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**Minimum Operational Performance Standards for Optional Equipment
which Displays Non-Radar Derived Data on Weather and Ground Mapping
Radar Indicators**

RTCA DO-174
March 20, 1981

Prepared by:
SC-133

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F O R E W O R D

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1.0 PURPOSE AND SCOPE

1.1 Introduction

This document sets forth minimum operational performance standards for optional equipment which displays non-radar derived data on weather and ground mapping radar indicators. Incorporated within these standards are system characteristics that should be of value to users, designers, manufacturers and installers. These characteristics are intended to accord with requirements of various users. The optional equipment as defined in this standard can provide graphic and/or alphanumeric data. This equipment is not intended to be a flight instrument, but rather a supplement to aid the flight crew in correlation of numerous data sources.

Section 1.0 of this document is intended to provide information needed to understand the rationale for equipment characteristics and requirements stated in the remaining sections. It describes typical equipment applications and operational goals, as envisioned by the members of Special Committee 133, and is the basis for the standards stated in Sections 2.0 through 4.0. Definitions essential to proper understanding of this document are also provided in Section 1.0.

Section 2.0 contains the minimum performance standards for the equipment. These standards define the required performance under standard operating conditions and stressed physical environmental conditions. It also details the recommended bench test procedures necessary to demonstrate compliance.

Section 3.0 describes the performance required of the installed equipment. Tests for the installed equipment are included when performance cannot be adequately determined through bench testing.

Section 4.0 describes the operational characteristics for equipment installations and defines conditions that will assure the operator that operations can be conducted safely and reliably in the expected operational environment.

Compliance with these standards by manufacturers, installers and users is recommended as one means of assuring that the equipment will satisfactorily perform its intended function(s) under all conditions normally encountered in routine operations.

It is recognized that any regulatory application of this document in whole, or in part, is the sole responsibility of appropriate governmental agencies.

Since the measured values of equipment performance characteristics may be a function of the method of measurement, standard test conditions and methods of test are recommended in this document.

The word "equipment" as used herein includes all components or units necessary (as determined by the manufacturer or installer) for the equipment to properly perform its function.

In the establishment of the optional equipment standards, the inclusion of color was not considered to be a minimum requirement for the radar display element on which the non-radar derived data is being displayed. However, it was recognized that the state of the art of both technology and product development is such that many radar displays may, either now or in the future, include color capability. In this regard, for those equipments that do provide color displays, it was considered critical in RTCA/DO-173, "Minimum Operational Performance Standards for Airborne Weather and Ground Mapping Pulsed Radars," that the color characteristics of the radar-derived data be precisely defined with attendant minimum performance requirements and test procedures for verification of performance. Appendix A to DO-173 covers this situation. Additional colors may be used to display non-radar derived, nonflight-critical information. The selection and specification of colors used for this purpose do not require minimum performance standards. Care should be taken, however, to ensure that when nonradar derived data is displayed concurrently with radar-derived data, either the choice of display colors or the juxtaposition of display elements does not result in any degradation in display interpretation or discrimination between each type of data.

1.2 Operational Considerations

Typical applications include but are not limited to:

- a. The use of such equipment to display navigation-related information.
- b. The storage of frequently used information in a manner which allows rapid retrieval, thus reducing flight crew workload.

The equipment must be of sufficient content and accuracy so as to display useful information on the weather radar indicator. When displayed with radar-derived data, the auxiliary information shall not degrade displayed radar information.

1.3 Test Procedures

The test procedures and associated limits specified throughout this document are intended to be used as one means of demonstrating compliance with the minimum acceptable performance parameters. Although specific test procedures are cited, it is recognized that other methods may be preferred by the test activity.

These alternate procedures may be used if they provide at least equivalent information. In such cases, the procedures cited herein should be used as one criterion in evaluating the acceptability of the alternate procedures.

The order of tests suggests that the equipment be subjected to a succession of different tests as it moves from design, and design qualification, into operational use. For example, compliance with the requirements of Section 2.0 should have been demonstrated as a precondition to satisfactory completion of the installed system tests of Section 3.0.

Four types of test procedures are included which should be used at different stages in the equipment life cycle. These are discussed in the following paragraphs.

1.3.1 Environmental Tests

Environmental tests are specified in Subsection 2.3. The procedures and their associated limit requirements are intended to provide a laboratory means of determining the electrical and mechanical performance of the equipment under environmental conditions expected to be encountered in actual operations. Test results may be used by equipment manufacturers as design guidance, in preparation of installation instructions and, in certain cases, for obtaining formal approval of equipment design and manufacture.

1.3.2 Bench Tests

Bench test procedures are specified in Subsection 2.4. These tests are conducted at the equipment level and are intended to provide a laboratory means of demonstrating compliance with the requirements of Subsections 2.1 and 2.2. Test results may be used by equipment manufacturers as design guidance for monitoring manufacturing compliance and, in certain cases, for obtaining formal approval of equipment design and manufacture.

