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Minimum Operational Performance Standards (MOPS) for Devices that Prevent Blocked Channels Used in Two-Way Radio Communications Due to Unintentional Transmissions

RTCA DO-207
January 25, 1991

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FOREWORD

This document was prepared by Special Committee 163 of the Radio Technical Commission for Aeronautics. It was approved by the RTCA Executive Committee on January 25, 1991.

RTCA is an association of aeronautical organizations of the United States from both government and industry. Dedicated to the advancement of aeronautics, RTCA seeks sound technical solutions to problems involving the application of electronics and telecommunications to aeronautical operations. Its objective is the resolution of such problems by mutual agreement of its member organizations. The findings of RTCA are in the nature of recommendations to all organizations concerned. Since RTCA is not an official agency of the United States Government, its recommendations may not be regarded as statements of official government policy unless so enunciated by the U. S. government organization or agency having statutory jurisdiction over any matters to which the recommendations relate.

Coordination of these standards was accomplished by RTCA SC-163 with the European Organisation for Civil Aviation Equipment (EUROCAE) WG-38.

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1.0 PURPOSE AND SCOPE

1.1 Introduction

This document sets forth minimum operational performance standards for systems that prevent blocked frequencies used in air traffic control (ATC) two-way radio communications due to unintentional transmissions. Incorporated within these standards are system characteristics that should be beneficial to users of the systems as well as to designers, manufacturers and installers.

Compliance with these standards is recommended as a means of assuring that the equipment will perform its intended function(s) satisfactorily under all conditions normally encountered in routine operations. Any regulatory application of this document is the sole responsibility of appropriate government agencies.

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

This document considers an equipment configuration to consist of: transmitter, receiver, power supply, microphone, control panels, antenna, interconnecting cables and related accessories. It should not be inferred that all equipment will necessarily include all of the foregoing components as separate units. This will depend on the specific design configuration chosen by the manufacturer. Additional functions and components that may refer to expanded equipment capabilities that exceed the stated minimum requirements are identified as optional features. Equipment features that are beyond the scope of this document may be developed in future RTCA activities.

If the equipment implementation includes a computer software package, the guidelines contained in RTCA/DO-178A, *Software Considerations in Airborne Systems and Equipment Certification*, shall be considered.

1.2 System Overview

The aviation communications system includes ground-based and airborne receiving and transmitting equipment that provides air-to-ground, ground-to-air, air-to-air and ground-to-ground voice and data communications. The equipment addressed in this document provides the means for reducing unintentional transmissions that adversely affect two-way voice radio communications.

Disruption to voice communications in the ATC system presents the potential for degrading flight safety. Although these communication disruptions may occur in areas where traffic density is low, the growth of air traffic (and communications) has increased the number of disruption incidents. The FAA concluded, as early as 1968, that the occurrence of communication disruptions presented serious problems, e.g., the loss of separation standards between aircraft, near mid-air collisions, delays and potentially disastrous disruptions of traffic flow. Various educational programs and advisory material issued by the FAA have not reduced the problem. In fact, subsequent surveys have indicated that the problem has intensified.

In 1984, the FAA was petitioned to enact rulemaking requiring two-way radio communication systems employing anti-blocking and stuck microphone protection circuitry. The FAA subsequently published the petition for rulemaking for public comment. The majority of responses to the petition for rulemaking were favorable.

Because an industry standard for such devices was not available, the FAA deferred further action on the petition for rulemaking and requested that the Radio Technical Commission for Aeronautics (RTCA) Executive Committee establish a Special Committee to develop appropriate guidance and equipment standards.

As a result of the FAA's request, the RTCA Executive Committee established Special Committee 163 to develop design criteria and guidance information pertaining to unintentional or simultaneous transmissions that adversely affect two-way radio communications, and to develop minimum operational performance standards (MOPS) for devices that minimize unintentional and/or simultaneous transmissions. This MOPS only addresses unintentional transmissions.

Unintentional transmissions may be caused by a jammed microphone push-to-talk (PTT) button or by equipment malfunction that results in a continuous transmission from the associated transmitter. This problem is often referred to as the "stuck-mike" problem.

1.3 Operational Application

This specification is applicable to ground-based, ground mobile and airborne two-way UHF and VHF radio voice communications equipment used for control of air traffic. These standards apply to three different methods of incorporation: retrofit, modification and new designs.

