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

3488

COUNTERMEASURES EQUIPMENT, NON-COMMUNICATION SYSTEMS

1. OBJECTIVE

The objective of the procedures outlined in this MTP is to provide a means of evaluating the technical performance and characteristics of countermeasures equipment designed to operate against non-communication electronic systems.

2. BACKGROUND

An important tactic in modern warfare is the aggressive action taken to deny the enemy the use of his systems and equipment which utilize the electromagnetic spectrum. Such systems/equipment in the fields of communication, navigation, surveillance, weapons control and associated areas operate in various bands of the electromagnetic spectrum and are therefore vulnerable to intentional interference or countermeasures created by an opposing force. The contested spectrum currently ranges from long "radio" wavelengths, through the "radar" and infrared wavelengths, to the visible portion of the spectrum.

Engineering tests of prototype electronic countermeasures systems are required to determine the extent to which the equipment meets the technical performance characteristics as prescribed in the appropriate QMR, SDR, TC or other applicable specification, to provide data for use in further development, and for the determination of the suitability of the system for service test.

The electronic countermeasures (ECM) systems applicable to this document are classified according to use and described in Appendix A.

3. REQUIRED EQUIPMENT

a. Electronic-type laboratory, with adjacent open area
b. Integrated field test facility of adequate area, incorporating:

1) Tracking radar
2) Telemetry
3) Timing
4) Control communications

c. Victim systems, real or simulated, airborne and ground-based types; conceptually related to the test item (See Appendix A)
d. Fixed-wing and/or rotary-wing aircraft with test instrumentation installation capabilities
e. Signal generators

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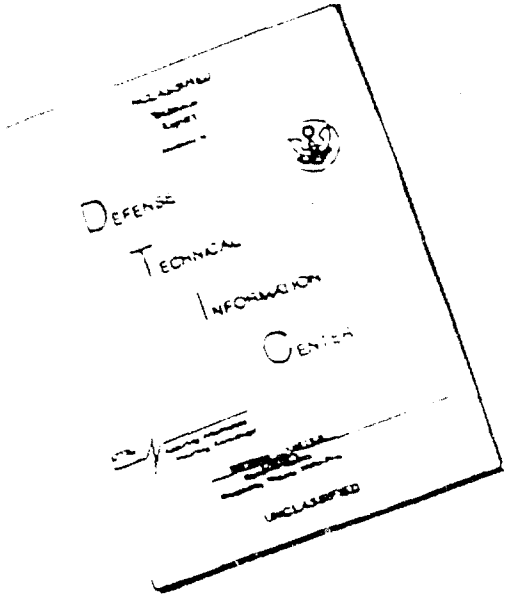

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f. Oscillators
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l. Oscillographs
m. Magnetic tape recorders
n. Vacuum-tube voltmeters
o. Multimeters
p. RF attenuators, terminations, and couplers
q. Photographic equipment, still, cine, and CRT types

4. REFERENCES

A. MIL-STD-449(-), Measurement of Radio Frequency Spectrum Characteristics
B. MIL-STD-463(-), Electromagnetic Interference Technology-Definition and System of Units
C. Classified FM's and TM's
D. ETA 40(RL), Operational and Organizational Maintenance Instructions for Multipurpose Jammer (MPJ) Installed in U-1A Aircraft (U), USAEPG, April 1963
E. ETA 41(R1), Operational and Organizational Maintenance Instructions for Multipurpose Jammer (MPJ) Installed in 2 ½ ton Truck (U), USAEPG, April 1963
F. ETA 140, Engineering Design Test of AN/ALQ-37(XE-1) Multi-purpose Jammer (U), USAEPG, October 1963
G. USAEPG-TP-244, Engineering Test of Radar Jammer AN/ALQ-80 (U), USAEPG, September 1967
H. Jamming Effectiveness Instrumentation Study - Technical Report, RADC-TR-197, Rome Air Development Center, 31 March 1960
I. An Apparatus for the Statistical Assessment of Jamming Effectiveness, Telecommunications Establishment, Ottawa, Canada, May 1959
J. Skolnik, M. I., Introduction to Radar Systems, McGraw-Hill Book Company, New York, 1962
K. Terman & Pettit, Electronic Measurements, 2nd Edition, McGraw-Hill Book Company, New York, 1952
L. MTP 3-1-002: Sample Size and Confidence Intervals
M. MTP 6-2-507, Safety
N. MTP 6-2-135, Infrared Equipment
O. MTP 6-2-165, Lasers
P. MTP 6-2-514, Electrical Power Requirements

5. SCOPE

5.1 SUMMARY

5.1.1 Technical Characteristics

The procedures outlined in this MTP provide general guidance for evaluating the technical performance and characteristics of countermeasures equipment capable of operation against non-communication type electronic victim systems. The cumulative test results together with the results of the appropriate Common Engineering Tests will allow an estimate to be made of the suitability of the equipment to meet the required military needs.

The specific tests to be performed are divided into parameter and field tests. These tests, along with their intended objectives, are listed below:

a. Parameter Tests

1) Electromagnetic Characteristics and Directional Antenna Test - The objective of this subtest is to determine if the transmitter and receiver characteristics as well as the antenna field pattern and directional characteristics of the item under test meet applicable criteria.
2) Special Features Tests - The objective of this subtest is to determine if the technical characteristics of the test item special subsystems meet applicable criteria.
3) Primary Power Tests - The objective of this subtest is to determine if the primary power requirements of the item under test meets applicable criteria.

b. Field Tests

1) Intercept and Direction Finding - The objective of this subtest is to determine the technical performance and characteristics of the test item intercept/direction finding (I/DF) subsystem.
2) Jamming Tests - The objective of this subtest is to determine the technical performance and characteristics of the test item jammer subsystem.
3) ECM System Tests - The objective of this subtests is to determine technical performance and characteristics of both the I/DF and jammer subsystems operating together.

