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

Provides a method of evaluating the capability of towed carriers, such as cannon carriages, air defense artillery mounts, and missile launchers, to withstand tactical movement without damage to the weapon or vehicle. Covers brake systems, slope performance, towing resistance, turning capability, endurance, vibration effects, and effects of deep water immersion. Does not cover tests of the armament.

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US ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

DRSTE-RP-702-101
*Test Operations Procedure 2-2-511 12 July 1977
AD No.

ROAD TESTS OF MOBILE WEAPONS

1. SCOPE. This TOP describes procedures for conducting standardized road and cross-country tests of mobile weapons which are moved as trailed loads behind prime movers. It covers tests performed to evaluate the capability of towed carriers, such as field cannon carriages, air defense artillery mounts, and missile launchers, to withstand tactical movement without damage to the weapon or vehicle. Tests of armament components are described in other TOP's.

2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities.

ITEM	REQUIREMENT
Automotive test courses	Selected from those listed in TOP 1-1-011 to suit test requirements. Equivalent courses may be used.
Instrumentation van	As described in TOP/MTP 2-1-005 and 2-2-808.

*This TOP supersedes MTP 2-2-511, 22 Dec 1965.

2.2 Instrumentation.

ITEM	MAXIMUM ERROR OF MEASUREMENT*
Brake test instrumentation	As described in TOP/MTP 2-2-608
Accelerometers	"g" level to ±5%

*Values may be assumed to represent ±2 standard deviations; thus the stated tolerances should not be exceeded in more than 1 measurement out of 20.

3. PREPARATION FOR TEST.

a. Obtain the prime mover vehicles specified by the requirements document or by the allowance list of the using unit. If no particular vehicle is specified, select vehicles based on the weight of the towed weapon and the rated towing load of the vehicle. Both tactical trucks and high speed tracked vehicles should be considered.

b. Prepare the towed weapons and prime movers for optimum operation with particular attention given to brake systems, lubrication, tire inflation, and proper weight distribution.

c. For brake system tests, install test instrumentation in accordance with TOP/MTP 2-2-608. For mountain highway brake tests, standard approved warning signboards and signals are mounted on the towed weapon and prime mover as required.

4. TEST CONTROLS.

a. Perform periodic lubrication and maintenance services throughout testing in accordance with the applicable lubrication orders and technical manuals.

b. Use only tires and wheels which are standard to the current Army inventory and which are common to the test item, unless otherwise specified.

c. Do not conduct mountain brake tests at night, during inclement weather, in congested traffic, or when the road surface may introduce a hazard to the test vehicle or other traffic on the road. Dry, unobstructed surfaces are used for all tests unless the test plan introduces a specific requirement.

d. Maintain the severity level of the secondary road and cross-country courses as constant as possible throughout testing using the procedures described in TOP 1-1-010.

e. Use safety chains between prime movers and towed weapons in addition to the standard coupling.

f. Observe all safety SOP's throughout test operations.

5. PERFORMANCE TESTS.

5.1 Brake System.

5.1.1 Performance. Using a suitable wheeled vehicle as the prime mover (preferably a cargo truck of the appropriate size), conduct the applicable brake system performance tests (i.e., burnish, stopping ability, pedal effort, etc.) and the mountain brake test described in TOP/MTP 2-2-608.

5.1.2 Endurance. Test brake endurance in accordance with TOP/MTP 2-2-608. Use the mileage accumulated during the towed weapon endurance test (para 5.5) to evaluate brake endurance as applicable for off-highway and general operation.

5.1.3 Data Required. Collect and record data in accordance with TOP/MTP 2-2-608.

5.2 Slope Performance.

5.2.1 Method. Determine the longitudinal grade and side slope performance of the towed weapon when attached to each of its prime movers in accordance with TOP 2-2-610.

5.2.2 Data Required. Collect and record data in accordance with TOP 2-2-610.

5.3 Towing Resistance.

5.3.1 Method. Determine the power losses attributable to the suspension system of the towed weapon in accordance with TOP 2-2-605.

5.3.2 Data Required. Collect and record data in accordance with TOP 2-2-605.

5.4 Turning.

5.4.1 Method. Determine the minimum turning capability of each prime mover with the towed weapon connected in accordance with TOP 2-2-609.

5.4.2 Data Required. Collect and record data in accordance with TOP 2-2-609.

5.5 Endurance.

5.5.1 Method.

a. Load each vehicle designated as a prime mover with the cargo or simulated payload it is designed to carry.

b. Tow the weapon using its different prime movers at reasonable and practical speeds over the various test courses listed in table 1. The mileages indicated are for guidance when specific requirements are not stated, and should be altered to suit specific test requirements at the discretion of the test director. Use soldier operators to accumulate a portion of the test mileage as established on a test-to-test basis during test planning. Record the driver's judgment of the road performance (ease of handling, tracking, etc.) of the test vehicle on each type of course.

c. During the test, perform scheduled preventive maintenance as prescribed in the applicable technical manual; perform unscheduled corrective maintenance as required to keep the vehicle operational. Soldier-maintainers perform the organizational level maintenance functions as required during operation and testing by military test and evaluation personnel, and participate in direct and general support maintenance as necessary. Observe the operator's daily checks and services to obtain representative times required to perform the tasks. Record all maintenance action data.

Table 1 - Recommended Test Courses and Minimum Mileages

Course[a/]	Test Mileage			
	Wheeled		Tracked	
	miles	km	miles	km
Perryman high speed paved road	50	80	50	80
Munson Area gravel road	120	190	100	160
Belgian block	80	130	-	-
Perryman secondary road	100	160	100	160
Perryman cross-country No. 4	100	160	100	160
Churchville cross-country	100	160	100	160
Mountain highway	[b/]		-	-

a/Courses are those used at Aberdeen Proving Ground and described in TOP 1-1-011. Equivalent courses may be used.

b/Mileage as accumulated during mountain brake test (TOP/MTP 2-2-606), when applicable.