1.3.3 Installed System Tests

The installed system test procedures and their associated limit requirements are specified in Section 3.0. Although bench and environmental test procedures are not included in the installed system tests, their successful completion is a precondition to completion of the installed tests. In certain instances, however, installed system tests may be used in lieu of bench test simulation of such factors as power supply characteristics, interference from or to other equipment installed on the aircraft, etc. Installed tests are normally performed under two conditions:

- a. With the aircraft on the ground and using simulated or operational system inputs.
- b. With the aircraft in flight using operational system signals appropriate to the equipment under test.

Test results may be used to demonstrate functional performance in the environment in which the equipment is intended to operate.

In addition, the ground test procedures may be used as an optional check of equipment performance following corrective maintenance.

1.3.4 Operational Tests

The operational tests are specified in Section 4.0. These test procedures and their associated limits are intended to be conducted by operating personnel as one means of ensuring that the equipment is functioning properly and can be reliably used for its intended function.

1.4 Definitions

Radar referenced data - Data that uses the radar indicator's range and azimuth marks as its reference grids. Navigation waypoints being displayed on the radar indicator is an example of radar referenced data.

Non-radar referenced data - Data that uses anything other than the radar indicator's range and azimuth marks as its reference grids. Alphanumeric data or pointers on a reference scale are two examples of non-radar referenced data.

2.0 OPTIONAL EQUIPMENT REQUIREMENTS

2.1 General Requirements

The airborne equipment shall meet the following general requirements.

2.1.1 Airworthiness

The design and manufacture of the airborne equipment must provide for installation so as not to impair the airworthiness of the aircraft.

2.1.2 Intended Function

The equipment must perform its intended function, as defined by the manufacturer, and its proper use must not create a hazard to other users of the National Aviation System.

2.1.3 Federal Communications Commission Rules

The equipment must comply with all applicable rules of the Federal Communications Commission.

2.1.4 Operation of Controls 1/

The design of the equipment shall be such that the controls intended for use during flight cannot be operated in any possible position, combination or sequence which would result in a condition that would be detrimental to the reliability of the equipment or operation of the aircraft.

2.1.5 Accessibility of Controls

Controls which are not normally adjusted in flight shall not be readily available to flight personnel.

2.1.6 Effects of Test

The design of the equipment shall be such that the application of the specified test procedures shall not be detrimental to the equipment's performance following the application of these tests, except as specifically allowed.

1/ Caution to system designers: Care should be taken in the design to ensure that normal operation of the controls, including pilot inputs, shall not produce an unacceptable or abnormal level of pilot workload.

2.1.7 Fire Protection

Except for small parts (such as knobs, fasteners, seals, grommets and small electrical parts) that would not contribute significantly to the propagation of fire, all materials used must be self-extinguishing.

NOTE: A possible means of showing compliance is contained in Federal Aviation Administration Regulations, Part 25, Appendix F.

2.2 Equipment Performance - Standard Conditions

2.2.1 Mode Selection

Means shall be provided for selection of data and each available mode of operation for the optional equipment.

NOTE: Sub-mode controls such as page or line advance shall be classified as being grouped within the mode control for selection of page mode.

2.2.2 Simultaneous Data Display (when provided)

Under conditions of simultaneous display of radar and auxiliary data, the readability and interpretation of radar information shall not be degraded.

2.2.3 Cycle to Cycle Symbol Stability (Jitter)

Symbol jitter caused by the equipment (excluding quantizing errors) shall not exceed 15% of the symbol or character size.

2.2.4 Update Rate

For aircraft attitude related data, (example: Pitch, roll, heading, etc.) the equipment must provide new data for display at least two times per second. For positional data, (example: Range and bearing to a navigational point, latitude and longitude of a navigation point, etc.) the equipment must provide new data for display at least once every five seconds.

2.2.5 Refresh Rate

The equipment must refresh the display information at a rate no less than that of the radar indicator.

2.2.6 Graphic Display (when provided)

2.2.6.1 Symbol Size

Graphic display symbols, other than lines or line segments, must be at least 0.10" x 0.10" and shall be unambiguous so as to avoid misinterpretation.

2.2.6.2 Symbol Overlap

Overlap of symbols, excluding symbol to line or line to line overlap, should not result in the loss of primary auxiliary data. Primary auxiliary data is data that the equipment designer has defined as having priority over data being displayed.

2.2.6.3 Graphic Symbol Positional Accuracy

a. Radar referenced data

The position of any symbol or line when referenced to the weather radar indicators range and azimuth marks shall be accurate to $\pm 8\%$ of the selected radar range and ± 5 degrees in azimuth.

b. Non-radar referenced data

The position of any symbol or line when referenced to its associated scale or reference point shall be accurate to $\pm 2\%$ of the full scale value.

2.2.7 Alphanumeric Display (when provided)

2.2.7.1 Character Size

Alphanumeric characters shall be at least 0.070" x 0.070".

2.2.7.2 Character Overlap

In no case should the character or its position cause erroneous interpretation of the data.

