RECOVERY VEHICLES, FULL-TRACKED

Army Test and Evaluation Command
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13. ABSTRACT

Describes a method for evaluation of recovery vehicle performance and operational characteristics. Identifies supporting tests, facilities, and equipment required. Provides procedures for test preparation, initial inspection, vehicle characteristics, safety, hydraulic systems, endurance, durability, and reliability. Applicable to full-tracked recovery vehicles.

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U. S. ARMY TEST AND EVALUATION COMMAND
DEVELOPMENT TEST II (ET) - SYSTEM TEST OPERATIONS PROCEDURES

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RECOVERY VEHICLES, FULL-TRACKED

SECTION I
GENERAL

1. Purpose and Scope. This TOP provides guidance for planning tests of full-tracked recovery vehicles to assure their conformance with Required Operational Capabilities (ROC's), Development Plans (DP's), MN's and other guidance documents. Appropriate subtests suitable to meet the requirements of development tests I, II or III (formerly development suitability tests, engineering tests, initial production tests) and other customer sponsored tests can be selected from those listed in section II.

2. Background. A recovery vehicle, full-tracked is a self-propelled, full-tracked vehicle designed primarily for recovery of disabled vehicles, however its multipurpose capabilities include hoisting of materials for transport and heavy components during maintenance as well as towing of trailers, weapons and other vehicles with weights comparable to its own. The hull and cab assembly is constructed of cast armor and/or armor plate to protect the crew and equipment against small arms fire, artillery shell fragments and land mines. The vehicle is capable of operation over cross country terrain.

3. Equipment and Facilities. Equipment and facilities are covered in the references of section II.

SECTION II
TEST PROCEDURES

4. Supporting Tests.

a. Subtests to be considered in formulating a development test plan, with TOP/MTP and other references, are listed below. The list is generally in a preferred order of completion; factors to consider are discussed in paragraph 5c.

TEST SUBJECT TITLE	PUBLICATION NO.
(1) Preparation for Test (refer to para 5)	
(2) Automotive	
Initial Inspection (refer to para 6)	2-2-502
Stowage	2-2-802
Vehicle Characteristics (refer to para 7)	2-2-500
Preliminary Operation	2-2-505
Safety Evaluation (refer to para 8)	2-2-508
Braking, Tracked Vehicles	2-2-627
Steering	2-2-609
Center of Gravity	2-2-800
Hydraulic System	As described in applicable Military Specification
Gradeability and Side Slope Performance	2-2-610
Toxic Hazards	2-2-614
Winches	2-2-712
Acceleration - Maximum and Minimum Speeds	2-2-602
Standard Obstacles	2-2-611
Night Performance of Combat Vehicles	2-2-616
Electromagnetic Interference (Noncommunications Equipment)	2-2-613
Electromagnetic Emissions (Electronic Equipment)	*6-2-542
High and Low Temperatures	*2-2-816
Engine and Power Train Cooling Systems	2-2-607
Cold Starting and Warmup	2-2-650
Rain and Freezing Rain	2-2-815
High Altitude Effects	2-2-702
Load Distribution and Ground Pressure	2-2-601
Vehicle Fuel Consumption	2-2-603
Fuels and Lubricants	2-2-701
Tracks	2-2-705

*When published.

TEST SUBJECT TITLE	PUBLICATION NO.
Tracked Vehicle Suspension Systems	2-2-714
Towing Resistance	2-2-605
Drawbar Pull	2-2-604
Fording	2-2-612
Noise	3-2-811
Soft Soil Vehicle Mobility (Prepared Sites)	2-2-619
Off-Road Mobility (Natural Sites)	As determined by ROC, MN, test directive, and available terrain.
Field Shock and Vibration	2-2-808
Security from Detection (Vehicles)	2-2-615
Infrared Emissions from Vehicles	2-2-812
Communication Equipment (Vehicle)	2-2-709
Air Conditioners	2-2-713
Vehicle Heaters - Personnel	2-2-708
Electrical Systems (Automotive)	2-2-601
Solar Radiation	4-2-825
High Humidity	4-2-820
Fungus Resistance	4-2-818
Salt Water and Salt-Laden Air	*1-2-604
Logistics-Over-The-Shore (LOTS)	2-2-520
Transportability	1-2-500
Cargo Loading Adaptability	2-2-537
Field Tests of Automotive Engines	2-2-721
Radioactive Components	3-2-711
Air Transportability	2-2-512 (until superseded by 1-2-500
Vehicle Collision and Accident	2-2-621
Endurance and Reliability (refer to para 9)	*2-1-001, 2-2-507
Durability (refereto para 9)	1-2-502, *2-1-001
Human Factors Engineering	2-2-803
Maintenance Evaluation	1-2-501, TECR 750-15
Value Engineering	In accordance with current directives
Overload Testing (Vehicle)	2-2-626
(3) Vulnerability.	
Protection Against Kinetic Energy Projectiles	2-2-715

*When published.

