UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

1. REPORT NUMBER: TOP-3-2-816	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): U. S. ARMY TEST AND EVALUATION COMMAND TEST OPERATIONS PROCEDURE HOP FIRING	5. TYPE OF REPORT & PERIOD COVERED: Final
6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s)	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: U. S. ARMY ABERDEEN PROVING GROUND (STEAP-MT-M) ABERDEEN PROVING GROUND, MARYLAND 21005	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: DARCOM-R 310-6
11. CONTROLLING OFFICE NAME AND ADDRESS: U. S. ARMY TEST AND EVALUATION COMMAND (DRSTE-AD-M) ABERDEEN PROVING GROUND, MARYLAND 21005	12. REPORT DATE: 18 May 1978 13. NUMBER OF PAGES: 10
14. MONITORING AGENCY NAME & ADDRESS (If different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Artillery, Self-propelled
Artillery, Towed
Hop Firing
*Carriage Displacement

*New

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Describes procedures for measuring the carriage motion of towed and self-propelled weapons during firing and the final carriage displacement after firing. Applies to towed and self-propelled artillery.

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US ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

DRSTE-RP-702-102
*Test Operations Procedure 3-2-816 18 May 1978
AD No.

HOP FIRING

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1. SCOPE. This TOP describes procedures for measuring the carriage motion of towed and self-propelled weapons during firing (commonly referred to as "hop") and the final carriage displacement after firing.

2. FACILITIES AND INSTRUMENTATION.

ITEM	REQUIREMENTS
Record cards	White cardboard, sized to contain the expected hop pattern or motion between parts of an assembly
Card supports	Fixtures to firmly support hop cards
Pencil holder	Similar to figure 1
Pencil-holder brackets	To firmly secure pencil holder to test item (para 5.1.1.1a)
High-speed framing camera	100 frames per second or more depending on the expected speed of the motion.

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*This TOP supersedes MTP 3-2-816, 15 June 1966.

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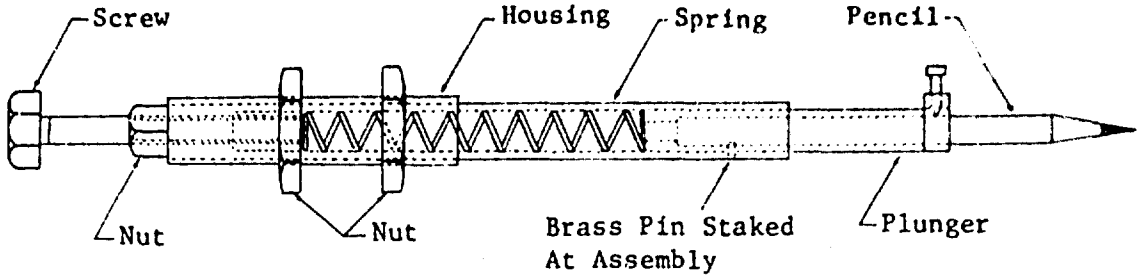


Figure 1. Pencil holder for hop records.

3. PREPARATION FOR MEASUREMENT.

3.1 Planning.

a. From the planned tests of the weapon select a firing subtest suitable for measuring hop concurrently with other test data. The subtest selected should include:

(1) Various firing elevations and directions of fire.

(2) The firing of each type of round or propelling charge used by the weapon.

b. Design a data-collection sheet for recording round-by-round data as required by the particular measurement technique.

c. Prepare a test operations checklist using the appendix as a guide and adding specifics for the test item and situation.

3.2 Weapon and Facilities.

a. Emplace the weapon with the carriage on the ground unless otherwise specified. Be sure that the ground is solid enough for the spade to be effective.

b. Fire at least one round to seat the weapon.

4. MEASUREMENT CONTROLS.

a. Be sure that pencil-holding brackets are rigidly secured and that the pencils are firmly held.

b. When the pencil is mounted on a wheel hub, lock the brakes so that the wheel cannot rotate. (Rotation of the wheel can produce an erroneous record if the pencil is not perfectly centered.)

c. Firmly seat the record-card supports to prevent wobbling and to withstand backblast.