5.1.2 Common Engineering Tests

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

a. 6-2-500, Physical Characteristics
b. 6-2-502, Human Factors Engineering
c. 6-2-503, Reliability
d. 6-2-504, Design for Maintainability
e. 6-2-507, Safety

5.2 LIMITATIONS

The variety of countermeasures equipment to which this MTP is applicable preclude detailed coverage of any particular item. The testing methods outlined are intentionally general to provide test coverage for various countermeasures equipment and may be adapted, as necessary, to accomodate specific items. It is left as a task for the test engineer to categorize the specific test item in accordance with the guidance established in Appendix A, and select the applicable test procedures from those given herein.

6. PROCEDURES

6.1 PREPARATION FOR TEST

a. Select test equipment having an accuracy of at least ten times greater than that of the function to be measured, that is in keeping with the state of the art, and with calibrations traceable 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 tolerances, 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 subtest, 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 averaging 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 all support aircraft are properly instrumented as required, that arrangements for supporting and participating agencies, activities, and facilities have been made, and that authorization for electromagnetic radiation at specific frequencies, power levels, and modulations for required periods has been obtained.

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 modified procedures will not affect the validity of the test results.

6.2.1 Parameter Tests

6.2.1.1 Electromagnetic Characteristics

a. Determine the test item electromagnetic charactistics in accordance with the procedures given in MIL-STD-449(-), Measurement of Radio Frequency Characteristics, MTP 6-2-135, Infrared Equipment or MTP 6-2-165, Lasers, as applicable, depending upon the design of the item under test.

NOTE: Principal parameters to be measured in accordance with the above procedures shall include but not be limited to:

1) Antenna field patterns, transmitting and receiving
2) Receiver

   a) Frequency range
   b) Sensitivity
   c) Selectivity
   d) Standard response
   e) Dynamic range

3) Transmitters

   a) Frequency
   b) Power output
   c) Modulation
   d) Emission spectrum

b. Record data in accordance with the above procedure applicable to the test item.

c. During performance of the above procedures, correlate direction finding and/or directional jamming antenna positioning subsystem operation with the antenna pattern measurements.

d. Record azimuth or elevation (or tilt) antenna indicator readings in tabular form opposite a listing of the corresponding antenna pattern measurements describing the main lobe.

e. If the test item incorporates polarization control equipment, correlate such equipment in the manner described in steps (c) and (d), above

6.2.1.2 Special Features Tests

a. Develop and perform subtests for such special features as may be incorporated in various test item system designs based on specifications and requirements set forth in applicable instruction manuals, QMR, SDR, and equivalent sources.

b. Record special features test data in forms appropriate to the function involved. These shall include tabulated data, magnetic tape/graphic recordings, photographs of indicators and other visual displays, etc.

6.2.1.3 Primary Power Tests

a. Subject the item under test to the procedures given in MTP 6-2-514, Electrical Power Requirements.

6.2.2 Field Tests

6.2.2.1 Intercept and Direction Finding

a. Prescribe aircraft flight paths (if required) for airborne equipments on map overlays or scaled diagrams showing the following minimum information:

1) Length and direction of data runs
2) Altitudes
3) Data points
4) Ground equipment sites and reference points

b. Install ground-based (test range) tracking radar or optical tracking system(s) as required to obtain space position plots of airborne items, and correlate all test activities (ground-ground and air-ground) by a common range timing system.

c. Connect test instrumentation to the test item intercept/DF(I/DF) subsystem as required to:

1) Measure each victim transmitter (VT) carrier frequency.
2) Measure the signal strength of each received carrier.
3) Analyze each VT signal to the extent necessary to identify the victim system.
4) Measure and record the bearing (I/DF antenna azimuth and elevation/tilt) of each received signal.

d. Deploy test item and one or more victim transmitters at various distances (slant range) and orientations with respect to the test item.

NOTE: Test item and victim equipments shall be sited/flown at representative minimum-to-maximum tactical inter-system ranges. Distance and transmitter power outputs may be reduced as outlined in Appendix A.

e. Energize all equipment and calibrate all test instrumentation as a unit.

f. Operate the victim transmitter(s), as appropriate, at:

1) Various frequencies
2) Minimum-to-normal power outputs
3) Typical modulations
4) Different antenna orientations and polarization, if available

g. Under the conditions outlined in Step (f) above, operate the test item intercept/DF subsystem and test instrumentation, and record the following information in appropriate form:

1) Victim transmitter(s)

a) Locations and periods of operation
b) Frequencies
c) Power outputs
d) Modulating signal forms
e) Antenna orientations (azimuth and elevation/tilt)
f) Antenna polarization(s)

2) Test item

a) Location and time of measurements
b) Victim transmitter frequencies
c) Victim transmitter signal strengths
d) Victim transmitter characteristics recordings
e) Directional data on each victim transmitter (azimuth and elevation/tilt of test item antenna)
f) Polarization of victim transmitter signals

h. Repeat Steps (f) and (g) above, as required to resolve incongruities

6.2.2.2 Jamming

a. Prescribe aircraft flight paths (if required), as outlined in paragraph 6.2.2.1, Step (a).

b. Install ground-based (test range) tracking systems as outlined in paragraph 6.2.2.1, Step (b).

c. Deploy the test item jammer and one or more victim receivers or sensors (VR) at various distances (slant range) and orientations with respect to the test item.

