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1 June 1970

Materiel Test Procedure 3-3-525
U. S. Army Armor and Engineer Board

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

VEHICULAR MOUNTED AUTOMATIC WEAPONS DISPERSION

1. OBJECTIVE

The objective of this Materiel Test Procedure (MTP) is to provide guidance for conducting direct-sight firing of vehicular mounted automatic weapons against vertical targets to determine dispersion characteristics.

2. BACKGROUND

The ultimate objective of any weapon system is to deliver effective fire rapidly and accurately on a target. Improved battlefield mobility and operating range of modern vehicles has placed an ever increasing demand on the front line supply system. This can be reduced to some extent by conservation of ammunition through the use of more accurate weapons and efficient fire control systems which results in less ammunition expended per target kill. Reducing the dispersion of automatic weapon systems is probably the most effective means of lessening the supply demand. Dispersion can be attributed to many factors such as those inherent to the weapon-ammunition combination, tolerances in the weapon mount and traversing and elevating and fire control systems and incompatibility of the man-machine combination. All of these factors except the last one will have been determined to a great extent under ideal test conditions during the design and engineering phases of testing. The service test is normally the first time that a weapon system will be tested under field conditions by personnel with the skill and aptitudes of those expected to use it in combat.

3. REQUIRED EQUIPMENT

- a. Binoculars and Spotting Scopes.
- b. Appropriate Firing Ranges.
- c. Ambulance with Medical Aid Personnel and Equipment.
- d. Appropriate Targets.
- e. Meteorological Equipment, as required for determining:
 - 1) Windspeed and direction
 - 2) Ambient temperature
 - 3) Relative humidity
- f. Appropriate Ammunition.
- g. Boresighting Devices as required.
- h. Calibrated Cunner's M1A1 Quadrant.
- i. Star Gage, Boresight or other instruments as required to measure Barrel Wear and overall condition.
- j. Gridded Target.
- k. Tape Measure.
- l. Cameras, Still, Motion or Video as available with necessary Film

and Video Recorder when applicable.
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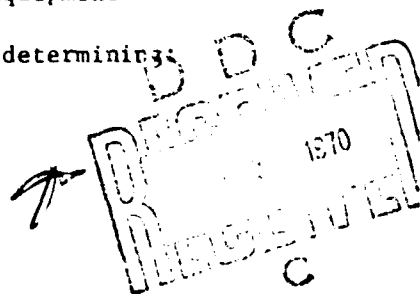
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4. REFERENCES

- A. USATECOM Regulation 385-6, Verification of Safety of Materiel During Testing.
- B. USAMCR 385-12, Verification of Safety of Materiel From Development Through Testing, Production, and Supply to Disposition.
- C. Applicable Range Regulations and Standing Operating Procedures.
- D. Qualitative Materiel Requirement (QMR), Small Development Requirement (SDR), or other appropriate document.
- E. Pertinent Technical Publications.
- F. MTP 2-3-500, Preoperational Inspection and Physical Characteristics.
- G. MTP 3-3-500, Preoperational Inspection and Physical Characteristics (Armament and Individual Weapons).
- H. MTP 3-3-501, Personnel Training.
- I. MTP 3-3-503, Boresight and Zero.

5. SCOPE

5.1 SUMMARY

This MTP outlines the procedures for determining the dispersion characteristics of vehicular mounted automatic weapons:

- a. Preparation for Test - Procedures for the training and familiarization of personnel, inspection of materiel, preparation of range site, break-in firing and boresighting and zeroing of the weapon system.
- b. Test Conduct - A determination of the dispersion characteristics of: (1) rigidly mounted vehicular mounted machine guns and (2) vehicular mounted automatic weapons of the 20 millimeter class, firing single shots and prescribed size bursts of specified ammunition at various stages of gun barrel life.

5.2 LIMITATIONS

None

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Safety

The test officer shall insure that a Safety Release has been received from HQ, USATECOM in accordance with reference 4A and that is is understood prior to commencing testing.

