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This TOP describes the procedures for conducting a rail impact test.

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US ARMY DEVELOPMENTAL TEST COMMAND
TEST OPERATIONS PROCEDURE

*Test Operations Procedure TOP 1-2-501 15 September 2008
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RAIL IMPACT TESTING

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*This TOP supersedes TOP 1-2-501, dated 30 June 1995

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1. SCOPE.

a. This TOP describes the procedure for conducting a rail impact test. The rail impact test is used to verify structural integrity of the test item and the adequacy of the tie-down system and tie-down procedures. This TOP is intended for vehicles and equipment that will be transported by rail; to determine the effect of normal railroad car impacts that occur during rail shipment over the full life span of the test item.

b. This TOP is not intended for separate testing of small individually-packaged pieces of equipment that would normally be shipped and tested when mounted on a pallet. It does not cover vibration induced by railcar movement.

2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities.

Item	Requirement
Straight dry level section of railroad track 61 m (200 ft) minimum length, with additional track in order to reverse the test railcar/buffer car(s) for impacting in the opposite direction	To provide distance to accelerate locomotive and the test item railcar to specified impact speeds
Locomotive, Inclined Ramp, Tug Car, or other Mechanical Drive	To accelerate the railcar with the test item to the required pre-impact velocity
Test railcar equipped with end-of-car cushioned draft gear and a conventional underframe (without cushioning) and chain tie-downs	To transport the test item into the buffer car(s)
Buffer car(s) (1 to 5) with total weight of 113,400 kg (250,000 lb), with the first buffer car equipped with standard (friction) draft gear and remaining buffer cars (if any) equipped with either standard draft gear or cushioned draft gear, with the draft gear compressed for either case.	To act as buffer car(s) into which the test item car is impacted
Use of other railcar types for testing to be representative of the intended shipping methods	Advanced approval of Director, SDDCTEA, Attn: SDTE-DPE, Building 1990, 709 Ward Drive, Scott AFB, IL 62225
Temperature conditioning chamber (if required)	To provide the required temperature environment for the test item

2.2 Instrumentation.

Devices for Measuring	Measurement accuracy
Rail impact speed (timers)	±0.16 km/hr (±0.1 mph)
Locomotive speed (speedometer)	±0.16 km/hr (±0.10 mph)
Coupler force (strain-gauged coupler) (if required)	±2.2 kN (±500.0 lbf)
Tie-down bolt torque (torque wrench) (if required)	±5% of reading
Acceleration (accelerometers) (if required)	±0.05g
Strain (strain gauges) (if required)	±5 microstrain
Temperature (thermocouples) (if required)	±2.0 °C (±3.6 °F)
Optical instruments (video, movie, and still camera)	As required

3. REQUIRED TEST CONDITIONS.

3.1 Test Planning.

a. The Program Manager (PM) or the contractor must develop the rail tie-down procedures for the item and provide them to the US Military Surface Deployment and Distribution Command Transportation Engineering Agency (SDDCTEA) for approval. The Director, SDDCTEA is the designated Land Mode Transportability Agent for the Department of Defense (DoD) [1**].

b. Review previous test reports and/or suitable tie-down procedures for similar test items as prescribed in TEA PAM 55-19[2].

c. Acquire the tie-down procedures and special railcar requirements from the PM or contractor after approval by SDDCTEA.

d. Check applicable equipment publications for special transportability requirements. This may include the basic vehicle weight plus additional payload weight for equipment, ammunition, etc.

e. Satisfy the requirements of MIL-STD-209K[3] for the tie-down provisions of the test item. The requirements include but not limited to:

number of provisions, paragraph 5.2.1
provision dimensions, paragraph 5.2.4
size, clearance, and directional capabilities, paragraph 5.2.2
strength of provisions, connection and supporting structural frame, paragraph 5.2.3

** Superscript numbers/letters correspond to those in Appendix A, References.

3.2 Test Preparation.

a. Successfully complete the requirements of MIL-STD-209K before beginning rail impact testing.