A

5. MEASUREMENTS.

5.1 Carriage Hop.

5.1.1 Hop-Card Records.

5.1.1.1 Method.

a. Attach pencil holders to the test item so that the pencil will be perpendicular to the expected direction of motion. For self-propelled weapons, typical attachment points are the drive sprocket (fig 2) or roadwheel hubs or corner points of the carriage. For towed weapons, typical attachment points are wheel hubs (fig 3) when the axle is not pivoted to the bottom carriage, trail ends, or bottom carriage.

b. Position the card supports parallel to the expected direction of motion with the record card in contact with the pencil.

c. If the relative motion between two parts of an assembly as a result of firing is to be measured, mount a record card on one part and a pencil-holding bracket on the other. A linear variable displacement transformer may be used for this measurement when displacement versus time is of interest.

d. Label the point at which the pencil makes contact with the record card before firing as "1" or "start."

e. Fire the weapon and record carraige movement through one complete recoil and counterrecoil cycle.

f. After firing, label the point at which the pencil comes to rest as "2" or "stop."

g. Repeat the above measurement procedure as necessary to obtain reocrds for each firing condition of interest.

5.1.1.2 Data Required. Record the following data for each hop record as applicable:

a. Test-item nomenclature.

b. Pencil attachment points.

c. Date of firing.

d. Round number.

e. Gun elevation and azimuth.

f. Propelling charge.

g. Soil condition (hard, soft, sandy, etc.).

h. Tire air pressures if the weapon is fired with tires in contact with the ground.

i. Manner in which the weapon is emplaced.

j. If the hydraulic lockout system (provided on some weapons to afford a rigid firing base) was used.