6.1.2 Personnel

- a. Ensure the availability of service personnel, representative of those that will operate the test item in the field, who have been trained in

accordance with procedures of MTP 3-3-501 and are cognizant of the following:

- 1) Pertinent technical publications for the test items
- 2) Applicable range regulations and standing operating procedures
- 3) Objective of the test
- 4) Pertinent data required
- 5) Method of obtaining observations
- 6) Method of recording data
- 7) Safety hazards

b. Record the following for all test personnel:

- 1) Name, rank or grade
- 2) Military Occupational Specialty (MOS)
- 3) Training time in MOS
- 4) Experience in MOS

6.1.3 Inspection

Subject weapon system and vehicle on which it is mounted to the applicable inspections described in MTP 2-3-500 and MTP 3-3-500 recording all pertinent data on the test vehicle, test weapon system and the number of rounds previously fired through the gun and gun barrel by type, when applicable.

6.1.4 Ammunition

The test officer shall ensure the availability of sufficient standard ammunition for each weapon to be tested and the following shall be recorded for each type of ammunition:

- a. Number of rounds recorded
- b. Lot number of rounds recorded

6.1.5 Pretest Operations

- a. Make necessary arrangements for use of 100-meter range facilities.
- b. Erect the following:

- 1) Panel targets at appropriate field ranges for the system being tested.

NOTE: All targets must have a distinct aiming cross and be of sufficient size to insure that each round of all bursts fired will impact on them.

- 2) A boresight and zeroing target as described in MTP 3-3-503 at the required range for the weapon system.
- 3) A gridded target as a convenient range as described in MTP 3-3-503.

NOTE: This target is for checking alignment of sights through-

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out subsequent firing exercises.

- c. Place available meteorological equipment near the field firing site.
- d. Position the firing vehicle at the firing point on level ground. Measure and record vehicle cant and pitch with M1A1 quadrant.
- e. Perform all required prefiring checks and fire the weapon to the extent required to ensure that it is functioning properly.
- f. Boresight and zero the fire control/weapon systems at 100 meters range as described in MTP 3-3-503 except for the firing of single shot 3-round groups in lieu of the prescribed bursts.

NOTE: Zeroing should be done with the gun in the forward position with respect to the vehicle.

g. Aim weapon system on the gridded target and mark or record point of alignment for each optical sight and the gun barrel.

h. Record the following:

1) After boresighting:

- a) Equipment used
- b) Setting on each boresight knob or sight upon completion of boresighting.

2) After zeroing:

- a) Range to target
- b) Fire control equipment used
- c) Ammunition used by type and lot number
- d) Number of rounds fired
- e) Final boresight knob or sight setting
- f) Ambient temperature
- g) Relative humidity
- h) Windspeed and direction

6.2 TEST CONDUCT

Evaluate the dispersion characteristics of vehicular mounted automatic weapons by determining the following for each test item:

- a. Single shot dispersion with each type of ammunition provided.
- b. Dispersion of burst size(s) specified for the particular weapon at representative combat ranges with each type of ammunition provided.
- c. Dispersion of burst size(s) specified for the particular weapon at representative combat ranges with specified combat mix of different types of ammunition.
- d. Degree of degradation in accuracy (i.e., increase in dispersion) at major increments of expected barrel/gun life cycle and vehicle operation.

NOTE: For ease of use, this test procedure is divided into two

parts, i.e., machine guns of the 7.62 mm and .50 caliber classes and automatic weapons of the 20 millimeter class and above.

6.2.1 Machine Guns - Rigidly Mounted

NOTE: The term "rigidly mounted" as used in this text denotes weapons installed in vehicles in such a manner as to provide precise gear or hydraulic type control by the gunner in traverse and elevation. The opposite is a flexible or free mounted weapon where all movement is accomplished by man-handling.

At the completion of the break-in firing and zeroing of paragraphs 6.1.5e and 6.1.5f perform the following:

6.2.1.1 Groups Fired by Single Shots

a. Lay the weapon, in the unstabilized mode, precisely on the aiming cross and fire 3 groups of 10 single shots with each type of ammunition provided at a range of 100 meters without relaying the weapon. Record the target impact distances from the point of aim in both the horizontal and vertical axes for each round fired.