2.2.7.3 Numerical Value Accuracy

Any numerical readout of data computed within the equipment must be accurate to $\pm 5\%$ for angular data. Any numerical data computed outside the equipment must be displayed accurate to $\pm 2\%$. Readout of any selected frequencies or channels must be exact.

2.3 Equipment Performance - Environmental Conditions

The test procedures described below are intended to provide a laboratory means of determining the overall performance characteristics of the equipment under conditions representative of those which may be encountered in actual aeronautical operations.

Unless otherwise specified, the test procedures applicable to a determination of equipment performance under environmental test conditions are set forth in RTCA Document DO-160A, "Environmental Conditions and Test Procedures for Airborne Equipment," dated January, 1980.

It will be noted that some of the performance requirements in Subsections 2.1 and 2.2 are not enumerated in some tests contained in DO-160A. Judgment and experience have indicated that these particular performance parameters are not susceptible to certain environmental conditions and that the level of performance specified in Subsections 2.1 and 2.2 will not be measurably degraded by exposure to these particular environmental conditions.

2.3.1 Temperature and Altitude Tests

2.3.1.1 Low Temperature Test

When the equipment is subjected to the low temperature test conditions of DO-160A, Subsection 4.4, the following requirements of this standard shall be met, where applicable:

- a. Paragraph 2.2.1 - Mode Selection
- b. Paragraph 2.2.6.3 - Graphic Symbol Positional Accuracy
- c. Paragraph 2.2.7.3 - Numerical Value Accuracy

2.3.1.2 High Temperature Test

When the equipment is subjected to the high temperature test conditions of DO-160A, Subsection 4.5, the following requirements of this standard shall be met, where applicable:

- a. Paragraph 2.2.1 - Mode Selection
- b. Paragraph 2.2.6.3 - Graphic Symbol Positional Accuracy
- c. Paragraph 2.2.7.3 - Numerical Value Accuracy

2.3.1.3 Altitude Tests

When the equipment is subjected to the altitude test conditions of DO-160A, paragraph 4.6.1, the following requirements of this standard shall be met, where applicable:

- a. Paragraph 2.2.6.3 - Graphic Symbol Positional Accuracy
- b. Paragraph 2.2.7.3 - Numerical Value Accuracy

2.3.1.4 Decompression Test (when required)

When the equipment is subjected to the decompression test conditions of DO-160A, paragraph 4.6.2, the following requirements of this standard shall be met, where applicable:

- a. Paragraph 2.2.6.3 - Graphic Symbol Positional Accuracy
- b. Paragraph 2.2.7.3 - Numerical Value Accuracy

2.3.1.5 Overpressure Test (when required)

When the equipment is subjected to the test conditions of DO-160A, paragraph 4.6.3, the following requirements of this standard shall be met, where applicable:

- a. Paragraph 2.2.6.3 - Graphic Symbol Positional Accuracy
- b. Paragraph 2.2.7.3 - Numerical Value Accuracy

2.3.2 Temperature Variation Test

When the equipment is subjected to the temperature variation test conditions of DO-160A, Section 5.0, the following requirements of this standard shall be met, where applicable:

- a. Paragraph 2.2.1 - Mode Selection
- b. Paragraph 2.2.6.3 - Graphic Symbol Positional Accuracy
- c. Paragraph 2.2.7.3 - Numerical Value Accuracy

2.3.3 Humidity Test

After the equipment has been subjected to the test conditions of DO-160A, Section 6.0, the following shall apply.

Within 15 minutes after primary power is applied, the equipment shall operate at a level of performance which indicates that no significant failures of components or circuitry have occurred.

Within four hours after primary power is applied, the following requirements of this standard shall be met, where applicable:

- a. Paragraph 2.2.1 - Mode Selection
- b. Paragraph 2.2.6.3 - Graphic Symbol Positional Accuracy
- c. Paragraph 2.2.7.3 - Numerical Value Accuracy

2.3.4 Shock Tests

The application of these tests may result in damage to the equipment under test. Therefore, these tests may be conducted after the other tests have been completed. Paragraph 2.1.6, "Effects of Test," does not apply.

2.3.4.1 Operational Shocks

Following application of the operational shocks specified by DO-160A, Subsection 7.1, the following requirements of this standard shall be met, where applicable:

- a. Paragraph 2.2.1 - Mode Selection
- b. Paragraph 2.2.6.3 - Graphic Symbol Positional Accuracy
- c. Paragraph 2.2.7.3 - Numerical Value Accuracy

2.3.4.2 Crash Safety Shocks

Following application of the crash safety shocks specified by DO-160A, Subsection 7.2, the equipment under test shall have remained in its mounting, and no parts of the equipment or its mounting shall have become detached and free of the equipment.

