RTCA, Inc.
1150 18th Street, NW, Suite 910
Washington, DC 20036 USA

Minimum Operational Performance Standards for the Depiction of Navigational Information on Electronic Maps

RTCA DO-257B
March 22, 2018

Prepared by: SC-227
©2018, RTCA, Inc.

Copies of this document may be obtained from

RTCA, Inc.
1150 18th Street, NW, Suite 910 Washington, DC 20036 USA

Telephone: 202-833-9339
Facsimile: 202-833-9434
Internet: www.rtca.org

Please visit the RTCA Online Store for document pricing and ordering information.

FOREWORD

This document was prepared by Special Committee 227 (SC-227) and approved by the RTCA Program Management Committee (PMC) on March 22, 2018.

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:

- coalescing aviation system user and provider technical requirements in a manner that helps government and industry meet their mutual objectives and responsibilities;

- analyzing and recommending solutions to the system technical issues that aviation faces as it continues to pursue increased safety, system capacity and efficiency;

- 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.

The organization's recommendations are often used as the basis for government and private sector decisions as well as the foundation for many Federal Aviation Administration Technical Standard Orders and several advisory circulars.

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.

"Disclaimer"

This publication is based on material submitted by various participants during the SC approval process. Neither the SC nor RTCA has made any determination whether these materials could be subject to valid claims of patent, copyright or other proprietary rights by third parties, and no representation or warranty, expressed or implied is made in this regard. Any use of or reliance on this document shall constitute an acceptance thereof "as is" and be subject to this disclaimer.

This Page Intentionally Left Blank

EXECUTIVE SUMMARY

RTCA/DO-257A was originally prepared by RTCA Special Committee 181 (SC-181). It was approved by the RTCA Program Management Committee on June 25, 2003 and supersedes RTCA/DO-257, Minimum Operational Performance Standards for the Depiction of Navigational Information on Electronic Maps. RTCA/DO-257B was prepared by RTCA Special Committee 227 (SC-227). It was approved by the RTCA Program Management Committee on March 22, 2018 and supersedes RTCA/DO-257A.

The purpose of this revision is to incorporate recent changes made in DO-236C/ED-75D[43] and DO-283B[47], reflect current human factors standards and address technology updates for display systems. DO-236C/ED-75D[43] contains Minimum Aviation System Performance Standards (MASPS) for area navigation systems in a Required Navigation Performance (RNP) environment. The equipment requirements are further defined in DO-283B[47] by the Minimum Operational Performance Standards (MOPS). Each of those documents were recently updated to assist designers, manufacturers, and installers of avionics equipment, service providers and users of RNP systems to improve navigation capability for world-wide operations. DO-257B incorporates the DO-236C/ED-75D[43] MASPS and DO-283B[47] MOPS changes for RNP operations that are presented via navigation information to the flightcrew on the flight displays.

Additionally, current human factors data reflected in documents such as AC 25-11B[18] and other related guidance was added in this revision to provide display usability information for display equipment designers and manufacturers.

This Page Intentionally Left Blank

TABLE OF CONTENTS

1.0 PURPOSE AND SCOPE 1

1.1 Introduction 1
1.2 System Overview 2
1.2.1 EMD Systems Covered by this MOPS 2
1.2.1.1 Processing 3
1.2.1.2 Display 3
1.2.1.3 Controls 3
1.2.2 Data Sources 3
1.2.2.1 Database 4
1.2.2.2 Position Source 4
1.2.2.3 Additional Data 4
1.3 Operational Application 4
1.4 Intended Function(s) 4
1.5 Operational Goals 5
1.6 Assumptions 5
1.7 Test Requirements 5
1.7.1 Environmental Tests 5
1.7.2 Bench Tests 6
1.7.3 Installed Equipment Tests 6
1.7.4 Installed Operational Performance Characteristics 6
1.8 Definitions of Terms 6
1.8.1 Definitions Unique to this MOPS 6
1.8.2 Standard Definitions 8
1.9 Aircraft Equipment Information Vulnerabilities 8