NOTE: The center of impact, extreme horizontal and vertical dispersion and their 80 percent value shall be determined as described in paragraphs 6.4.1 and 6.4.2.

b. Repeat step a relaying the weapon on the aiming point after each round is fired.

c. Repeat steps a and b with the weapon in the stabilized mode as applicable.

d. Record the following for each shot group:

- 1) Date and time.
- 2) Nomenclature and serial number of weapon.
- 3) Type and lot number of ammunition.
- 4) Nomenclature and serial number of vehicle on which the weapon is mounted.
- 5) Number of miles weapon has been installed on vehicle.
- 6) Number of previous rounds fired through:
 - a) Weapon
 - b) Barrel
- 7) Range to target.
- 8) Fire control equipment used.
- 9) Gunner's name.
- 10) Loss of boresight, if any (measured on gridded target).
- 11) Gage reading of barrel, when applicable.

6.2.1.2 Groups Fired by Bursts

a. Using the same weapons as for firing described in paragraph 6.2.1.1, lay precisely on the aiming point and fire one group of 25 rounds and one group of 30 rounds with each type of ammunition and with specified combat mix of ammunition at a range of 100 meters. Relay the sights for each group. Record data as applicable for each burst as described in paragraph 6.2.1.1 and the following:

NOTE: These groups are for determining the differences, if any, in dispersion characteristics between the various types of ammunition and for establishing a base for comparison of groups fired periodically throughout the service test.

- 1) Number of rounds used for zeroing
- 2) Size of bursts
- 3) Type of ammunition
- 4) Description of combat mix of ammunition

b. Periodically through the service test, fire dispersion groups consisting of three 20-round bursts of each type and/or prescribed combat mix of ammunition at prescribed field ranges, if any, or at least 500 meters under the following conditions:

- 1) Barrels will be gaged to ensure that they are within prescribed wear limits.
- 2) Boresight retention will be checked on a gridded target.
- 3) Zero will be checked or refined as required by single shot firing without time limit and confirmed with a 20-round burst.
- 4) Relay the weapon sight precisely for each of the three 20-round bursts.
- 5) Use the same rate of fire for all groups and record the data required in step a.

NOTE: Center of impact and dispersion characteristics (extreme and 80%) shall be determined as described in paragraph 6.4.1 and 6.4.2.

c. For weapons having a dual automatic repeat step b using the other rate of fire.

6.2.1.3 Accelerated Barrel Wear Test

Conduct each of the following firing tests starting with a new barrel and the system zeroed at a range of 100 meters:

NOTE: Every effort should be made to avoid firing-schedule interruptions so that valid barrel wear results can be obtained. Stoppages or other delays during the first few groups fired can be disregarded. However, any delay that will allow a

thoroughly heated barrel to cool to any appreciable degree is sufficient to terminate the test of that particular barrel.

a. Fire 20-round bursts at an elapsed rate of 85 rounds per minute (1 burst every 14 seconds) at a range of 100 meters until 3,000 rounds have been fired or dispersion becomes excessive, whichever occurs first and perform the following:

- 1) Relay the weapon precisely for each burst.
- 2) Measure and record target impact distances from the aiming point in both horizontal and vertical planes.
- 3) Check for excessive dispersion after each of the first five bursts and thereafter for each tenth burst.

NOTE: 1. Determination of dispersion (extreme and 80%) and center of impact shall be determined as described in paragraphs 6.4.1 and 6.4.2.
2. Dispersion is excessive when it exceeds specified requirements by 20 percent.

- 4) Measure the full length of the bore with a bore-wear gage or other suitable instrument when dispersion becomes excessive or after 3,000 rounds have been fired for comparison with the barrel wear criteria published for the specific weapon.
- 5) Record applicable data described in paragraph 6.2.1.1 and the following:

- a) Range to target
- b) Number of rounds in bursts
- c) Elapsed time between bursts
- d) Number of bursts fired
- e) Total rounds fired
- f) Delays in firing programs, if any
- g) Bore-wear gage measurements upon completion of firing

b. Fire 30-round bursts at an elapsed rate of 150 rounds per minute (1 burst every 12 seconds) at a range of 500 meters using the procedures as described in step a except for the following:

- 1) Continue firing until 1,500 rounds have been fired or dispersion becomes excessive, whichever occurs first.
- 2) Checks for excessive dispersion after each fifth burst following check after each of the first five bursts.

