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This Test Operations Procedure (TOP) provides conventional test methods employing conventional test instrumentation for testing coventional radars. Single tests and subtests designed to test radar components, transmitters, receivers, antennas, etc., and system performance are conducted with single item instruments such as meters, generators, attenuators, counters, oscillators, plotters, etc., and with adequate land areas for conducting field tests.

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US ARMY TEST AND EVALUATION COMMAND

TEST OPERATIONS PROCEDURE

AMSTE-RP-702-105 7 September 1984
*Test Operations Procedure 6-2-222
AD No.

RADAR, TARGET AND RANGING

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1. SCOPE

This Test Operations Procedure (TOP) provides conventional test methods employing conventional test instrumentation for testing conventional radars. Single tests and subtests designed to test radar components, transmitters, receivers, antennas, etc., and system performance are conducted with single item instruments such as meters, generators, attenuators, counters, oscillators, plotters, etc., and with adequate land areas for conducting field tests.

This TOP does not provide test methods for testing modern special type sophisticated radars, but is restricted to a variety of conventional radars. It does not provide detailed procedures for any specific radar, but allows flexibility in designing appropriate test setups for a variety of radars. Each subtest of a radar test plan will require its own test setup both in instruments used and methodology applied. This method of testing is generally easier to assemble and use than an automated test setup which would require more know-how, time, software, and instrumentation to design and assemble. For highly specialized radars requiring the benefits of automation, it must be realized that each automated setup is only good for each specific subtest. TOPs will have to be written for modern radars requiring automation to measure, analyze, and record subtest parameters. Highly specialized modern radars will require specific automation setups designed by knowledgeable engineers to test specific technical characteristics in the test plan subtests.

*This TOP supersedes MTP 6-2-222, 4 April 1969.

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1.1 Objective

This TOP delineates general test procedures for measuring and evaluating the technical performance and characteristics of target and ranging radar systems and their suitability for employment in the intended tactical environment.

1.2 Common Engineering Tests

Not included in this TOP are the following Common Engineering Tests which apply to this commodity.

a. 1-2-610, Human Factors, Part I Test Procedures, Part II HEDGE.

b. 6-2-504, Maintenance/Maintainability, 25 March 1970, AD No. 871133.

c. 6-2-507, Safety and Health Evaluation-Communications/Electronic Equipment, 15 June 1981, AD No. A103808.

d. 6-2-517, Transmitter Frequency Accuracy and Stability, 31 December 1980, AD No. A100394.

2. FACILITIES AND INSTRUMENTATION

As indicated in paragraph 1, radars can be tested with individual test instruments manually connected, calibrated and adjusted, and test data recorded manually. However, automated test equipment and systems are available with increased accuracy and automatic data recording that result in considerable reduction in both time and cost. The facilities, instrumentation, and procedures in this TOP are predicated on the use of these automated test instruments and systems.

2.1 Facilities

For testing the individual components of the radar system, other than antenna, any electronic laboratory with screened room and appropriate instrumentation would be adequate.

If the antenna is to be tested, an adequate antenna test facility will be required.

For performance testing under controlled and repeatable conditions, an automated facility such as the Weapon System Electromagnetic Environment Simulator (WSEES), described in appendix B, is required.

For field testing, a land area of sufficient size to disperse test elements to adequate ranges is required. This area should be isolated and free from radio interference. Adequate communications and control with both ground and airborne tracking facilities are also required. Adequate targets for the type radar being tested must be available.

2.2 Instrumentation

The following test instrumentation (preferably with digital interface bus for programable instrumentation) may be required to support this TOP.

a. Power meters, both average and peak

b. Frequency counters

c. Signal sampling devices

d. Variable and fixed attenuators

e. Signal generators

f. Sweep generators

g. Spectrum analyzers

h. Pulse generators

i. Oscillators

j. Multimeters

k. Voltmeters

l. Real-time clock

m. Computers (desk top/mini)

n. Plotter/printer

o. Graphics terminal

p. Alphanumeric terminal

q. Assorted microwave interconnection equipment

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Justification
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Availability Codes
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A-1

2.3 Characteristics/Requirements

The characteristics of the test instrumentation are determined by the performance specifications of the individual equipment or system being tested. In some cases, instrumentation may have to be fabricated for specific test requirements. All instrumentation must have an accuracy greater than that specified for the test item. All instrumentation shall be calibrated by approved methods and instrumentation traceable to the National Bureau of Standards. The major facilities and instrumentation indicated above can provide the necessary characteristics and setups required to perform the subtests indicated in this TOP.

