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13 ABSTRACT

Describes a method for evaluation of vehicle, wheeled and tracked, performance and endurance characteristics under overload conditions. Identifies supporting tests, facilities, and equipment required. Provides procedures for safety, sensitivity, and uncovering weak points. Discusses test mileage, inspections, measurements, and loading. Applicable to vehicle and vehicle component structure.

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

AMSTE-RP-702-101
Test Operations Procedure 2-2-626 18 May 1973

OVERLOAD TESTING (VEHICLE)

SECTION I
GENERAL

1. Purpose and Scope. a. There are two possible applications for overload testing of vehicles:

(1) To determine the sensitivity of vehicles to the carrying of realistic overloads to which they may be subjected by troops in the field and to assure vehicle safety under these conditions. This type of test may be part of a development test I, II, or III (formerly DST, ET, or IPT).

(2) To reduce the time and cost for uncovering weak points of vehicles or major components. This type of test will not be part of a development test II (ET) or III but could be a part of a development test I or an engineer design test with the concurrence of the customer.

b. This TOP describes the manner in which these overload tests are conducted. ROC's, DP's, and specifications normally do not state specific overload conditions; overloading may be implied, however, by a requirements document that requires the vehicle to be able to withstand reasonable driver abuse.

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2. Background. In many types of engineering projects it is accepted practice to subject structural components to overload conditions in order to assure a certain degree of safety under those conditions, provide data for a sensitivity analysis, or reduce the cost and duration of the test. This approach is also applicable to Army vehicles.

a. Safety and Sensitivity. Army vehicles, particularly cargo carrying trucks and trailers, will almost always be subjected to overloading during their service life. Under field conditions, where control is difficult, the usual concern in loading vehicles is not how much weight the vehicle is designed to hold but how much materiel can be piled on the vehicle within the space available. This being the case, it is important, first, to establish by test that unsafe conditions do not develop if the vehicle is overloaded; for example, the brakes should hold, steering should not be made too difficult, and the cargo bed must not be unstable thereby contributing to cargo shifting. Second, it is important to assure that the vehicle is not overly sensitive to overloading; that is, that the vehicle was built with a sufficient margin of error that, in the event of overloading, it will still be able to perform its mission without failure. In any sensitivity test, one is concerned with the effect of changing one parameter, in this case weight, upon the overall performance of the system. The overload tests discussed here could well be a part of any DT I, II, or III to simulate a condition of reasonable normal use.

b. Rapid Uncovering of Weak Points. The second type of overload testing involves an entirely different objective and different theoretical justification. In this case the overloading of the vehicle will theoretically uncover problem areas in a shorter period of time, and at less cost, than would be possible with a design load. While overload testing to quickly uncover weak points has merit under certain conditions (perhaps during DT I or engineer design test), it should not be undertaken without full cognizance and approval of the sponsoring agency.

c. Reduced Mileage in Endurance and Durability Tests. A third type of overload testing, while not considered suitable for Army vehicles at this time, is mentioned here only to complete the discussion on this subject. This is the type of test that is exemplified by the standard fatigue (SN curve) test of metals. The SN curve, which is empirically determined, may show, for example, that 10^5 stress applications of 20,000 psi are equivalent to 10^8 stress applications at 15,000 psi. Persons speculating on using the same approach for vehicles feel that the day might come when, for example, a 20,000-mile test with 20 percent overload may be found to be equivalent to a 30,000-mile test at rated load. This type of test, while used in industry, has not found acceptance in the Army because of (a) the lack of data to correlate miles under overload conditions with miles under normal load conditions and (b) the problem that is encountered in trying to reason that a failure that occurs under overload conditions can fairly be considered a deficiency in design or manufacture. This TOP does not deal with this third form of overload testing which, though having some validity, has many unresolved questions outstanding with regard to quantification and correlation with actual field use.

3. Equipment and Facilities. Realistic payloads that will not increase the rigidity of the test vehicle structure must be used. Supporting equipment and facilities, including test courses, are indicated in the referenced TOP's/MTP's or references listed in the appendix.

SECTION II
TEST PROCEDURES

4. Preliminary Activities. Initially the results of the safety evaluation and other test phases are reviewed for potential hazards from overloading. Notes are made of potential failures that would endanger test personnel. Safety SOP's are prepared as needed. Vehicle characteristics determined without the overload are reviewed, with reference to the following TOP's/MTP's as applicable.

	TITLE	PUBLICATION NO.
a.	Inspections (Automotive) (see also para 7)	2-2-502
b.	Safety Evaluation	2-2-508
c.	Stowage	2-2-802
d.	Load Distribution and Ground Pressure	2-2-801
e.	Vehicle Fuel Consumption	2-2-603
f.	Steering	2-2-609
g.	Braking, Wheeled Vehicles	2-2-608
h.	Braking, Tracked Vehicles	2-2-627
i.	Trailers, Semitrailers, and Dollies	2-2-020
j.	Tracked Vehicle Suspension Systems	2-2-714
k.	Tracks	2-2-705
l.	Endurance Testing of Wheeled Vehicles	2-2-506
m.	Endurance Testing of Tracked Vehicles	2-2-507
n.	Center of Gravity	2-2-800

o. Vehicle Characteristics 2-2-500

p. Field Shock and Vibration Testing of Vehicles 2-2-808

q. Tires 2-2-704

5. Testing to Simulate Vehicle Overload

a. Objective. To determine the sensitivity of vehicles to realistic overload conditions to which they may be subjected by troops in the field, and to assess vehicle safety under these conditions.

b. Standards. If information on tactical overloading is in the ROC, DP, or specification, it will be used. If the information is not available, the overload condition will consist of a cargo of the maximum density material that could reasonably be placed on the vehicle and transported over cross-country terrain.

c. Method.