NOTE: Dispersion is excessive when it exceeds specified requirements by 20 percent.

6.2.2 Automatic Weapons - 20 Millimeter

Determine the dispersion characteristics of the test item upon

completion or break-in firing and zeroing as described in paragraph 6.1.4 as follows:

6.2.2.1 Groups Fired by Single Shots

a. Lay the test weapon, in the unstabilized mode, precisely on the aiming cross of a 6.1 x 6.1 meter target pointed over the front of the vehicle, unless otherwise prescribed, at a range of 100 meters and fire 1 group of 10 single shots with each type of ammunition or combat mix of ammunition provided, relaying the test weapon after each shot (no time limit). Record the target impact distances from the point of aim in both the horizontal and vertical axes for each round fired and the following group shot data:

- 1) Date and time.
- 2) Nomenclature and serial number of weapon.
- 3) Type and lot number of ammunition.
- 4) Nomenclature and serial number of vehicle on which the weapon is mounted.
- 5) Number of miles test item has been installed on vehicle.
- 6) Number of previous rounds fired through:
 - a) Weapon
 - b) Barrel
- 7) Range to target and size of target.
- 8) Fire control equipment used (primary or secondary/unstabilized or stabilized).
- 9) Gunner's name.
- 10) Loss of boresight, if any (measured on gridded target).
- 11) Gage reading of barrel, when applicable.
- 12) Number of rounds fired in group.
- 13) Rate of fire (no time limit, or x number of rounds per minute).
- 14) Whether gunner was permitted to relay after each shot.
- 15) Direction weapon is pointing in relation to the front of the vehicle.
- 16) Date and time the weapon system was last zeroed.

b. Repeat the procedures of step a using the prescribed rapid single shot rate of fire.

c. Periodically throughout the service test, repeat the procedures described in steps a and b above at prescribed field ranges for the weapon system.

NOTE: Verify zero and rezero, if necessary after any appreciable movement of the vehicle or lapse of time.

d. When applicable, repeat the procedures of steps a, b and c above with the weapon system in the stabilized mode.

e. Repeat representative samples of firing test described in steps a, b, c and d above with the weapon pointed over the side (90° from the front) of the vehicle.

6.2.2.2 Groups Fired by Bursts

a. Using 6.1 x 6.1 meter targets at 100 meter range and the same weapons that were used for firing described in paragraph 6.2.2.1, lay the weapon in the unstabilized mode precisely on the aiming point and fire one group of each specified burst size for the weapon system with each type of ammunition provided using the low automatic rate. Record the applicable data as described in paragraph 6.2.2.1 and the following for each group:

- 1) Size of burst
- 2) Rate of automatic fire used

b. Repeat the procedures of step a above using the high automatic rate of fire. Make determinations and measurement and record data as described in paragraph a above.

NOTE: This firing data will serve as a basis for the following:

1. Determining the differences, if any, in the dispersion characteristics of the various types of ammunition.
2. Determining the size of targets that will be required to ensure impact of all projectiles of the different size groups and bursts on the target at the various prescribed field ranges.
3. Comparison of dispersion of groups fired periodically throughout the service test.

c. Periodically throughout the service test, repeat the firing test procedures describes in steps a and b at prescribed field ranges for the weapon system.

NOTE: To obtain valid hit capability data, targets must be large enough to ensure that each single shot or each round of each burst fired, as applicable, will impact upon it. When dispersion at a prescribed range is greater than practical size target, the range should be reduced and the reasons therefore explained in the test plan and/or report as applicable.

d. When applicable, repeat firing procedures of steps a, b and c above with the weapon system in the stabilized mode.

e. Repeat representative samples of firing tests described in steps a, b, c and d above with the weapon pointed over the side (90° from the front) of the vehicle.