3. PREPARATION FOR TEST

a. Review TECOM Pamphlet 70-3, Research, Development, and Acquisition Project Engineers' Handbook for guidance on test planning, execution, reporting, and post-test activities.

b. Establish and/or continually maintain a readily accessible project log and project file.

c. Review local installation project office handbook, standing operating procedures (SOP), and implementing directives which govern the administrative processes of preparing test plans, conducting tests, preparing reports, reporting to the Test Resources Management System (TRMS), and budgeting.

d. Acquire and review all descriptive, instructional, and specification material on the test items issued by Government and contractor(s) for checking the test plans subtest objectives, criteria, facility(ies), and instrumentation requirements.

e. Determine the scheduled availability of the test item.

f. Ensure availability of appropriate facilities and coordinate the test support requirements including personnel, equipment, maintenance, spare parts, and instrumentation.

g. Review the detailed test plan.

h. Record, as a minimum, the following data:

(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 calibration data of test equipment selected for the tests.

(3) Damages to the test item(s) incurred during transit and/or manufacturing defects.

(4) Test item photographs.

i. Establish instrumentation or measurement system mean error and standard deviation of error.

j. Determine test item sample size.

k. Check with the responsible frequency management agency to ensure authorization for radiation in the required frequency bands during the anticipated test period if a field test is to be performed. Check adherence to Electronic Security (ELSEC) and Operational Security (OPSEC) guidelines.

4. TEST CONTROLS

a. Organize test team and establish responsibilities for test conduct, reporting, and data control.

b. Check to ensure that test equipment and accessories are available, operational, and meet certified calibration requirements.

c. Perform an operational check of the test item(s) to ensure normal, correct functioning.

d. Prepare and implement adequate safety precautions to provide safety for personnel and equipment and ensure all safety SOPs are observed throughout the test.

e. Prepare and monitor 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 TOP 3-1-002, Confidence Intervals and Sample Size.

5. PERFORMANCE TESTS

NOTES: 1. Because of the variability of both equipment and functions of the radar systems that may be tested, these procedures may be modified when required by the design or characteristics of the test item. Such modification shall not affect the validity of the test results.

2. These test procedures are predicated upon the use of automated test systems or instrumentation with digital interface for programable instrumentation. Manual instrumentation may be used with appropriate procedure modification and an increase in time and cost.

3. Some of these test procedures may not be applicable to all test items. Appropriate government and contractor technical manuals should be reviewed prior to testing and the specific tests that are appropriate determined.

4. Since the test setups to be used will vary based on the design and characteristics of both the test item and the computer and programmable instrumentation available, specific test setups and operational procedures are not provided.

5.1 Test Methods

5.1.1 Component Tests

5.1.1.1 General

a. Perform, unless indicated otherwise, component test procedures and test setups in accordance with MIL-STD-449 or 469 and with modifications to incorporate the newer programable instrumentation.

b. The Electromagnetic Environmental Test Facility (EMETF) has been using a Hewlett Packard 9845 desk top computer with interface bus programed to test against MIL-STD-449 and 469 for several years. It also has test programs and setups available for both transmitter and receiver measurements.

5.1.1.2 Transmitter Subtests

a. Review the technical characteristics of the test item transmitter and the programable instrumentation and assemble and program a test setup to measure and record the transmitter power output (peak and/or average as applicable), pulse characteristics, duty cycle, spectrum characteristics and, where required, the frequency accuracy and stability. Consider the factors in the test setup to include, but not limited to:

(1) It is preferable to use a dummy load on the output, but, if the antenna must be used, permission to radiate at the frequencies shall be obtained.