2.0 EQUIPMENT PERFORMANCE REQUIREMENTS AND TEST PROCEDURES 11

2.1 General Requirements 11
2.1.1 Airworthiness 11
2.1.2 Intended Function(s) 11
2.1.3 Federal Communications Commission Rules 11
2.1.4 Fire Protection 11
2.1.5 Controls 11
2.1.5.1 General 12
2.1.5.2 Layout 13
2.1.5.3 Keypads 13
2.1.5.4 Rotary Knobs 14
2.1.5.5 Cursor Control Device 15
2.1.5.6 Touch Screens 15
2.1.6 Color 16
2.1.7 Effects of Tests 17
2.1.8 Design Assurance 17
2.1.9 Shared Display Considerations 18
2.2 Equipment Performance Requirements: Standard Conditions -All EMDs 19
2.2.1 Symbols 19
2.2.2 Labels 20
2.2.2.1 General 20

2.2.2.2 Labels for Fixes, Waypoints and Other Symbols 20
2.2.2.3 Data Field Labels 21
2.2.2.4 Controls Labels 21
2.2.3 Display 22
2.2.4 Display Operating Characteristics and Status Indications 23
2.2.4.1 General 23
2.2.4.2 Map Range and Panning 23
2.2.4.3 Map Orientation 24
2.2.4.4 Update Rate 25
2.2.4.5 Decluttering 26
2.2.5 Database 26
2.2.5.1 Database Standard 26
2.2.5.2 Database Interface 27
2.2.5.3 Database Version and Operating Period 27
2.3 Equipment Performance Requirements: Standard Conditions – Plan View Map Display 28
2.3.1 Map Depiction 28
2.3.2 Symbols 28
2.3.3 Flight Plan Displayed on the EMD 29
2.3.4 Display of the RNP System Active Sensor 30
2.3.5 Waypoints 31
2.3.6 Defined Path 31
2.3.7 Display of Additional Information on the EMD 32
2.4 Equipment Performance Requirements: Standard Conditions – Aerodrome Moving Map Display 32
2.4.1 Map Depiction 32
2.4.1.1 Position Accuracy 32
2.4.1.2 Map Attributes 35
2.4.1.2.1 Runways 35
2.4.1.2.2 Taxiways 35
2.4.1.2.3 Taxi Routes 36
2.4.1.3 Depiction of Ownship Position 36
2.4.1.4 Layering Prioritization of Aerodrome Map Features 37
2.5 Equipment Performance Requirements: Standard Conditions- Vertical Situation Display 37
2.5.1 VSD Depiction 37
2.5.1.1 Swath 38
2.5.1.2 Symbols 40
2.5.1.3 Flight Plan Display on the VSD 40
2.5.1.3.1 Defined Vertical Path 42
2.5.1.3.2 Waypoint Altitude Constraints 42
2.5.1.4 Display of Additional Information 42
2.5.1.4.1 Scales 42
2.5.1.4.2 Vertical Information Depiction 43
2.5.2 Labels 44
2.5.3 Display Operating Characteristics and Status Indications 44
2.5.4 Shared Display Considerations 44
2.6 Equipment Performance – Environmental Conditions 45
2.7 Equipment Performance Bench Test Requirements 46
2.7.1 Definitions of Terms and Conditions of Test 47
2.7.2 Required Test Equipment 47
2.7.3 Detailed Test Procedures 48
2.7.3.1 Bench Test Characteristics 48

2.7.3.1.1 Initial Conditions 48
2.7.3.1.2 Bench Test Scenarios 48
2.7.3.2 EMD Requirements and Test Cross Reference 49
2.7.3.3 Verification by Demonstration 51
2.7.3.4 Display Orientation 51
2.7.3.5 Map Range 52
2.7.3.6 Placement and Orientation Accuracy of Symbols and Graphics 52
2.7.3.7 Display Update Rate 54
2.7.3.8 Flight Plan Edit 54
2.7.3.9 Defined Path 55
2.7.3.10 Position Accuracy 55
2.7.3.11 VSD Symbols 55
2.7.3.12 Flight Plan Display 56
2.7.3.13 Display of Additional Information 56
2.7.3.14 Vertical Information Depiction 56