b. Note and replace any existing damage to the test item or railcar including damage to chains, linkages, binders, or other load-securing devices.

c. Personnel operating the locomotive or inclined ramp must be properly trained prior to testing.

d. Test all test items at maximum gross weight (fully loaded) unless otherwise specified in the transportability requirements.

e. Ensure that the fuel tank for the test item is approximately 3/4 full, in accordance with Joint Manual 24-204[4], during the test.

f. Place gearshift levers of automatic or manual transmission in neutral and secure with wire (TEA PAM 55-19).

g. Ensure that the parking brakes on the test item are set during vehicle securement for safety reasons. The brakes must be released prior to performing the rail impact test (TEA PAM 55-19).

h. Inflate tires to highway pressure (TEA PAM 55-19).

i. Ensure that trailers are rail impact tested as attached to their prime movers (TEA PAM 55-19) unless otherwise specified in the Detailed Test Plan.

j. Ensure that semitrailers that do not have dedicated prime movers can be tested on specialized test flatcars with retractable hitches or stanchions (Joint Manual 24-204).

k. Blocking and bracing is not permitted (TEA PAM 55-19). Do not use chock blocks on wheels.

l. Ensure that chains are used symmetrically around the test item on the railcar in accordance with SDDCTEA approved procedures or procedures found in the test item's Technical Manual. The tie-down chain should make an approximate 45-degree (TEA PAM 55-19) angle with the deck of the test railcar, when viewed from the side. Do not cross tie-down chains.

m. Ensure that the number of chains required per test item is properly determined and defined as two times the ratio of vehicle weight to chain working load limit (TEA PAM 55-19). Most vehicles have four tie-down provisions, and each provision should have the same number of chains attached to it.

n. Ensure that the chain tie-down tension is proper with a deflection of no more than about an inch with the weight of a person standing on it (TEA PAM 55-19).

o. Do not use wire rope for any purposes other than securing rotating parts of the test item (e.g., turret tank or movable parts, to include outriggers and booms) without advanced approval by SDDCTEA. Torque nuts on wire rope clips to their correct value. Torque cable clamps to the following guideline values (TEA PAM 55-19):

61 N-m (45 ft-lb) for 0.95-cm (3/8-in.) wire rope cable
88 N-m (65 ft-lb) for 1.3-cm (1/2-in.) wire rope cable
176 N-m (130 ft-lb) for 1.6-cm (5/8-in.) wire rope cable

p. Dummy loads are permitted only when individual equipment is not available at the time of test. The use of dummy loads must be approved by SDDCTEA prior to testing. Substituted (dummy) loads must be of equal weight, weight distribution, and size and have similar dynamic characteristics as the actual item that is replaced.

q. Ensure that speed indicator instrumentation is positioned and calibrated prior to test conduct to determine the speed of the loaded railcar at impact. Position the instrumented coupler, if required, on the impacted end of the stationary car(s) to measure coupler force during impact. Position additional transducers, such as accelerometers (in three mutually perpendicular axes), strain gauges, thermocouples, etc., at selected locations on the test item and railcar deck, if required. Attach a calibrated speedometer to the locomotive and use it as a speed indicator for the locomotive engineer.

r. Prior to rail impact testing, take photographs of the test setup to document the tie-down procedures. Video coverage may be provided for each impact test.

4. TEST PROCEDURES.

4.1 Rail Impact Test.

a. Accomplish the rail impact by securing the test item on the railcar and propelling the car into one to five stationary buffer cars using a locomotive or inclined ramp. Measure actual impact speeds by determining the speed of the loaded railcar immediately prior to impact or at the point of impact if feasible.

b. Position the stationary railcar(s) with its coupler compressed and its air and hand brakes set. Position the knuckles of the buffer and test cars for coupling.