(2) Where appropriate, attenuators should be used to prevent damage to test instrumentation.

b. Check and calibrate the total test setup to ensure that any attenuation, SWR, or phase shift condition is known and accounted for in all measurements prior to recording data.

c. Make measurements at high, medium, and low frequencies if the transmitter is tunable. Make automated tests at all frequencies when testing modern radars employing frequency hopping between discrete frequencies.

d. Program the computer to make all measurements and record the data in either graphic or alphanumeric format, as applicable.

e. Turn on the test item and instrumentation and make and record measurements, as applicable, of power output, pulse, duty cycle, spectrum and frequency accuracy and stability.

f. Make phase noise and ambient conditions measurements.

5.1.1.3 Receiver Subtests

a. Review the receiver characteristics of the test item and select appropriate programable test instrumentation for making measurements of sensitivity and spurious response. Refer to TOPs 6-2-544 and 6-2-545 respectively.

b. Check and calibrate the total setup to ensure that any attenuation, SWR, or phase shift condition is known and accounted for in all measurements prior to recording data.

c. Program the computer to make all measurements, and record the data in either graphic or alphanumeric format, as applicable.

d. Turn on the test item and all instrumentation, and make and record measurements as applicable, of sensitivity, selectivity and spurious response.

e. Test Moving Target Indicator (MTI) Radars to measure cancellation ratio and subclutter visibility.

NOTE: MTI radars vary in respect to fixed target cancellation and clutter visibility. If a fixed target is truly stationary, it may be cancelled completely. However, many fixed targets, such as trees and vegetation, are moving slightly because of wind and thus show up as clutter on the radar. Some systems have adjustable or fixed phase gating which can completely eliminate this clutter. The characteristics of the test item should be reviewed to determine how it should respond to fixed targets. If it should have clutter and the cancellation is complete in the cancellation test, a small amount of phase shift or phase jitter can be programed on the WSEES for the fixed target signal in both the cancellation and subclutter visibility tests.

f. Measure the cancellation ratio (difference between fixed target with MTI and fixed target without MTI) by:

(1) Phase locking the receiver to the WSEES or phase lock the WSEES to the test item.

(2) Programing the WSEES to simulate a fixed target at medium range and connect to receiver input.

(3) Using a calibrated oscilloscope, measure and record the receiver output level with the MTI out and the MTI in.

g. Measure the subclutter visibility of an MTI test item (difference between moving target signal at same level as fixed target with no MTI and moving target signal at same level as fixed target with MTI) by:

(1) Phase locking the WSEES and test item receiver as in paragraph g(1) above.

(2) Programing the WSEES to simulate a strong fixed target and a moving target, and connect to a receiver input.

(3) Lower receiver gain (with a calibrated oscilloscope on the receiver ouput and the MTI disabled, until the fixed target signal is not limited.)

(4) Adjust moving target signal until it is at same level as fixed target, and measure and record levels from WSEES and on oscilloscope.

(5) Engage MTI and adjust moving target signal until it is even with fixed target signal, and measure and record signal level of moving target signal from WSEES and on oscilloscope.

5.1.1.4 Antenna Test. Measure, if an antenna test is required, in accordance with procedures in MIL-STD-449 or 469 as applicable, and/or TOP 6-2-020.

5.1.2 System Performance Tests

NOTE: The WSEES was designed to provide all of the signals necessary to make a controlled and repeatable performance test of a radar or weapon system without activating the transmitter of the test item. All timing and phase locking when applicable, can be provided by the WSEES or, if necessary, the WSEES can be phase locked to the test item. Direct connection is preferable, but radiated signals can be used if necessary.

a. Review the specifications and characteristics of the test item and program, and connect the WSEES to exercise the test item in all situations that could be anticipated in the tactical environment to include, but not limited to:

(1) Single targets at various signal levels and speeds moving at various aspect angles to the test item.

(2) Multiple targets moving at various aspect angles.

(3) Targets with equal and different signal levels and crossing paths to include simultaneous targets moving through the range gate of tracking radars.