NOTE: Test item and victim equipments shall be sited/flown at representative minimum-to-maximum tactical inter-system ranges. Distances and transmitters power outputs may be reduced as outlined in Appendix A.

d. Connect test instrumentation to each VR as required to measure:

1) Relative signal strengths of normal desired signals and jamming signals
2) VR output characteristics to determine the degree of degradation caused by various modes and levels of jamming, i.e., jamming effectiveness

e. Energize all equipment and calibrate all test instrumentation as a unit.

f. Under each condition of test item-victim orientation, operate the jammer in each design mode with respect to:

1) Carrier frequency manipulation
2) Variable power output
3) Modulating signal forms
4) Look-through operation
5) Antenna position control and limits
6) Antenna polarization

g. Under the conditions outlined in Step (f) above, operate the victim receivers or sensors, and record the following information in appropriate form:

1) Test item (jammer)

a) Locations and operational periods
b) Jamming frequencies
c) Power outputs
d) Modulation types
e) Modulating signal characteristics
f) Look-through interval data
g) Antenna position data
h) Antenna polarization

2) Victim receiver/sensor (VR)

a) Locations and time of events
b) Field strength of normal signal(s)

c) Field strength of jamming signals at the selected jammer-victim distances (J1, J2, - - - -).
d) Tabular data, chart/tape recordings and photographs of normal VR output signals and displays
e) Tabular data, chart/tape recordings and photographs of VR output signals and displays as the VR is subjected to the various jamming modes and levels

h. Repeat Steps (f) and (g) above, as required to resolve incongruities.

6.2.2.3 ECM System Test

a. Deploy one or more victim transmitters at various distances (slant range) and orientations with respect to the test item as outlined in Appendix A.

b. Connect test instrumentation to the test item as required to:

1) Measure each victim transmitter carrier frequency
2) Measure the signal strength of each received carrier
3) Analyze each VT signal to the extent necessary to identify the victim system.
4) Measure and record the bearing of each received signal (antenna azimuth and elevational / tilt).

c. Energize all equipment and calibrate all test instrumentation as a unit.

d. Operate the victim transmitter(s), as appropriate, at:

1) Various frequencies
2) Minimum-to-normal power output
3) Typical modulations
4) Different antenna orientations and polarization, if available

e. Under the conditions outlined in Step (d) above, operate the victim receivers or sensors, test item intercept/DF subsystem all test instrumentation, and jammer subsystem in each design mode with respect to:

1) Carrier frequency manipulation, e.g., narrowband, broadband, or swept-band
2) Variable power output
3) Modulating signal forms
4) Look-through operation
5) Antenna position control and limits
6) Antenna polarization

f. Record the following information in appropriate form:

1) Victim transmitter(s)

a) Locations and periods of operation
b) Frequencies
c) Power outputs
d) Modulating signal forms

e) Antenna orientations (azimuth and elevation/tilt)
f) Antenna polarization(s)

2) Victim receiver/sensor (VR)

a) Locations and time of events
b) Field strength of normal signal(s)
c) Field strength of jamming signals at the selected jammer-victim distances (J1, J2 - - - - -).
d) Tabular data, chart/tape recordings and photographs of normal VR output signals and displays
e) Tabular data, chart/tape recordings and photographs of VR output signals and displays as the VR is subjected to the various jamming modes and levels.

3) Test item (jammer)

a) Locations and operational periods
b) Jamming frequencies
c) Power outputs
d) Modulation types
e) Modulation signal characteristics
f) Look-through interval data
g) Antenna position data
h) Antenna polarization

g. Repeat steps (a) thru (f) above, as required to resolve incongruities.

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 numbers, manufacturer's name, and function of the item(s) under test.

b. Nomenclature, serial number, accuracy tolerances, calibration 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 defects.

6.3.2 Test Conduct

Data to be recorded in addition to specific instructions listed below for each subtest 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 presentations 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 and components, 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 Parameter Tests

6.3.2.1.1 Electromagnetic Characteristics

a. Record data in accordance with MIL-STD-449(-), MTP 6-2-135, or MTP 6-2-165 as applicable.

b. Record azimuth or elevation (or tilt) antenna indicator readings in tabular form opposite a listing of the corresponding antenna pattern measurements describing the main lobe.

6.3.2.1.2 Special Features Tests

a. Record special features test data in forms appropriate to the function involved. These shall include tabulated data, magnetic tape/graphic recordings, photographs of indicators and other visual displays, etc.

6.3.2.1.3 Primary Power Tests

a. Record data in accordance with MTP 6-2-514.

6.3.2.2 Field Tests

6.3.2.2.1 Intercept and Direction Finding

a. Record the following intercept/DF test data items in appropriate form for each condition:

1) Victim transmitter(s)

a) Locations and periods of operation
b) Frequencies
c) Power outputs
d) Modulating signal forms
e) Antenna orientations (azimuth and elevation/tilt).
f) Antenna polarization(s)

2) Test item

a) Location and time of measurements
b) Victim transmitter frequencies

c) Victim transmitter signal strengths
d) Victim transmitter characteristics recordings
e) Directional data on each victim transmitter (azimuth and elevation/tilt of test item antenna).
f) Polarization of victim transmitter signals

6.3.2.2.2 Jamming

a. Record the following items in appropriate form for each condition of victim receiver/sensor-test item jammer operation:

1) Test item (jammer)

a) Locations and operational periods
b) Jamming frequencies
c) Power outputs
d) Modulation types
e) Modulation signal characteristics
f) Look-through interval data
g) Antenna position data
h) Antenna polarization

2) Victim receiver/sensor (VR)

a) Locations and time of events
b) Field strength of normal signal(s)
c) Field strength of jamming signals at the selected jammer-victim distances (J1, J2, - - -).
d) Tabular data, chart/tape recordings and photographs of normal VR output signals and displays.
e) Tabular data, chart/tape recordings and photographs of VR output signals and displays as the VR is subjected to the various jamming modes and levels.