1.4 Operational Goals

These devices are intended to minimize communication disruptions caused by unintentional transmissions that are detrimental to the safety and efficiency of flight operations. Equipment designers, manufacturers and installers are encouraged to provide indications or annunciations to the pilot of transmitter operation, or of impending or existing actions by the equipment to inhibit transmitter operation.

1.5 Assumptions

1.5.1 Unintentional Continuous Transmissions

Transmissions of an unreasonable duration are considered detrimental, for the purpose of this specification, and must be terminated and may be annunciated. Unintentional continuous radio frequency transmissions that cause frequency blocking can be produced by the following conditions:

1.5.1.1 Stuck Microphone PTT Switches

Stuck microphone PTT switches are the most common causes of frequency blocking in the category of unintentional continuous transmissions. These conditions are often caused by improper microphone stowage provisions and techniques or by a defective microphone PTT switch, the contacts of which will not properly open when the button is released.

1.5.1.2 Loose Microphone Jacks

A malfunction that provides a low resistance between a PTT line and airplane ground is a frequent cause of unintentional transmitter keying. Although unmodulated, the emitted radio frequency can cause blocking of the selected frequency channel. This condition is often caused by a loosely secured microphone jack. Rotation of this jack can cause the attached microphone high, microphone low, PTT and ground wires to twist, thereby applying excessive tension on the jack terminals, and, in turn, causing the PTT line terminal to short to one of the other terminals. This condition will result in unintentional continuous transmitter emissions. The insulation on these

wires can also be damaged by rotary manipulation of an unsecured microphone jack. This condition creates a potential for unintentional transmitter keying due to shorting wires.

1.5.1.3 PTT Line Activation by Other Causes

A PTT line can be activated unintentionally by other low resistance paths to ground that are originated by associated malfunctioning line replaceable units (LRUs) such as audio selector panels, audio accessory units, remote electronics units, transceivers and by defective airplane wiring. It is assumed, however, that these unwanted conditions are comparatively rare, and are not significant contributors to the unintentional continuous transmission problem.

1.5.1.4 Unkeyed Continuous Transmissions

Continuous unintentional transmissions, which are not initiated by unintentional keyline activation, may be caused by a circuit malfunction within the transmitter itself. It is assumed that this condition occurs infrequently and, in any event, will not be a significant contributor to the frequency blocking problem.

1.6 Test Procedures

The test procedures specified in this document are intended to be used as one means of demonstrating compliance with the performance requirements. Although specific test procedures are cited, it is recognized that other methods may be preferred. 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 specified suggests that the equipment be subjected to a succession of tests as it moves from design, and design qualification, into operational use. For example, compliance with the requirements of Section 2.0 shall have been demonstrated as a precondition to satisfactory completion of the installed system tests of Section 3.0.

Three types of test procedures are specified. These include:

a. Environmental Tests

Environmental test requirements 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.

Unless otherwise specified, the environmental conditions and test procedures contained in RTCA/DO-160C, *Environmental Conditions and Test Procedures for Airborne Equipment*, will be used to demonstrate equipment compliance.

b. Bench Tests

Bench test procedures are specified in Subsection 2.4. These tests provide a laboratory means of demonstrating compliance with the requirements of Subsection 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.

c. Installed Equipment Tests

The installed equipment test procedures and their associated limits are specified in Section 3.0. Although bench and environmental test procedures are not included in the installed equipment tests, their successful completion is a precondition to completion of the installed tests. In certain instances, however, installed equipment 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:

(1) With the aircraft on the ground and using simulated or operational system inputs.

(2) With the aircraft in flight using operational system inputs appropriate to the equipment under test.

Test results may be used to demonstrate functional performance in the intended operational environment.

1.7 Definition of Terms

Unintentional Transmission(s) - Transmitter operation when such operation is not intended. This is commonly referred to as a stuck-mike condition.

LRU - Line Replaceable Unit

PTT - Push-To-Talk

2.0 EQUIPMENT PERFORMANCE REQUIREMENTS AND TEST PROCEDURES

2.1 General Requirements

The following general requirements shall be met by all unintentional transmission prevention equipment. Equipment designed to prevent unintentional transmissions shall include the capability of automatically inhibiting transmitter operation.

