

25 August 1969

Materiel Test Procedure 2-3-509
U. S. Army Armor and Engineer Board

U. S. ARMY TEST AND EVALUATION COMMAND
COMMON SERVICE TEST PROCEDURE

FORDING

1. OBJECTIVE

The objective of this Materiel Test Procedure is to outline general procedures to be followed in determining the fording ability of military vehicles with and without fording kits attached.

2. BACKGROUND

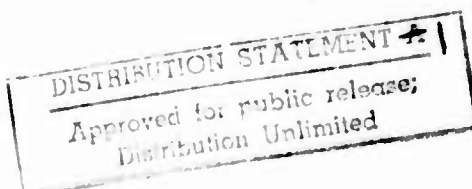
Mobility, communications, and effective firepower have always been the keys to offensive operations in warfare. Development of mechanized forces provided greatly increased speed and maneuverability in all areas except in crossing water barriers. In World War II mechanized combat and support vehicles moved swiftly cross-country on a broad front, but were channeled back onto the narrow established routes of travel afforded by bridges at every sizable water obstacle. This led to the requirements for shallow and deep fording and then to floating, swimming, and underwater fording.

Shallow fording is defined as the ability of a vehicle, with its suspension in contact with the ground, to negotiate a water obstacle to a specified depth without the use of special waterproofing kits. The definition of deep fording is the same, except that it is to a specified depth by application of a special waterproofing kit. These depths include sinkage depths and wave heights. Deep fording requirements for fully enclosed armored vehicles has been to the maximum depth practicable consistent with adequate freeboard. Freeboard is to be measured from the lowest water entrance point to the top of the waves. The fording requirement for any specific vehicle will be shown in the appropriate Qualitative Materiel Requirement (QMR), Small Development Requirement (SDR), Military Characteristics (MC) or Technical Characteristics (TC). The definition of underwater fording has not been officially published. However, general use of the term has denoted the ability of a fully enclosed armored vehicle with its suspension on the ground to negotiate a water obstacle while completely submerged and having air ducts for the crew and the engine.

Those parts of the deep fording and underwater fording kits which are not installed during production of the vehicle are usually installed by the vehicle crew prior to fording. However, some functional verification checks may be required which are beyond the capability of the crew.

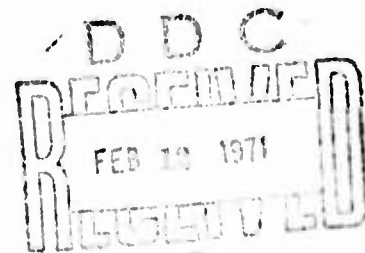
3. REQUIRED EQUIPMENT

- a. Suitable Water Obstacles
- b. Slope Gauge
- c. Long Straight Edge
- d. Sounding Line
- e. Tape Measure
- f. Fording Kit (when applicable)



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- g. Life Preservers
- h. Safety Boat with trained operators
- i. Ambulance with trained aid man and resuscitator
- j. Scuba Equipment and two qualified divers
- k. Recovery Vehicle
- l. Test Loads, if applicable
- m. Materials Handling Equipment (MHE)
- n. Towed Loads, if applicable
- o. Control Radios on safety boat, recovery vehicle and test vehicle

4. REFERENCES

- A. USATECOM Regulation 385-6, Verification of Safety of Material During Testing.
- B. Pertinent SOP or other documents pertaining to safety during test operation.
- C. MTP 2-3-510, Inland Waterway Operations.
- D. MTP 10-3-501, Operator Training and Familiarization.

5. SCOPE

5.1 SUMMARY

This MTP describes the following tests and evaluations for determining the shallow and deep water fording capability of wheeled and tracked vehicles and underwater fording capability of applicable tracked vehicles:

- a. Preparation for Test - Procedures for training and familiarization of personnel, scheduling to ensure the availability of personnel and facilities, and an inspection of the test item to determine its condition prior to testing.
- b. Shallow Fording Test - A study to determine the ability of the test item to ford shallow water obstacles without the aid of kits.
- c. Deep Fording Test - A study to determine the ability of the test item to ford deep water obstacles with the aid of fording kits.
- d. Underwater Fording - A study to determine the ability of the test item to negotiate a water obstacle while completely submerged.