6.3.2.2.3 ECM System Test

a. Record the following items in appropriate form for each condition of victim transmitter - victim receiver/sensor - test item jammer operation:

1) Victim transmitter(s)

a) Locations and periods of operation
b) Frequencies
c) Power outputs
d) Modulating signal forms
e) Antenna orientations (azimuth and elevation/tilt)
f) Antenna receiver/sensor (VR)

2) Victim receiver/sensor (VR)

a) Locations and time of events
b) Field strength of normal signals
c) Field strength of jamming signals at the selected jammer-victim distances (J1, J2, - - - _.

d) Tabular data, chart/tape recordings and photographs of normal VR output signals and display.
e) Tabular data, chart/tape recordings and photographs of VR output signals and displays as the VR is subjected to the various jamming modes and levels.

3) Test item (jammer)

a) Locations and operational periods
b) Jamming frequencies
c) Power outputs
d) Modulation types
e) Modulation signal characteristics
f) Look-through interval data
g) Antenna position data
h) Antenna polarization

6.4 DATA REDUCTION AND PRESENTATION

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

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

6.4.1 Parameter Tests

6.4.1.1 Electromagnetic Characteristics

a. Electromagnetic characteristics test data shall be reduced and presented as prescribed in MIL-STD-449(-), MTP 6-2-135 or MTP 6-2-165, as applicable.

b. Directional antenna test data shall be presented in the form of graphs (polar or cartesian) of the antenna patterns with the indicator readings superimposed.

6.4.1.2 Special Features Tests

a. Special features test data shall be presented in a manner dictated by the exact nature of the data, function, and the test item design.

6.4.1.3 Primary Power Tests

a. Primary power test data shall be reduced and presented as prescribed in MTP 6-2-514.

6.4.2 Field Tests

Presentation of field test results shall consist of a composite documentation of the reduced and correlated data arranged by test phases in the general form of narrative description and discussion; photographs and diagrams of test setups and flight patterns; and graphed, tabulated and photographic data.

Major points, appropriate to the test item, to be made clearly evident are:

a. Accuracy and speed of data acquisition in the intercept/DF process.

b. Accuracy and reaction time of interfacing processes between intercept and jamming actions.

c. Jamming effectiveness with respect to different jamming modes and levels, and different types of victim systems.

A written report shall accompany all test data and shall consist of conclusions and recommendations drawn from test results. The test engineer's opinion, concerning the success or failure of any of the functions evaluated shall also be included. In addition, equipment specifications that will serve as the model for a comparison of the actual test results should be included.

Equipment evaluation usually will be limited to comparing the actual test results to the equipment specifications and the requirements as imposed by the intended usage. The results may also be compared to data gathered from previous tests of similar equipment performed under similar conditions.

APPENDIX A

COUNTERMEASURES EQUIPMENT, NON-COMMUNICATION SYSTEM

1. GENERAL

Engineering tests of prototype electronic countermeasures equipment are usually performed to verify the adequacy of design and materials selection, and to establish performance characteristics such as reliability and accuracy. The classifying of electronic countermeasures equipment as to function, the establishment of universal test procedures, and the acquiring of accurate data from such tests greatly aids in evaluating the performance of countermeasures equipment from the standpoint of design considerations.

The following paragraphs describe categories of non-communication electronic countermeasures equipments and the tests required to evaluate the performance of such items.

2. CLASSIFICATION OF NON-COMMUNICATION ELECTRONIC COUNTERMEASURES SYSTEMS

Electronic countermeasures (ECM) exist in many forms broadly categorized as (1) electronic systems whose basic function is to radiate electromagnetic energy in diverse forms to disable, confuse, or deceive victim systems and (2) material or devices having electromagnetic reflection, absorption, or intrinsic radiation properties deployed in ways to either mask real targets or create false targets. The ECM systems mentioned in (1) above, generally incorporate the primary capabilities of:

a. Victim signal detection and identification (intercept).
b. Victim location (direction finding)
c. Selection of the most effective jamming mode.
d. Transmission of the jamming signals

The jamming signal characteristics and manipulation may be designed for complex deception or confusion tactics in operation against specific types of victim system or may be of a multi-purpose nature; the latter usually designed to obscure the normal reception or sensing capability of several victim types.

2.1 NON-COMMUNICATION VICTIM SYSTEMS

Non-communication victim systems include both ground-based and airborne types categorized, for the purpose of this document, by the victim transmitter-receiver positional relationship as follows:

a. Conjugate transmitter and receiver as in a monostatic radar set, characterized by reception and analysis of echoes of its own emission. Examples are:

1) Search/detection type: air and ground combat surveillance radars
2) Tracking type: gun direction, missile tracking, mortar/gun locator, drone tracking radars
3) Ground mapping: side looking airborne radar (SLAR)
4) Navigation: airborne doppler navigation radar, terrain avoidance radar, radar altimeter.

b. Widely separated (non-conjugate) transmitter and receiver as in a drone control system, characterized by one-way transmission. Another example is a tactical position-fixing and navigation system comprised of several transmitters in a ground complex and receivers in aircraft and ground vehicles.

c. Receiver, receptor, or sensor only, e.g. an infrared detection system, airborne or ground-based.

