30 August 1968

Materiel Test Procedure 9-4-001
Yuma Proving Ground

U. S. ARMY TEST AND EVALUATION COMMAND
ENVIRONMENTAL TEST PROCEDURE

DESERT ENVIRONMENTAL TESTING OF CONSTRUCTION, SERVICE, AND SUPPORT EQUIPMENT

1. OBJECTIVE

The objective of this Materiel Test Procedure ~~(MTP)~~ is to provide a procedure for determining the capability of construction, service, and support equipment to withstand exposure and to function effectively in desert environments.

2. BACKGROUND

Construction, service, and support equipment plays a vital role in the effective use of large units in desert areas. The lack of developed transportation and utility networks places a heavy burden on support troops and their equipment.

Particularly critical items include construction equipment, water treatment and supply items, POL distribution equipment, and power generators. The availability of these items, and their capability to function as designed, will have an influence far above that in the more civilized temperate areas. In the desert, the proper performance of support equipment is a matter of survival.

This increased need occurs simultaneously with some of the world's most extreme climatic and geophysical conditions. Material transported, stored, and operated in deserts experience unique stresses because of these conditions and environmental tests of developmental equipment are necessary to validate design test results and to determine the technical acceptability of the test item for service in such environments.

3. REQUIRED EQUIPMENT

3.1 INSTRUMENTATION

In addition to instrumentation required by the applicable MTP's, the following items (or instrumentation capable of exceeding these requisites) are required.

a. Temperature measuring devices (thermometers 0-200°F range, accuracy ±2°F, thermocouples 30° - 180°F, accuracy ±2°F).
b. Transducers for measuring shock (0-20 g range, accuracy ± 0.2g)
c. Vehicle instrumentation (odometers, precision 0.1 mile, accuracy - 10%; speedometers range - 0 to 70 mph, accuracy - ±5 mph.
d. Vehicular traffic sensor and counter
e. Earth materials test equipment for gradation analysis, soil consistency, moisture determination, soil density, and bearing strength.

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f. Dust analysis equipment
g. Standard meteorological instrumentation

3.2 FACILITIES

In addition to the facilities required by the applicable MTP's, the following facilities are required to provide a desert environment.

a. Roads sufficient to provide representative desert paved and secondary roads described in reference C.
b. Areas which in combination will be representative of the three main desert types: See references A and B for details.

1) Sandy deserts
2) Gravelly deserts
3) Stoney and rocky deserts

c. Functioning or performance areas, preferably outside of restricted areas, including the following surfaces. See references A and B for details

1) Sandy
2) Desert pavement
3) Hard or rocky
4) Unconsolidated gravels

4. REFERENCES

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J. Department of the Army, Field Manual, FM 31-25, Desert Operations, Headquarters, Department of the Army, January 1964.
K. Department of the Army, Technical Manual, TM 5-545, Geology and its Military Applications, August 1952.
L. MTP 2-4-001, Desert Environmental Test of Wheeled and Tracked Vehicles
M. MTP 3-4-001, Desert Environmental Test of Armament and Individual Weapons
N. MTP 10-4-001, Desert Environmental Test of General Supplies and Equipment
O. MTP 9-3-506, Safety

5. SCOPE

5.1 SUMMARY

This MTP describes in general terms, the preparation, conduct, recording, and reporting methods used for the desert environmental testing of construction, service and support equipment. Specific subtests include:

a. Safety - The objective of this subtest is to determine if the test item is safe for use in a desert environment.
b. Exposure - The objective of this subtest is to determine the effects of desert envrionmental exposure to construction, service and support equipment while in various utilization modes such as storage, transportation and handling.
c. Performance - The objective of this subtest is to determine the capability of construction, service and support equipment to perform in a desert environment.
d. Security From Detection - The objective of this subtest is to determine the capability of construction, service, and support equipment to avoid detection when stored or operated in a desert environment.
e. Maintenance - The objective of this subtest is to determine the maintenance requirements for construction, service and support equipment engendered or aggravated by a desert environment.

5.2 LIMITATIONS

a. The material presented in this MTP is limited to field testing. Guidance for testing equipment in simulated environments or other induced hot-dry conditions has been intentionally avoided.
b. Items having little or limited use in desert areas, such as waterways equipment and railway rolling stock, are not covered in this MTP.
c. Procedures outlined in this MTP do not constitute detailed test plans. A test for desert environmental testing of an item may be assembled utilizing the guidance in this MTP but each environmental test planning activity must make its own judgement as to the applicability of each procedure and must determine how best to obtain the required data from each item under test.