5.2 LIMITATIONS

This test is limited to testing of vehicles which are designed to negotiate a water obstacle with their suspension on the bottom. Service testing of swimming and floating vehicles is covered in MTP 2-3-510.

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Safety

The test officer shall review the Safety Release, issued by Headquarters,

USATECOM, to identify any safety limitations imposed on the test item during testing, and to determine whether any special tests are required to check test item safety.

6.1.2 Scheduling

The test officer shall be responsible for the following:

- a. Determining the type of fording (shallow, deep or underwater), as indicated in the QMR, and the maximum depth required.
- b. Availability of suitable test sites.
- c. Availability of necessary medical, safety and recovery vehicle support.
- d. Availability of towed loads, when required.
- e. Availability of suitable cargo, when required.

6.1.3 Personnel

- a. Ensure the availability of service personnel who have been trained using the criteria of MTP 10-3-501 and are cognizant of the operation, and maintenance of the test item, installation of fording kits and the proper use of safety equipment.
- b. Record pertinent data as required by MTP 10-3-501.

6.1.4 Pre-Test Inspection

6.1.4.1 Self-Propelled Vehicles

Prior to testing have qualified maintenance personnel inspect the test item. The inspection should include but not be limited to the following:

- a. Check engine and transmission for proper operation.
- b. Check main engine air cleaners.
- c. Check driver's controls and instruments.
- d. Check the condition of the vehicle suspension.
- e. Check all lights.
- f. Check stowage of on equipment material.
- g. Check to ensure that the track is adjusted extra tight, if applicable.
- h. Check the oil levels of the following and fill to the specified level:

- 1) Main engine crankcase
- 2) Transmission
- 3) Winch gear case
- 4) Mechanical transmission
- 5) Hydraulic reservoir

i. Sample all fuel, oil, and lubricants to assure that no water is present, prior to the conduct, of the fording operation.

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NOTE: Samples should be taken from the lowest point in the system.

j. On vehicles equipped with permanent fording equipment ensure that equipment is properly installed and operative.

k. Inspect fording kits for completeness and serviceability using fording kit manual and/or instructions.

6.1.4.2 Non-Self-Propelled Vehicles

Prior to testing have qualified maintenance personnel inspect the test item. The inspection should include but not be limited to the following:

a. Check the condition of the vehicle suspension.

b. Check all lights.

c. Check the intervehicular cables, hose, and chains.

d. Sample all lubricants to assure that no water is present prior to the conduct of the fording operation.

NOTE: Samples should be taken from the lowest point in the system.

6.2 TEST CONDUCT

NOTE: Fording tests will be conducted just prior to the scheduled maintenance service.

6.2.1 Shallow Fording Test

6.2.1.1 Self-Propelled Vehicles

a. Select a suitable fresh water stream or pond with a hard bottom and, prior to the fording test, carefully reconnoiter the bottom to ensure that there are no holes, soft spots or obstacles that would create too great a depth or cause an accident. Mark the routes through the water with stakes or bouys.

NOTE: During testing a continuous reconnaissance should be made of the bottom to detect ruts caused by the test vehicle before they become a safety hazard.

b. Without any special preparation, other than the pre-test inspection, operate the unloaded vehicle in water up to the maximum depth and for the time specified in the QMR or other pertinent document or for a minimum of 30 minutes if no time is specified. Testing should be started at a low vehicle speed and the vehicle speed gradually increased until the maximum speed considered practical and safe for water operation is attained. Record the following:

NOTE: Caution should be taken with small wheeled vehicles so as not to reach speeds that could force water into the air-intake system.