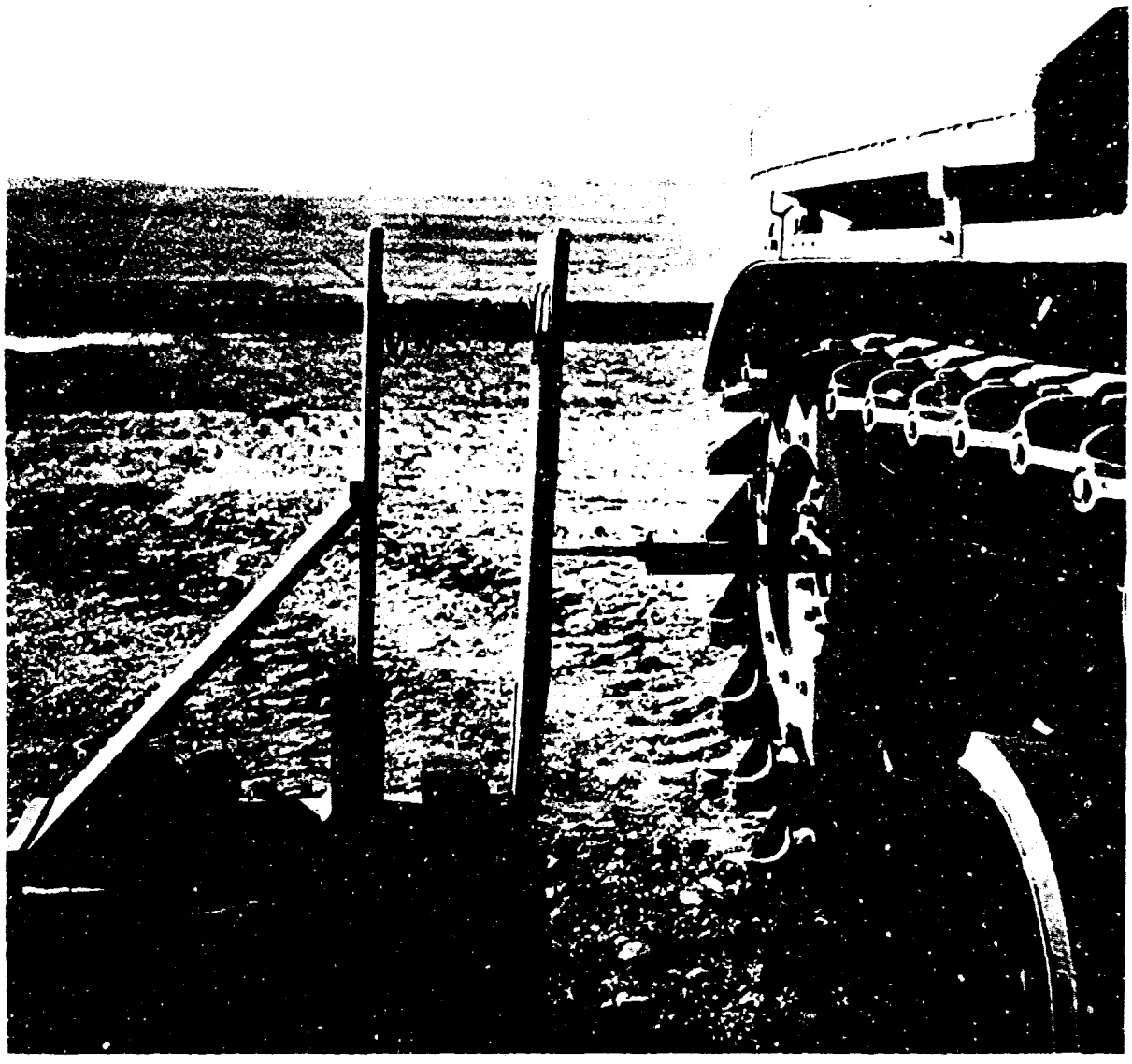


Figure 2. Position of hop-recording equipment on drive sprocket of self-propelled vehicle.