2.1.1 Airworthiness

In the design and manufacture of the equipment, the manufacturer shall provide for installation so as not to impair the airworthiness of the aircraft.

2.1.2 Intended Function

The equipment shall perform its intended function(s), as defined by the manufacturer, and its proper use shall not create a hazard to other users of the National Airspace System.

2.1.3 Federal Communications Commission Rules

All equipment shall comply with the applicable rules of the Federal Communications Commission.[1]

2.1.4 Fire Protection

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

NOTE: One means of showing compliance is contained in Federal Aviation Regulations (FAR) Part 25, Appendix F.

2.1.5 Operation of Controls

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

2.1.6 Accessibility of Controls

Controls that do not require adjustment during flight shall not be readily accessible to flight personnel.

2.1.7 Effects of Test

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

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[1] It is not intended that this requirement relating to FCC rules be interpreted as a precondition for obtaining other applicable approvals such as an FAA TSO authorization.

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2.2 Equipment Performance - Standard Conditions

2.2.1 Automatic Termination of Transmission

The equipment shall terminate a continuous transmission after a maximum of 35 seconds.

Note: (1) It is preferred that the radio and audio equipment return to the receive mode after transmission termination and that equipment provide a means to alert the crew that the transmission has been terminated. An annunciation to the user that transmission is about to be terminated is also desirable, providing the opportunity for the user to reset the timer prior to termination.

(2) Transmissions may be detected by sensing the RF output signal from the transmitter, the primary input current or power to the transmitter, the push-to-talk line, or by sensing other appropriate control or status lines in the radio system. It is preferred that the sensing method use signals that are provided within, directly to, or directly from the transmitter.

2.2.2 Resetting of Transmission Timer

The transmission timer shall be reset by one or both of the following conditions: (a) at the beginning of the transmission (except as provided by paragraph 2.2.3); (b) by a primary power interrupt.

Note: (1) With a device designed to tolerate a power interrupt it is possible that a deliberate momentary PTT release may not be recognized as an attempt to reset the timer. The VHF transmitter may then be unintentionally disabled following expiry of the continually counting timer.

(2) The consequence of allowing momentary power interrupts to reset the timer is only that an accidentally stuck microphone may not be terminated for between 35 to 70 seconds, rather than the proposed 35 seconds. This event will only occur when the stuck microphone coincides with a power interruption.

2.2.3 Bypass Switch

A means of immediate operator override of the transmitter termination function may be provided. Such means of override shall be substantially incapable of being left in the bypass or override position either deliberately or accidentally and shall not reset the transmission timer. A spring-loaded, guarded toggle switch is one means of complying with this requirement.

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2.3 Equipment Performance - Environmental Conditions

The environmental tests and performance requirements described in this subsection provide a laboratory means of determining the overall performance characteristics for the equipment under conditions representative of those that may be encountered in actual aeronautical operations.

Some of the environmental tests contained in this subsection do not have to be performed unless the manufacturer wishes to qualify the equipment for that particular environmental condition. These tests are identified by the phrase "when required." If the manufacturer wishes to qualify the equipment under any of these additional environmental conditions, then the appropriate "When Required" tests shall be performed.

Unless otherwise specified, the test procedures applicable to a determination of equipment performance under environmental test conditions are contained in RTCA Document DO-160C, *Environmental Conditions and Test Procedures for Airborne Equipment.*

Some of the performance requirements in Subsection 2.2 are not required to be tested to all of the conditions contained in RTCA/DO-160C. Judgement and experience have indicated that these particular performance parameters are not susceptible to certain environmental conditions and that the level of performance specified in Subsection 2.2 will not be measurably degraded by exposure to these conditions.

2.3.1 Temperature and Altitude Tests (RTCA/DO-160C, Section 4.0)

RTCA/DO-160C contains several temperature and altitude test procedures that are specified according to equipment category. These categories are included in Subsection 4.3 of DO-160C. The following subparagraphs contain the applicable test conditions specified in Section 4.0 of DO-160C.