TEST SUBJECT TITLE	PUBLICATION NO.
Armored Vehicle Vulnerability to Conventional Weapons	2-2-617
Vulnerability to Nuclear Weapons	2-2-618

b. In the event the vehicle mounts a weapon, appropriate tests are covered in TOP Volume III.

SECTION III
SUPPLEMENTARY INSTRUCTIONS

5. Preparation for Test

a. Review of Test Guidance.

(1) The subtests that are selected by the test agency are governed by requirements in the ROC's, MN's, and DP's and by test directives from supervising agencies. The levels of acceptable performance are usually stipulated. If adequate test guidance does not exist, the test plan writer will make appropriate inquiries to the responsible directorate at TECOM.

(2) Certain important characteristics, especially those involving advanced engineering technology, may not be specifically covered by the requirements document but should nevertheless be included in the test plan and evaluated as a part of development test I, II, or III, per AR 1000-1 (formerly the developmental suitability test, engineering test, and initial production test). These may include such features as infrared emissions, shielding against fallout radiation, decontamination of CBR agents, noise measurements, transient voltages and electromagnetic interference and emissions.

b. Safe Operations During Testing. All hazardous test operations must be covered by a standing operating procedure (SOP) that will provide compulsory safety measures to be followed (e.g., as required by APG Regulation 385-1 at Aberdeen Proving Ground). Some typical operations that are categorized as hazardous are: amphibious operations, carrying bulk quantities of fuel, longitudinal and side slope operation, operation in inclosed chambers (such as cold rooms), and transportation of explosives. Safety measures for routine operations are prescribed in local safety manuals. Lesser routine hazards are covered by internal operating procedures. If a hazardous test is contemplated, the test director should assure that a suitable SOP covers the testing. If none is available, he must write one and obtain approval for its use.

c. Sequence and Selection of Subtests. Of primary consideration in the sequencing of subtests is the need, in the early months of testing, to thoroughly investigate the "critical issues" listed in the CTP in

time for the decision meeting. Otherwise sequencing of subtests should consider performing the high-risk, short-duration tests early and the low-risk, long-duration tests later in the test period. When required by a TECOM directive, a formalized assessment of the risk associated with each subtest will be made in accordance with TECR 70-34. The high-risk subtests are those in which a failure may lead to early termination of the vehicle test or justify an early judgment on critical performance parameters.

(1) Such items as stowage compartments, fording kits, cold weather kits, maintenance test packages, heaters, and air conditioners can be utilized and at least partially tested while the vehicle is undergoing endurance testing. Certain tests, such as those involving vulnerability and accident safety, should be scheduled late in the test program because of the possibility of damaging the vehicle. The type of test, availability of certain kits and similar equipment, and the nature of the possible effect of the test phase on the vehicle or equipment being tested are also factors. A safety evaluation, for instance, would be conducted immediately after the initial inspections and preliminary operation so that the safety aspects could be disseminated to interested agencies. Performance tests covering (e.g.) standard obstacles, drawbar pull, cooling, engine cold starting, and mobility should be conducted prior to or at intermediate endurance testing mileages. It is desirable to obtain the performance data before the engine, drive train, and chassis are subjected to the rigors of extensive endurance testing but after adequate run-in. Comparisons of the performance of various vehicles over a number of years will thus be more valid since all will have been tested in generally the same physical condition.

(2) To test and evaluate a full-tracked recovery vehicle a number of subtests apply. The selection of appropriate tests is dependent upon the type of test (e.g., development test I), the availability of test resources (e.g., number of vehicles, funding, test facilities), the time available for the test, the special characteristics of the vehicle, and the desires of the agency overseeing the test program. The possible test phases that may be included in test plans are listed in paragraph 4, rarely will a vehicle be subjected to all. Certain phases of the development tests may require participation by the Boards just as in the past some engineering test phases were combined with the service test when directed by Headquarters, TECOM.

d. Sample Size. The test sample size is usually determined far in advance of testing by the number of vehicles on a production contract, the funds available for testing, or the nature of the test. When the test director has an input regarding the sample size, he should use available mathematical procedures, taking cognizance of stipulated confidence and reliability levels as explained in paragraph 10. Miles that each vehicle must travel are determined simultaneously with sample sizes.

e. Familiarization and Training. When new features are introduced on a vehicle, it may be necessary to train operators, maintenance personnel, and the test director. Such training will normally be given by TACOM or a contractor, and should be arranged at an early date.

