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15 December 1969

Materiel Test Procedure 6-2-105
Electronic Proving Ground

U. S. ARMY TEST AND EVALUATION COMMAND
COMMODITY ENGINEERING TEST PROCEDURE

3477

GROUND STATION, GEODETIC, RADIO RANGING

1. OBJECTIVE

The objective of this Materiel Test Procedure is to present the engineering test procedures necessary to determine the technical performance of the ground station portion of geodetic survey systems relative to criteria as expressed in applicable Qualitative Materiel Requirement (QMR), Small Development Requirement (SDR), Technical Characteristics (TC), and other applicable requirements or documentation.

2. BACKGROUND

Geodetic surveying by aerial electronic techniques relies on the ability of the system to measure geodetic distances between widely separated ground locations to map standard accuracies. A least squares adjustment of these distances then establishes the geodetic positions of the ground station locations.

A typical geodetic survey system is composed of an airborne distance measuring interrogator set and several ground-based radio ranging transponder sets. The airborne interrogator set derives ranging data from the ground transponders and records these data in time indexed form for subsequent reduction and correlation. The ground station nominally consists of a control-indicator unit, a transmitter-receiver composed of a modulator-oscillator, frequency converter-transmitter, and radio receiver units together with associated power supplies and antennas.

Engineering tests of prototype ground stations for geodetic survey systems are required to determine the extent to which the equipment meets applicable requirements and has the specialized characteristics necessary for its intended use.

3. REQUIRED EQUIPMENT

- a. Oscilloscope
- b. Standard test set or companion interrogator set
- c. Spectrum analyzer
- d. Camera with scope adapter
- e. Dummy load
- f. Directional coupler
- g. Voltmeter
- h. Frequency meter

4. REFERENCES

- A. MIL-E-5400K, Electronic Equipment, General Specification for, 1966.

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- B. MIL-E-4158D, Electronic Equipment, Ground, General Specification for, 1967.
- C. Technical Report SEG-TR-64-72, SHORAN Geodetic Survey System, Electronic AN/USQ-32, Cubic Corporation, April 1965
- D. Ross, J. E. R., Geodetic Applications of SHORAN, Geodetic Survey of Canada, Publication No. 78.
- E. Report No. 43, Notes, Tables and Glossary on Orbital and Geodetic Terms, Dynalectron Corporation, February 1963.
- F. Aalakson, E. I., Fickeissen, I. O., The Effects of Meteorological Conditions on the Measurement of Long Distances by Electronics, Transactions, American Geophysical Union, Vol. 31, No. 6, pp 816-826, December 1950.
- G. MTP 3-1-002, Confidence Intervals and Sample Size.
- H. MTP 6-2-020, Radar Antenna Subsystem Tests.
- I. MTP 6-2-030, Beacons, Electronic.
- J. MTP 6-2-075, Distance Measuring Equipment (DME), General.
- K. MTP 6-2-242, Receiver-Transmitter, General.
- L. MTP 6-2-300, Towers and Masts.
- M. MTP 6-2-334, Survey Systems, Airborne.
- N. MTP 6-2-507, Safety.

5. SCOPE

5.1 SUMMARY

5.1.1 Technical Characteristics

The procedures outlined in this MTP describe in general terms a methodology for empirically determining the technical performance and characteristics of geodetic survey system ground stations in performing their intended transmitting and receiving functions.

The cumulative test results, alongwith the results of appropriate common engineering tests, will permit an estimate to be made of the degree of compliance of the item under test with applicable specifications and requirements, and the suitability of the item for further testing.

The specific tests to be performed are divided into component (laboratory-type) and system (field) tests. These tests, and their intended objectives, are given as follows:

a. Component Tests - The objectives of these tests is to determine the input-output and operating characteristics of the overall system to which the test item may be a part or to subsystems which may interface with the test item.

b. System Tests - The objectives of these tests are to:

- 1) Determine the spectral content and ranging transmission sequence (address response) for each mode of operation.
- 2) Determine the transponder's response to an improper address following phase lock.

5.1.2 Common Engineering Tests

Not included in this MTP are the following Common Engineering Tests which are applicable to these commodities:

- a. MTP 6-2-500, Physical Characteristics
- b. MTP 6-2-502, Human Factors Engineering
- c. MTP 6-2-503, Reliability
- d. MTP 6-2-504, Design for Maintainability
- e. MTP 6-2-508, Electromagnetic Vulnerability
- f. MTP 6-2-509, Electromagnetic Compatibility
- g. MTP 6-2-514, Electrical Power Requirements
- h. MTP 6-2-515, Transmitter Range Tests
- i. MTP 6-2-517, Frequency Accuracy and Stability
- j. MTP 6-2-530, Altitude and Temperature Altitude Test
- k. MTP 6-2-531, Temperature Test
- l. MTP 6-2-532, Sunshine Test
- m. MTP 6-2-533, Rain Test
- n. MTP 6-2-534, Humidity Test
- o. MTP 6-2-535, Fungus Test
- p. MTP 6-2-536, Salt Fog Test
- q. MTP 6-2-537, Dust Test
- r. MTP 6-2-538, Explosive Atmosphere Test
- s. MTP 6-2-539, Immersion Test
- t. MTP 6-2-540, Vibration Test
- u. MTP 6-2-541, Shock Test

5.2 LIMITATIONS

The procedures provided herein are limited to the testing of those characteristics of ground station transponder sets which are not covered in the referenced common and commodity MTP's.