2.3.1.1 Ground Survival Low Temperature Test and Operating Low Temperature Test

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, paragraph 4.5.1., and the following requirements of this standard shall be met:

a. Paragraph 2.2.1 - Automatic Termination of Transmissions
b. Paragraph 2.2.2 - Resetting of Transmission Timer

2.3.1.2 Ground Survival High Temperature Test and Short-time Operating High Temperature Test

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, paragraph 4.5.2, and the following requirements of this standard shall be met:

a. Paragraph 2.2.1 - Automatic Termination of Transmissions
b. Paragraph 2.2.2 - Resetting of Transmission Timer

2.3.1.3 Operating High Temperature Test

The equipment shall be subjected to the test conditions specified in RTCA/DO-160C, paragraph 4.5.3, and the following requirements of this standard shall be met:

a. Paragraph 2.2.1 - Automatic Termination of Transmissions
b. Paragraph 2.2.2 - Resetting of Transmission Timer

This test is intended for equipment whose continued operation in the event of loss of cooling is essential to the safe flight of the aircraft.

2.3.1.4 In-Flight Loss of Cooling Test

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, paragraph 4.5.4, and the following requirements of this standard shall be met:

a. Paragraph 2.2.1 - Automatic Termination of Transmissions
b. Paragraph 2.2.2 - Resetting of Transmission Timer

This test is intended for equipment whose continued operation in the event of loss of cooling is essential to the safe flight of the aircraft.

2.3.1.5 Altitude Test

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, paragraph 4.6.1, and the following requirements of this standard shall be met:

a. Paragraph 2.2.1 - Automatic Termination of Transmissions
b. Paragraph 2.2.2 - Resetting of Transmission Timer

2.3.1.6 Decompression Test

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, paragraph 4.6.2, and the following requirements of this standard shall be met:

a. Paragraph 2.2.1 - Automatic Termination of Transmissions
b. Paragraph 2.2.2 - Resetting of Transmission Timer

2.3.1.7 Overpressure Test

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, paragraph 4.6.3, and the following requirements of this standard shall be met:

a. Paragraph 2.2.1 - Automatic Termination of Transmissions
b. Paragraph 2.2.2 - Resetting of Transmission Timer

2.3.2 Temperature Variation Test

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, Section 5.0, and the following requirements of this standard shall be met:

a. Paragraph 2.2.1 - Automatic Termination of Transmissions
b. Paragraph 2.2.2 - Resetting of Transmission Timer

2.3.3 Humidity Test

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, Section 6.0, and the following requirements of this standard shall be met:

a. Paragraph 2.2.1 - Automatic Termination of Transmissions
b. Paragraph 2.2.2 - Resetting of Transmission Timer

2.3.4 Operational Shocks and Crash Safety Tests

2.3.4.1 Operational Shocks

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C,

Subsection 7.2, and the following requirements of this standard shall be met:

a. Paragraph 2.2.1 - Automatic Termination of Transmissions
b. Paragraph 2.2.2 - Resetting of Transmission Timer

2.3.4.2 Crash Safety

The application of the crash safety shock tests may result in damage to the equipment under test; therefore, this test may be conducted after the other tests have been completed. In this case, Paragraph 2.1.7, "Effects of Test," does not apply.

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, Subsection 7.3, and shall meet the requirements specified therein.

2.3.5 Vibration Tests

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, Section 8.0, and the following requirements of this standard shall be met:

a. Paragraph 2.2.1 - Automatic Termination of Transmissions
b. Paragraph 2.2.2 - Resetting of Transmission Timer

2.3.6 Explosion Proofness Test (When Required)

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, Section 9.0. During this test the equipment shall not cause detonation of the explosive mixture within the test chamber.

2.3.7 Waterproofness Tests (When Required)

2.3.7.1 Drip Proof Test

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, paragraph 10.3.1, and the following requirements of this standard shall be met:

a. Paragraph 2.2.1 - Automatic Termination of Transmissions
b. Paragraph 2.2.2 - Resetting of Transmission Timer

2.3.7.2 Spray Proof Test

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, paragraph 10.3.2, and the following requirements of this standard shall be met:

a. Paragraph 2.2.1 - Automatic Termination of Transmissions
b. Paragraph 2.2.2 - Resetting of Transmission Timer

Note: This test shall be conducted with the spray directed perpendicular to the equipment.