- 1) Maximum depth of water

- 2) Type of bottom
- 3) Type of vehicle traction devices
- 4) Length of time spent in fording operation
- 5) Maximum vehicle speed attained

c. During the fording test perform the following:

- 1) Observe and record ease of controlling the vehicle.
- 2) Observe and record any tendency of the vehicle to float.
- 3) Stop the vehicle in the water several times, and shut the engine off. Record the ease of starting the engine.
- 4) Observe and record the effects of the water on the performance of engine, power train, and brake operation.
- 5) Observe and record the effects of spray or splash at various speeds and water depths on the following:
 - a) Operation of the vehicle
 - b) Visibility of the driver
 - c) Equipment materiel
- 6) Observe and record the amount and location of leakage in crew and passenger areas.

d. After the vehicle has left the water, apply the brakes while operating the vehicle at various speeds and record adverse affects of the fording operation on the performance of the brakes.

e. Determine the maximum entrance and exit slope which the test item is able to negotiate and record the following:

- 1) Maximum entrance slope
- 2) Maximum exit slope
- 3) Type of soil on slope
- 4) Condition of slope (wet or dry)
- 5) Whether slopes were prepared or unprepared

f. At the completion of the fording test perform the following:

- 1) Remove inspection plates, or other doors/storage covers and record evidence of leakage and water damage or contamination.
- 2) Sample all fuel oil and lubricants and record evidence of water contamination.

NOTE: Samples should be taken from the lowest point in the system.

- 3) Perform the scheduled maintenance on the vehicle and record evidence of water damage and in particular damage to brake bands and drums and wiring insulation.

g. If the test item has cargo carrying capacity, repeat steps a through e with the test item loaded to capacity and record the following:

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- 1) Type of cargo
- 2) Weight of cargo
- 3) Amount and type of damage to cargo

h. If the test item is capable of towing a load, repeat steps a through e while towing the maximum towed load and record the following:

- 1) Type of towed vehicle.
- 2) Type of cargo on towed vehicle.
- 3) Gross weight of towed vehicle.
- 4) Amount of damage to towed load caused by splash and spray from test vehicle.

6.2.1.2 Non-Self-Propelled

Couple the vehicle to a suitable prime mover and perform the following:

a. Determine the suitability of the test item prime mover combination for fording operation by performing the procedures of steps a and b of paragraph 6.2.1.1.

b. Observe and record the following during fording operations:

- 1) Trailing abilities of the test item
- 2) Tendency of test item to float
- 3) Adverse effects of water, on a brake performance
- 4) Amount and location of leakage

c. Perform the procedures described in steps d, e, and f of paragraph 6.2.1.1 if applicable.

d. If the test item has cargo carrying capacity, repeat steps a through c with the test item loaded to capacity and record the following:

- 1) Type of cargo
- 2) Weight of cargo
- 3) Amount and type of damage to cargo

6.2.2 Deep Fording Test (Self-Propelled Vehicles Only)

6.2.2.1 Preparation for Test

a. Install the fording kit in accordance with published instructions and record the following:

- 1) Time required for installation.
- 2) Number of personnel.
- 3) Special tools required, if any.
- 4) Difficulties encountered, if any.
- 5) Adequacy of installation instructions.
- 6) Adequacy of on-board stowage for crew-installed fording kit components.

b. In addition to the pre-test inspection of paragraph 6.1.4.1, the

following shall be performed:

- 1) Check radio and intercom, including extension cord.
- 2) Check main engine air intake hoses for tightness.
- 3) Check to ensure that oil filler cap on main engine is closed and wired down.
- 4) Check oil level dip sticks on main engine and ensure that transmission is closed tightly.
- 5) Check exhaust system and tighten all clamps while hot from operation.
- 6) Check to ensure that auxiliary generator engine is top dead center on compression stroke, and plug engine exhaust.
- 7) Check personnel heater (switch should be in OFF position) and plug exhaust.
- 8) Check stowing of machine gun and mount.
- 9) Check drain valves (should be in closed position).
- 10) Check fuel cap (should be tight) and vent system.
- 11) Check fording sealer application on the following:
 - (a) Main winch cable door, if applicable
 - (b) Nosepiece
 - (c) Hull
 - (d) Fire extinguisher external remote controls, if applicable
- 12) Check battery sealer.
- 13) Check bilge pumps to ensure they are operational and intake screens are clean.
- 14) Remove and stow all padlocks.
- 15) Start engine and check for full performance.