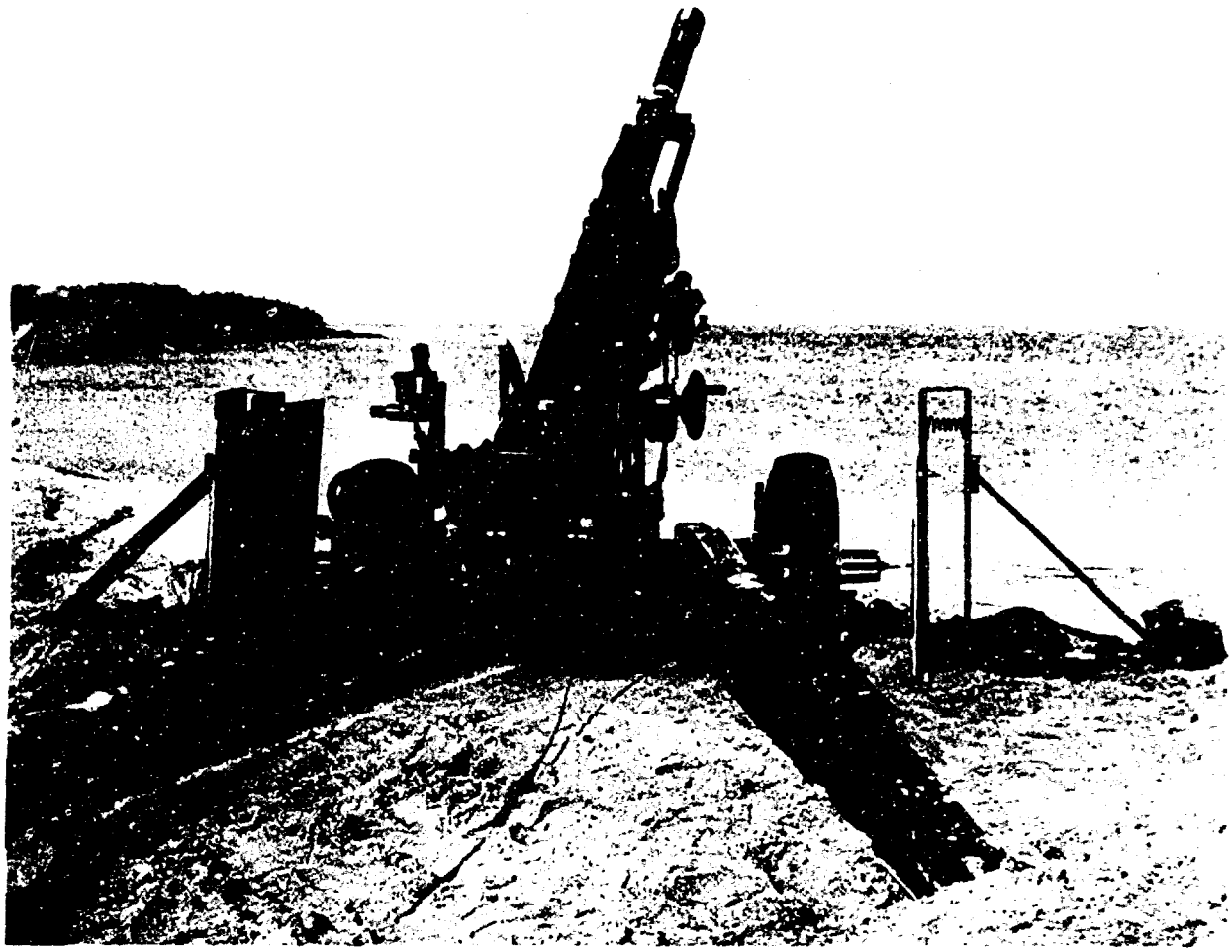


Figure 3. Position of hop-recording equipment on wheel hubs of towed weapon.

5.1.2 Photographic Records. Cameras can be used in conjunction with accurately placed reference marks to record time versus distance of movement. Timing marks on the film are used to establish the time-travel relationship.

5.1.2.1 Method.

a. Paint or tape crossmarks on the test item at selected points in the vertical plane of interest (bottom carriage, trails or spades, cradle or tube, etc.).

b. Position the camera(s) to photograph carriage movement following the guidance of TOP/MTP 4-2-816.

c. Mount a fixed reference crossmark in the camera field of view to aid in measuring displacement.

d. Measure and record distances between camera, crossmarks, and fixed reference.

e. Fire the weapon and record carriage movement through one complete recoil and counterrecoil cycle.

f. Repeat the above procedure as necessary to obtain records for each firing condition of interest.

5.1.2.2 Data Required.

a. Distances between camera, crossmarks, and fixed reference.

b. Camera focal length, framing speed, and timing-mark rate.

c. Data as required for hop records in paragraph 5.1.1.2.

5.2 Carriage Displacement.

5.2.1 Method.

a. For rearward displacement, firmly position a stake in the ground in front of the weapon carriage, offset from the line of fire and 30 to 60 centimeters behind the maximum rearward position of the muzzle to preclude movement as a result of muzzle blast.

b. For sideward displacement, firmly position two or more stakes in the ground to the side of the weapon and parallel to the longitudinal axis of the carriage.

c. Record the distance from each stake to fixed points on the carraige.

d. Fire the weapon and again measure distances as in c above.

e. Record carriage displacement as the difference between the measurements obtained in steps c and d above.

f. Repeat the above procedure as necessary to obtain measurements for each firing condition of interest.