3.0 MANUFACTURER CONSIDERATIONS FOR INSTALLED EQUIPMENT 57

3.1 EMD Installation 57
3.2 Installed Equipment Performance Requirements 57
3.2.1 Installed Equipment Performance Requirements for RNP 57
3.2.2 AMMD System Installed Equipment Performance Requirements 58
3.2.3 VSD Installed Equipment Performance Requirements 59
3.3 Test Procedures for Installed Equipment Performance 59
3.3.1 EMD Symbology Test Procedure 59
3.3.2 EMD Graphical Flight Planning 59

4.0 EQUIPMENT OPERATIONAL PERFORMANCE CHARACTERISTICS 61

5.0 MEMBERSHIP 63

APPENDIX A ABBREVIATIONS A-1

APPENDIX B ACRONYMS AND GLOSSARY B-1

B.1 Acronyms B-1
B.2 Glossary B-2

APPENDIX C BIBLIOGRAPHY AND REFERENCES C-1

C.1 International Civil Aviation Organization (ICAO) Publications: C-1
C.2 Federal Aviation Administration (FAA) Publications: C-1
C.3 European Aviation Safety Agency (EASA) Publications: C-2
C.4 RTCA, INC. Documents: C-3
C.5 Society of Automotive Engineer (SAE) Publications: C-3
C.6 Military Publications: C-3
C.7 Other Publications: C-4

APPENDIX D LIST OF SHALLS.....D-1

D.1 General Requirements D-1
D.2 Equipment Performance Requirements.....D-2

APPENDIX E GUIDANCE FOR THE USE OF COLOR ON ELECTRONIC MAP DISPLAYS……..E-1

E.1 Potential Issues and Limitations E-1
E.2 Conventions E-1
E.3 Recommendations..... E-2

TABLE OF TABLES

Table 1-1: Terms for Use in Performance Requirements and Test Procedures 8
Table 2-1: Minimum Set of Information Display and Control Function Requirements 19
Table 2-2: Environment and Test Performance Requirements 46
Table 2-3: Requirements/Test Cross Reference..... 50
Table A-1: Abbreviations A-1
Table D-1: General requirements.....D-1
Table D-2: Equipment Performance Requirements D-2
Table E-1: Color Coding..... E-1

TABLE OF FIGURES

Figure 1-1: Electronic Map Display System 3
Figure 2-1: Keypad Layouts..... 14
Figure 2-2: Viewing Angles..... 22
Figure 2-3: Rotating and Non-Rotating Symbols 29
Figure 2-4: Examples of GPS Antenna Offset..... 34
Figure 2-5: Track Mode VS. Flight Plan Mode..... 38
Figure 2-6: Swath Adjustment to Look into Turn..... 39
Figure 2-7: Non-Rotated Symbol Placement Error 52
Figure 2-8: Rotated Symbol Placement and Orientation Error 53
Figure 2-9: Define Path Orientation and Error 53
Figure 2-10: Cross Track Deviation Error..... 54

1.0 PURPOSE AND SCOPE

1.1 Introduction

This document contains minimum operational performance standards (MOPS) for the graphical depiction of navigation information on electronic map displays (EMDs) used for flightcrew awareness of the aircraft/ownship position relative to other items depicted on the EMD. The EMD is intended to support, but not replace, the navigation and guidance information presented on the primary flight displays. This document includes requirements for electronic map displays depicting the plan view (in-flight), airport map (surface), and vertical (profile) information.

Navigation information, as used in this document, is information intended to be used to assist the pilot to identify the aircraft's position with respect to flight plans, fixes, and navaids (such as VORs, NDBs, etc.) as well as items on the airport surface. The requirements in this MOPS have been updated to support RNP systems, specifically when the plan view map is displayed and used to display defined paths generated by the RNP system. Additionally, this MOPS assumes no changes to operational requirements. These standards may be applied to moving map displays irrespective of the display technology used (see definitions in Section 1.8). These standards specify EMD characteristics that should be useful to designers, manufacturers, installers, and users of the EMD.