2.3.7.3 Continuous Stream Proof Test

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, paragraph 10.3.3, and the following requirements of this standard shall be met:

a. Paragraph 2.2.1 - Automatic Termination of Transmissions
b. Paragraph 2.2.2 - Resetting of Transmission Timer

NOTE: This test shall be conducted with the stream directed perpendicular to the equipment.

2.3.8 Fluids Susceptibility Tests (When Required)

The following subparagraphs contain the applicable test conditions specified in Section 11.0 of RTCA/DO-160C.

2.3.8.1 Spray Test

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, paragraph 11.4.1, and the following requirements of this standard shall apply:

a. At the end of the 24-hour operational period, the equipment shall function.

b. Following the two-hour operational period at ambient temperature, after the 160-hour exposure period at elevated temperature, the following requirements of this standard shall be met:

(1) Paragraph 2.2.1 - Automatic Termination of Transmissions
(2) Paragraph 2.2.2 - Resetting of Transmission Timer

2.3.8.2 Immersion Test

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, paragraph 11.4.2, and the following requirements of this standard shall apply:

a. At the end of the 24-hour immersion period, the equipment shall function.

b. Following the two-hour operational period at ambient temperature, after the 160-hour exposure period at elevated temperature, the following requirements of this standard shall be met:

(1) Paragraph 2.2.1 - Automatic Termination of Transmissions
(2) Paragraph 2.2.2 - Resetting of Transmission Timer

2.3.9 Sand and Dust Test (When Required)

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, Section 12.0, and the following requirements of this standard shall be met:

a. Paragraph 2.2.1 - Automatic Termination of Transmissions
b. Paragraph 2.2.2 - Resetting of Transmission Timer

2.3.10 Fungus Resistance Test (When Required)

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, Section 13.0, and the following requirements of this standard shall be met:

a. Paragraph 2.2.1 - Automatic Termination of Transmissions
b. Paragraph 2.2.2 - Resetting of Transmission Timer

2.3.11 Salt Spray Test (When Required)

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, Section 14.0, and the following requirements of this standard shall be met:

a. Paragraph 2.2.1 - Automatic Termination of Transmissions
b. Paragraph 2.2.2 - Resetting of Transmission Timer

2.3.12 Magnetic Effect Test

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, Section 15.0, and the equipment shall meet the requirements of the appropriate instrument or equipment class specified therein.

2.3.13 Power Input Tests

2.3.13.1 Normal Operating Conditions

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, paragraphs 16.5.1 and 16.5.2, as appropriate, and the following requirements of this standard shall be met:

a. Paragraph 2.2.1 - Automatic Termination of Transmissions
b. Paragraph 2.2.2 - Resetting of Transmission Timer

Any timers in the equipment may be reset by momentary power interruptions of durations less than those defined in subparagraphs 16.5.1.4 and 16.5.2.3 of RTCA/DO-160C. The equipment is not required to operate during these power interrupts but must automatically recover to normal operation after them.

2.3.13.2 Abnormal Operating Conditions

The application of the low voltage conditions (dc) (Category B equipment) test may result in damage to the equipment under test; therefore, this test may be conducted after the other tests have been completed. Paragraph 2.1.7, "Effects of Test," does not apply.

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, paragraph 16.5.3 and 16.5.4, as appropriate, and the following requirements of this standard shall be met:

a. Paragraph 2.2.1 - Automatic Termination of Transmissions
b. Paragraph 2.2.2 - Resetting of Transmission Timer

2.3.14 Voltage Spike Tests

The following subparagraphs contain the applicable test conditions specified in Section 17.0 of RTCA/DO-160C.

2.3.14.1 Category 'A' Requirements (if applicable)

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, Subsection 17.3, and the following requirements of this standard shall be met:

a. Paragraph 2.2.1 - Automatic Termination of Transmissions
b. Paragraph 2.2.2 - Resetting of Transmission Timer

2.3.14.2 Category 'B' Requirements (if applicable)

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, paragraphs 17.4.1, "Intermittent Transients," and 17.4.2, "Repetitive Transients," and the following requirements of this standard shall be met:

a. Paragraph 2.2.1 - Automatic Termination of Transmissions
b. Paragraph 2.2.2 - Resetting of Transmission Timer