6.3 TEST DATA

6.3.1 Preparation for Test

6.3.1.1 Personnel

Record the following for all test personnel:

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- a. Name
- b. Rank or grade
- c. Military Occupational Specialty (MOS)
- d. Training time in MOS
- e. Experience in MOS

6.3.1.2 Inspection

Record the following:

- a. Vehicle inspection data collected as described in the applicable sections of MTP 2-3-500.
- b. Weapon system inspection for each gun data collected as described in the applicable sections of MTP 3-3-500.
- c. Number of rounds fired, by type, when applicable:
 - 1) Through the gun
 - 2) Through the barrel

6.3.1.3 Ammunition

Record the following for each type ammunition received:

- a. Type of ammunition
- b. LOT number
- c. Number of rounds received

6.3.1.4 Pretest Operations

Record the following:

- a. Pitch and cant of test vehicle in degrees
- b. For boresighting:
 - 1) Equipment used
 - 2) Setting on each boresight knob or sight
- c. For zeroing:
 - 1) Setting on each boresight knob or sight
 - 2) Range to target in meters
 - 3) Fire control equipment used
 - 4) For ammunition used:
 - a) Type
 - b) Lot number
 - c) Number or rounds used
 - 5) Distance of CI of final zeroing group from the aiming point
 - 6) Ambient temperature in °F.
 - 7) Relative humidity in %

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- c) Windspeed and direction in mph and degrees, respectively
- 9) Point of alignment of the following on the gridded target:
 - a) Each optical sight
 - b) Gun barrel

6.3.2 Test Conduct

6.3.2.1 Machine Guns - Rigidly Mounted

6.3.2.1.1 Groups Fired by Single Shots -

Record the impact distances from the point of aim both horizontal and vertical, for each round fired in inches, and the following for each shot group:

- a. Date and time.
- b. Nomenclature and serial number of weapon.
- c. Type and lot number of ammunition.
- d. Nomenclature and serial number of vehicle on which the weapon is mounted.
- e. Number of miles weapon has been installed on vehicle.
- f. Number of previous rounds fired through:
 - 1) Weapon
 - 2) Barrel
- g. Range to target.
- h. Fire control equipment used.
- i. Gunner's name.
- j. Loss of boresight, if any (measured on gridded target).
- k. Gage reading of barrel, when applicable.
- l. Number of rounds fired in the group.
- m. Whether relay after each round was permitted.
- n. Whether gun was stabilized or in the unstabilized mode.

6.3.2.1.2 Groups Fired by Bursts -

Record applicable data collected as indicated in paragraph 6.3.2.1.1 and the following:

- a. Number of rounds used for zeroing
- b. Size of bursts
- c. Type of ammunition
- d. Description of combat mix of ammunition

6.3.2.1.3 Accelerated Barrel Wear Test -

Record applicable data collected as indicated in paragraph 6.3.2.1.1 and the following:

- a. Range to target
- b. Number of rounds in bursts

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- c. Elapsed time between bursts
- d. Number of bursts fired
- e. Total rounds fired
- f. Delays in firing programs, if any
- g. Bore-wear gage measurements upon completion of firing

6.3.2.2 Automatic Weapons - 20 Millimeter and Above

6.3.2.2.1 Groups Fired by Single Shots

Record the impact distances from point of aim, both horizontal and vertical, in inches, for each round fired and the following for each shot group:

- a. Date and time.
- b. Nomenclature and serial number of weapon
- c. Type and lot number of ammunition.
- d. Nomenclature and serial number of vehicle on which the weapon is mounted.
- e. Number of miles test item has been installed on vehicle.
- f. Number of previous rounds fired through:
 - 1) Weapon
 - 2) Barrel
- g. Range to target and size of target.
- h. Fire control equipment used (primary or secondary/unstabilized or stabilized).
- i. Gunner's name.
- j. Loss of boresight, if any (measured on gridded target).
- k. Gage reading of barrel, when applicable.
- l. Number of rounds fired in group.
- m. Rate of fire (no time limit, or x number of rounds per minute).
- n. Whether gunner was permitted to relay after each shot.
- o. Direction weapon is pointing in relation to the front of the vehicle.
- p. Date and time the weapon system was last zeroed.