General categories of these systems are illustrated in Figures A1 through A5. Since the victim receiver or sensor is the real target for jamming and the victim transmitter provides the potential means of locating and identifying the victim, the separation inherent in b. above and lack of emission in c. above become factors in accomplishment of the intercept/DF function and correlation with the jamming function.

3. DESCRIPTION OF TESTS

In order to realize maximum ECM system effectivity and at the same time avoid undue interference to the friendly electromagnetic environment, full knowledge of the system's performance characteristics is essential. This knowledge must be acquired by means of comprehensive engineering test processes. The procedures contained within this document are designed to aid in obtaining such knowledge from the following types of ECM systems:

a. Special-and multi-purpose electronic countermeasures (ECM) systems (the test items).

b. ECM systems having intercept/direction finding (I/DF) and active jamming capabilities, separate or integrated

c. Airborne and ground-based test items.

d. Test item and victim systems operating in state-of-the-art portions of the electromagnetic spectrum.

e. Airborne and ground-based victim systems.

f. Victim systems broadly classed as radar-type and one-way transmission or reception type.

Test item features, functions, or characteristics requiring application of security measures are excluded from consideration by this document, as are ECM systems/equipments designed for operation against communication systems only, variable-time (proximity) fuze ECM systems, countermeasures material and false target devices, and electronic counter-countermeasures.

The procedures are divided into two parts, parameter tests and field tests, both of which are described below.

3.1 PARAMETER TESTS

Parameter tests are performed in order to obtain basic engineering data on the technical characteristics of the test item. Such characteristics are measured under controlled quasi-laboratory conditions.

3.1.1 Electromagnetic Characteristics and Directional Antenna Tests

Electromagnetic characteristics of the test item are determined by means of continuous subtests, appropriate to the test item design, conducted in accordance with standard procedures. The principal parameters to be measured includes:

a. Antenna field patterns, transmitting and receiving
b. Receiver-

1) Frequency range
2) Sensitivity
3) Selectivity
4) Standard response
5) Dynamic range

c. Transmitter-

1) Frequency
2) Power output
3) Modulation
4) Emission spectrum

The accuracy and repeatability of directional characteristics of direction finding antennas and directional jamming antennas shall be measured by correlation of the antenna positioning subsystem operation with the antenna pattern measurements during the above tests. Azimuth and elevation (or tilt) indicator readings are measured at the pattern measurement points, describing the main lobe. Polarization control equipment is tested in a similar manner.

3.1.2 Special Features Tests

Due to inherent security restrictions and the wide variety of possible special functions and equipments incorporated in various ECM system designs, specification of definitive subtests necessary to measure the technical characteristics of the special subsystems is beyond the scope of this document. These subtests shall be developed for each test item type at the time of test plan preparation based on the specifications and requirements set forth in the instruction manuals, the QMR/SDR and equivalent sources.

Examples of special functions/equipments in the above category are:

a. Victim signal analysis and processing
b. "Look-through" feature
c. Jamming mode/parameter generation and control
d. Indicator, display and presentation equipments

3.1.3 Primary Power Tests

Measurements of the electrical power requirements of the test item shall be performed in accordance with standard procedures, appropriate to test item design.

3.2 FIELD TESTS

The design of field tests for a specific test item is governed by:

a. Test item operational features and concept of employment
b. Victim system(s) technical and operational characteristics and the modes of employment.

Field test measurements are described in terms of the test item major functions, i.e. intercept/DF and jamming, and are performed individually or concurrently as indicated by the ECM-victim oppositions applicable to a given test item. Basic deployment combinations are illustrated in Figure A6.

Test item and victim equipments shall be sited/flown at representative minimum-to-maximum tactical inter-system ranges. For practical considerations, reduced distances may be employed and transmitter power outputs reduced by calculated corresponding amounts, considering angles, distances and system linearities.

1) Surveyed location of ground sites shall be indicated on topographical maps of the test areas.
2) Aircraft flight paths for airborne equipments shall be prescribed on map overlays or scaled diagrams showing the following minimum information:

    a) Length and direction of data runs
    b) Altitudes
    c) Data points
    d) Ground equipment sites and reference points

Test activities (ground-ground and air-ground) shall be coordinated by means of suitable voice radio nets and correlated by a common timing system.

Space position plots of airborne items shall be provided by ground-based (test range) tracking or optical system correlated with range timing.

3.2.1 Intercept and Direction Finding

One or more victim transmitters (VT) are deployed at various distances (slant range) and orientations with respect to the test item and operated, as appropriate, at-

a. Various frequencies
b. Minimum-to-normal power outputs

c. Typical modulations
d. Different antenna orientations and polarization, if variable.

Under the above VT conditions, the test item intercept/DF (I/DF) subsystem and associated test instrumentation is operated to:

a. Detect and measure each VT carrier frequency
b. Measure the signal strength of each received carrier
c. Analyze each VT signal to the extent necessary to identify the victim system; record signal presentations by appropriate means, e.g. tape or chart recorder, photographically.
d. Measure and record the bearing (I/DF antenna azimuth and elevation/tilt) of each received signal from maximum signal strength to the half-power points.

Airborne test items or victim systems are measured during the data runs described in paragraph 3.2.

3.2.2 Jamming

One or more victim receivers or sensors (VR) are deployed at various distances (slant range) and orientations with respect to the test item jammer (J). Each VR shall be instrumented to-

a. Measure the relative strengths of normal desired signals and jamming signals and
b. Measure and record the VR output characteristics to determine the degree of degradation caused by various modes and levels of jamming, i.e. jamming effectiveness.