Compliance with these standards is recommended as one means of assuring that the EMD will perform its intended function(s) (see Intended Function(s) in Section 1.4) satisfactorily under all conditions normally encountered in routine aeronautical operations. Any regulatory application of these standards is the sole responsibility of the appropriate governmental agencies.

Section 1.0 provides information on purpose and scope needed to understand the rationale for EMD characteristics and standards stated in the remaining sections. It describes typical EMD applications and operational goals as well as establishes the basis for the standards stated in Sections 2.0 through 3.0. Definitions and assumptions essential to proper understanding of this document are also provided in this section.

Section 2.0 contains general guidance and minimum performance standards for the EMD. These standards specify the required performance under standard operating and environmental conditions. Section 2.1 contains requirements and general guidance that may not have associated test procedures. Section 2.1 and 2.2 provide requirements for all EMDs addressed in this document, including the plan view map, airport map, and vertical situation displays (VSD). Requirements in Section 2.3 apply to the plan view map display. Requirements in Section 2.4 apply only to airport map displays. Requirements in Section 2.5 apply only to the VSD. Also included are recommended bench test procedures necessary to demonstrate EMD compliance with the stated minimums.

Section 3.0 describes manufacturer's considerations for installed equipment performance and references source documents for installation guidance.

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

Appendix A is a list of abbreviations recommended for use with EMDs and associated documents. Appendix B contains a glossary of terms and acronyms, while Appendix C contains a bibliography and a list of all references cited in this document. Appendix D

 © 2018, RTCA, Inc.

contains a list of all "shall" requirements in the body of the document (summarized for the convenience of the applicant and test team). Appendix E contains guidance on the use of color.

The acronym EMD, as used in this document, includes all components and features necessary for the system to properly perform its intended function(s). Standards for the design and implementation of optional features, beyond those required for a minimum EMD, only apply if those features are implemented. This MOPS also includes characteristics of the operational environment for which these requirements are appropriate.

1.2 System Overview

An electronic map display system, herein referred to as the EMD, is a flight deck device or combination of devices which includes electronic map displays depicting any combination the plan view, airport map, and VSD information. The intent of this MOPS is to specify requirements for EMDs that are used to aid the flightcrew when navigating or taxiing the aircraft. It is recognized that the equipment that generates the electronic map defined in this document may also generate other information on the same display, such as a Course Deviation Indicator (CDI) or a flight director. However, this MOPS only addresses the aspects of the EMD specified in Figure 1-1. References to other standards are provided where available and appropriate.

As shown in Figure 1-1, the EMD will receive inputs from a navigation system or sensor (e.g., flight management system, Global Navigation Satellite System (GNSS) navigator, etc.). The components that drive the EMD, such as the navigation position source, database, etc., may be either internal or external to the physical box or a partitioned function that houses the EMD. In either case, the requirements in this document pertain to the EMD, the associated human-machine interfaces (display, controls, etc.), and relevant internal database(s). In the cases where components are external, there are still requirements in this MOPS that apply, e.g. navigation data quality, interfaces, performance, etc. In addition, this document contains requirements related to the position sensor for Aerodrome Moving Map displays. In this MOPS, all other components are considered outside the scope of this document (see Figure 1-1).

1.2.1 EMD Systems Covered by this MOPS

The EMD may have the physical form of a processing unit including microprocessor, display, input/output of digital data signal and analog discrete signals, and program memory. Additionally, the processing unit will include or be complemented by a unit designed to allow for flightcrew interface and interaction with the EMD, such as a control panel. Figure 1-1 below illustrates a functional configuration and its interfaces.

> *Note: The figure is not intended to illustrate all elements of the performance and functional requirements contained in this MOPS.*

© 2018, RTCA, Inc.