5.2.2 Data Required.

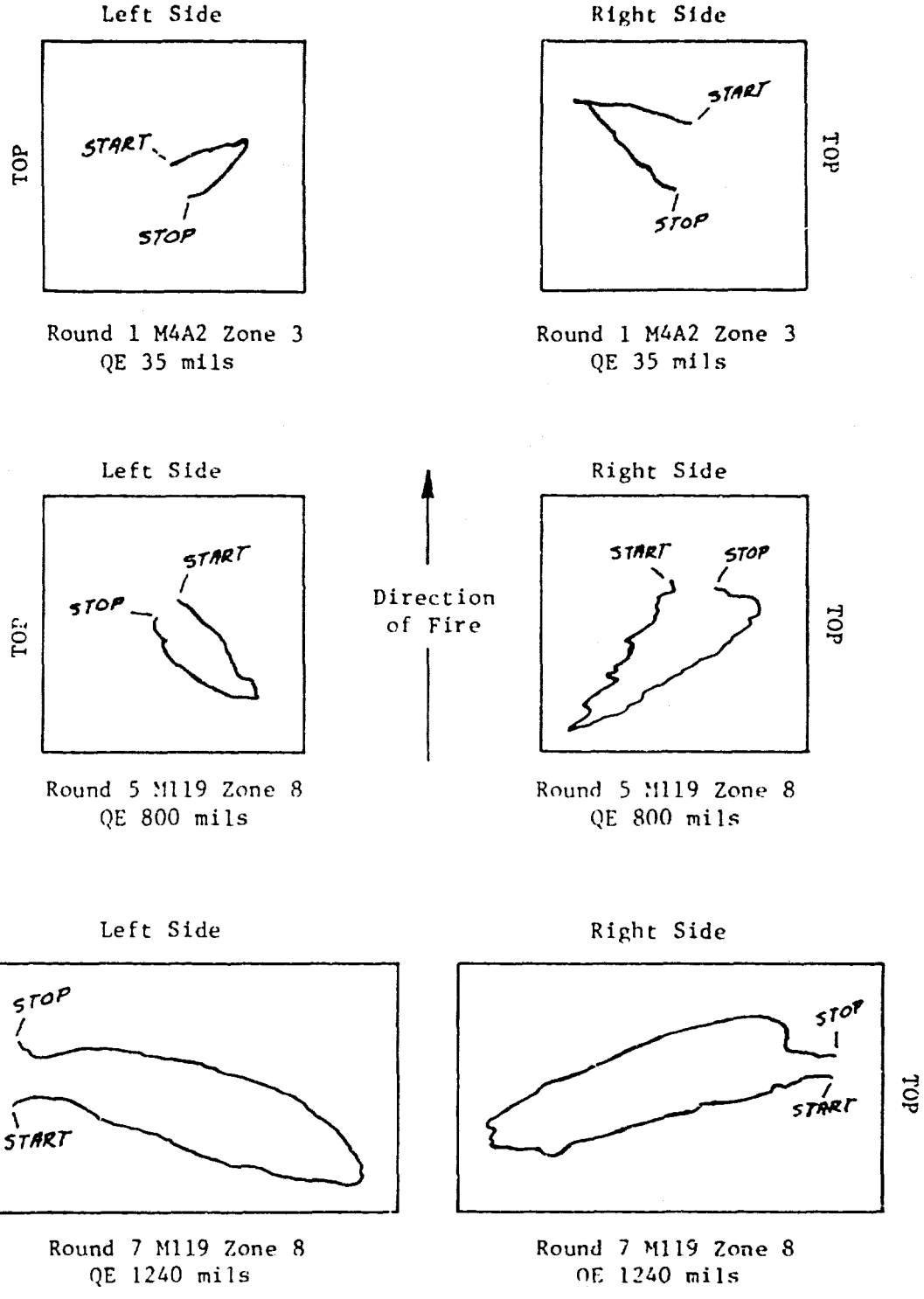
a. Carriage displacement and direction of movement.

b. Data as required for hop records in paragraph 5.1.1.2.

6. DATA REDUCTION AND PRESENTATION.

a. Tabulate all data.

b. Present hop-record data as shown in figure 4. Group the records by round number, firing elevation, and carriage position. When records are reproduced in other than full size, include a scale on the reproduction.



Full Scale

NOTE: View this page with card properly oriented for correct perspective.

Figure 4. Typical hop-record data.

c. When appropriate, show a diagram of the carriage, indicating the point of attachment for the pencil brackets. This is particularly important for self-propelled weapons for which hop records are made for various directions of fire.

d. Analyze the photographic records to determine displacement distances versus time, using film-reader equipment.

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APPENDIX
CHECKLIST GUIDE FOR HOP FIRING

ITEM	YES	NO	NA
1. All operating personnel briefed on test requirements, special procedures, hazards, and any unusual aspects of test.			
2. Ammunition components inspected, assembled, available, and identified.			
3. Weapon properly emplaced (lay established, spades dug in, seating round fired, etc.).			
4. Pencil-holder brackets rigidly secured.			
5. Record cards firmly supported.			
6. Camera(s) positioned properly (field of view checked).			
7. Camera loaded and checked for operation (proper lens, framing rate, IRIG timing, etc.).			
8. Safety requirements accomplished (SOP checklist completed and SOP posted*).			
9. Required data recorded.			

*SOP 385-67 at APG.