5.5.2 Data Required.

a. Quantities and intervals at which fuels and lubricants are added.

b. Repairs made or parts replaced.

c. Maintenance time.

d. Mileage for each prime mover, the courses traversed.

e. Performance of the towed weapon or prime mover (sidesway, bouncing, tracking, etc.) on each course.

5.6 Instrumented Towing.

5.6.1 Method.

a. Boresight the direct and indirect fire control equipment of the weapon system under test, and measure boresight retention during the test in accordance with TOP 3-2-709.

b. Instrument the towed weapon with accelerometer gages at various locations considered to be critical during road testing. Typical locations to record acceleration and vibration data are presented in table 2.

Table 2 - Typical Accelerometer Locations

Location	Plane
Panoramic telescope head	Triaxial
Panoramic telescope elbow eyepiece	Triaxial
Elevation quadrant (panoramic telescope side)	Triaxial
Mount, telescope pivot arm bracket	Triaxial
Direct fire telescope, M114, front	Triaxial
Quadrant, M14	Triaxial
Direct fire telescope eyepiece	Triaxial
Left trail, inside surface center, 90 inches from trail pivot	Triaxial
Gun carriage platform, curbside	Vertical
Gun carriage platform, roadside	Vertical
Wheel arm, curbside	Triaxial
Wheel arm, roadside	Triaxial

c. Tow the weapon over the carriage courses listed in table 3 and record accelerometer output signals on magnetic tape. Signals are transmitted to the tape recorder by cables suspended between the test vehicle and an instrumentation van (TOP/MTP 2-1-005 and 2-2-808) that is operated on smooth roads paralleling the test courses. During cross-country operations, signals are transmitted by radio-link telemetry.

Table 3 - Carriage Courses

Course*	Speed	
	mph	km/hr
Munson 6-inch washboard	2 and 2-1/2	3.2 and 4.0
Munson Belgian block	10	16.1
Munson 2-inch washboard	3	4.8
Munson spaced bump	10	16.1
Munson radial washboard	8	12.9
Perryman cross-country No. 1	10	16.1
Perryman cross-country No. 3	5 to 10	8.0 to 16.1

*Courses are those used at Aberdeen Proving Ground and described in TOP 1-1-011. Equivalent courses may be used.

5.6.2 Data Required.

a. Accelerometer locations.

b. Courses traversed.

c. Prime mover speeds over each course.

d. Peak acceleration values.

e. Dominant frequency ranges of vibration.

f. Boresight retention data in accordance with TOP 3-2-709.

5.7 Fording. To satisfy NATO requirements for negotiation of water obstacles, 1/ mobile weapons must be capable of immediate use after:

a. Shallow fording in fresh or salt water without a special waterproofing kit, or

b. Complete submergence in fresh or salt water using a waterproofing kit (or, alternatively, after being floated across a deep water obstacle, if feasible).

1/ TB 34-9-30, Fordability and Flotation Agreement.

When a special waterproofing kit is not required for submergence of towed weapons, both shallow and deep fording requirements can be tested by performing one deep-water immersion test.

5.7.1 Method.

5.7.1.1 Preparation. Inspect the weapon system, including all fire control equipment, and prepare it for extended road or cross-country movement, as directed in the appropriate operator and maintenance manuals.

5.7.1.2 Shallow Fording.

a. Shallow ford the towed weapon with its prime mover in accordance with TOP 2-2-612 at the maximum depth required by the vehicle specification but not less than 30 inches (0.76 m).

b. After removal from the water, check the operability of the weapon in accordance with 5.7.1.4 below.

5.7.1.3 Deep-Water Immersion.

a. When a waterproofing kit is required, install the kit in accordance with published instructions.

b. Using cable controls (prime mover or crane), completely submerge the weapon in water for a minimum of 30 minutes. When the weapon is required to demonstrate an "immersion proof" capability, submerge the weapon to a covering depth of 3 feet (0.9 m) from its highest point for 2 hours to satisfy NATO requirements. 2/

c. Remove the weapon from the water. Inspect for the presence of water in the recoil system, cannon barrel, carriage components, and fire control equipment (i.e., sights, storage boxes, etc.).

d. Check weapon operability in accordance with 5.7.1.4 below.

5.7.1.4 Post Test Operation. As soon as possible after fording (within 1 hour), emplace the weapon on a firing range and, unless a condition develops or is observed that could prevent safe firing operation, remotely fire the weapon according to the schedule of table 4. Use ammunition that is standard for the weapon with inert projectiles and fuzes. Record any performance anomaly or condition resulting from fording or immersion.

2/ TB 34-9-31, "Immersion Proof" Requirements for Ground Forces Equipment.

Table 4 - Firing Schedule

Test Round	Firing Elevation	Percent of upl
1	Mean	50
2	Mean	75
3	Mean	100
4 and 5	Max	75
6 to 8	Max	100
9 to 15	Min	100

5.7.2 Data Required.

a. Condition of the system components before and after the fording or immersion test.

b. Time shallow forded or immersed.

c. Time between removal from water and first round fired.

d. Photographic coverage of the fording or immersion operation.

e. Depth of water or covering depth, as applicable.

f. Recoil time of cycle (if time for hookup is possible).

g. Recoil length.

6. DATA REDUCTION AND PRESENTATION.

a. Convert acceleration data recorded on magnetic tapes to rms acceleration data using appropriate data processing equipment. Make spectral analyses in the linear mode to show major vibration frequencies on the weapon. Perform other analyses as required using the techniques described in TOP 1-1-050.

b. Tabulate all data collected during the road tests and compare with test criteria.

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