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Materiel Test Procedure 6-2-090
Electronic Proving Ground

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

FLIGHT LINE ANALYZERS

1. OBJECTIVE

The objective of the procedures outlined in this MTP is to provide a means of evaluating the technical performance and technical characteristics of flight line analyzers relative to criteria specified in Qualitative Materiel Requirements (QMR), Small Development Requirements (SDR), Technical Characteristics, (TC), or other applicable documents, and determining their suitability for an intended use.

2. BACKGROUND

The primary purpose of flight line analyzers is for use in testing of aircraft electronic automatic flight control and many other systems. The flight line analyzer, which may be either built-into the flight control system or portable test equipment brought to the aircraft for performing the tests: (1) Supplies signal voltages to the aircraft system under test; (2) Indicates the operability of various system equipments on meters or indicator lamps; and (3) Assists in trouble-shooting various systems that are not operating properly. Indicators are usually of the go or no-go type to simplify operator interpretation of system checkout.

As aircraft electronics grow in amount and complexity, a similar growth must occur in the equipment needed to check it out. Therefore, it is necessary that appropriate engineering tests be performed to ensure that new flight line analyzers meet the engineering requirements of military systems.

3. REQUIRED EQUIPMENT

a. DC Power Supply
b. AC Power Supply
c. Impedance Meter
d. Voltmeter (VTVM)
e. Ohmmeter
f. Frequency Meter
g. Oscilloscope
h. Precision Potentiometer
i. Test Set or Test Fixture (conceptually related to the equipment component, or system intended to be operated on by the test item)

4. REFERENCES

A. USATECOM Project Report 4-3-4200-02, Military Potential Test Flight Line Analyzers, September 1963.
B. TM 11-6625-518-1 and TM 11-6625-518-45, Flight Line Analyzers AN/ASM-80

C. MIL-STD-461, Electromagnetic Interference Characteristics Requirements for Equipment
D. MIL-STD-462, Electromagnetic Interference Characteristics, Measurement of
E. MIL-STD-463, Definitions and System of Units, Electromagnetic Interference Technology
F. MIL-STD-810B, Environmental Test Methods
G. MTP 3-1-002, Confidence Intervals and Sample Size
H. MTP 6-2-507, Safety
I. MTP 6-2-210, Power Supply, Electrical

5. SCOPE

5.1 SUMMARY

5.1.1 Technical Characteristics

The procedures outlined in this MTP provide general guidance for determining and evaluating the technical performance and technical characteristics of flight line analyzers. The cumulative test results together with the results of the appropriate Common Engineering Tests will allow an estimate of the test item's capabilities and the suitability of the equipment to meet the required military needs.

The specific tests to be performed, along with their intended objectives, are listed below:

a. Radio Frequency Interference - The objective of this subtest is to determine the objectionable radiation or emission caused by operation of the test item, and the interference to the test item caused by electromagnetic radiation from other equipment in the system operating environment.

b. Adequacy of Power Source - The objective of this subtest is to determine if the power source is adequate for normal operation of the test item.

c. Input and Output Impedance - The objective of this subtest is to determine the input and output impedance of the test item.

d. Sensor Circuitry Sensitivity and Accuracy - The objective of this subtest is to determine the sensitivity and accuracy of the test item's sensor circuitry relative to specific criteria.

e. Indicator Characteristics - The objective of this subtest is to determine if the test item's indicating system operates in accordance with applicable criteria.

f. Fault Isolation Ability - The objective of this subtest is to determine the ability of the test item to isolate the fault to the assembly, subassembly, or component level.

g. Allowable Tolerance - The objective of this subtest is to determine the degree of accuracy and discrimination of the test item to preclude the rejection of units under test which are in fact within specifications, or acceptance of units under test which are not in fact within specifications.

h. Self Test Characteristics - The objective of this subtest is

to determine if the operating characteristics meet applicable criteria when the test item is used in a system test.

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 flight line analyzers 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 flight line analyzers and may be adapted, as necessary, to accommodate specific equipment. It is left as a task for the test engineer to 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 one order of magnitude greater than that afforded by the item under test, 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 of calibration 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 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 appropriate security measures are instituted to safeguard classified materiel and data, as applicable.