Under each condition of test item-victim distance and orientation, the jammer shall be operated in each design mode with respect to:

a. Carrier frequency manipulation, e.g. narrowband, broadband, or swept-band.
b. Variable power output
c. Modulation type, e.g. CW, AM, FM, or combinations
d. Modulating signal forms, e.g. noise, special audio, pulse forms, or unique deception signals dictated by analysis of intercepted victim signals.
e. Look-through operation
f. Antenna position control and limits; manual, gyro-stabilized, and/or slaved operation
g. Antenna polarization

This test should be repeated using a VT as a trigger for the ECM system. The ECM action will vary with the transmitter used, as would be the case with a transceiver.

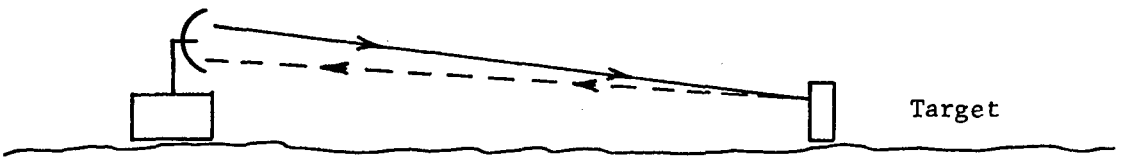


Figure A-1. Victim Type: Surface-to-surface radar-(detection/surveillance).

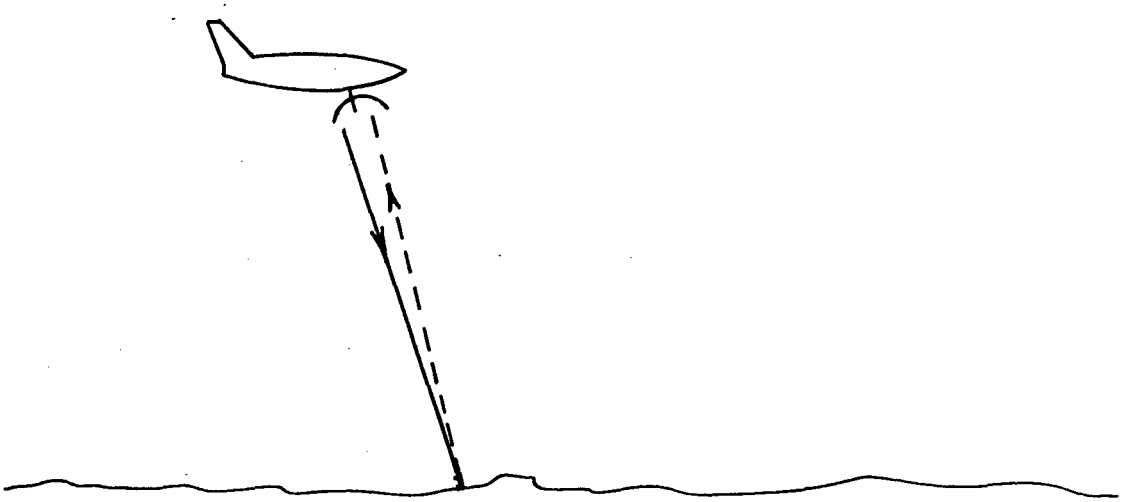
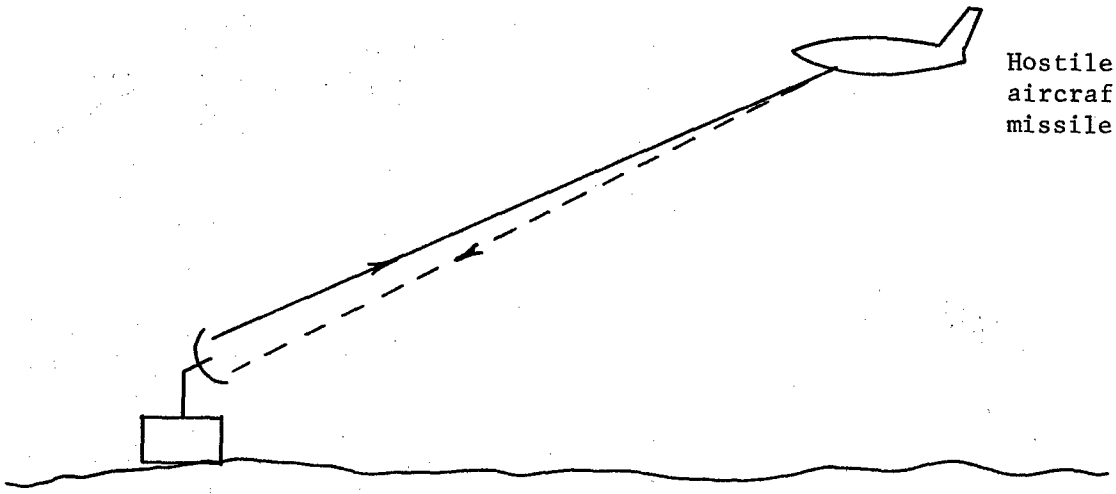
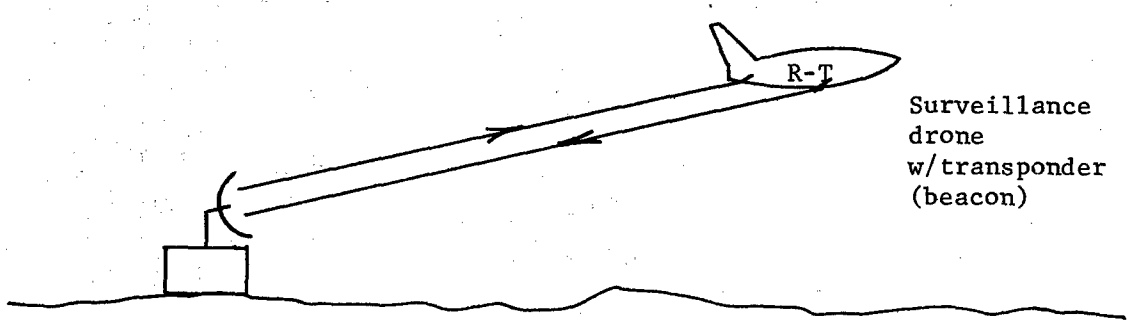


Figure A-2. Victim Type: Air-to-surface radar-(surveillance/navigation).