c. Subject the moving railcar to impacts at speeds of 6.4 and 9.7 km/hr (4.0 and 6.0 mph) ±0.8 km/hr (±0.5 mph), and 12.9 km/hr (8 mph) +0.8, -0.0 km/hr (+0.5, -0 mph). If the speed is below 12.9 km/hr (8 mph), repeat the impact. Conduct the impact by accelerating the railcar to the desired speed using either a locomotive equipped with a speed-measuring device or inclined ramp. Release the railcar loaded with the test item approximately 15 m (50 ft) from the stationary buffer railcar(s) and allow it to coast until it impacts.

d. Turn the railcar with the test item around and subject the moving railcar to an impact at a speed of 12.9 km/hr (8.0 mph) +0.8, -0.0 km/hr (+0.5, -0.0 mph), impacting the opposite end of the test railcar from first three impacts for a total of four impacts. If it is not possible to turn the test car around but the buffer car(s) because of track layout, ensure that the fourth impact must be accomplished in the reverse direction.

e. No tie-down chain adjustment is permissible after rail impact testing commences. If an adjustment of the restraint occurs, the entire rail impact procedure (e.g. four impacts beginning at 6.4 km/hr (4.0 mph)) must be repeated from the beginning.

f. At the conclusion of each impact, inspect the test item for equipment damage, and the tie-down provisions as well as tie-down procedure for evidence of possible failure. Take photographs of the damage as needed. Once the test has started, there will be no readjustment of the test item, nor any reconditioning of the tie-down devices. If the initial tie-down devices fail, repeat the entire test provided a revised method of securing is feasible and approved by SDDCTEA. At the completion of the test, examine the test item for any permanent displacement or damage, and conduct a functional and operational checkout. Compare the results with the pretest data.

g. If the test item is exposed to test conditions that exceed allowable limits, conduct an appropriate physical examination of the test item and perform an operational check (when practical) before testing is resumed.

h. If the test item can be transported in more than one orientation, such as lengthwise and crosswise on the railcar, repeat the four impacts for each orientation.

4.2 Temperature Conditioning.

a. If the rail impact test is to be conducted at temperature extremes, conduct the following prior to impacting:

(1) Secure the test item on the railcar and place the test item in the temperature chamber/enclosure and adjust the chamber air temperature to the test temperature. The temperature chamber/source should be located as close to the rail impact site as possible for best efficiency.

(2) Following temperature stabilization of the test item, maintain the storage temperature for the period specified in the test plan before rail impact testing. Temperature stabilization is attained when the temperature of the operating part of the test item considered to have the longest thermal lag is changing no more than 2 °C (3.6 °F) per hour.

(3) Disconnect the temperature conditioning chamber/source, if employed, and perform the rail impact test as stated in paragraph 4.1.

b. If the test item is being conditioned when detached from the railcar, conduct the following after the conditioned item is mounted on the railcar:

(1) Replace the test item in the temperature chamber and adjust chamber air temperature to the test temperature.

(2) Following temperature stabilization of the test item, maintain the storage temperature for a minimum of twice the amount of time that the test item has been out of the temperature chamber.

(3) Perform the rail impact test as stated in paragraph 4.1.

c. If the test item remains outside the conditioning chamber for more than 15 minutes, then reconditioning is required. If more impacts are required after 15 minutes, recondition the test item for 30 minutes after the test item has stabilized at the required test temperature.

4.3 Failure Definition.

a. A test item is classified as not having survived the rail impact test and is deemed a failure if any item that is attached to or included as an integral part of the test item breaks free, loosens, or shows any sign of permanent deformation beyond specification tolerances.

b. The test item must be fully functional after the rail impact test. Failure of the test item to operate as designed (i.e., move, shoot, and communicate) will result in a test failure.

c. Breaking of any tie-down chain will constitute a non-test. With the restraint replaced, the test must be re-started at the 6.4-km/hr (4.0-mph) impact.

d. Loosening of any tie-down chain will not constitute a test failure. If any of the tie-down chains are tightened between impacts, the test should be re-started at the 6.4-km/hr (4.0-mph) impact.