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 Radio Frequency Interference Test

Subject the item under test to radio frequency measurements in accordance with the procedures given in MIL-STD-461, 462, and 463.

6.2.2 Adequacy of Power Supply Test

Subject the power supply of the item under test to the power supply procedures given in MTP 6-2-210.

6.2.3 Input and Output Impedance Test

a. Connect a vector impedance meter (or other impedance measuring instrumentation) across the output of the flight line analyzer under test.

b. Energize all equipment and adjust the test item to produce an output.

c. Utilizing the impedance meter, measure and record the following:

1) Frequency of output (if applicable)
2) Magnitude of (Z) in ohms
3) Phase angle (θ)
4) Whether the reactance is inductive or capacitive

d. Repeat steps (b) and (c) above, for each output of the flight line analyzer.

e. Determine and record the input impedance of the test item as outlined above.

6.2.4 Sensor Circuitry Sensitivity and Accuracy Test

a. Connect a precision potentiometer in series with the sensor circuitry of the item under test.

b. Energize the flight line analyzer and apply a predetermined voltage to the sensor circuitry.

c. Record type, impedance, and tolerance of potentiometer and applied voltage.

d. Adjust the resistance value until the sensor circuit produces an output. Record the resistance value.

e. Disconnect the precision potentiometer and, depending upon the item under test, connect measurement instrumentation as required to monitor the output of the test item.

f. Energize all equipment and adjust the test item to produce an output.

g. Record the test item control setting (indicated output) and the actual measured output in tabular form.

h. Repeat steps (f) and (g) above, for each test item control setting and for conditions of increasing and decreasing control settings, as applicable.

6.2.5 Indicator Characteristics Test

a. Connect a precision potentiometer in series with the indicator system circuitry of the flight line analyzer under test.

b. Energize the test item and apply a predetermined voltage to the indicator system circuitry.

c. Record type, impedance, and tolerance of potentiometer, and applied voltage.

d. Adjust the potentiometer resistance value until the indicator circuit produces an output. Record the resistance value.

6.2.6 Fault Isolation Ability Test

a. Connect the flight line analyzer under test to a suitable test set or test fixture.

NOTE: Test sets or fixtures may be procured with the test items, or may be developed at a later date as required to validate the operational and performance characteristics of the test items.

b. Establish known out-of-tolerance conditions within the aircraft components, starting with a condition above the upper tolerance limit (when given). Validate the settings with laboratory calibrated meters.

c. Energize all equipment and monitor the flight-line analyzer indications and control settings as it operates on the out-of-tolerance condition.

d. Gradually decrease the out-of-tolerance condition of the parameter, as indicated by monitored test results, until the flight line analyzer indicator signifies a go condition.

e. Repeat steps (b), (c) and (d) above, with an out-of-tolerance condition established below the lower tolerance limit.

f. Record the upper and lower tolerance limits as measured by the flight line analyzer.

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

6.2.8 Self Test Characteristics Test

a. Conduct the first phase of the self test when the test item has been inactive for at least eight hours.

b. Energize the test item, allow for warm-up if required, and switch to the self-test mode.

c. Repeat this test as a check of the test item each day before starting general tests.

d. Repeat the test several times daily after the item has been in use.

e. Record the test item indications for each self test. Analyze any trouble indications.

6.2.9 System Test

a. Connect the flight line analyzer under test to the actual equipment, component, or system intended to be operated on by the actual test item.

b. Energize all equipment utilizing normal power sources, allow sufficient time for warm-up, and calibrate all equipment as a unit. Record all values or no-go conditions.

c. Correct indicated faults, if any, and continue the test until a satisfactory check is made for the entire aircraft assembly, which can be checked by the test item.

d. Operate the aircraft system to determine whether tested components actually function satisfactorily. Record and analyze all indications of actual malfunctions.

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 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 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 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 error stated accuracy.

6.3.2.1 Radio Frequency Interference Test

Record data in accordance with MIL-STD-461, 462 and 463.

6.3.2.2 Input and Output Impedance Test

a. Record frequency input and output (where applicable), in Hz.

b. Record magnitude of input and output impedance (Z), in ohms.

c. Record phase angles (θ), in degrees

d. Record whether reactances are inductive or capacitive.