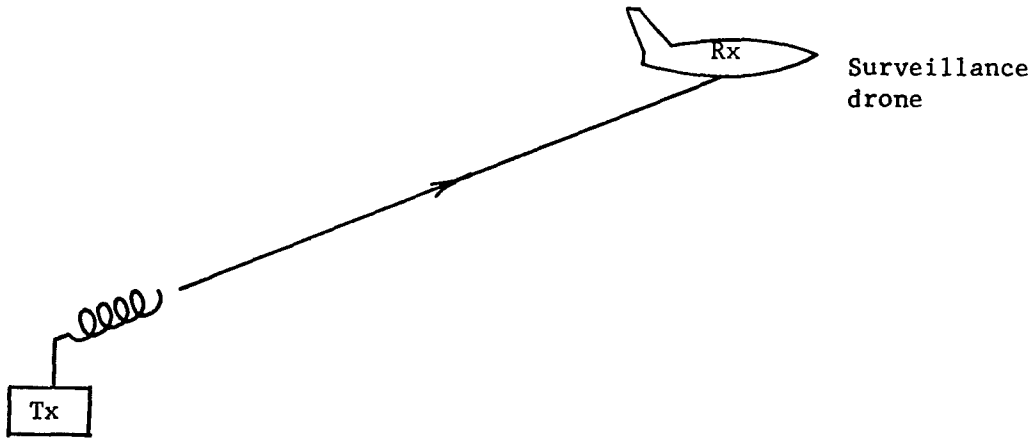


a. Detection or tracking radar

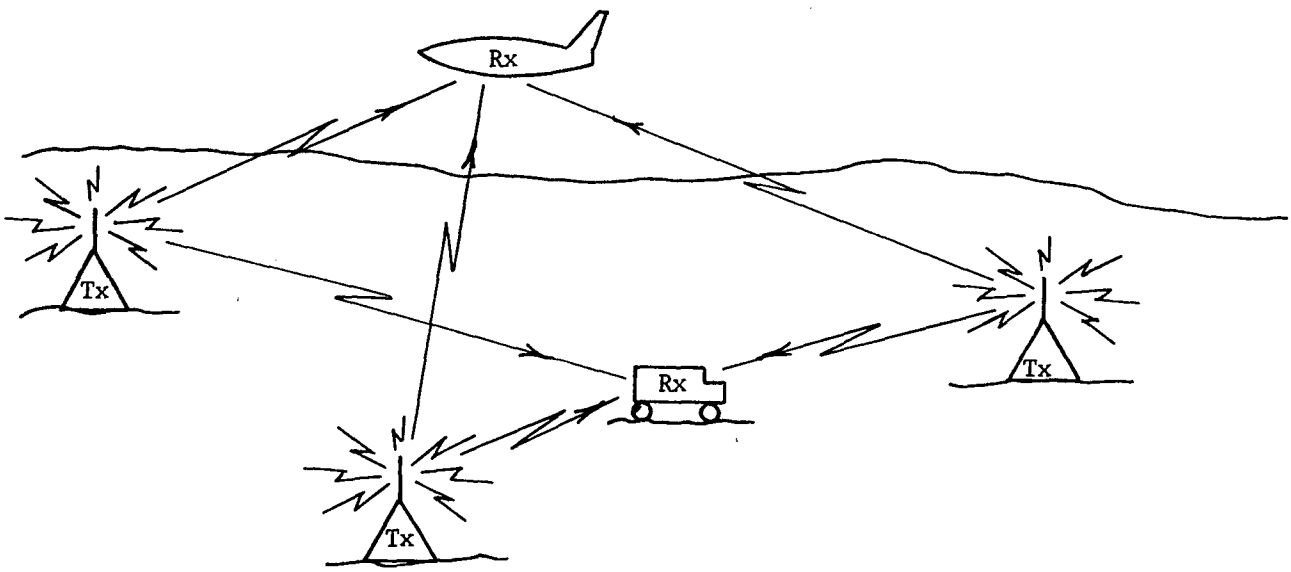


b. Drone tracking radar-(part of drone control system)

Figure A-3. Victim Type: Surface-to-air Radars



a. Remote control system-(drone flight control)



b. Tactical position-fixing & navigation system-(air & ground vehicles)

Figure A-4. Victim type: Non-conjugate transmitter-receiver systems.