e. Test controls should be adequate to assure repeatability of the process and maintain test parameters within prescribed tolerances. Nevertheless, any impact in which the measured speed of the test car is greater than the upper limit of the test tolerance, +0.8 km/hr (+0.5 mph), is considered a valid test at that incremental impact speed provided that the materiel tested, its restraint system, and the rail car are not adversely affected (i.e., damage, permanent deformation, and/or performance degradation), and the next incremental impact speed is not exceeded. This contingency does not alter the need to perform four successive impacts at progressively escalating impact speeds, thus imparting a nominally increasing amount of strain energy to the restrained test item. For example, a rail impact test in which impact speeds of 8.9, 9.7, 13.1, and 13.4 km/hr (5.5, 6.0, 8.1, and 8.3 mph) were recorded and no equipment damage was noted would be considered a satisfactory test, the 8.8 km/hr (5.5 mph) impact qualifying as the incremental 6.4 km/hr (4.0 mph) impact.

5. DATA REQUIRED.

The following data are required:

a. Documentation of the tie-down devices used to secure the test item (photos, drawings, materials list, etc.).

b. Description of existing damage on test item or railcars.

c. Description of the test railcar and individual buffer car(s).

d. Description of the test item, including weight, dimensions, and general location on the test car.

e. Direction of the impact (define forward end of test item).

f. Impact speeds.

g. Results of examination and operational checkout tests.

h. If necessary, transducer measurements (i.e. acceleration, temperature, strain, etc.) of various locations on the test item and railcar.

i. Effects on the test item and tie-down devices including deficiencies, shortcomings, or limitations that occur during rail impacting.

6. DATA PRESENTATION.

a. Prepare photographs and/or sketches of tie-down configurations.

b. Prepare a graph of peak coupler force versus actual impact speed, if required.

c. Prepare photographs of setup, instrumentation, and any damaged components.

d. If required, compile tables of peak acceleration levels and/or plots of time versus acceleration for each impact.

e. If required, present video documentation of actual impacts.

f. Prepare any pertinent graphs to represent other transducer measurements, if required (i.e. strain versus time, temperature recordings, etc.).

APPENDIX A. REFERENCES.

1. DODI 4540.07, Operations of the DOD Engineering for Transportability and Deployability Program (Incorporating Administrative Change 1, September 11, 2007), October 12, 2004.

2. TEA Pamphlet 55-19 Tie-down Handbook for Rail Movements, Sixth Edition, September 2003.

3. MIL-STD-209K, Military Standard, Interface Standard for Lifting and Tiedown Provisions, 22 February 2005.

4. Joint Manual 24-204, TM 38-250, NAVSUP Pub 505, MCO P4030.19G, DLAI 4145.3, Preparing Hazardous Materials for Military Air Shipment, 11 December 2001.

REFERENCE FOR INFORMATION ONLY

a. Association of American Railroads (AAR) Open Top Loading Rules Manual (OTLRM), "General Rules for Loading All: Section No. 6 Rules for Loading Military Equipment and Materiel. Toll free 877-999-8824 (Washington, DC: AAR, Revised Annually).

b. AR 70-47, Engineering for Transportability, 19 August 1985.

c. MIL-STD-810F, Environmental Test Methods and Engineering Guidelines, January 2000.

d. MIL-STD-1366E, Interface Standard for Transportability Criteria, 31 October 2006.

Forward comments, recommended changes, or any pertinent data which may be of use in improving this publication to the following address: Test Business Management Division (TEDT-TMB), US Army Developmental Test Command, Aberdeen Proving Ground, MD 21005-5055. Technical information may be obtained from the preparing activity: Support Equipment Division (TEDT-AT-WFE), US Army Aberdeen Test Center, 400 Colleran Road, Aberdeen Proving Ground, MD 21005-5059. Additional copies are can be requested through the following website: http://itops.dtc.army.mil/RequestForDocuments.aspx, or through the Defense Technical Information Center, 8725 John J. Kingman Rd., STE 0944, Fort Belvoir, VA 22060-6218. This document is identified by the accession number (AD No.) printed on the first page