c. Record type of vehicle traction device (type of tires or track).

d. Equip the test item with two tow cables, one should be secured to a tow eye on each end of the vehicle. The free end of each cable should be tied down on top of the vehicle in a readily accessible position for emergency recovery operations. A flotation buoy should be connected to the end of each cable.

e. If an underwater breathing apparatus is to be used, check it thoroughly and ensure that only qualified personnel use it.

f. Before actual deep fording begins, carefully reconnoiter the stream or pond bottom to ensure that it does not exceed the prescribed maximum depth, that there are no holes, quicksand or obstacles which could create too great a depth or cause an accident. Mark the route with flags or buoys to ensure that the vehicle stays within the reconnoitered area. Record the following:

NOTE: In checking water depths, it must be remembered that sinkage and wave heights must be considered in figuring the maximum depth.

- 1) Maximum depth of water
- 2) Type of bottom to water obstacle

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g. Ensure that safety equipment and trained safety personnel are at the fording site prior to beginning testing.

h. Check operators for knowledge of fording operation to be accomplished and knowledge of emergency hand signals.

6.2.2.2 Test Conduct

a. With the kit installed, operate the vehicle for a minimum distance of 5 miles before entering the water and record detrimental effects of fording kit on test item performance.

b. Connect a tow cable to the test vehicle and a suitable wrecker or recovery vehicle so that the test vehicle can be retrieved quickly in case the engine floods, or a severe leak is detected and enter the water slowly.

c. Leave the vehicle stationary at the maximum prescribed deep fording depth for a minimum of 15 minutes and carefully check all sealed points for leaks and the bilge pumps for proper operation.

d. If no serious leaks are discovered, proceed with actual fording operations for the length of time specified in the QMR or a minimum of 15 minutes. Record the following:

- 1) Duration of fording operation
- 2) Maximum speeds attained

- NOTE:
1. Deep fording should be done with the transmission in low range and the engine running at a steady rpm.
 2. If the engine should stall, it should be restarted immediately if the fording kit allows an underwater start capability. If the engine cannot be restarted on the first attempt, the vehicle should be retrieved from the water as soon as possible.
 3. When the driver is submerged, he must be kept on course by radio or through the intercom system.

e. During fording operations observe and record the following:

- 1) Driver difficulties in controlling the test item.
- 2) Tendency of the vehicle to float.
- 3) Effects of water on the operational performance of the test item.
- 4) Location and rate of leakage observed in each of the crew areas, if any.
- 5) Adequacy of bilge pumps.
- 6) Conditions prejudicial to crew and passenger safety in event the test item must be abandoned in the water.

f. Determine the maximum entrance and exit slope which the test item is able to negotiate without drowning the engine, or filling the cargo space with water and record the following:

- 1) Maximum entrance slope
- 2) Maximum exit slope

- 3) Type of soil on slope
- 4) Condition of slope (wet, dry)
- 5) Whether slopes were prepared or unprepared

g. After the vehicle leaves the water jettison parts which have been so designed and operate the vehicle on land for approximately 5 miles. Record the following:

- 1) Adequacy of means provided to jettison components of the kit, if applicable.
- 2) Re-usable components which have been jettison.
- 3) Adverse effect of kit components not jettisoned on the vehicle performance, if any.

h. Apply the brakes while operating the test vehicle at various speeds and record if the brake performance has been adversely affected by fording operation.

i. If the vehicle is capable of towing a load repeat steps a through h while towing the maximum towed load and record the following:

- 1) Type of towed vehicle
- 2) Type of cargo on towed vehicle
- 3) Gross weight of towed vehicle

j. At the completion of the test perform the following:

- 1) Remove the remaining fording kit parts and record the following:
 - a) Time required to remove parts.
 - b) Adequacy of instructions for removal.
 - c) Difficulties in returning the vehicle to condition for land operation.
- 2) Remove inspection plates, or other doors/storage covers and record evidence of leakage.
- 3) Sample all fuel, oil, and lubricants and record evidence of water contamination.