6. Initial Inspection and Servicing.

a. An initial inspection is conducted to assure that the test items are in good condition and that major component serial numbers and other pretest data are recorded prior to initiation of the test program. These include:

(1) Serial numbers and other identification of vehicle and major components.

(2) Examination of maintenance test package for completeness.

(3) Electrical sytem output (per TOP/MTP 2-2-502).

(4) Odometer mileage and engine-hour readings.

(5) On-vehicle equipment (OVE) stowage (per TOP/MTP 2-2-802).

b. The vehicle is drained of all fluids and is completely serviced by lubricating and filling with standard lubricants, fuels and other fluids. The identification and quantity of all fluids used are recorded and attention is called to unusual quantities. If drain or fill times are unreasonably long, these should be noted together with information on influencing factors such as size of drain plugs.

7. Vehicle Characteristics. Vehicle characteristics including physical dimensions are recorded in accordance with TOP/MTP 2-2-500. A characteristics photograph is taken, and a tabulation of important features is assembled also in accordance with TOP/MTP 2-2-500.

8. Safety Evaluation. An interim safety release should be generated within 60 days of test initiation. The interim safety release recommendation is given based on subtests performed early in the test. The subtests include, but are not limited to, preliminary operation, braking, steering, center of gravity, gradeability, side slopes, toxic hazards, winches, speed, obstacles, and night operations. The safety evaluation does not end with the issuance of the safety release: it is considered to be a continuing subtest throughout the test program and, when required, will include vehicle collision and accident safety.

9. Hydraulic System. Description and required capabilities of the hydraulic system for a typical recovery vehicle, the M88, full-tracked, medium recovery vehicle, are provided in Military Specification MIL-R-45343B and amendments (Reference 14, Appendix A). If similar information is not available for the test vehicle in DP's, specification or

standards the above Military Specification should be used as guide in developing test procedures.

10. Endurance, Durability, and Reliability.

a. Endurance is a general term that is concerned with the ability of a vehicle to perform satisfactorily under typical field conditions for long periods of time. Endurance tests of tracked vehicles are covered in TOP/MTP 2-2-507 which prescribes test courses and number of miles unless otherwise prescribed by the directive or guidance document.

b. Durability is a precise term that relates to the mathematical probability that a vehicle will be able to operate under typical field conditions for a specified number of miles before requiring major overhaul. Since durability tests require many samples and considerable funding, they are seldom conducted; the endurance test, which is much more limited, is usually conducted instead. TOP 1-2-502 describes a durability test and provides guidance for selecting sample sizes and distances.

c. Reliability is defined as the probability that an item will perform its intended function for a specified time under specified conditions (i.e., the probability of successfully completing a mission without incurring a mission-aborting failure). The reliability requirement is usually expressed as a probability of success for one or more specified operational and environmental cycles or functional sequences (mission). This requirement may be expressed in several ways; e.g., as an acceptable mean-time-between failure (MTBF). In the MTBF context "T" may be expressed as hours, cycles, rounds, miles, etc. Most of the data for the reliability determination are obtained from the endurance test, which simultaneously provides data for the maintenance evaluation.

d. The matter of endurance, durability, and reliability is more fully covered in TOP/MTP *2-1-001.

*When published.

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APPENDIX
REFERENCES

1. AR 70-38, "Research Development, Test, and Evaluation of Materiel for Extreme Climatic Conditions."

2. AR 705-25, "Reliability Program for Materiel and Equipment."

3. AR 1000-1, "Basic Policies for Systems Acquisition by the Department of the Army."

4. AMC Supplement 1 to AR 70-10, "Test and Evaluation During Research and Development of Materiel."

5. AMC Supplement 1 to AR 705-50, "Army Materiel Reliability and Maintainability."

6. AMCR 385-12, "Life Cycle Verification of Materiel Safety."

7. AMCP 702-3, "Reliability Handbook."

8. AMCP 706-134, "Maintainability Guide for Design."

9. TECR 70-23, "Equipment Performance Reports."

10. TECR 70-34, "Risk Analysis for Suitability Tests."

11. TECR 385-6, "Verification of Safety of Materiel During Testing."

12. TECR 750-15, "Maintenance Evaluation During Testing."

13. MIL-STD-721B, "Definition of Terms for Reliability Engineering, Human Factors, and Safety."

14. Military Specification, Recovery Vehicle, Full-Tracked, Medium, M88, MIL-R-45343B (ORD), 7 October 1960, with Amendments 2 and 3.

15. Bekker, M. G., "Introduction to Terrain Vehicle Systems," The University of Michigan Press, Ann Arbor, Michigan.