6.3.2.2.2 Groups Fired by Bursts

Record applicable data collected as indicated in paragraph 6.3.2.2.1 and the following for each group:

- a. Size of burst
- b. Rate of automatic fire used

6.4 DATA REDUCTION AND PRESENTATION

6.4.1 Dispersion

NOTE: Dispersion requirements for all current combat vehicle mounted

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automatic weapons are expressed in terms of figure of merit.

a. The 100 percent and 80 percent dispersion of each group will be measured and expressed as Figure of Merit (FM) in mils.

NOTE: The 80 percent FM will be determined by the half and half method, i.e., discarding the worst 10 percent from both the horizontal and vertical plane and computing the FM for the remaining rounds.

- 1) The formula for computing the figure of merit is: Extreme Horizontal Dispersion (EHD) + Extreme Vertical Dispersion (EVD) \div 2 or $\frac{\text{EHD} + \text{EVD}}{2} = \text{FM}$.
- 2) The formula for conversion to mils is as follows:
 - a) $\text{Mils} = \frac{1000 \times W}{R}$ where W and R are the linear measure and range expressed in the same units.
 - b) $\text{Mils} = \frac{1000 \times W}{39.37 \times R}$ where W is in inches and R is in meters.
- 3) For an example, the 10-round group shown in Appendix A was fired at a range of 500 meters. The 100 percent EHD was 36 inches and the EVD was 69 inches. The 90 percent EHD was 15 inches and the EVD was 47 inches.

a) The 100 percent figure of merit was computed as follows:

$$\frac{36 \times 1000}{39.37 \times 500} = 1.80 \text{ mils (EHD)}$$

$$\frac{69 \times 1000}{39.37 \times 500} = 3.50 \text{ mils (EVD)}$$

$$\frac{1.80 \times 3.50}{2} = 3.15 \text{ FM (100 percent)}$$

b) The 80 percent figure of merit was computed as follows:

$$\frac{15 \times 1000}{39.37 \times 500} = 0.76 \text{ mils 90 percent of EHD}$$

$$\frac{47 \times 1000}{39.37 \times 500} = 2.38 \text{ mils 90 percent of EVD}$$

$$\frac{0.76 \times 2.38}{2} = 0.90 \text{ FM (80 percent)}$$

b. Average the 100 and 80 percent FM value from all separate but

like firings in order to provide a more reliable indication of dispersion than a single sample can produce.

6.4.2 Center of Impact (CI)

Compute the CI, defined as the mid-point of the group or the average distance of all rounds from the point of aim, as follows (See Appendix A):

$$CI(H) = \frac{X_1 + X_2 + X_3 + X_4 + X_5 \dots + X_n}{n}$$

$$CI(V) = \frac{Y_1 + Y_2 + Y_3 + Y_4 + Y_5 \dots + Y_n}{n}$$

where: n = number of rounds

All rounds to the left or below the point of aim are given negative direction.