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 General Preparations

a. Verify that test facilities, equipment, accessories and personnel are available, operational and properly calibrated, Power sources shall be checked to ensure correct outputs.

b. Final arrangements for supporting or participating agencies, activities and facilities shall be made.

c. Operating instructions for test instruments to be used during test conduct should be obtained and made available to test personnel.

d. A test log book or folder shall be prepared and utilized to record data obtained during tests.

e. Test Personnel shall be briefed prior to testing on the purpose of the test and results and parameters to be anticipated.

6.1.2 Test Item Preparations

NOTE: In the evaluation and reporting of test results, it is of the utmost importance to know when a failure occurs. In some cases, the cause of failure might occur prior to receipt of the test items, yet unrealistically be reported as a test failure. Data of this nature must, in order to ensure valid reporting, be discovered and recorded before environmental testing starts.

a. Prior to beginning environmental testing of construction, service and support equipment, personnel responsible for test conduct shall develop and prepare a test sample size plan using the following criteria:

1) Each test lot if possible, shall consist of a statistically significant number of test items. (Major items may not be economically available in sufficient quantity to provide statistically significant samples. Extreme care must be taken in evaluating data in such cases).
2) Sufficient control items shall be used to isolate and identify areas requiring corrective action. (Corrective action in this context includes redesign of the test item, redesign of packaging or storage configurations for the test item, or reduction of exposure limits)

NOTE: Although test samples may consist of a single test item, their size should be larger if possible to increase the statistical accuracy of the test.

b. Prior to beginning environmental testing of construction, service and support equipment, personnel responsible for test conduct shall ensure that all test items undergo a thorough initial inspection to determine the following:

1) That all test items, ancillary equipment and maintenance packages are present.

2) That all test items and their components are correctly assembled, properly labeled, and ready for test.
3) That all test items arrive at the testing installation in an acceptable condition.

NOTE: Deficiencies discovered during the initial inspection shall be corrected whenever possible or an appropriate notation shall be made in the test log for possible consideration during the data reduction phase.

4) That all test items are clean and lubricated according to appropriate maintenance instructions.
5) That all test items possess dimensions and physical characteristics which conform to the applicable military characteristics prescribed in appropriate documents. (MTP 9-2-500).
6) That all test items have successfully completed the safety portion of the applicable commodity engineering test.

6.1.3 Subtest Preparations

6.1.3.1 Exposure Preparations

6.1.3.1.1 Storage Exposure Preparations

a. Items to be subject to desert storage exposure shall be instrumented (thermocoupled) to provide the following temperature data:

1) Overpack skin temperatures
2) Container skin temperatures
3) Storage container interior air temperature
4) Maximum test item skin temperatures
5) Average test item skin temperatures
6) Temperature of critical components (Power supplies, electronic components, optical items, etc.)

b. Instrument each storage site to determine and record ambient air temperatures at 200 cm above and 5 cm below the ground surface.

6.1.3.1.2 Transportation Exposure

Items to be subjected to transportation exposure shall be instrumented to provide the following data:

a. Storage container interior air temperatures
b. Average test item skin temperatures
c. Temperature of critical components
d. Triaxial acceleration of test item
e. Triaxial acceleration of critical components

6.1.3.2 Performance Subtest Preparations

a. Test items which have been left in sealed containers for exposure tests shall be removed and identified.

b. All test items shall be inspected for visual signs of deterioration. Discrepancies noted shall be corrected if possible or recorded in the test log for consideration during the test data reduction phase.

c. Physical characteristics measured in 6.1.2.b(5), shall be measured to determine changes from data as originally measured. Appropriate notations regarding measured changes shall be entered into the test log.

d. Assemble all items, which are components of major items to be tested, to standard components. (Pumps, scraper blades, generators, etc.)

e. Prepare all items requiring installation or erection according to appropriate operation manuals. (Water tanks, pipelines, conveyors, etc.)

f. The test item shall be photographed where appropriate.

6.1.3.3 Security from Detection Subtest Preparations

a. Restore all natural material, displaced or removed for siting of the test item, to its original position or condition insofar as possible.

b. Ensure that the following terrain types are available for Security from Detection testing:

1) Open desert pavement (no cover)
2) Rocky or boulder strewn desert (no vegetation)
3) Terrain having xerophyte vegetation (non-succulent)
4) Surfaces having or composed of loose or drifted sand

6.1.3.4 Maintenance Subtest Preparations

a. Ensure all maintenance instructions, tools, and specified spare parts are available.

b. Clean and lubricate all test items for desert operation according to appropriate maintenance instructions.

6.1.3.5 Safety Subtest Preparations

Prior to committing test items to exposure and performance tests, review applicable safety statement or safety release and examine test items for conformity and for the presence of other hazardous conditions.