2.3.5 Vibration Tests

When the equipment is subjected to the vibration test conditions of DO-160A, Section 8.0, the following requirements of this standard shall be met, where applicable:

- a. Paragraph 2.2.1 - Mode Selection
- b. Paragraph 2.2.6.3 - Graphic Symbol Positional Accuracy
- c. Paragraph 2.2.7.3 - Numerical Value Accuracy

2.3.6 Explosion Test (when required)

During application of the explosion test procedures of DO-160A, Section 9.0, the following requirements of this standard shall be met, where applicable:

- a. Paragraph 2.2.6.3 - Graphic Symbol Positional Accuracy
- b. Paragraph 2.2.7.3 - Numerical Value Accuracy

2.3.7 Waterproofness (Drip Proof) Test (when required)

After subjecting the equipment to the test conditions of DO-160A, Section 10.0, the following requirements of this standard shall be met, where applicable:

- a. Paragraph 2.2.1 - Mode Selection
- b. Paragraph 2.2.6.3 - Graphic Symbol Positional Accuracy
- c. Paragraph 2.2.7.3 - Numerical Value Accuracy

2.3.8 Fluids Susceptibility Tests (when required)

2.3.8.1 Spray Test

After the equipment has been subjected to the conditions of the spray test specified by DO-160A, paragraph 11.2.1, the following shall apply:

At the end of the 24-hour exposure period, the equipment shall operate at a level of performance which indicates that no significant failures of components or circuitry have occurred.

At the end of the 160-hour exposure to elevated temperature and following the two-hour operational period at ambient temperature, the following requirements of this standard shall be met, where applicable:

- a. Paragraph 2.2.6.3 - Graphic Symbol Positional Accuracy
- b. Paragraph 2.2.7.3 - Numerical Value Accuracy

2.3.8.2 Immersion Test

At the end of the 24-hour immersion period specified in DO-160A, paragraph 11.2.2, the equipment shall operate at a level of performance which indicates that no significant failures of components or circuitry have occurred.

At the end of the 160-hour exposure to elevated temperature and following the two-hour operational period at ambient temperature specified in DO-160A, paragraph 11.2.2, the following requirements of this standard shall be met, where applicable:

- a. Paragraph 2.2.6.3 - Graphic Symbol Positional Accuracy
- b. Paragraph 2.2.7.3 - Numerical Value Accuracy

2.3.9 Sand and Dust Test (when required)

After subjecting the equipment to the test conditions of DO-160A, Section 12.0, the following requirements of this standard shall be met, where applicable:

- a. Paragraph 2.2.6.3 - Graphic Symbol Positional Accuracy
- b. Paragraph 2.2.7.3 - Numerical Value Accuracy

2.3.10 Fungus Resistance Test (when required)

After subjecting the equipment to the test conditions of DO-160A, Section 13.0, the following requirements of this

standard shall be met, where applicable:

- a. Paragraph 2.2.6.3 - Graphic Symbol Positional Accuracy
- b. Paragraph 2.2.7.3 - Numerical Value Accuracy

2.3.11 Salt Spray Test (when required)

After subjecting the equipment to the salt spray test conditions of DO-160A, Section 14.0, the following requirements of this standard shall be met, where applicable:

- a. Paragraph 2.2.1 - Mode Selection
- b. Paragraph 2.2.6.3 - Graphic Symbol Positional Accuracy
- c. Paragraph 2.2.7.3 - Numerical Value Accuracy

2.3.12 Magnetic Effect Test

When the equipment is subjected to the magnetic effect test conditions of DO-160A, Section 15.0, the equipment shall meet the requirement of the category for which it is designed.

2.3.13 Power Input Tests

2.3.13.1 Normal Operating Conditions

When the equipment is subjected to the test conditions of DO-160A, Subsection 16.3, the following requirements of this standard shall be met, where applicable:

- a. Paragraph 2.2.6.3 - Graphic Symbol Positional Accuracy
- b. Paragraph 2.2.7.3 - Numerical Value Accuracy

2.3.13.2 Abnormal Operating Conditions

- a. When the equipment is subjected to the test conditions of DO-160A, Subsection 16.3, it shall start and continue to operate electrically and mechanically. Degradation of performance is tolerable provided the equipment will resume normal operation when input power is returned to normal operating conditions.
- b. DC operated equipment shall operate satisfactorily within two minutes of returning primary power voltage(s) to normal after testing to low voltage conditions. The two minute time period does not include the time required for operation of automatic protective circuits.

- c. The gradual reduction to zero of the primary power voltage(s) for DC operated equipment shall produce no evidence of the presence of fire or smoke. The application of this test may result in damage to the equipment under test. Therefore paragraph 2.1.6, "Effects of Test," does not apply.