2.3.15 Audio Frequency Conducted Susceptibility Test

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, Section 18.0, and the following requirements of this standard shall be met:

a. Paragraph 2.2.1 - Automatic Termination of Transmissions
b. Paragraph 2.2.2 - Resetting of Transmission Timer

2.3.16 Induced Signal Susceptibility Test

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, Section 19.0, and the following requirements of this standard shall be met:

a. Paragraph 2.2.1 - Automatic Termination of Transmissions
b. Paragraph 2.2.2 - Resetting of Transmission Timer

2.3.17 Radio Frequency Susceptibility Test (Radiated and Conducted)

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, Section 20.0, and the following requirements of this standard shall be met:

a. Paragraph 2.2.1 - Automatic Termination of Transmissions
b. Paragraph 2.2.2 - Resetting of Transmission Timer

Note: The radiated and conducted RF test signal should exclude the frequency to which the receiver is tuned and all frequencies within the receiver's resonant passband.

2.3.18 Emission of Radio Frequency Energy Test

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, Section 21.0.

2.3.19 Lightning Induced Transient Susceptibility Test (When Required)

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, Section 22.0, and the following requirements of this standard shall be met:

a. Paragraph 2.2.1 - Automatic Termination of Transmissions
b. Paragraph 2.2.2 - Resetting of Transmission Timer

2.3.20 Lightning Direct Effects Test (If Applicable)

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, Section 23.0.

2.3.21 Icing Test (When Required)

The equipment shall be subjected to the test conditions as specified in RTCA/DO-160C, Section 24.0.

2.4 Equipment Test Procedures

2.4.1 Definitions of Terms and Condition of Test

The following are definitions of terms and conditions under which the following tests should be conducted.

a. Power Input Voltage

Unless otherwise specified, all tests shall be conducted with the power input voltage adjusted to design voltage plus or minus two percent. 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., 400Hz), the input frequency shall be adjusted to design frequency plus or minus two percent.

(2) In the case of equipment designed for operation from an ac source of variable frequency (e.g., 300 to 1000 Hz), unless otherwise specified, the test shall be conducted with the input frequency adjusted to within five percent 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 Equipment - All equipment used in the performance of the tests should be identified by make, model and serial number where appropriate, and its latest calibration date. When appropriate, all test equipment calibration standards should be traceable to national and/or international standards.

e. Test Instrument Precautions - Due precautions shall be taken during 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.

f. Ambient Conditions - Unless otherwise specified, all tests shall be made within the following ambient conditions:

(1) Temperature: +15 to +35 degrees C
(+59 to +95 degrees F)

(2) Relative Humidity: Not greater than 85%

(3) Ambient Pressure: 84 to 107 kPa (equivalent to + 5000 to -1500 feet) (+1525 to -460 meters)

When tests are conducted at ambient conditions that differ from the above values, allowances shall be made and differences recorded.

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.

2.4.2 Detailed Test Procedures

2.4.2.1 Automatic Termination of Transmissions (paragraph 2.2.1)

Equipment Required

Wattmeter (Bird Electronics Model 611 or equivalent).

Stopwatch.

Measurement Procedure

Key the associated transmitter. Determine the length of time required for automatic termination of output power.

If a bypass switch is incorporated, activate switch and determine that transmitter output power resumes. Release bypass switch and verify that transmitter RF output ceases.

2.4.2.2 Resetting of Transmission Timer (paragraph 2.2.2)

Equipment Required

Wattmeter (Bird Electronics Model 611 or equivalent).

Oscilloscope (Tektronix Model 453 or equivalent).

Measurement Procedure

Key the associated transmitter. After the transmitter output has been automatically terminated, interrupt the keyed condition or the primary power or both (one at a time) depending upon equipment configuration. Determine that transmitter RF output resumes.

3.0 INSTALLED EQUIPMENT PERFORMANCE

This section states the minimum acceptable level of performance for the equipment when installed in the aircraft. For the most part, installed performance requirements are the same as those contained in Section 2.0, which were verified through bench and environmental tests. However, certain requirements may be affected by the physical installation (e.g., antenna patterns, receiver sensitivity, etc.) and can only be verified after installation. The installed performance limits stated below take into consideration these situations.

3.1 Equipment Installation

The equipment shall be installed in accordance with the manufacturer's installation instructions.