6.2.1 Exposure

6.2.1.1 Storage Exposure

The storage made will be consistent with the normal practice as described in the maintenance package. In the absence of maintenance packages, refer to Field or Technical Manuals for the test item.

a. Emplace the test item in the test site in a manner corresponding to storage of the item in a Forward Depot Supply Area.

b. Ensure the proper functioning of all temperature measuring devices attached to the test item.

c. Select the most appropriate exposure type for the particular item to be tested, from Figure 1., and subject the emplaced test item to a condition of 3780 degree (Fahrenheit) - hours above 90°F. Typical combinations which will meet this criteria are shown in Table I.

NOTE 1: The storage mode will be consistent with the normal practice as described in the maintenance package. In the absence of maintenance packages, refer to Field or Technical Manuals for the test item.

2: During testing, according to b and c above, vehicular traffic will be routed upwind of the Forward Supply Depot area. A minimum of 120 and 240 vehicles will pass during the "A" and "B" exposure periods respectively. Dust deposits at least 6 inches deep will be maintained on adjoining roads.

d. Record the following data during exposure of the test item, at hourly intervals:

1) Ambient air temperature (200 cm above ground ± 2°F)
2) Ground temperature (5cm below surface, ± 2°F)
3) Thermocouple readings (see 6.1.3.1.1 a.)
4) Relative humidity

e. Record the following data continuously during exposure to the test item:

1) Precipitation (± 0.01 inch)
2) Wind speed (200 cm above surface, ±5 mph)
3) Wind direction (± 10°)
4) Solar radiation (± 1.0 BTU/ft^2/hr

f. After each exposure, inspect the test item as prescribed by appropriate maintenance documents and record in the test log all deficiencies and discrepancies discovered.

g. Emplace the test item in the test site in a manner corresponding to storage of the item in a Forward Supply Point.

h. Same as b above

i. Select the most appropriate exposure type for the particular item to be tested from Figure 2., and subject the emplaced test item to a minimum of 21 days with four hours of temperature in excess of 100°F each day.

NOTE: During testing procedures h through j, a minimum of 60 vehicles will be routed upwind of the storage area. Dust deposits of at least 6 inches shall be maintained on adjoining roads.

	Equipment Categories				
	1	2	3	4	5
	Pipeline Construction Map Reproduction, Bath and laundry facilities	Water Supply and treatment equipment, Storage Tanks, Pumps, liquid transporters and dispensers	Cranes Material handling, Highway/ road and Maintenance	Earth handling and bridging equipment, Tractors	Engines, Motors, Generators
EXPOSURE TYPE ("A" or "B") (See Table I)	A	A	B	B	B

Figure I. (Exposure-Equipment Chart-Forward Depot Supply Area)

EXPOSURE TYPE "A"

CONDITIONS	Air Temperature (°F) No. of Days *	No. Hr/Day	Min. Temp	Ground Temperature (°F) No. of Days *	No. Hr/Day	Min. Temp
Severity	5	2	110	5	3	140
Level	+10	1	110	+10	4	135
I	+18	8	100			
Severity	5	1	110	5	1	140
Level	+10	4	105	+20	4	135
II	+23	8	100			
Severity	10	4	105	10	1	135
Level III	+30	8	100	+30	4	130
MINIMUM	48	6	100	30	2	130

* For Exposure Type "B" Multiply by 2.

Table I. (Exposure Criteria - Forward Depot Supply Area)

	Equipment Categories				
	1 Pipeline Construction Map Reproduction, Bath and Laundry Facilities	2 Water Supply and Treatment Equipment, Storage Tanks Pumps, Liquid Transporters and Dispensers	3 Cranes, Material Handling, Highway/ road and Maintenance Equipment	4 Earth Handling and Bridging Equipment, Tractors,	5 Engines, Motors, Generators
EXPOSURE TYPE ("A" or "B")	NOT TESTED IN THIS MODE	A	B	B	A

Figure 2. (Exposure-Equipment Chart-Forward Supply Point)

J. Same as d above
k. Same as e above
l. Same as f above

6.2.1.2 Transportation Exposure

a. Load the item to be tested onto a suitable transport vehicle. (If the use of pallets is optional, the test item will be tested without pallets).

