e., muzzle brake and bore evacuator) (MTP 2-2-800).
- e. Length of tube.
- f. Length of complete cannon in calibers.
- g. Distance from centerline of trunnion to breech rear face.
- h. Travel of projectile in bore.
- i. Volume of chamber.
- j. Upper pressure limit of propellant.
- k. Muzzle velocity and chamber pressure for each service round.
- l. Maximum range:
 - 1) Horizontal.
 - 2) Vertical.
 - 3) Effective ceiling.

m. Rifling:

- 1) Length.
- 2) Direction.
- 3) Twist.
- 4) Number of grooves.
- 5) Width of grooves.
- 6) Width of lands.
- 7) Depth of grooves.

n. Type of breech mechanism.

o. Type of firing mechanism.

p. Maximum rate of fire (normal and sustained).

q. Cartridge case ejection path and velocity.

r. Muzzle energy.

6.2 TEST CONDUCT

6.2.1 Prefiring Functioning

a. Gymnasticate the recoil mechanism as described in MTP 3-2-600, if applicable.

b. Determine and record the following:

- 1) Suitability of components.
- 2) Ease of operation and functioning of the breech mechanism.
- 3) Operation and functioning of the firing mechanism.
- 4) Efficiency and adequacy of all safety and locking devices.
- 5) Ease of assembly, such as tube to breech ring and gun to mount.
- 6) Satisfactory ejection of cartridge case, when applicable.
- 7) Proper seating and condition of gas-check pad, when applicable.
- 8) Ease of assembly of bore evacuator and muzzle attachments, when applicable.
- 9) Condition of metal surfaces, such as burrs, rust, or abnormal wear.
- 10) Functioning of the counterbalance mechanism (design strength and operation).
- 11) Proper provision for lubrication and drainage.
- 12) Ease of operation in the assembly of spindle and obturator parts, when applicable.
- 13) Ease of operation of the elevation and traverse handwheels, insofar as gun balance is concerned.

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6.2.2 Ambient Conditions Firing Tests

6.2.2.1 Proof Firing Test

Any tube to be fired for test purposes shall first be "proof fired" to disclose any deficiency or malfunctioning that would preclude its further use. Under no circumstances shall it be used with personnel exposed until a safety proofing history is developed.

Conduct proof firing tests at local ambient temperatures with the types and number of rounds specified in the item test directive. If no firing schedule is given by the directive, the rounds shall be fired in the following sequence: one round each at 50, 75, 100, 115, and again at 100 percent of the upper pressure limit (upl) of propellant proof.

This pressure value will be shown on the weapon drawing.

Measure chamber pressure (MTP 3-2-810) and muzzle velocities (MTP 4-2-805) on all rounds.

After the firing of each round, examine all weapon parts to locate any visible damage and record observations.

6.2.2.2 Basic Firing Program

a. Fire the rounds shown in Table I for a test of the weapon system at 100 percent of the upl of the propellant (as rated from the cannon being tested) under ambient temperature conditions.

NOTE: This test can often be fired in conjunction with other tests.

Table I. Basic Round Schedule

No. of Rounds	Elevation	Traverse
10	Equal Increments from Max to Min	0°
3	Max, Mean, Min	0°
3	Same	Max right
3	Same	Max left

b. Determine and record the following:

- 1) Seating distance on all separate-loading rounds as described in MTP 4-2-802.
- 2) Ramming velocities, when applicable, on all rounds, using a high-speed camera.
- 3) Chamber pressure on all rounds (reference MTP 3-2-810).
- 4) Length of recoil, when applicable, on all rounds as described in MTP 3-2-600.
- 5) Strain measurements on appropriate components, when firing representative rounds, as described in MTP's 3-1-006 and 3-2-809.
- 6) Muzzle velocities on all rounds for which strain measurements are taken, as described in MTP 4-2-805.

NOTE: If recoil systems, mounts, etc., are being tested simultaneously, appropriate measurements are made in accordance with the applicable MTP's such as 3-2-510, 3-2-600, 3-2-816, 3-2-817.

c. Record equipment malfunctions and examine the cannon and its associated components for the following, and record results:

- 1) Breaks, cracks (especially in welded sections), deformations, displacement, interferences, and similar deficiencies. Detailed photographs shall be made of any deficiencies noted.
- 2) The need for safety interlocks. Interlocks should prevent such occurrences as firing from out-of-battery position and accidental firings before the crew is clear of the recoiling parts.
- 3) The ability of the bore evacuator and scavenger systems to adequately evacuate propellant fumes and gases.
- 4) Determination of whether or not the ejection velocity and/or path of cased ammunition (when used) will create a hazard to the gun crew or nearby equipment.

d. High-speed motion pictures may be made when trouble areas must be studied, or to show weapon stability or the effect of firing shock on crew and equipment.