2.3.14 Voltage Spike Conducted Test

2.3.14.1 Category A Requirements

After testing to Category A requirements as specified in DO-160A, Subsection 17.2, if applicable, the equipment shall continue to operate electrically and mechanically without degradation of performance. The following requirements of this standard shall be met, where applicable:

- a. Paragraph 2.2.6.3 - Graphic Symbol Positional Accuracy
- b. Paragraph 2.2.7.3 - Numerical Value Accuracy

2.3.14.2 Category B Requirements

2.3.14.2.1 Intermittent Transients

Following application of intermittent transients specified by DO-160A, paragraph 17.4.1, the following requirements of this standard shall be met, where applicable:

- a. Paragraph 2.2.6.3 - Graphic Symbol Positional Accuracy
- b. Paragraph 2.2.7.3 - Numerical Value Accuracy

2.3.14.2.2 Repetitive Transients

When the equipment is subjected to the repetitive transients specified by DO-160A, paragraph 17.4.2, the following requirements of this standard shall be met, where applicable:

- a. Paragraph 2.2.6.3 - Graphic Symbol Positional Accuracy
- b. Paragraph 2.2.7.3 - Numerical Value Accuracy

2.3.15 Audio Frequency Conducted Susceptibility Test

When the equipment is subjected to the test conditions of DO-160A, Section 18.0, the following requirements of this standard shall be met, where applicable:

- a. Paragraph 2.2.6.3 - Graphic Symbol Positional Accuracy
- b. Paragraph 2.2.7.3 - Numerical Value Accuracy

2.3.16 Induced Signal Susceptibility Test

When the equipment is subjected to the test conditions of DO-160A, Section 19.0, the following requirements of this standard shall be met, where applicable:

- a. Paragraph 2.2.6.3 - Graphic Symbol Positional Accuracy
- b. Paragraph 2.2.7.3 - Numerical Value Accuracy

2.3.17 Radio Frequency Susceptibility Test (Radiated & Conducted)

When the equipment is subjected to the test conditions of DO-160A, Section 20.0, the following requirements of this standard shall be met, where applicable:

- a. Paragraph 2.2.6.3 - Graphic Symbol Positional Accuracy
- b. Paragraph 2.2.7.3 - Numerical Value Accuracy

2.3.18 Emission of Radio Frequency Energy Test

When the equipment is subjected to the test conditions of DO-160A, Section 21.0, it shall meet the requirements specified by that paragraph.

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2.4 Equipment Test Procedures

2.4.1 Definitions of Terms and Conditions of Test

Some of the tests are of a subjective nature. It must be kept in mind that the equipment is not intended to be used as a primary flight instrument, but rather as a supplement to aid the flight crew.

The following definitions of terms and conditions of test are applicable to the equipment tests specified herein:

- a. Power Input Voltage - Unless otherwise specified, all tests shall be conducted with the power input voltage adjusted to design voltage + or -2%. The input voltage shall be measured at the input terminals of the equipment under test.
- b. Power Input Frequency
 - (1) In the case of equipment designed for operation from an AC source of essentially constant frequency (e.g., 400 Hz), the input frequency shall be adjusted to design frequency + or -2%.
 - (2) In the case of equipment designed for operation from an AC source of variable frequency (e.g., 300 to 1000 Hz), the input frequency shall be adjusted to within 5% of a selected frequency and within the range for which the equipment is designed.
- c. Adjustment of Equipment - The circuits of the equipment under test shall be properly aligned and otherwise adjusted in accordance with the manufacturer's recommended practices prior to application of the specified tests.
- d. Test Instrument Precautions - Due precautions shall be taken during conduct of the tests to prevent the introduction of errors resulting from the connection of voltmeters, oscilloscopes and other test instruments across the input and output impedances of the equipment under test.
- e. Ambient Conditions - Unless otherwise specified, all tests shall be conducted under conditions of ambient room temperature, pressure and humidity. However, the room temperature shall be not lower than 10 degrees C.
- f. Warm-up Period - Unless otherwise specified, all tests shall be conducted after a warm-up (stabilization) period of not less than fifteen minutes.

- g. Connected Loads - Unless otherwise specified, all tests shall be performed with the equipment connected to loads having the impedance values for which it is designed.
- h. Observer - In all tests, the observer is defined as a person with normal vision viewing the display (head on) from a distance of 30 inches.

2.4.2 Detailed Test Procedures

The test procedures set forth below are considered satisfactory for use in determining required performance under standard and stressed conditions. Although specific test procedures are cited, it is recognized that other methods may be preferred by the testing activity. These alternate procedures may be used if the manufacturer can show that they provide at least equivalent information. In such cases, the procedures cited herein should be used as one criterion in evaluating the acceptability of the alternate procedures.

Figure 1 illustrates a typical test set-up. The input data simulator may be different for each type of input and for every type of equipment configuration and it may be analog or digital in nature. Therefore, to make a general specification for the exact nature of the device is impracticable. It shall be the responsibility of the equipment manufacturer to specify the specific input data simulator that pertains to the particular equipment configuration under test. Calibration of the input data simulator shall be performed prior to performance of these tests, and the results of these calibrations shall be applied to the test results.

2.4.2.1 Operation of Controls (paragraphs 2.1.4 and 2.2.1)

Equipment Required

No equipment required.

