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Minimum Operational Performance Standards (MOPS) for Global Navigation Satellite System (GNSS) Airborne Active Antenna Equipment for theL1 Frequency Band

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FOREWORD

This report was prepared by Special Committee 159 (SC-159) and approved by the RTCA Program Management Committee (PMC) on December 13, 2006.

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- developing consensus on the application of pertinent technology to fulfill user and provider requirements, including development of minimum operational performance standards for electronic systems and equipment that support aviation; and
- assisting in developing the appropriate technical material upon which positions for the International Civil Aviation Organization and the International Telecommunication Union and other appropriate international organizations can be based.

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1. PURPOSE AND SCOPE

1.1 Introduction

This document contains minimum operational performance standards (MOPS) for GNSS airborne active antenna equipment designed to use the GPS or Gallileo L1 frequency augmented by other systems/equipment/techniques as appropriate to meet the performance requirements for primary means of navigation for en route, terminal, non-precision, and precision approach phases of flight. An active antenna is one integrated with a preamplifier. Minimum requirements for passive designs are specified in DO-228 and DO-228, Change 1.

Section 1.0 of this document provides information and assumptions needed to understand the rationale for equipment characteristics and requirements stated in the remaining sections. It describes typical equipment applications and operational goals, and forms the basis for the standards stated in Sections 2.0 through 4.0.

Section 2.0 contains the minimum performance standards for the equipment. These standards define 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 conditions normally encountered in routine aeronautical operations.

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

It is recognized that any regulatory application of these standards is the responsibility of appropriate government agencies.

Inasmuch as 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.

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1.2 System Overview

The GNSS is a world-wide position, velocity, and time determination system that includes one or more satellite constellations, receivers, and system integrity monitoring, augmented as necessary to support the required navigation performance for the actual phase of operation. The GNSS includes ground control and monitoring stations, satellites, and avionics including antenna(s), and currently consists of the United States Global Positioning System (GPS), the European Galileo, the Russian Federation Global Orbiting Navigation Satellite System (GLONASS), and others. GLONASS is not covered by this MOPS. This MOPS only applies to the GPS and Galileo L1 frequency band. The planned Japan QZSS system may be included in the future. The GNSS also includes Satellite Based Augmentation Systems (SBASs), the United States WAAS, the European EGNOS, Japan's MSAS and, in the future, the Indian GAGAN.

1.3 Operational Applications

The GNSS active antenna equipment is intended to be used in all phases of aircraft operation, including on the surface, approach and landing, departure, terminal, and en route.

1.4 Intended Function

The airborne GNSS navigation system can be used as a primary means navigation system in an aircraft when approved and an operational GNSS navigation satellite system is available. Incorporated within these standards are equipment characteristics that should be useful to users, designers, manufacturers, and installers of the equipment. This document defines the antenna performance for antennas that will be used with GNSS receiver equipment in the L1 frequency band.

1.5 Operational Goals

The operational goal for the GNSS antenna is to provide adequate GNSS satellite signals under a wide range of environmental conditions and installations that will assure safe flight operations. The requirements of this document provide the minimum requirements for antennas designed for GNSS service and employing active designs at the L1 frequency.

1.6 Assumptions

It is assumed that the GNSS active antenna will be used with GNSS receiver equipment defined in an appropriate MOPS.

1.7 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.

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The order of tests specified suggests that the antenna 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 systems tests of section 3.0.

Four types of test procedures are specified. These include:

a. Environmental Tests

Environmental test requirements are specified in Section 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 antenna under environmental conditions expected to be encountered in actual operations.

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

b. Bench Tests

Bench Test procedures are specified in Section 2.4. These tests provide a laboratory means of demonstrating compliance with the requirements of Section 2.2. Test results may be used by antenna manufacturers as design guidance, for monitoring compliance, and, in certain cases, for obtaining formal approval of antenna 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 antenna tests, their successful completion is a precondition to completion of the installed tests. In certain instances, however, installed antenna tests may be used in lieu of bench test simulation of such factors as power supply characteristics, interference from, or to, other antenna 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 antenna under test.

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

d. 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(s).

1.8 Definition of Terms

Active Sub-assembly	Portion of the active antenna unit that includes all circuitry except for the passive radiating element and its associated passive feed network.

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Axial Ratio	The ratio of the major axis to the minor axis of the polarization ellipse.
dBic	dB relative to an isotropic antenna with circular polarization.
dBm	dB relative to one milliwatt.
Elevation Angle	The angle between the axis of the measurement line and the installed antenna horizontal plane.
G/T Ratio	The ratio of the passive radiating element gain to the equivalent input noise temperature of the active subassembly (referred to the passive antenna terminals)
HIRF	High Intensity Radiated Fields (e.g., from a off-board high power radar transmitter)
Polarization	That property of a radiated electromagnetic wave describing the time-varying direction and amplitude of the electric field vector; specifically, the figure traced as a function of time by the extremity of the vector at a fixed location in space, as observed along the direction of propagation.
Total Transducer Gain	The product of the active antenna unit passive antenna element gain and the active subassembly gain.
VSWR	Voltage Standing Wave Ratio.

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