It is assumed that the procedures outlined in the referenced common and commodity MTP's will be selectively applied to the extent required by the particular characteristics and applicable criteria for each test item.

6. PROCEDURES

6.1 PREPARATION FOR TEST

a. Select test equipment ideally having an accuracy of at least ten orders of magnitude greater than that afforded by the item under test, that is in keeping with the state-of-the-art, and whose calibration is certified in accordance with Department of the Army Regulations to assure traceability to the National Bureau of Standards.

b. Record the following information:

- 1) Nomenclature, serial number(s), manufacturer's name, and function of the item(s) under test.
- 2) Nomenclature, serial number, accuracy tolerance, calibration

requirements, and last date calibrated of the test equipment selected for the tests.

c. Ensure that all test personnel are familiar with the required technical and operational characteristics of the item under test, such as stipulated in Qualitative Materiel Requirements (QMR), Small Development Requirements (SDR), and Technical Characteristics (TC).

d. Review all instructional material issued with the test item by the manufacturer, contractor, or government, as well as reports of previous tests conducted on the same types of equipment, and familiarize all test personnel with the contents of such documents. These documents shall be kept readily available for reference.

e. Prepare record forms for systematic entry of data, chronology of test, and analysis in final evaluation of the test item.

f. Prepare adequate safety precautions to provide safety for personnel and equipment, and ensure that all safety SOP's are observed throughout the test and that the item has successfully completed MTP 6-2-507, Safety.

g. Thoroughly inspect the test item for obvious physical and electrical defects such as cracked or broken parts, loose connections, bare or broken wires, loose assemblies, bent fragile parts, and corroded plugs and jacks. All defects shall be noted and corrected before proceeding with the test.

h. Prior to beginning any sub-test, verify correct power source, necessary test instrumentation and inter-connection cabling, and that the equipment is aligned, if necessary, as specified in the pertinent operating instructions to ensure, insofar as possible, it represents an average equipment in normal operating condition.

i. Prepare a test item sample plan sufficient to ensure that enough samples of all measurements are taken to provide statistical confidence of final data in accordance with MTP 3-1-002. Provisions shall be made for modification during test progress as may be indicated by monitored test results.

j. Ensure that arrangements for supporting and participating agencies, activities and facilities have been made, that authorization for electromagnetic radiation at specific frequencies, power levels and modulations for required periods has been obtained, and that appropriate security measures are instituted, as required, to safeguard classified materiel and data.

6.2 TEST CONDUCT

NOTE: Modification of these procedures shall be made as required by technical design of the item under test and availability of test equipment, but only to the extent that such modifications will not affect the validity of the test results.

6.2.1 Component Tests

a. Determine the input-output and operating characteristics of the particular test item system components as required, in accordance with applicable procedures given in the following:

- 1) MTP 6-2-020, Radar Antenna Subsystem Tests
- 2) MTP 6-2-030, Beacons, Electronic

- 3) MTP 6-2-075, Distance Measuring Equipment (DME), General
- 4) MTP 6-2-242, Receiver-Transmitter, General
- 5) MTP 6-2-300, Towers and Masts
- 6) MTP 6-2-334, Survey Systems, Airborne

b. Record data in accordance with the above referenced MTP's.

6.2.2 System Tests

6.2.2.1 Address Response

a. Set up the ground station transponder for normal operation in accordance with applicable instructions.

b. Connect the test apparatus as indicated in Figure 1, and adjust their controls or coupling levels as necessary to display a complete re-transmission sequence of suitable amplitude.

c. Deploy a companion interrogator set at a distance beyond the far-field minimum of the larger antenna.

NOTE: If issued with the test item, a test set may be used (in lieu of the companion interrogator set) to the extent of its capability, providing that accuracy and calibration requirements have been met.

d. Enter identical keying codes on the transponder and interrogator consoles.

e. Interrogate the transponder and record both the time and frequency domain displays of the response.

f. Repeat Steps d and e above, for each available keying code and "station call" or "voice test" functions if present.

6.2.2.2 Improper Address

a. Set up the ground station transponder and test apparatus as outlined in paragraph 6.2.2.1 above, and adjust the interrogator-transponder test link for normal operation.

b. Select an interrogator keying code at random and interrogate the transponder for each available setting of the transponder keying code switches.

c. Ensure that the transponder has achieved phase lock under each of the above conditions and record the response to each improper address.