(4) Multiple targets increasing in number to saturation or specification maximum.

(5) Targets with various signal levels crossing over or near the test item to determine minimum operational range and whether the system operation can be impaired by strong signals.

b. Check the WSEES to ensure that it is properly programed, and record program data, if necessary.

c. Install appropriate monitoring and recording equipment.

d. Turn on test item, WSEES, and all instrumentation and measure and record all data for each test sequence.

e. Simulate a system fault and check the fault isolation system operation with all indicators or recorders operational and nonoperational if the test item has a fault isolation or self-check system. Note whether the fault can be located if the fault isolation system is nonoperational or impaired.

5.1.3 Field Tests

a. Determine, when designing the system field tests of the performance data from tests of paragraph 5.1.2, whether all the same test conditions are achievable with the field test facilities that are to be used.

b. Connect appropriate monitoring and recording equipment to the test item so that performance evaluation can be compared.

c. Validate the cancellation and subclutter visibility tests also by using field fixed targets and a calibrated signal generation for signal substitution measurements in cancellation tests and as the moving target in subclutter tests. Provide the signal levels for the difference determinations from the attenuator readings on the single generator.

5.2 Data Required

NOTE: Because of the various types and functional characteristics of the Radar Systems that may be tested, specific data requirements cannot be specified. The general data requirements delineated may be modified as required by the characteristics of the test item.

5.2.1 Provide the following data for each subtest in addition to the data listed for each subtest:

a. A block diagram of the test setup identifying all test equipment, simulators, test items, auxiliary equipment and interconnections as appropriate.

b. Test item sample size.

c. Photographs or graphic and alphanumeric presentations, as appropriate, to support test results.

d. Instrumentation or measurement mean error and accuracy.

5.2.2 Component Tests

Provide in accordance with MIL-STD-449 or 469 with appropriate modifications to accommodate the new programable test instrumentation and recorders being used.

5.2.3 System Performance Tests

a. Provide a description of each test sequence scenario and appropriate data to confirm that the sequence was properly programed and executed.

b. Provide appropriate descriptive and photographic, graphic, and/or alphanumeric data indicating the radar or weapon system performance during each test sequence.

c. Indicate the equipment performance and accuracy for each test sequence if the fault isolation test was performed, and provide a description with supporting data, as appropriate.

5.2.4 Field Tests

Provide a description of each test sequence and the performance of the radar or weapon system with supporting data, as appropriate, if field tests are performed.

6. DATA REDUCTION AND PRESENTATION

6.1 General

Process raw test data, in general, to include but not limited to the following steps:

a. Mark test data for identification and correlation according to subtest.

b. Organize data into tabular and graphical form.

c. Modify data to correct for nonstandard conditions.

d. Determine the statistical variation of the results in terms of the average value and standard deviation of the particular quantities and the correlation among two or more quantities.

NOTE: The test directive or Independent Evaluation Plan/Test Design Plan (IEP/TDP) and Specification/Military Requirements document serves to define the types and characteristics of the raw test data, and the ultimate objective of the test program defines the form of the test data desired.

6.2 Component Tests

Evaluate the data from each subtest in reference to equipment specifications or standards, and arrange in proper format to support the evaluation.

6.3 System Performance Tests

a. Evaluate the input data and the test item performance for the test sequence referenced to equipment specifications, stated requirements and the capability of test item to perform in the intended tactical environment. Arrange and format test data, as appropriate, to support the evaluation and conclusions.

b. Evaluate the fault isolation data to determine the ability to isolate the fault accurately and whether or not the test item can be properly maintained with the fault isolation indicators inoperative. Format the data to support the evaluation.

6.4 Field Tests

Analyze and format the data in the same manner as the applicable performance or MTI tests. Compare the data with the closed link tests and any differences noted and evaluated with respect to specifications or requirements.