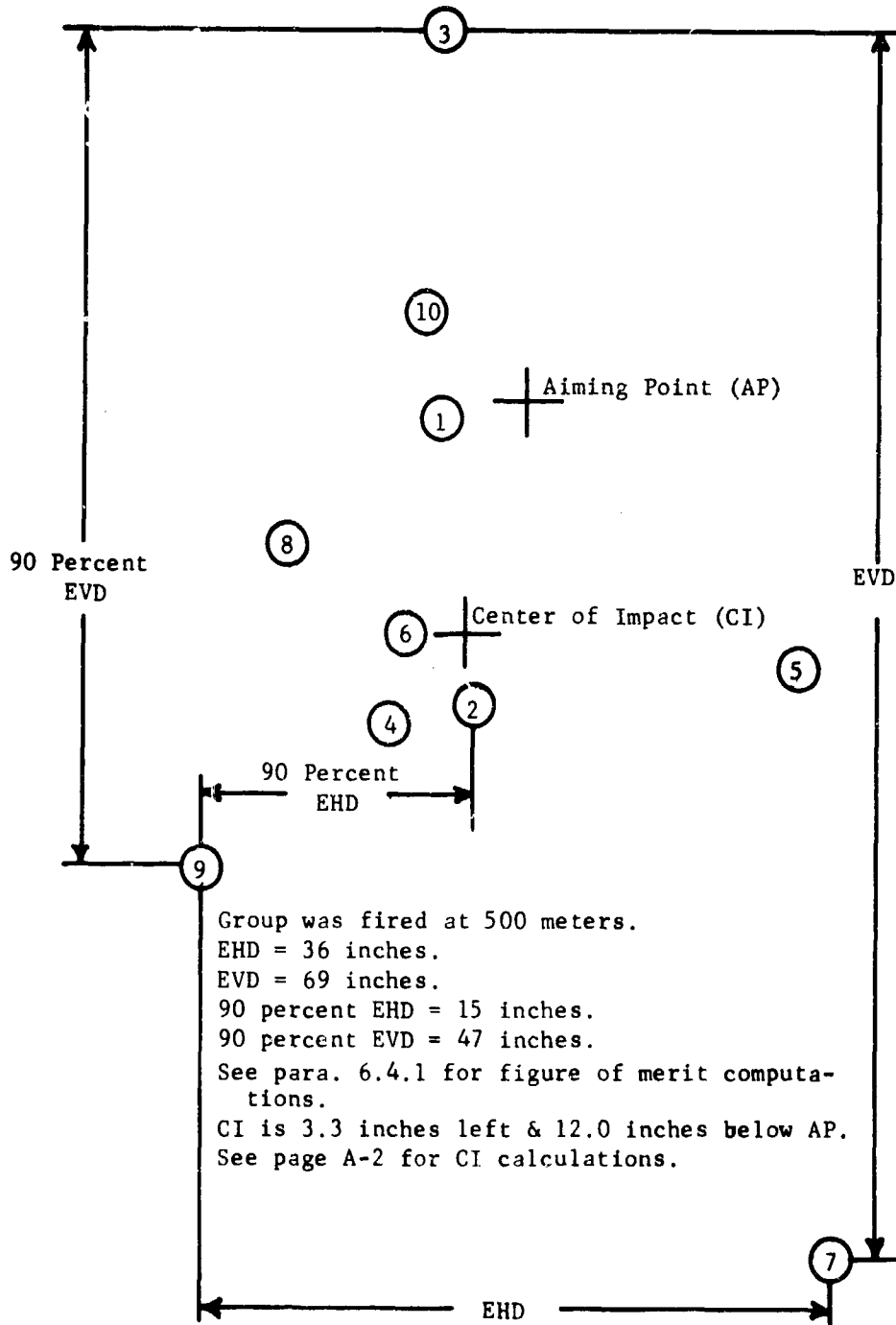
6.4.3 Effects of Barrel Wear

Compare the shot groups fired at various stages of barrel wear to determine the effect such wear has on dispersion.

APPENDIX A

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EXTREME DISPERSION - HORIZONTAL (EHD) & VERTICAL (EVD) and 90 PERCENT OF EHD AND EVD



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The shot group shown on page A-1 was fired at 500 meters. The group consisted of 10 rounds, which upon measurements were found to be distributed as follows with respect to the aiming point. (Locations below or left of aiming point are considered minus.)

<u>Round No.</u>	<u>Distance from Aiming Point (Inches)</u>	
	<u>Horizontal</u>	<u>Vertical</u>
1	-5	-1
2	-3	-17
3	-5	21
4	-8	-18
5	15	-15
6	-7	-13
7	18	-48
8	-14	-8
9	-18	-26
10	-6	5

To find the center of impact (CI), all horizontal and vertical measurements were added algebraically (subtracting minus values, adding plus values). These sums were -33 inches horizontal and -120 inches vertical. Divided by 10, the number of rounds, the values became -3.3 and -12.0 inches respectively which are the location of the CI measured in inches horizontally and vertically from the aiming point.

Using the formula of Mils = $\frac{1000 \times W}{39.37 \times R}$, where W is inches and R is meters, the CI was computed as follows:

$$\frac{-3.3 \times 1000}{39.37 \times 500} = 0.168 \text{ mils left}$$

$$\frac{-12.0 \times 1000}{39.37 \times 500} = 0.609 \text{ mils down}$$

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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 Army Service Test Procedure describes test methods and techniques for evaluating the Dispersion Characteristics of Automatic Weapons (Vehicular Mounted) of 7.62mm, 0.50 caliber and 20mm Classes. 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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