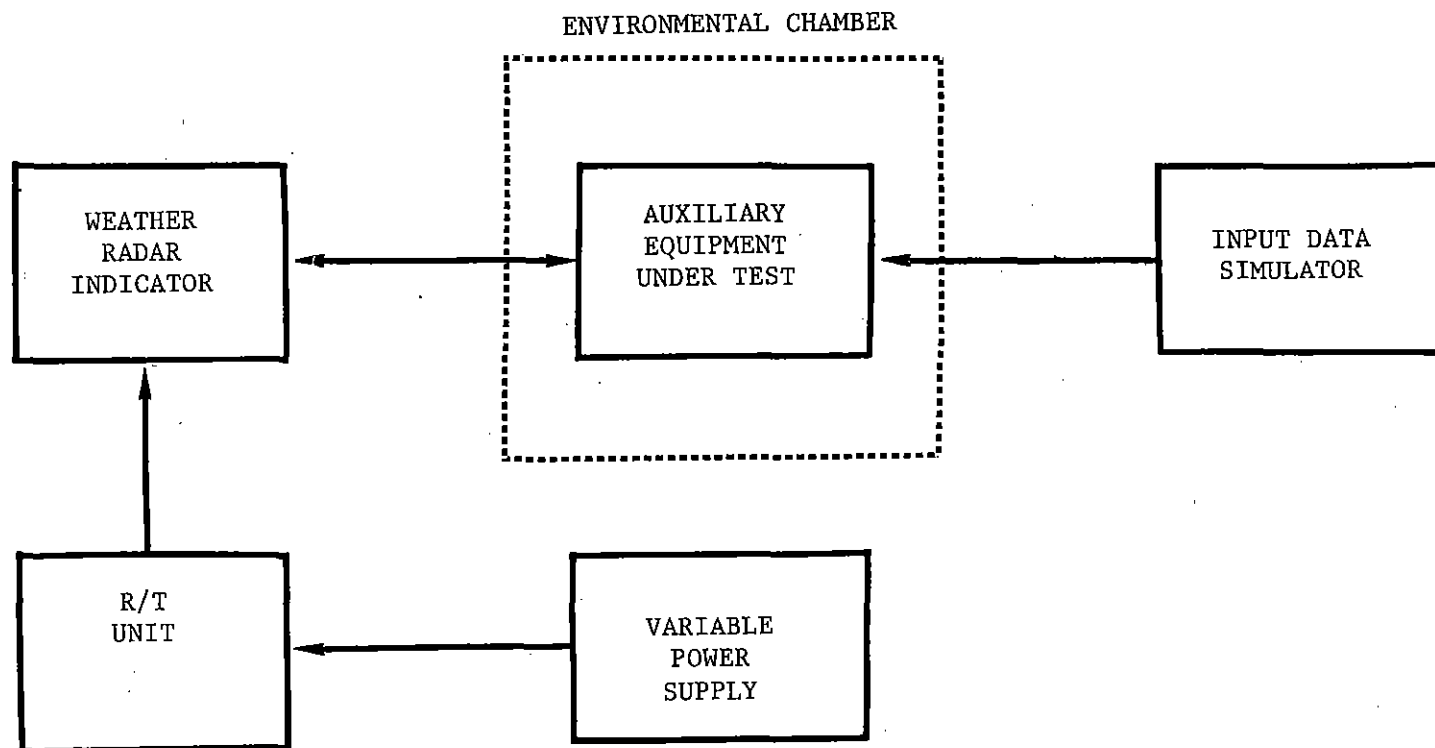
Measurement Procedure

All control functions should be varied through their full range to ensure that the control performs its function according to the manufacturer's specification. If the control function is specified in other test procedures, it need not be tested in this test procedure.

2.4.2.2 Simultaneous Data Display (paragraph 2.2.2) (when provided)

Equipment Required

Input data simulator (As specified by the equipment manufacturer).



NOTE: Alternative equipment configuration may dictate connecting the variable power supply, simulating aircraft power, either directly to the equipment under test or to the radar indicator or as defined by the equipment manufacturer.

TYPICAL TEST SETUP

FIGURE 1

Measurement Procedure

Select a mode of operation that allows simultaneous display of radar and auxiliary data. Generate a test pattern that simulates radar-derived data. Position either graphic or alphanumeric data so that it overlies the test pattern. Determine that the readability or interpretation of the test pattern is not degraded. Repeat for every character or symbol available.

2.4.2.3 Cycle to Cycle Symbol Stability (Jitter) (paragraph 2.2.3)

Equipment Required

Input data simulator(s) (As specified by the equipment manufacturer).

Calipers, ruler or equivalent.

Measurement Procedure

Connect the input data simulator(s) to the equipment under test. Operate the equipment in each of its operating modes and measure the jitter of the symbols. The observer should also determine that the jitter does not cause any distracting visual effects or erroneous interpretation of data.

2.4.2.4 Update Rate (paragraph 2.2.4)

Equipment Required

Input data simulator(s) (As specified by the equipment manufacturer).

Measurement Procedure

Connect the input data simulator(s) to the equipment under test. The observer shall vary the input data and verify that the display changes smoothly and meets the requirements of paragraph 2.2.4.

2.4.2.5 Refresh Rate (paragraph 2.2.5)

Equipment Required

Input data simulator(s) (As specified by the equipment manufacturer).

