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

Minimum Aviation System Performance Standards (MASPS) for Enhanced Vision Systems and Enhanced Flight Vision Systems

RTCA DO-408
December 13, 2024

Prepared by SC-213
© 2024, RTCA, Inc.

Copies of this document may be obtained from
RTCA, Inc.
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 originally prepared by the RTCA Special Committee 213 Standards for Enhanced Flight Vision Systems and Synthetic Vision Systems (EFVS/SVS) jointly with EUROCAE WG-79. It was approved by the RTCA Program Management Committee on December 12, 2024 and the EUROCAE Council on December 12, 2024.

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 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 (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.

The recommendations of RTCA 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 (TSOs).

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 United States Government organization or agency having statutory jurisdiction over any matters to which the recommendations relate.

EXECUTIVE SUMMARY

RTCA DO-408/EUROCAE ED-327 was originally prepared by RTCA Special Committee 213 (SC-213)/ EUROCAE Working Group 79 (WG-79). It was approved by the RTCA Program Management Committee EUROCAE Council on December 12, 2024. This document refines and expands the previously defined requirements for Enhanced Vision Systems (EVS) and Enhanced Flight Vision Systems (EFVS).

TABLE OF CONTENTS

1 PURPOSE AND SCOPE 1

1.1 Introduction and Purpose of Document 1
1.2 Scope of the Document 1
1.3 Background 2
1.4 Structure of the Document 3
1.5 Relationship to ICAO Documents 4
1.6 References 4
1.6.1 RTCA and EUROCAE References 4
1.6.2 Other References 5

2 APPROACH AND METHODOLOGY 9

2.1 Document Development Process 9
2.2 Methodology 9
2.3 EVS and EFVS Intended Function 9
2.3.1 EFVS Used During Category 2 and 3 Operations 13
2.3.2 Use of EFVS for Lower than Standard Take-Off Credit 13
2.4 Concept of Operations 13
2.4.1 Operational Use of EVS 13
2.4.2 Operational Use of EFVS 14
2.4.3 Flight Crew Roles and Responsibilities 15
2.4.4 Required Visual References 16
2.4.5 EFVS Operations to 100 feet above the TDZE (Capability 1) 16
2.4.6 EFVS Operations to Touchdown and Roll-Out (Capability 2 and 3) 17
2.4.7 EFVS Operational Credit 19
2.5 Key Terms and Definitions 19
2.5.1 Definitions 19
2.5.2 Key MASPS Terms 21
2.5.3 Application of “Shall” and “Should” 21

3 SYSTEM PERFORMANCE REQUIREMENTS (MASPS) 23

3.1 Operational Performance Assessment (OPA) Process 23
3.2 Assumptions 23
3.3 Requirements Overview 23
3.3.1 Requirements Hierarchy 23
3.4 EVS Requirements 24
3.4.1 EVS Performance Requirements 24
3.4.2 EVS Equipage Requirements 25
3.5 EFVS Requirements 30
3.5.1 EFVS Operational Requirements 32
3.5.2 EFVS Performance Requirements 37
3.5.3 EFVS Equipage Requirements - HUD 43
3.5.4 EFVS Equipage Requirements – Sensor and Imagery 47
3.5.5 EFVS Equipage Requirements – Controls 54
3.5.6 EFVS Equipage Requirements – Landing Roll-Out Failure Mitigations for Capability 3 EFVS 55

3.5.7 EFVS Equipage Requirements – Pilot Monitoring 60
3.6 Safety Requirements 61
3.6.1 EVS/EFVS Safety Requirements 61

4 INTEROPERABILITY REQUIREMENTS 67

4.1 Purpose of Interoperability Requirements 67
4.2 Scope of Interoperability Requirements 67
4.3 EVS/EFVS Operational Domains 67
4.4 Ownship Domain 67
4.5 Other Aircraft and Vehicles Domain 67
4.6 Airspace and Ground Domain 67
4.7 EVS/EFVS Interoperability Requirements 68
4.7.1 EVS Interoperability Requirements 68
4.7.2 EFVS Interoperability Requirements 68
4.7.3 Interop Data for EFVS 69

5 PERFORMANCE VERIFICATION 71

5.1 Verification Methodology 71
5.1.1 Verification 71
5.2 Analysis and Laboratory/Bench Tests 72
5.2.1 Installed equipment 72
5.2.2 Enhanced Vision Sensor Performance 73
5.3 Operational Performance Assessment 74
5.3.1 General Requirements 74
5.4 Simulation / Flight Testing 75
5.4.1 Testing 75
5.4.2 Environment 76
5.4.3 Test Conditions 76
5.4.4 Test Points 78
5.5 Evaluations 79
5.5.1 Taxi 79
5.5.2 Take-off 80
5.5.3 Climb and Descent and Lateral Modes 80
5.5.4 Instrument Approaches to the DA/DH 80
5.5.5 Final Approach from the DA/DH, Flare, Landing, and Roll-out To Safe Taxi Speed. 81
5.5.6 Rejected Landing 82
5.5.7 Pilot Monitoring (PM) 82
5.5.8 Failure Cases 83
5.5.9 Ice Protection System 85
5.5.10 Evaluation Matrix 85