6.3 TEST DATA

6.3.1 Preparation for Test

Data to be recorded prior to testing shall include but not be limited to:

a. Nomenclature, serial number(s), manufacturer's name, and function of the item(s) under test.

b. Nomenclature, serial number, accuracy tolerances, calibration

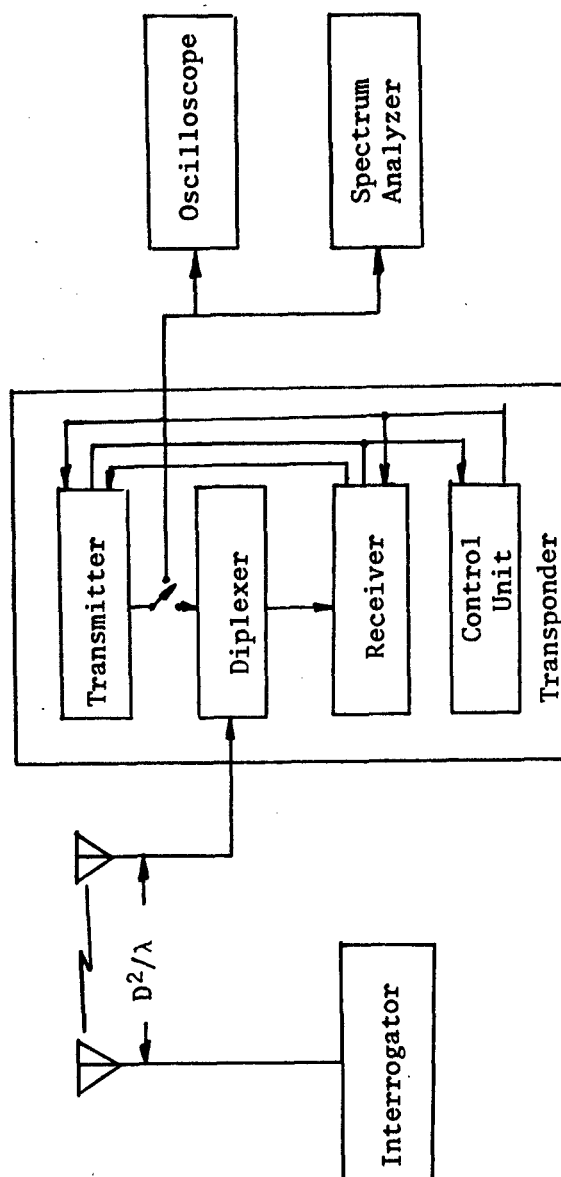


Figure 1. Simplified Block Diagram of Test Equipment Interconnections.

requirements, and last date calibrated of the test equipment selected for the tests.

c. Damages to the test item incurred during transit and/or manufacturing.

6.3.2 Test Conduct

Data to be recorded in addition to specific instructions listed below for each sub-test shall include:

a. A block diagram of the test setup employed in each specified test. The block diagram shall identify by model and serial number, all test equipment and interconnections (cable lengths, connectors, attenuators, etc.) and indicate control and dial settings where necessary.

b. Photographs or motion pictures (black and white or color), sketches, charts, graphs, or other pictorial or graphic presentation which will support test results or conclusions.

c. An engineering logbook containing, in chronological order, pertinent remarks and observations which would aid in a subsequent analysis of the test data. This information may consist of temperatures, humidity, pressures, and other appropriate environmental data, or other description of equipment or components, and functions and deficiencies, as well as theoretical estimations, mathematical calculations, test conditions, intermittent or catastrophic failures, test parameters, etc., that were obtained during the test.

d. Test item sample size (number of measurement repetitions).

e. Instrumentation or measurement system mean error stated accuracy.

6.3.2.1 Component Tests

Component input-output and operating characteristics test data shall be recorded as specified by the reference MTP's given in paragraph 6.2.1.

6.3.2.2 System Tests

6.3.2.2.1 Address Response -

Record the following:

a. Time and frequency domain displays of each response.

b. Suitably calibrated and annotated photographs of the time and frequency waveforms exhibited for each of the specified test conditions.

6.3.2.2.2 Improper Address -

Record the following:

a. Test item response descriptions for each test condition

b. Descriptions of applied stimulus for each test condition

6.4 DATA REDUCTION AND PRESENTATION

Processing of raw test data shall, in general, consist of organizing, marking for correlation and identification, and grouping the test data according to sub-test title. Test criteria or test item specifications shall be noted on the test data presentation to facilitate analysis and comparison. Where necessary, test data measurements shall be converted to be compatible with units given by test criteria or specifications.

Specific instructions for the reduction and presentation of individual sub-test data are outlined in the succeeding paragraphs.

6.4.1 Component Tests

Data obtained from test item system or subsystem component tests shall be reduced and presented in accordance with applicable portions of the MTP's referenced in paragraph 6.2.1.

6.4.2 System Tests

a. Address Response - The frequency and time domain photographs of the ground station reply transmissions shall be presented for comparison with test criteria. Data shall be correlated as necessary through Fourier analysis with statistical methods of data reduction being employed where required to arrive at confidence intervals or other measures of performance as expressed in the applicable test criteria.

b. Improper Address - Descriptions of test item response to other than desired codes shall be presented for evaluation with respect to imposed requirements.

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