6.3.2.4 Sensor Circuitry Sensitivity and Accuracy Test

a. Record type, impedance, and tolerance of potentiometer used in series with the sensor circuitry.

b. Record applied voltage.

c. Record resistance value which produces sensor circuits output with the applied voltage.

d. Record the indicated and actual output in tabular form, for various settings of the test item's output control circuits.

6.3.2.5 Indicator Characteristics Test

a. Record type, impedance, and tolerance of potentiometer used in series with the indicator circuitry.

b. Record applied voltage
c. Record resistance value which produces indicator circuits output with the applied voltage.

6.3.2.6 Fault Isolation Ability Test

Record data regarding fault isolation characteristics in a suitable form for comparison with applicable criteria.

6.3.2.7 Allowable Tolerance Test

a. Record nominal, and upper and lower tolerance limits values as specified in applicable criteria.
b. Record the types of faults inserted and amount inside or outside tolerance limits.
c. Record go or no-go tolerance limits as measured by the test item.

6.3.2.8 Self Test Characteristics

a. Record warm-up time, if required.
b. Record the test item indications for each self test.

6.3.2.9 System Test

a. Record all values or no-go conditions.
b. Record all indications or actual malfunctions.

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 Radio Frequency Interference Test

Radio frequency interference measurement data shall be reduced and presented in accordance with the procedures given in MIL-STD-461, 462, and 463.

6.4.2 Adequacy of Power Supply Test

Power supply measurement data shall be reduced and presented in accordance with the procedures given in MTP 6-2-210.

6.4.3 Input and Output Impedance Test

Input and output impedance test data shall be presented in tabular forms consisting of test item input and output impedance magnitudes (Z) and phase angles (θ), as a function of frequency where applicable, and also whether the reactances are inductive or capacitive.

6.4.4 Sensor Circuitry Sensitivity and Accuracy Test

a. Sensor circuitry test data shall be reduced as necessary to the units required by test criteria and sensor sensitivity determined, recalling that:

$$\text{Sensitivity in ohms per volt} = \frac{1}{\text{Current Sensitivity}}$$

b. Indicated and actual output test data shall be presented in the tabular form as specified in paragraph 6.2.4. Uncertainties of measurement must be assessed in terms of statistical probabilities. Multiple measurement readings made to determine the repeatability of instrument settings or indications shall be subject to statistical reduction to determine the standard deviation of a single reading and the mean. Where data indicates a normal probability curve, probable error of a single test or measurement would be of interest.

c. Only accidental errors should be considered in the reduction, it being assumed that systematic errors have been identified and appropriate corrections made for their presence.

d. It should be noted that the measurement procedure tacitly assumes that the measurand remains constant over a reasonable period of time so that the movement of the pointer, or other indicator which occurred when the measurement system was first put in operation, has ceased.

6.4.5 Indicator Characteristics Test

The test item's indicator system sensitivity test data shall be reduced and presented as outlined in paragraph 6.4.4 a., above.

6.4.6 Fault Isolation Ability Test

Fault isolation ability test data shall be presented in both tabular and graphical form. The graphical presentation shall emphasize systematic errors or deviations from linearity.

Data reduction techniques shall be appropriate to the manner and form in which the data were collected. Statistical inferences shall be made regarding measures of central tendency and dispersion of accuracy or error data. Where data indicated a normal probability curve, probable error in a single reading shall be computed. Where data is not representative of normal probability, standard deviation is more often quoted as a measure of dispersion.

6.4.7 Allowable Tolerance Test

Allowable tolerance test data shall be presented in a form suitable for comparison with applicable criteria. The degree of accuracy and discrimination of the test item to accept or reject units which are within or not within tolerance limits shall be determined by comparison with applicable specifications.

6.4.8 Self Test Characteristics

Self test characteristics data shall be reduced to and presented in the form best suited to determine the degree of assurance that the operation of the test item is within tolerances before actual tests or monitoring operations are performed.

6.4.9 System Test

System test data shall be reduced to and presented in the form best suited for analysis of the test item's accuracy, resolution, and repeatability. Statistical reduction of data shall be performed as dictated by the test data and test criteria.

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.