6.2.2.3 Cannon Component Tests

a. Determine the ability of the test cannon components to operate satisfactorily under various firing rates and percentages of upl, using the firing sequence of Table II.

b. Determine and record the data shown in the footnotes to the table.

NOTE: The cannon shall be fired from a mean elevation and 0° traverse position.

6.2.2.4 Rate-of-Fire Tests

Using ammunition obtained from a ground dump located near to the weapon, an experienced crew will attempt to maintain the rate of fire prescribed in the QMR or military characteristics, at the prescribed gun elevation. Immediately upon cessation of firing, a projectile will be loaded and not fired to see if a cook-off will occur.

During the rate-of-fire test a bore evacuation test, as applicable, will be made as described in 6.2.2.6 below.

As appropriate, a maximum-rate-of-fire test may be conducted, again followed by a cook-off test. The rate of fire achieved is recorded, as are time to cook-off, if any, and all pertinent data.

Observations of blast, smoke, fumes, ease of handling ammunition, and obscuration will be recorded.

6.2.2.5 Blast

Table II. Minimum Basic Test Rounds for Component Testing

No. of Rounds	Rate of Fire*	% UPL	Breech Ring, Block Firing, or Mechanical Problems	Bore Evacuator, Scavenger Problems	Muzzle Adaptor Problems	Required Data
1	Slow	50	. . . .	X	. . . .	(1)
1	Slow	75	. . . .	X	. . . .	(1)
1	Slow	100	X	X	. . . .	(3)
1	Slow	115	X	. . . .	. . . .	(2)
1	Slow	100	X	. . . .	. . . .	(2)
5	3 per min (37 - to 90-mm)	100	. . . .	X	. . . .	(1)
5	2 per min (90-mm and larger)	100	. . . .	X	. . . .	(1)
25	1 per min	115	X	. . . .	X	(2,4)
5	2 per min	50	X	X	. . . .	(3)
5	2 per min	75	X	X	. . . .	(3)
5	2 per min	100	X	X	X	(3,4)

*For smaller caliber automatic-type weapons (i.e., 37 - to 40 -mm), short, rapid-fire bursts are fired in accordance with applicable procedures.

¹Record whether bore evacuation and scavenger systems adequately evacuate propellant fumes and gases and/or residue from unburnt cartridge cases.

²Record:

- a. Seating distance, before firing, on all separate-loading rounds as described in MTP 4-2-802.
- b. Ramming velocities, when applicable, on all rounds, using a high-speed camera.
- c. Length of recoil on all rounds, when applicable, as described in MTP 3-2-600.
- d. Strain measurements on appropriate components, when firing representative rounds, as described in MTP's 3-1-006 and 3-2-809.
- e. Recoil pressure and travel records, when applicable, firing representative rounds, as described in MTP 3-2-600.
- f. Muzzle velocity and chamber pressure on all rounds for which strain measurements are taken, as described in MTP 4-2-805.
- g. Presence of breaks, cracks, deformations, interferences, or similar deficiencies at the completion of each firing sequence.

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³ Record the data indicated in notes 1 and 2.

⁴ Record effect of muzzle adaptors on weapon recoil, when applicable.

Obtain blast measurements in accordance with MTP 3-2-811.

6.2.2.6 Bore Evacuation

Determine and record the efficiency of bore evacuators of cannon that are to be used as part of a weapon system which has an enclosed crew compartment (such as a tank), using samples of noxious gases and following the procedures of MTP 2-2-614.

NOTE: The test may be conducted during single-shot or during rate-of-firing testing.

6.2.2.7 Obscuration

a. The crew will note obscuration from flash and smoke on a down-range target during single-shot firing and rate-of-fire testing.

b. Record the periods of obscuration.

6.2.3 Extreme Temperature Firing Tests

Following firing tests at ambient temperature, the cannon shall be subjected to the extreme temperature firing tests of Table III in an environmental chamber. The procedure is as follows:

Table III. Extreme Temperature Firing Schedule

No. of Rounds (Minimum)*	Percent UPL	Weapon Temperature OF
1	75	+70
2	100	+70
2	115	+70
1	75	+145
2	100	+145
2	115	+145
1	75	-25
2	100	-25
2	115	-25
1	75	-50
2	100	-50
2	115	-50

*For automatic weapons additional rounds shall be fired as directed in the test plan or stated in the applicable weapon specification.

a. Conduct the firings at weapon mean elevation and 0° traverse, when applicable.

b. Adjust propelling charge weights to give the prescribed percent of upl, and condition the charges to $70^{\circ} \pm 5^{\circ}\text{F}$. Regardless of weapon temperature, the propellant is fired at 70°F .

c. Before firing at each temperature level, soak the cannon at the designated temperature for 48 hours, or as long as necessary for the cannon temperature to be stabilized.

d. Immediately before and just after firing at each extreme temperature, conduct, magnetic particle inspections for cracks in the breech-block, breech ring, tube, muzzle brake, and bore evacuator. (Refer to MTP 3-2-807.)

e. During firing obtain the following information:

- 1) Propellant chamber pressures for each round, using copper crusher gages as described in MTP 3-2-810.
- 2) Projectile seating distance on all separate-loading rounds (MTP 4-2-802).
- 3) Effectiveness of projectile loader-rammer operation, when applicable, obtained by use of a high-speed camera.