NOTE: Self propelled, wheeled equipment will be driven in travel mode and not mounted on a transport vehicle. Self propelled, tracked equipment will be transported on a trailer or "lowboy" and tested in the transported mode.

b. Test items shall be exposed to desert conditions in the following manner:

1) Vehicle transported items shall be moved over a minimum of 150 miles of paved roads, 450 miles of secondary roads, and 70 miles over a course similar to the YPG Desert March Trail, at a speed such that the safety of the crew is maintained throughout.
2) Loaded self-propelled, tracked equipment shall be moved over a minimum of 150 miles of paved roads, 450 miles of secondary roads and 35 miles of the YPG Desert Trail at a speed of 20 mph.
3) Self-propelled wheeled vehicles shall be driven over a minimum of 150 miles of paved roads, 450 miles of secondary roads and 35 miles of the YPG Desert March Trail at a speed of 11 miles per hour.

c. Record the following data continuously during the transported subtest:

1) Ambient air temperature ± 2°F
2) Thermocouple readings ± 2°F
3) Vehicle bed temperature ± 2°F
4) Vehicle direction ± 10°
5) Accelerometer readings ± 1.0 g
6) Time ± 1 min
7) Vehicle speed ± 2 mph
8) Vehicle mileage ± 0.1 mi.
9) Course description

d. After each exposure, inspect the test item as prescribed by appropriate maintenance documents and record in the test log all deficiencies and discrepancies discovered.

6.2.2 Performance

a. Construction, service and support equipment shall be performance tested after exposure testing indicated in 6.2.1, according to applicable procedures set forth in Volume 9 MTPs. (MTP's may be selected as applicable)

b. In addition to the data prescribed by applicable Volume 9 MTP's the following data shall be recorded.

1) Meteorological data for the days performance tests are conducted.
2) Terrain conditions at the performance test site

NOTE: Construction, service and support equipment consisting of motorized or mechanized vehicular components shall, in addition to testing procedures contained above, be tested in accordance with MTP 2-4-001 (Desert Environmental testing of wheeled and tracked vehicles).

6.2.3 Security from Detection

a. Site the test item in the following types of desert terrain:

1) Open desert pavement, no cover
2) Rocky or boulder strewn desert, no vegetation
3) Terrain having xerophyte vegetation (non-succulent)
4) Surfaces composed of loose or drifted sand

b. Replace or remove displaced natural material

c. Observe and record the camouflage and concealment qualities of the test item situated in each of the above terrain types. (Observations and recordings will include the sky conditions and time of day when observations are made).

NOTE: In the case of storage covering areas greater than 4 sq. yards, observations will be made from the air.

6.2.4 Maintenance

a. Test items shall be removed from storage, or off-loaded from transportation and assembled or loaded for functioning.

b. Observe and record necessary action to ensure serviceability of the test item (actions include cleaning, removal of accumulated dust, tightening connections and fastenings, etc.)

c. Observe and record the use of or need for tools or equipment or other supplies to accomplish maintenance actions.

6.2.5 Safety

a. Data relating to test item safety shall be identified from the applicable safety statement/release.

b. Safety test conduct shall be performed according to MTP 9-3-506 and in addition, the following observations shall be noted during each of the other subtests given in this MTP:

1) Interior temperature of test item relative to ambient conditions.
2) Clarity of the test item's identification
3) Presence of safety warnings
4) Safety of handling instruction/procedures
5) Presence and adequacy of safety devices
6) Sharp or projecting edges, controls, etc.
7) Accessibility to emergency cut-off controls
8) Replaceable safety devices
9) Adequacy of instructions for dealing with emergencies
10) Adequacy of lashings and blockings
11) Protruding load safety marking's adequacy
12) Adequacy of personnel operating instructions (from safety point of view considering heating conditions present during desert testing.

c. Safety deficiencies noted during conduct of safety tests and other tests shall be recorded and steps taken whenever possible to eliminate all unsafe conditions.

6.3. TEST DATA

6.3.1 Exposure Tests

6.3.1.1 Storage Exposure

a. Record the following data at hourly intervals:

1) Ambient air temperature (200 cm above ground ± 2°F)
2) Ground temperature (5 cm below surface, ± 2°F)
3) Thermocouple readings
4) Relative humidity

b. Record the following data continuously during testing:

1) Test site precipitation (± 0.01 inch)
2) Wind speed (200 cm above surface ± 5 mph)
3) Wind direction (± 10°)
4) Solar radiation (± BTU/ft^2/hr)

c. Record all deficiencies and discrepancies discovered during the inspection performed after each exposure and note all deficiencies corrected.

