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Minimum Operational Performance Standards for GPS Ground-Based Regional Augmentation System Airborne Equipment

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Foreward

This document was prepared by RTCA Special Committee 159 (SC-159) and approved by the RTCA Program Management Committee (PMC) on March 13, 2008.

Airservices Australia sponsored the development of this standard to support the concurrent development, design, specification and commercialization of the ground portion of the Ground based Regional Augmentation System.

RTCA, Incorporated is a not-for-profit corporation formed to advance the art and science of aviation and aviation electronic systems for the benefit of the public. The organization functions as a Federal Advisory Committee and develops consensus-based recommendations on contemporary aviation issues. RTCA's objectives include but are not limited to:

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- Developing consensus on the application of pertinent technology to fulfill user and provider requirements, including development of Minimum Operation Performance Standards (MOPS) 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 (ICAO) and the International Telecommunication Union (ITU) and other appropriate international organizations can be based.

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This document was based on DO-253B, DO-229D and ICAO SARPS.

If a requirement from DO-253B is completely applicable, the section/subsection in this document will contain the statement "The equipment shall [GRAS-470] meet the requirements of (Applicable Standard such as DO-253B, Section 2.3.2, 'Design Assurance')." Note that the requirements numbering sequence in this document starts at 401 and corresponds to 001 for DO-253B which currently has requirements from 001 to 317. This document will have requirements running from 401 to 717, less any DO-253B requirements which do not apply plus any new requirements which will start at 801. Thus [GRAS-470] corresponds to DO-253B requirement [LAAS-070]. DO-229D 'shall' requirements were not numbered so when a section from DO-229D is referenced, it will be indicated together with requirement numbers starting at 801.
A new Test Cross Reference Matrix that includes all the minimum performance requirement 'shalls' was created using the one in DO-253B as the starting point. It has a column added between the Requirement Section reference and the DO-253B requirement number that shows the new requirements numbers [i.e. 401 etc]. When a DO-229D or other requirement is added, as noted above, it will have a requirement number in the range of 801-1495 and no corresponding DO-253B requirement number. The Test Cross Reference Matrix – Table 2-12 captures the minimum performance requirement shalls in Sections 2.1 through 2.5. Shalls in Sections 2.6 & 2.7 are test requirements and are not included in Table 2-12.

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1 PURPOSE AND SCOPE

1.1 Introduction

This document contains minimum operational performance standards (MOPS) for airborne navigation equipment using signals from the Global Navigation Satellite System (GNSS) augmented by a Ground-Based Regional Augmentation System (GRAS). These standards are derived from the requirements specified in RTCA DO-253B, *Minimum Operational Performance Standards (MOPS) for the Local Area Augmentation System (LAAS), RTCA DO-229D Minimum Operational Performance Standards for GPS/WAAS Airborne Equipment, and ICAO Annex 10, Volume 1, GNSS SARPS* (Amendment 81 to the ICAO Annex 10 Volume 1).

Rather than repeat verbatim the words from the above Standards, this Standard references the source Standard. Where no change in wording is necessary to the source Standard, this Standard simply refers to the source by Document Number i.e. DO-253B and Section number and Name. For example,

> Section 2.1.4 General Human Factors Requirements and Applicable Documents
>
> The GRAS equipment shall *[GRAS-404]* meet the requirements of DO-253B, Section 2.1.4, 'General Human Factors Requirements and Applicable Documents'.

If the referred Section in DO-253B contains the word LAAS, for the purposes of this Document, LAAS shall be interpreted as meaning GBAS or GRAS as appropriate.

If a minor change was necessary, the reference was either modified with a description of the exception or the requirement modified by saying for example, "except that "PAN" is deleted".

Requirements are described as "shalls" and are followed by a reference number e.g. *[GRAS-437]* which is listed in a matrix of test requirements elsewhere in this Standard. To eliminate any possible confusion with the test reference numbering, the GRAS test reference numbers in this document start at 401. The LAAS [DO-253B] numbers start at 001 and currently end at 317. The test reference numbers in this document between 401 and 717 are the DO-253B number plus 400. Additional requirements either new or from other Standards begin at 801.

Throughout this document, the term "GRAS" is used as a generic reference to Ground-Based Augmentation Systems (GBAS) as defined by the International Civil Aviation Organization (ICAO) in Annex 10, Volume 1, Chapter 3. The requirements in this standard are intended to meet the ICAO Standards and Recommended Practices (SARPs) for the GBAS aircraft element.

The standards in this document define minimum performance requirements, functions and features for GRAS airborne equipment to support all phases of flight including en-route, terminal, LNAV (Lateral NAVigation), LNAV/VNAV (Lateral NAVigation/Vertical NAVigation), LP (Localizer Approach with FAS data but without vertical guidance), LPV (Localizer Precision with Vertical guidance) (but not CAT-I/II/III). It is also intended that GRAS will support guided missed approach, departure with vertical guidance, surface guidance and other operational needs as they evolve in the future. GRAS equipment will be compatible with GBAS and will be able to use the signal in space for approved approach operations.

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This standard covers the computation and output of position, velocity, and time (PVT) to support area navigation and other applications such as Automatic Dependence Surveillance Broadcast (ADS-B).

Note: The requirements for area navigation systems continue to evolve. Applicable standards include RTCA/DO-236(), RTCA/DO-229D, RTCA/DO-187() (as amended by TSO-C115()) and RTCA/DO-208() (as amended by TSO-C129()).

Compliance with these standards by manufacturers, installers and users is recommended as a means of assuring that the equipment will satisfactorily perform its intended functions under conditions encountered in routine aeronautical operations.

The regulatory application of these standards is the responsibility of appropriate government agencies. In the United States, the Federal Aviation Administration (FAA) plans to publish one Technical Standard Order (TSO) for GRAS. TSO-C162 covers the VDB requirements for GBAS and is applicable to GRAS.

The word "equipment" or “GRAS equipment”, as used in this document, includes all components or units necessary (as determined by the equipment manufacturer or installer) to properly perform its intended function. Thus with reference to Figure 1-4 the “equipment” may include some or all of the shaded functionality in addition to the basic functionality (cross-hatched) that is necessary to properly perform its intended function.

In this document, the term “shall” is used to indicate requirements. An approved design would meet every requirement, which can be assured by inspection, test, analysis, or demonstration. The term “must” is used to identify items which are important but are either duplicated somewhere else in the document as a “shall”, or are considered to be outside the scope of this document. The term “should” is used to denote a recommendation that would improve the GRAS equipment, but does not constitute a minimum requirement.

This document facilitates traceability by identifying each specific requirement with a requirement designator. The notation “[GRAS-XXX]”, where XXX is a three or four digit number, identifies each specific requirement for traceability purposes.

Section 1 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.

Section 2 contains the GRAS equipment performance requirements and test procedures for the GRAS equipment. These standards define required performance under standard operating conditions and stressed physical environmental conditions.

Section 3 provides references to guidance material for installed equipment performance.

Section 4 provides references to guidance material describing GRAS operational characteristics.

Appendix A contains a listing of acronyms, abbreviations and definitions.

Appendices C & F of DO-253B and Appendices C, D, E, F, G, H, I, K, L, M, N, Q, R & U of DO-229D apply whether specifically referenced or not.

1.2 Notional GRAS Overview

GRAS has been developed as a GNSS augmentation system to provide enhanced accuracy, PVT, continuity and integrity for GPS. This standard explicitly addresses the

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