NOTE: Samples should be taken from the lowest point in the system.

- 4) Perform the scheduled maintenance on the vehicle and record evidence of water damage and in particular damage to brake bands and drums, wiring insulation and other test item components.

6.2.3 Underwater Fording Test

6.2.3.1 Preparation for Test

Perform the procedures of paragraph 6.2.2.1 and the following:

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- a. Insert plug in main engine generator cooling system exhaust.
- b. Check tower installation, clamps, and straps.
- c. Check inside and outside ladders to ensure they are properly installed and secure.
- d. Check to see that lock pins are removed from exhaust dust valves.
- e. Check fording sealer application on:
 - 1) Personnel heater external air intake cap
 - 2) Periscopes and vision devices
 - 3) Hatch covers
- f. Check cupola cover to ensure it is properly installed and sealed.
- g. Secure life jackets to top of conning tower for quick release.
- h. Check scuba gear to ensure it is operational and stowed near driver station.
- i. Place a mark on the top of the conning tower pointing to the front of the vehicle to keep the commander oriented.

6.2.3.2 Test Conduct

Perform the procedures of paragraph 6.2.2.2 using a water obstacle of the depth specified in the QMR.

NOTE: Underwater fording operations are similar to deep fording, however as the depth increases, stronger currents are encountered which make reconnoitering of the bottom more difficult and more important. Because the driver is driving blind, guidance of the vehicle is more difficult. Also because of the difficulty in handling and connecting heavy cables in deep water, recovery of the vehicle is more difficult.

6.3 TEST DATA

6.3.1 Preparation for Test

6.3.1.1 Personnel

Record data as required in the applicable sections of MTP 10-3-501.

6.3.1.2 Pre-Test Inspection

Record the following:

- a. Components of the test item which are not functioning properly or are not in good condition, if any.
- b. Presence of water in fuel or lubricants.

6.3.2 Test Conduct

6.3.2.1 Shallow Fording Test

6.3.2.1.1 Self-Propelled Vehicles -

Record the following:

- a. Test vehicle model and serial number
- b. Maximum depth of water, in inches
- c. Type of bottom to water obstacle
- d. Type of vehicle traction device (type of tires or track)
- e. Length of fording operation, in minutes
- f. Maximum vehicle speed obtained in mph
- g. During the fording operation:
 - 1) Ease of controlling vehicle
 - 2) Tendency of the vehicle to float
 - 3) Ease of starting vehicle in the water
 - 4) Effects of water on performance of:
 - a) Engine
 - b) Power train
 - c) Brakes
 - 5) Effects of spray or splash on:
 - a) Operation of the vehicle
 - b) Visibility of the driver
 - c) Equipment materiel
 - d) Personnel
- h. Amount and location of water leakage in crew and passenger areas
- i. Performance of brakes after leaving the water
- j. For entrance and exit from the water obstacle:
 - 1) Maximum entrance slope, in percent of grade
 - 2) Maximum exit slope, in percent of grade
 - 3) Type of soil on slope
 - 4) Condition of slope (wet, dry)
 - 5) Whether slopes were prepared or not
- k. At the completion of the fording operation:
 - 1) Evidence of leakage, and water damage or contamination.
 - 2) Evidence of water in fuel, oil and lubricants.
 - 3) Evidence of water damage discovered during quarterly maintenance.
- l. For cargo, if applicable:
 - 1) Type of cargo
 - 2) Weight of cargo in pounds
 - 3) Amount and type of damage to cargo

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m. For towed load, if applicable:

- 1) Type of towed vehicle
- 2) Type of cargo on towed vehicle
- 3) Gross weight of towed vehicle, in pounds
- 4) Amount of damage to towed load

6.3.2.1.2 Non-Self-Propelled Vehicles -

Record the following:

- a. Test vehicle model and serial number
- b. Maximum depth of water, in inches
- c. Type of prime mover
- d. Length of fording operation in minutes
- e. Maximum vehicle speed attained, in mph
- f. During fording operations:
 - 1) Trailing abilities of the test item
 - 2) Tendency of the test item to float
 - 3) Adverse effects of water on brake performance
 - 4) Amount and location of leakage

g. Data collected as described in steps d, e, and f of paragraph

6.2.1.1

h. For cargo if applicable:

- 1) Type of cargo
- 2) Weight of cargo in pounds
- 3) Amount and type of damage to cargo

6.3.2.2 Deep Fording Test

6.3.2.2.1 Preparation for Test

Record the following:

a. For the fording kit installation:

- 1) Model and serial number.
- 2) Time required for installation, in minutes.
- 3) Number of personnel required.
- 4) Special tools required, if any.
- 5) Difficulties encountered, if any.
- 6) Adequacy of installation instructions.
- 7) Adequacy of on-board stowage for crew-installed fording kit components.

b. Components of the test item which are not functioning properly or are not in good condition, if any.

c. Amount of lubricant added to each of the following:

- 1) Main engine crank case
- 2) Transmission
- 3) Winch gear case
- 4) Mechanical transmission
- 5) Hydraulic reservoir

- d. Presence of water in fuel or lubricants
- e. Type of vehicle traction device (type of tires or tracks)
- f. For the water obstacle:

- 1) Maximum depth
- 2) Type of bottom

6.3.2.2.2 Test Conduct -

Record the following:

- a. Vehicle model and serial number.
- b. Detrimental effects of fording kit on performance of test item on land.
- c. Length of fording operation, in minutes.
- d. Maximum vehicle speed attained in mph.
- e. During fording operations:
 - 1) Difficulties in controlling the test item.
 - 2) Tendency of the vehicle to float.
 - 3) Effects of water on the operational performance of the test item.
 - 4) Location and rate of leakage observed in each of the crew areas.
 - 5) Adequacy of bilge pumps.
 - 6) Conditions prejudicial to crew and passenger safety in the event the test item must be abandoned in the water.
- f. For entrance and exit from the water:
 - 1) Maximum entrance slope
 - 2) Maximum exit slope
 - 3) Type of soil on slope
 - 4) Condition of slope (wet, dry)
 - 5) Whether slopes were prepared or unprepared
- g. After leaving the water:
 - 1) Adequacy of means provided to jettison components of the kit if applicable.
 - 2) Re-usable components which have been jettisoned.
 - 3) Effects of kit components not jettisoned on the vehicle performance.
 - 4) Performance of brakes after leaving water.

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h. For towed load if applicable:

- 1) Type of towed vehicle
- 2) Type of cargo on towed vehicle
- 3) Gross weight of towed vehicle in pounds

i. For removal of fording kit components:

- 1) Time required to remove parts, in minutes.
- 2) Adequacy of instructions for removal.
- 3) Difficulties in returning the vehicle to condition for land operation.

j. Post test inspection:

- 1) Evidence of leakage, and water damage or contamination.
- 2) Evidence of water contamination of fuels, oil, and lubricants.
- 3) Evidence of water damage discovered during quarterly maintenance

6.3.2.3 Underwater Fording Test

6.3.2.3.1 Preparation for Test -

Record data collected as described in paragraph 6.2.2.1.

6.3.2.3.2 Test Conduct -

Record data collected as described in paragraph 6.2.2.2.

6.4 DATA REDUCTION AND PRESENTATION

Summarize all data using tabulations, charts, graphs and diagrams, as applicable. The data will be analyzed to determine the extent the test item meets the fording requirements as specified in the QMR, SDR, MC, and TC. All photographs should be properly identified.

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