6.3.1.2 Transportation Exposure

a. Record the following data continuously during testing:

1) Ambient air temperature ± 2°F
2) Thermocouple readings ± 2°F

3) Vehicle bed temperature ± 2°F
4) Accelerometer readings ± 1.0g
5) Vehicle direction ± 10°
6) Time ± 1.0 min
7) Vehicle speed ± 2 mph
8) Vehicle mileage ± 0.1 mi
9) Course description

6.3.2 Performance

a. Record data as indicated in the applicable Volume 9 MTP selected for the particular test item.

b. Record the following environmental data measured during testing:

1) Meteorological data for the days during which performance tests are conducted.
2) Terrain conditions at the test site

6.3.3 Security from Detection

a. Record the characteristics of the terrain in which observations are to be made.

b. Record the observed camouflage and concealment qualities possessed by the test item for each terrain type on which testing is accomplished.

c. Record the time of day and sky conditions present when observations are made.

6.3.4 Maintenance

a. Record actions taken to ensure serviceability of the test item.

b. Record the use of need for tools or equipment or other supplies to accomplish maintenance actions.

c. Record the following data cumulatively:

1) Part(s) undergoing maintenance
2) Distance part was operated (in miles) if applicable
3) Time operated (in hours)
4) Maintenance time (in hours)
5) Maintenance by category (in hours)

a) Scheduled
b) Unscheduled

6) Total item down time (in hours)
7) Total item operating time (in hours and miles)

d. Maintenance operations themselves should be analyzed to see that there are no unreasonable hazards inherent in replacement or adjustment operations such as risks of pinching, cutting, burning, electrical shock or undue physical effort.

6.3.5 Safety

a. Record data as indicated in applicable portions of MTP 9-3-506.
b. Record safety observations indicated in 6.2.5 b.
c. Record safety discrepancies and deficiencies noted during the conduct of all subtests. (Conditions discovered unsafe and corrected shall be indicated and method of correction listed.)

6.4 DATA REDUCTION

6.4.1 Exposure

6.4.1.1 Storage Exposure

a. Graphically summarize data from thermocouples and meteorological instrumentation, recorded in 6.3.1.1, for the total test period as follows:

1) Plot monthly summaries of ambient air temperature and ground temperature, wind velocity, relative humidity and solar radiation, at 6-hour intervals and mark at daily intervals.
2) Plot data in (1) above at hourly intervals for a 24-hour period showing most extreme and mildest days and a representative day during the exposure period.
3) Key test item thermocouple readings to ambient air temperature and ground temperature and plot in the manner of the monthly and daily presentations in (1) and (2) above.

b. Prepare presentations as required to illustrate circumstances relating to malfunctions and failures attributed to desert environmental stresses.
c. Compare values from presentations, with prescribed or desired values, tolerances etc.,and determine the acceptability of the test item in this regard.

6.4.1.2 Transportation Exposure

a. Present meteorological data and thermocouple readings as indicated in 6.4.1.1 a.
b. Summarize graphically, acceleration and route data recorded in 6.3.1.2 a, to show the following:

1) Accelerometer readings, vehicle bed temperatures, test item temperature and air temperature as a function of mileage.

NOTE: Traces shall be annotated to show time of day and start and finish of various terrain courses.

c. Present profiles of routes followed (horizontal scale 1:15, 625 if map plotted, or 1:10,000 if surveyed; vertical scale 1:120) including annotations per surface conditions (type and microgeometry), slopes and other significant data.

d. Same as 6.4.1.1 b.
e. Same as 6.4.1.1 c.

6.4.2 Performance

a. Present data as indicated in the applicable Volume 9 MTP selected for the particular test item.
b. Same as 6.4.1.1 a.
c. Same as 6.4.1.1 b.
d. Same as 6.4.1.1 c.

6.4.3 Security from Detection

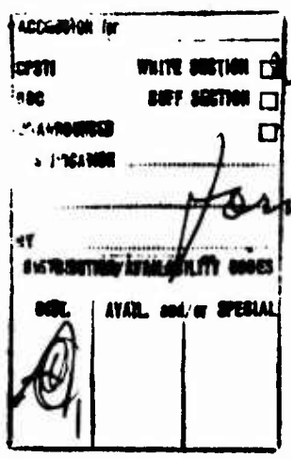
Present a narrative statement of results of the observations relating to security from detection. Photographic illustrations shall be used as required to substantiate the narrative.

6.4.4 Maintenance

a. Data recorded in Paragraph 6.3.4 will be summarized in graphical or tabular form.
b. Maintenance cost will be reported (in percent of maintenance time to operational time)
c. Day-to-day maintenance problems shall be reported in periodic interim reports and defect records and then summarized and analyzed in the overall formal report on the item. Changes in maintenance methods or modifications of the design to improve maintenance operations may be recommended and forwarded with the test results.
d. Observations should be supplemented with line drawings or photographs where necessary.

6.4.5 Safety

Observations and deficiencies will be reported in narrative form, supplemented as required by line drawings and photographs.



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