Measurement Procedure

Connect the input data simulator(s) to the equipment under test. Adjust the input data so that several symbols or characters are displayed. The observer shall verify that the equipment refreshes the display information at a rate no less than that of the radar indicator. Repeat this procedure for each operating mode of the equipment.

2.4.2.6 Graphic Display (paragraph 2.2.6)

2.4.2.6.1 Symbol Size (paragraph 2.2.6.1)

Equipment Required

Input data simulator(s) (As specified by the equipment manufacturer).

Ruler.

Measurement Procedure

Connect the input data simulator(s) to the equipment under test. Adjust the simulator to display one of the graphic symbols available.

Using the ruler, determine the size of the displayed symbol. Repeat this procedure for every different symbol. Alternatively, the input data simulator may be programmed to simultaneously display all of the available symbols. The observer must determine that all symbols used are unambiguous.

2.4.2.6.2 Symbol Overlap (paragraph 2.2.6.2)

Equipment Required

Input data simulator(s) (As specified by the equipment manufacturer).

Measurement Procedure

Connect the input data simulator to the equipment under test. If possible, adjust the input data so that the specified location on the display of two different symbols is identical. The observer must note that the primary data is still readable.

2.4.2.6.3 Graphic Symbol Positional Accuracy (paragraph 2.2.6.3)

Equipment Required

Input data simulator(s) (As specified by the equipment manufacturer).

Measurement Procedure

Connect the input data simulator(s) to the equipment under test. Adjust the input data so that a graphic symbol is positioned on one of the reference lines/points (radar range marks, azimuth marks or other scales).

Determine the error between the simulated input and the indicated position on the display. Perform this measurement for every input parameter and check at least one parameter at each selectable radar indicator range. Verify that in all cases the errors are within the limits set in paragraph 2.2.6.3.

NOTE: If the system uses altitude information for slant range correction of DME input data, then the symbol position on the display may not match the simulated distance input for short ranges. The following equation is used to convert slant range distance (nm) and altitude (ft) into true distance (nm).

$$\text{TRUE DISTANCE} = \sqrt{(\text{SLANT RANGE})^2 - \left(\frac{\text{ALTITUDE}}{6076}\right)^2}$$

2.4.2.7 Alphanumeric Display (paragraph 2.2.7)

2.4.2.7.1 Character Size (paragraph 2.2.7.1)

Equipment Required

Input data simulator(s) (As specified by the equipment manufacturer).

Ruler.

Measurement Procedure

Connect the input data simulator(s) to the equipment under test. Adjust the input data and/or the equipment under test to display all available alphanumeric characters.

Using the ruler, determine the size of the displayed characters. The observer must determine that each character or its position cannot cause erroneous interpretation of the data.

2.4.7.2 Character Overlap (paragraph 2.2.7.2)

Equipment Required

Input data simulator(s) (As specified by the equipment manufacturer).

Measurement Procedure

Connect the input data simulator to the equipment under test. If possible, adjust the input data and/or the equipment under test so that the specified location on the display of two different alphanumeric characters is identical. The observer must determine that the primary data is still readable.

2.4.2.7.3 Numerical Value Accuracy (paragraph 2.2.7.3)

Equipment Required

Input data simulator(s) (As specified by the equipment manufacturer).

Measurement Procedure

Connect the input data simulator(s) to the equipment under test. Operate the equipment in all modes that display numerical data. Determine the error between the information presented on the display and the simulated input data. Perform this comparison for every input parameter and for at least two values representing the upper and lower limits of each parameter to be displayed.

NOTE: If slant range corrected distance is displayed, refer to note in paragraph 2.4.2.6.3.

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3.0 INSTALLED EQUIPMENT PERFORMANCE

3.1 Test Conditions

3.1.1 Power Input

Unless otherwise specified, tests are conducted with the equipment powered by the aircraft's electrical power generating system.

3.1.2 Associated Equipment

All aircraft electrically operated systems and equipments must be operational before conducting electronic interference tests.

3.1.3 Environment

During the following tests, the equipment shall not be subject to environmental conditions that exceed those specified by the manufacturer.

3.1.4 Adjustment of Equipment

The circuits of the equipment under test shall be properly aligned and otherwise adjusted in accordance with the manufacturer's recommended practices prior to the application of specified tests.

3.1.5 Warm-up Period

Unless otherwise specified by the equipment manufacturer, tests shall be conducted after a warm-up period of not less than fifteen minutes.

3.2 Equipment Installation

3.2.1 Equipment Function

The equipment must be capable of operating in each of its intended modes of operation.

3.2.2 Equipment Accessibility

Equipment controls and displays installed for in-flight operation shall be readily accessible from the normal seated position. The appropriate operator/crew member(s) shall have an unobstructed view of displayed data when in the normal seated position.

3.2.3 Interference Effects

The equipment shall not be the source of unacceptable conducted or radiated interference nor be adversely affected by conducted or radiated interference from other equipment or systems installed in the aircraft.