Recommended changes to this publication should be forwarded to Commander, US Army Test and Evaluation Command, ATTN: AMSTE-AD-M, Aberdeen Proving Ground, MD, 21005-5055. Technical information may be obtained from the preparing activity: Commander, US Army Electronic Proving Ground, ATTN: STEEP-TM-AC, Ft Huachuca, AZ 85613-7110. Additional copies are available from the Defense Technical Information Center, Cameron Station, Alexandria, VA 22314. This document is identified by the accession number (AD No.) printed on the first page.

APPENDIX A

CHECKLISTS

A.1 Pretest

a. Detailed test procedure available _____

b. Instrument support facility available _____

c. Engineering logbook available _____

d. Safety precautions instituted _____

e. Test personnel informed of review rights _____

f. Sample plan available _____

A.2 Test Conduct

Detailed test procedure available _____

A.2.1 Transmitter Tests

a. Test setups inspected _____

b. Measurements completed, data recorded _____

A.2.2 Receiver Tests

a. Test setups inspected _____

b. Measurements made, data recorded _____

A.2.3 Antenna Tests

a. Test setups inspected _____

b. Measurements made, data recorded _____

A.2.4 System Performance Tests

a. Test setups inspected _____

b. Programing checked _____

c. Measurements made, data recorded _____

A.2.5 Field Tests

a. Test setup inspected _____

b. Measurements made, data recorded _____

APPENDIX B

FACILITY DESCRIPTION

APPENDIX B - DESCRIPTION OF THE WEAPON SYSTEM ELECTROMAGNETIC ENVIRONMENT SIMULATOR

The Weapon System Electromagnetic Environment Simulator (WSEES) of the Electromagnetic Environmental Test Facility is a highly versatile simulation and signal generation laboratory. It has been developed to test systems and equipment that operate in the radio frequency (RF) microwave region. WSEES RF signals duplicate those signals required to test the electromagnetic compatability and vulnerability of Army communication-electronics (C-E) equipment.

Through the use of specific signal generation, the WSEES provides the capability required to develop scoring data on both standard and adaptive systems. The WSEES is particularly well suited for the testing and scoring of advanced systems. The effects of interference and electronic countermeasures (ECM) can be evaluated under controlled and repeatable signal conditions. Such testing minimizes the need for elaborate field tests, aircraft, and other types of live targets. The WSEES is not transportable; its use is limited to those systems that can be placed inside its limited sized enclosure.

The system consists of an extremely complex and versatile RF generation unit, a control console, a real-time controller, a steerable platform, and a radar absorbent material (RAM) enclosure. The RF generation unit consists of hardware which accepts digital commands from the control console and quickly produces RF signals of the desired frequency (2.0 to 18.0 GHz), amplitude, and time characteristics. The control console provides media for entering and displaying the desired signal request data and logging the signals which were executed. It consists of a digital display panel, a digital interface with signal command memory capability, two input command tape drives, a manual command entry device, and a digital command logger. The real-time controller provides the capability to sense the reactions of a system under test and to determine how it has modified its operation. Once a change has been sensed, the controller issues commands to the control console to change the signals in a predetermined manner. The steerable platform and RAM enclosure provide the capability of radiating a WSEES signal to a missile system so that antenna-to-antenna coupling and missile control surface functions can be fully evaluated.

APPENDIX C

REFERENCES

1.	TECOM Pam 310-4	Index of Test Operations Procedures
2.	TECOM Supplement 1 w/change 1, to AMC Reg 310-6	Quality Assurance Publication
3.	TECOM Pam 70-3	Project Engineers' Handbook
4.	TECOM Reg 70-24	Documenting TECOM testing
5.	Military Standard 449	Radio Frequency Spectrum Characteristics, Measurement of
6.	Military Standard 469	Radar Engineering Design Requirements, Electromagnetic Compatability
7.	TOP 6-2-020	Radar Antenna Tests, 15 June 1981, AD No. A100393

APPENDIX D

ABBREVIATIONS

MIL STD	Military Standard
EMETF	Electromagnetic Environmental Test Facility
ADCS	Automatic Data Collecton System
WSEES	Weapon System Electromagnetic Environment Simulator
TOP	Test Operations Procedure
SWR	Standing Wave Ratio
MTI	Moving Target Indicator