6.2.4 Adverse Weather Condition Tests

The following adverse weather condition tests shall be conducted:

6.2.4.1 Headwind Test

a. Fire a minimum of two inert rounds while subjecting the test cannon to a minimum wind velocity of 25 mph, supplied by wind machines, blowing directly toward the weapon muzzle.

b. Record the following:

- 1) Wind velocity applied and specific direction.
- 2) Wind effect on bore evacuation efficiency.
- 3) Elevation of weapon.

6.2.4.2 Rain Test

a. If a rain test is required, subject the test item to the rain conditions of MIL-STD-810B, or as nearly so as facilities permit.

b. During exposure to rain, load a dummy round to evaluate breech operation and firing mechanism. If deemed necessary, fire the test item and record:

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- 1) Operation and functioning of the firing mechanism.
- 2) Efficiency and adequacy of all safety and locking devices.
- 3) Satisfactory ejection of cartridge case, when applicable.
- 4) Proper seating and condition of gas-check pad, when applicable.
- 5) Functioning of the counterbalance mechanism.
- 6) Ease of operation and functioning of the breech mechanism.

NOTE: For automatic breech operating weapons, a minimum of two inert rounds shall be fired to check the breech mechanism operation and functionability.

6.2.4.3 Freezing Rain Test

a. Unless otherwise indicated, subject the test item to the freezing rain conditions of MTP 2-2-815.

b. Following exposure to the condition of step a, field expedients will be used to remove ice that hinders operations and an attempt made to load and "fire" dummy rounds. If deemed necessary, fire two inert rounds and record data specified in paragraph 6.2.4.2b.

6.2.4.4 Mud Test

a. Unless otherwise indicated, the test item will be towed or driven through mud over a distance sufficient to produce a heavy layer of mud on movable cannon surfaces. The bore will be covered.

b. Following exposure, the weapon is wiped superficially with rags and attempts made to load and "fire" dummy rounds. If deemed necessary, fire two inert rounds through bore and record data specified in paragraph 6.2.4.2b.

6.2.4.5 Sand and Dust Test

a. The test item shall be towed over a dust course, or driven behind a dust-producing vehicle, for a sufficient distance to provide a heavy coating of dust. As an alternate test, should facilities permit, the breech end of the cannon shall be exposed to the dust test of MIL-STD-810B. The bore will be covered.

b. Following exposure, the weapon is wiped superficially with rags and attempts made to load and "fire" dummy rounds. If deemed necessary, two inert rounds may be fired through the bore and the data specified in paragraph 6.2.4.2b recorded.

6.2.5 Jump Firing Test

Determine the effects of muzzle attachments (e.g., muzzle brakes, blast deflectors) on the amount of jump by performing jump firing tests as

described in MTP 3-2-817.

6.2.6 Accuracy and Dispersion

Conduct accuracy tests as described in MTP 4-2-829. If the cannon has muzzle attachments (e.g., muzzle brakes, blast deflectors), conduct the test with and, if feasible, without the attachments to determine effects of the attachments on round-to-round dispersion.

6.2.7 Erosion and Service Life

Conduct erosion tests of the barrel and tests to determine service life, based upon factors such as erosion and fatigue, in accordance with MTP 3-2-805.

6.2.8 Post-Firing Procedure

Visually inspect, measure, photograph, and take impressions of the cannon as described in MTP 3-2-800.

6.3 TEST DATA

Data to be recorded are covered in paragraphs 6.1 and 6.2.

6.4 DATA REDUCTION AND PRESENTATION

The physical measurements and applicable material condition of the cannon under test, as determined during post-firing tests, shall be compared with the results obtained during prefiring inspection, to determine whether or not significant changes have occurred.

The number and types of rounds fired shall be compared with tube wear to establish preliminary criteria for determining tube accuracy or service life (MTP 3-2-805), and all conditions that may later be related to cannon performance (such as thermal cracks at the origin of rifling, which indicate the beginning of bore erosion) shall be noted.

Evaluate and record accuracy and dispersion data as described in MTP 4-2-829.

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