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Minimum Operational Performance Standards for Airborne Area Navigation Equipment Using a Single Collocated VOR/DME Sensor Input

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SC-137

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FOREWORD

This document was prepared by Special Committee 137 of the Radio Technical Commission for Aeronautics. It was approved by RTCA on May 24, 1990 and supersedes RTCA/DO-180, *Minimum Operational Performance Standards for Airborne Area Navigation Equipment Using VOR/DME Reference Facility Sensor Inputs*, approved September 17, 1982.

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1.0 PURPOSE AND SCOPE

1.1 Introduction

This document contains minimum operational performance standards (MOPS) for airborne area navigation equipment (2D and 3D) operated in the National Airspace System (NAS) using inputs from a single collocated VOR/DME station. Performance standards for equipment operated in other airspace, such as the North Atlantic Minimum Navigation Performance Standard (MNPS), are contained in the respective guidance material for that airspace. RNAV performance standards for equipment using other sensor inputs, such as multiple VOR or DME stations, including scanning DMEs, inertial navigation sensors and Loran-C, are contained in other RTCA MOPS. Incorporated within these standards are equipment characteristics that should be useful to users, designers, manufacturers and installers of the equipment. This document defines the performance, functions and features for a 2D system that performs only lateral guidance and a 3D system that performs both lateral and vertical guidance. Equipment may be manufactured and tested to meet 2D or 3D requirements (or both) in the en route, terminal and approach modes or any combination thereof.

Section 1.0 of this document provides information 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. Definitions and assumptions 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 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. In addition, to safely and efficiently implement area navigation, it is mandatory that the airborne equipment be designed such that all airborne operations responding to like controller instructions will result in similar maneuvering of the aircraft, regardless of system type.

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. For example, the airborne area navigation "equipment" may include: sensor(s), a computer unit, an input-output unit which interfaces with existing aircraft displays/systems, a control unit, a display, shock mount(s), etc. In the case of this example, all of the foregoing components or units comprise the "equipment." It should not be inferred from this example, however, that every area navigation equipment will necessarily include all of the foregoing components or units. This will depend upon the design used by the equipment manufacturer.

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

The equipment manufacturer should consider the criticality appropriate for installation certification in determining the level of software requirements as defined in RTCA/DO-178A, equipment failure analysis and fault monitoring to be accomplished.

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.

1.2 System Characteristics

An area navigation system, herein referred to as RNAV equipment, is an airborne device or combination of devices whose fundamental purpose is to provide navigation information relative to a selected geographically located point (called a waypoint).

In practice, the lateral navigation information displayed to the pilot commonly takes the form of bearing and distance from present aircraft position to the defined waypoint and deviation from a desired track proceeding to or from the waypoint. Supplemental information may also be supplied by some equipment to aid the pilot in various ways, but this information is peripheral to the basic function of the equipment.

Vertical Navigation (VNAV) may also be implemented to aid in compliance with specified altitudes and altitude constraints at waypoints.

The navigation accuracy of the RNAV equipment will permit navigation along and within conventional routes and airways and along random area navigation routes.

The capabilities of this equipment, if extended for terminal area and approach operations, must be compatible with navigation routes and procedures in the terminal area environment. RNAV equipment should also permit navigation along and within airspace allocated for RNAV non-precision approaches.

1.2.1 Waypoint Definition

A waypoint may be identified in several ways, i.e., by name, number or location. Waypoint location is necessary in the computation of navigation information and to minimize pilot workload during time critical phases of flight. At a minimum, enough waypoints should be provided to define the current and next two legs in the en route phase of flight, and to define an approach and missed approach. If the equipment is designed for long range en route navigation only, i.e., MNPS, waypoint definitions for approach and missed approach can be omitted.

In some mechanizations, waypoints are entered into the equipment in terms of their latitude and longitude. In other equipment, a waypoint's location may be specified in terms of a bearing and distance from any place whose position is itself known to the RNAV equipment. Additionally, for equipment employing VNAV, altitude/height information may be associated with a waypoint.

Fundamentally, RNAV equipment performing lateral navigation requires only one or, at the most, two waypoints at a time to provide navigation information. The number of waypoints that must be stored will be a function of the equipment mechanization ("TO-FROM" or "TO-TO") and the flight phase (en route/terminal/approach).