(1) The heaviest density payload governs the amount of overload that will be carried. A truck cargo body may be loaded, for example, with as many artillery projectiles as can be stacked for stable loading. Such a load of ammunition would occupy about 40 pounds per cubic foot of space. Inert ammunition is stacked into the test vehicle to determine the maximum overload weight. Other higher density loads also require consideration.

(2) Initially the empty, curb, and gross weights of the vehicle are determined for the payload for which the vehicle was designed. Then the maximum test overload condition is determined for the heaviest tactical load. A judgment factor exists at this stage as to the amount of properly distributed overload to be carried and on which test courses (TOP/MTP 2-2-801 and TOP 1-1-011). The test plan should specify the selected overload and test courses. Care is needed not to select an unusual or unsafe stowing arrangement for the overload which would not be realistic in service. (TOP/MTP 2-2-802 provides guidance on stowage.)

(3) The overload test is conducted over the courses prescribed in TOP 2-2-506 for three missions as defined in the ROC, DP, or specifications. Speeds are maintained at the same levels that were used in the original rated load test except where judgment would indicate a natural slowing down by a typical driver. In addition to the mission tests, the vehicle will undergo braking and steering tests. Overload testing should include consideration of the use of sandbags on the floor as an expedient often used in combat to help absorb blast from land mines. Special safety precautions are required to secure the loads in the vehicle to prevent a hazard to the driver.

(4) The effects of overloads on springs (TOP/MTP 2-2-714), tires (TOP/MTP 2-2-704), and tracks (TOP/MTP 2-2-705) must be considered.

(5) Overload testing of trailers requires consideration of pintle and lunette loads for full trailers and of fifth wheel loads on semitrailers (TOP/MTP 2-2-020).

d. Data Required. Applicable data are acquired from tests conducted in accordance with the TOP's/MTP's referenced in (4) and (5) above and from inspections and measurements prescribed in Section III, Supplementary Instructions. Pertinent observations of the operators are also recorded.

e. Analytical Plan.

(1) Reporting follows standard engineering practices and applicable TECOM regulations. The results of overload testing are compared with those of the normal test programs. It is necessary to present a summary of loadings, courses, etc., for use in the planning, conduct, and analysis of subsequent programs.

(2) Unless the ROC, DP, or specification has a specific requirement for acceptable performance under overload conditions, failures must be considered as shortcomings rather than deficiencies. The exception to this is that major safety failures must be classified as deficiencies.

6. Overload Testing for Rapid Uncovering of Weak Points

a. Objective. To rapidly uncover weak points in vehicles or major components through overload testing.

b. Standards. Generally, information on overloading will not be available in the ROC, DP, or other specifications. Information accumulated from previous tests on similar vehicles/components may be used as a guide in establishing a reasonable overload condition.

c. Method.

(1) Initially the curb and gross vehicle weights and weight distributions are determined. The gross vehicle weight and weight distribution are at the payload for which the vehicle was designed.

(2) The test overload condition is established with the aid of the Project Manager's office or applicable commodity command. In the choice of optimum weight, such factors as safety of test operations and the avoidance of unreasonable strains on any structural component should be considered. For a conventional truck, the optimum weight will be less than the maximum possible overload as described in paragraph 5c(1). The overload must be placed in a balanced manner. As part of the planning, appropriate test courses are selected (TOP/MTP 2-2-801 and TOP 1-1-011).

(3) The test cycles specified in TOP's/MTP's 2-2-506 and 2-2-507 are followed, but are reduced in number. Inspections are required more frequently during vehicle operations to avoid unnecessary damage to vehicle components.

d. Data Required. As indicated in paragraph 5d; also:

(1) Operational speeds, mph.

(2) Failures or problems experienced.

e. Analytical Plan. See paragraph 5e.

SECTION III
SUPPLEMENTARY INSTRUCTIONS

7. Inspections and Measurements. A careful initial inspection is required on the components that will be critically affected by an excessive payload. The test director notes the condition of items in a qualitative and quantitative manner. Qualitatively, the appearance, finish, and relationship to other parts are noted. Quantitatively, measurements are made of adjustments and positions; for example, spring heights, frame geometry, wheel camber and caster. In addition:

a. Trammel points may be established to permit a recording of permanent displacements that occur during overloading. Other possibilities are to use crushable displacement gages (lead and wax) or scratch gages which indicate displacements that occur during severe strains. Paint is used to mark initial condition of fasteners, etc.

b. Other measurements may be required depending on the nature of the test item. Examples include X-rays of tires, tracks, fire control equipment, and weapons to record positions of internal parts.

c. Since fluid control systems may leak during testing, initial volumes of hydraulic oils or other fluids are recorded to assure an accurate record of consumption or losses (TOP/MTP 2-2-603).

Similar measurements and inspections are made as required during and after testing.

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APPENDIX
REFERENCES

1. "A Study Establishing Methodology Describing The Automatic Vehicular Vibration Amplitude Environment," Aberdeen Proving Ground, Md., Report DPS-657, August 1962.

2. "Road Shock and Vibration Environment For A Series of Wheeled and Track-Laying Vehicles," Aberdeen Proving Ground, Md., Report DPS-999, June 1963.

3. TOP 1-1-011 Vehicle Test Facilities at Aberdeen Proving Ground.