NOTE: Electromagnetic compatibility problems noted after installation of this equipment may result from such factors as the design characteristics of previously installed systems or equipment and the physical installation environments. The installing facility will be responsible for resolving any incompatibility between this equipment and previously installed equipment. The various factors contributing to the incompatibility must be considered.

3.2.4 Failure Protection

Any probable failure of the equipment shall not degrade the normal operation of equipment or systems connected to it. Likewise, the failure of interfaced equipment or systems shall not degrade normal operation of this equipment.

3.3 Installed Equipment Performance Requirements

The indicator used to display the optional equipment information must meet all the requirements set forth in RTCA/DO-173, "Minimum Operational Performance Standards for Airborne Weather and Ground Mapping Pulsed Radars."

3.3.1 General Auxiliary Equipment Performance Requirements

The equipment shall be tested to determine compliance with the minimum requirements specified in Subsections 2.1 and 2.2. In order to meet these requirements, test results supplied by the equipment manufacturer as proof of conformity may be accepted in lieu of tests performed by the equipment installer.

3.3.2 Readability

The equipment shall be capable of displaying readable information under all cockpit conditions of ambient light. Visors, glareshields or filters are acceptable means of attaining daylight visibility.

3.4 Test Procedures for Installed Equipment Performance

The test procedures set forth below are considered satisfactory for use in determining required equipment performance when installed in aircraft. Testing requirements are stated in a manner that will make maximum use of bench test data while limiting flight tests to those which cannot be tested conveniently by other means. Although specific test procedures are cited, it is recognized that other methods may be preferred by the installing activity. These alternate procedures may be used if the installing activity can show that they provide at least equivalent information. In such cases, the procedures cited herein should be used as one criterion in evaluating the acceptability of the alternate procedures.

3.4.1 Conformity Inspection

Visually inspect the installed equipment to determine the use of acceptable workmanship and engineering practices. Verify that all electrical and mechanical connections have been properly assembled, and that the equipment has been installed and located in accordance with the manufacturer's installation instructions.

3.4.2 Ground Test Procedures

3.4.2.1 Equipment Function

Vary all aircrew-operable controls associated with the optional equipment individually through their full range and determine that the system is operating according to the manufacturer's instructions and that each control performs its intended function.

3.4.2.2 Equipment Accessibility

Determine that all controls and displays for the optional equipment are readily accessible and easily interpreted.

3.4.2.3 Interference Effects

With the equipment energized, individually operate each of the other electrically operated aircraft systems to determine that no operationally significant conducted or radiated interference occurs. Evaluate all usable combinations of control settings and operating modes of the equipment. Operate communications and navigation equipment on at least the low, high, and one mid-band frequencies. Make note of systems or modes of operation that will also be checked during the flight tests.

3.4.2.4 Power Supply Fluctuation

Under normal aircraft conditions, cycle the aircraft engine(s) through all normal power settings and verify proper operation of the equipment as conforming to the requirements of paragraph 3.3.2. Also, verify that proper equipment operation is restored within 30 seconds after a total power interruption.

3.4.3 Flight Test Procedures

3.4.3.1 Displayed Data Readability

Determine that normal conditions of flight do not significantly affect the readability of displayed data.

3.4.3.2 Interference Effects

For those aircraft equipment and systems that can only be checked in flight, determine that no operationally significant conducted or radiated interference exists. Evaluate all usable combinations of control settings and operating modes. Operate communications and navigation equipment on at least the low, high and one mid-band frequencies.

3.4.3.3 Equipment Function

Under actual flight operating conditions, determine that the optional equipment meets the requirements of paragraphs 2.2.6 and 2.2.7.

4.0 OPERATIONAL CHARACTERISTICS

4.1 Required Operational Characteristics

In order to assure the operator that the equipment can be operated safely and reliably in the expected operational environment, there are specific minimum acceptable performance parameters that must be met. The following paragraphs identify these equipment operational characteristics.

4.1.1 Power Input

Prior to flight it should be possible to verify that the equipment is receiving primary input power necessary for equipment operation.

4.1.2 Equipment Operating Modes

The equipment must be capable of operating and displaying information in each of the equipment operating modes pertinent to the specific installed configuration.

4.2 Test Procedures for Operational Characteristics

Operational equipment tests may be run as part of the normal pre-flight tests prior to initiation of a flight in which the equipment is expected to be utilized. For those tests which can only be conducted in flight, procedures should be developed by the user to perform these tests as early during the flight as possible in order to establish confidence that the equipment is performing its intended functions.

4.2.1 Power Input

With the aircraft's electrical power generating system operating, energize the equipment and verify that electrical power is available to the equipment.

4.2.2 Equipment Operating Modes

Verify that the equipment is capable of operating and displaying information as defined by the manufacturer's operating instructions for the specific installation.

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M E M B E R S H I PSpecial Committee 133

MINIMUM OPERATIONAL PERFORMANCE STANDARDS
FOR
OPTIONAL EQUIPMENT WHICH DISPLAYS NON-RADAR DERIVED DATA
ON WEATHER AND GROUND MAPPING RADAR INDICATORS

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