3.1.1. Accessibility

Controls and monitors, if provided for in-flight operation, shall be readily accessible from the pilot's normal seated position. The appropriate operator/crew member(s) shall have an unobstructed view of displayed data when in the normal seated positon.

3.1.2 Aircraft Environment

Equipment shall be compatible with the environmental conditions present in the specific location in the aircraft where the equipment is installed.

3.1.3 Display Visibility (if applicable)

Display intensity shall be suitable for data interpretation under all cockpit ambient light conditions ranging from total darkness to reflected sunlight.

3.1.4 Dynamic Response

Operation of the equipment shall not be adversely affected by aircraft maneuvering or changes in attitude encountered in normal flight operations.

3.1.5 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.

3.1.6 Interference Effects

The equipment shall not be the source of harmful 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 itself. It is not intended that the equipment manufacturer design for all installation environments. The installing facility will be responsible for resolving any incompatibilty between this equipment and previously installed equipment in the aircraft. The various factors contributing to the incompatibility shall be considered.

3.1.7 Inadvertent Turnoff

Appropriate protection shall be provided to avert the inadvertent turnoff of the equipment.

3.1.8 Aircraft Power Source

The voltage and voltage tolerance characteristics of the equipment shall be compatible with the aircraft power source.

3.2 Installed Equipment Performance Requirements

The installed equipment shall meet the requirements of Subsections 2.1 and 2.2.

3.3 Conditions of Test

The following paragraphs define conditions under which tests, specified in Subsection 3.4, shall be conducted.

3.3.1 Power Input

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

3.3.2 Associated Equipment or Systems

Unless otherwise specified, all aircraft electrically operated equipment and systems shall be turned on before conducting interference tests.

3.3.3 Environment

During test, the equipment shall not be subjected to environmental conditions that exceed those specified by the equipment manufacturer.

3.3.4 Adjustment of Equipment

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.

3.3.5 Warm-up Period

Unless otherwise specified, tests shall be conducted after a warm-up (stabilization) period of not more than fifteen minutes.

3.4 Test Procedures for Installed Equipment Performance

The following test procedures provide one means of determining installed equipment performance. 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 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 equipment shall be tested to demonstrate compliance with the minimum requirements stated in Subsection 2.2. In order to meet this requirement, test results supplied by the equipment manufacturer or other proof of conformity may be accepted in lieu of bench tests performed by the installing activity.

3.4.1 Ground Test Procedures

3.4.1.1 Conformity Inspection

Visually inspect the installed equipment to determine the use of acceptable workmanship and engineering practices. Verify that proper mechanical and electrical connections have been made and that the equipment has been located and installed in accordance with the manufacturer's recommendations.

3.4.1.2 Equipment Function

Vary all controls of the equipment through their full range to determine that the equipment is operating according to the manufacturer's instructions and that each control performs its intended function.

3.4.1.3 Interference Effects

With the equipment energized, individually operate each of the other electrically operated aircraft equipment and systems to determine that significant conducted or radiated interference does not exist. Evaluate all reasonable combinations of control settings and operating modes. Operate communication and navigation equipment on the low, high and at least one but preferably four mid-band frequencies. Make note of systems or modes of operation that should also be evaluated during flight. If appropriate, repeat tests using emergency power with the aircraft's batteries alone and the inverters operating.

3.4.1.4 Power Supply Fluctuations

Under normal aircraft conditions, cycle the aircraft engine (s) through all normal power settings and verify proper operation of the equipment as specified by the equipment manufacturer.

3.4.1.5 Equipment Accessibility

Determine that all equipment controls and displayed data are readily accessible and easily interpreted.

3.4.1.6 Functional Tests

a. With aircraft transceiver "on" and tuned to an appropriate test frequency, e.g., company gate frequency, with no incoming receiver signal, transmit in normal manner.

b. Transmit a test frequency and continue in transmit mode until automatic cutoff (35 seconds maximum).

c. Test any optional features in accordance with manufacturer's instructions.

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MINIMUM OPERATIONAL PERFORMANCE STANDARDS FOR DEVICES THAT PREVENT BLOCKED CHANNELS USED IN TWO-WAY RADIO COMMUNICATIONS DUE TO UNINTENTIONAL TRANSMISSIONS

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