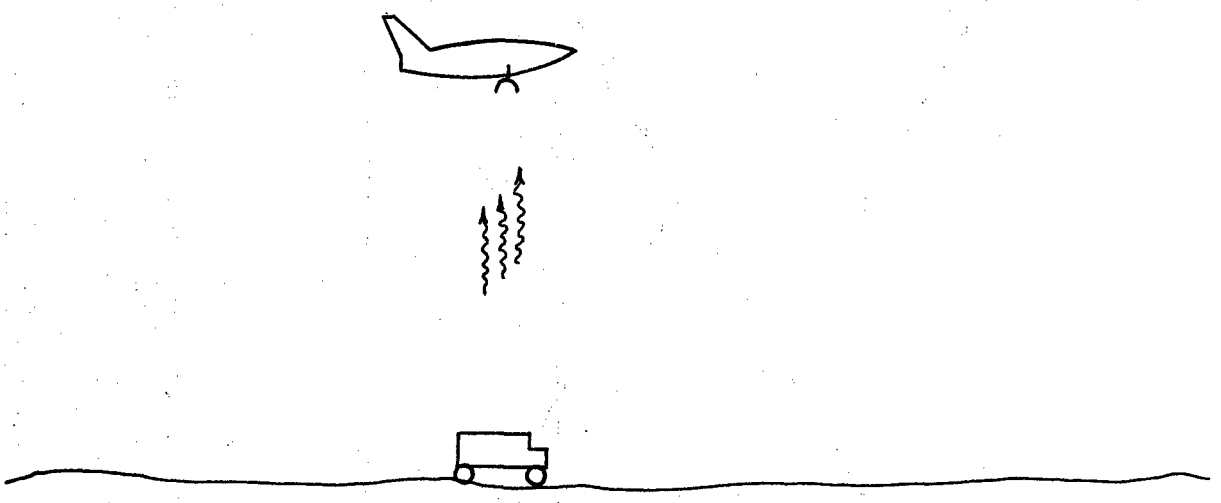
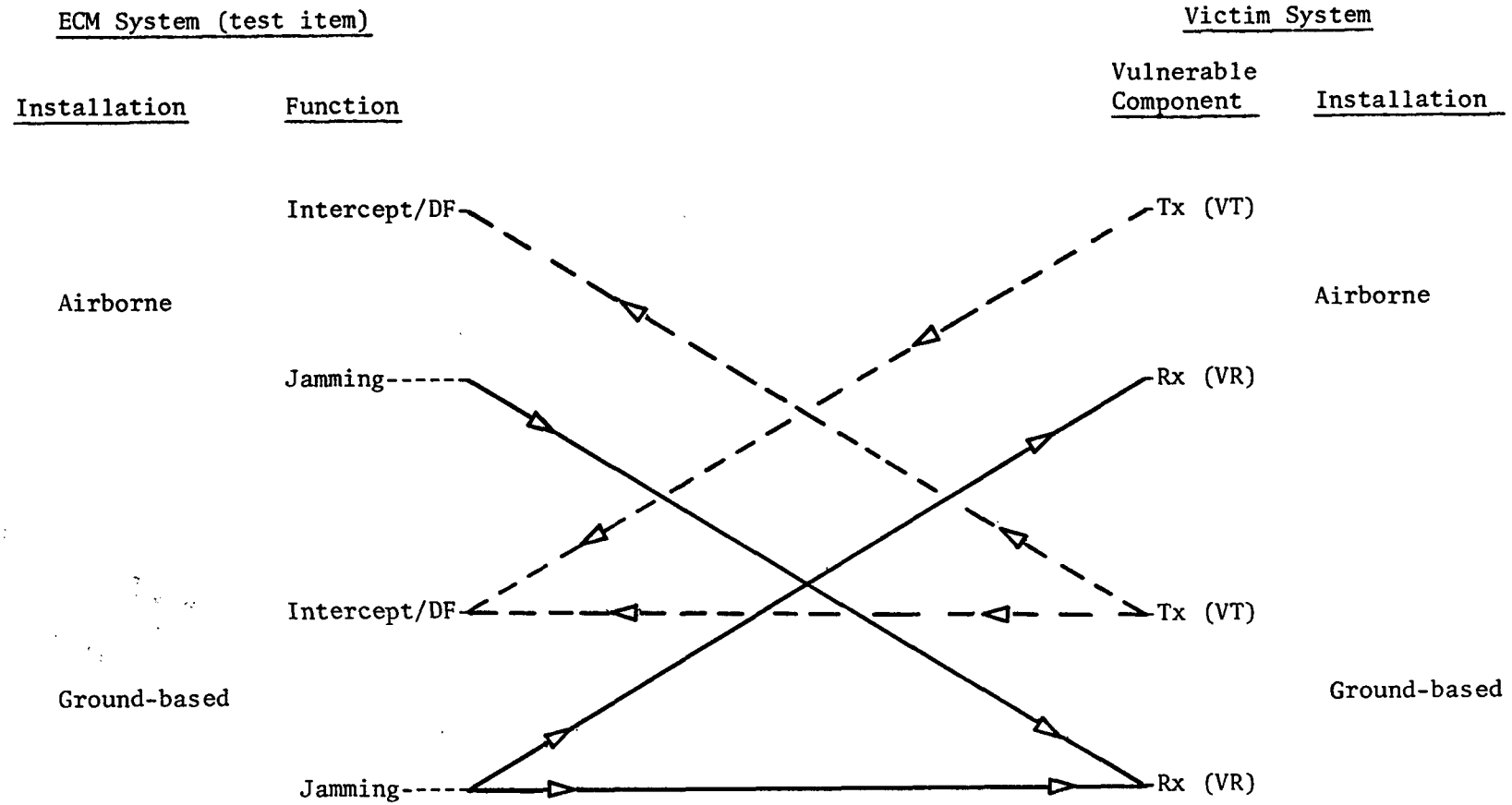


Figure A-5. Victim Type: Receptor/sensor-(airborne infrared surveillance system)



Notes: 1. Tx = transmitter; Rx = receiver or sensor.

2. Transmit and receive components of test item or victim system are not necessarily conjugate, e.g. intercept/DF may be ground-based, operating with an airborne jammer.

Figure A-6. Possible ECM-Victim Oppositions.