6 MEMBERSHIP 89

APPENDIX A OPERATIONAL SERVICES AND ENVIRONMENT DEFINITION A-1

APPENDIX B SYSTEM SAFETY REQUIREMENTS LOGIC B-1

B.1 System Safety Requirements Overview B-1
B.1.1 Hazard Assessment B-2
B.1.2 System Safety Levels and Probabilities B-2

B.1.3 Design Assurance Levels and Demonstration B-2
B.1.4 Environmental Qualification B-3
B.1.5 Safety Demonstration B-3
B.1.5.1 Mitigations B-3
B.2 Example Functional Hazard Assessments B-4
B.2.1 EFVS Capability 1: Operations to 100 feet height above the TDZE B-6
B.2.2 EFVS Capability 2: Operations to touchdown and roll-out (Minimum flight visibility for roll-out to a safe taxi speed) B-19
B.2.3 EFVS Capability 3: operations to touchdown and roll-out (Insufficient natural visibility for roll-out to a safe taxi speed) B-25

Table of Tables

Table 2-1: Lowest Minima Currently Authorized for FO or FP Landing Systems, or Landing and Rollout Systems 9
Table 2-2: Capabilities supporting Intended Function of EVS and EFVS 10
Table 2-3: Required Visual References per 14 CFR §91.176 16
Table B- 1: Hazard Assessment Effects, Probabilities and Design Assurance Levels B-2
Table B-2 - Example EFVS FHA, Part 25 aircraft, EFVS operation: MDA/DA/DH to 100 feet above the TDZE (Capability 1) B-7
Table B-3 - Example EFVS FHA, Part 25 aircraft, EFVS operation: DA/DH to touchdown, roll-out in minimum flight visibility (Capability 2) B-20
Table B-4 - Example EFVS FHA, Part 25 aircraft, EFVS operation: DA/DH to touchdown, roll-out in insufficient flight visibilities for safe roll-out (Capability 3) B-26

Table of Figures

Figure 1-1: EVS / EFVS diagram 3
Figure 1-2: Hierarchy of Requirements for EVS and EFVS 4
Figure 2-1: Salient Features of Capability 1 EFVS 11
Figure 2-2: Salient Features of Capability 2 EFVS 12
Figure 2-3: Salient Features of Capability 3 EFVS 12
Figure 2-4: EFVS Operation to 100 ft Above Touchdown Zone Elevation 17
Figure 2-5: EFVS Operation to Touchdown and Roll-out 18

Figure B- 1: Flight Phase Categories for FHA Definition B-5

1 PURPOSE AND SCOPE

1.1 Introduction and Purpose of Document

This Minimum Aviation System Performance Standard (MASPS) provides high-level system requirements for Enhanced Vision Systems (EVS) and Enhanced Flight Vision Systems (EFVS).

This document consolidates, clarifies, and expands requirements and intended functions previously published in DO-315(-) and DO-341. This document is intended to supersede these previous EFVS MASPS.

Synthetic Vision (SV) and Combined Vision System (CVS) requirements are contained in DO-407/ED-326.

Civil Aviation Authorities may use these performance standards to develop airworthiness criteria and approval processes for EVS or EFVS.

This standard is a product of a joint RTCA/EUROCAE industry committee to set standards that can be utilized by EASA, FAA and other regulatory organizations. The standards of this MASPS are global in nature and have international implications. They are written primarily to meet and logically expand upon the definitions and operational applications as established in the U.S. and in Europe. However, the regulatory structure of other civil aviation authorities may contain terminology and operational concepts that differ, and therefore impact corresponding requirements.

1.2 Scope of the Document

This document establishes the operational, system performance, equipage, safety, and interoperability requirements for EVS and EFVS, present and future.

This MASPS pertains to Parts 21, 23, 25, 27, and 29 aircraft. Additional requirements may be necessary for non-fixed wing aircraft (e.g., see RTCA DO-375/Eurocae ED-255). Specific installation and operational deployment issues associated with other vehicles, e.g., Urban Air Mobility and Advanced Air Mobility applications, have not been considered fully at this time.

This MASPS is written to span present capabilities as well as future technology developments and applications for EFVS within the framework as defined in the US under §91.176 for approach and landing in lieu of natural vision.

Synthetic Vision System (SVS) elements may be merged with EVS or EFVS, creating a CVS. The requirements for adding SVS to an EVS or EFVS are in DO-407/ED-326.

An EFVS requires the use of a Head-Up Display (HUD) or equivalent display. However, this document is not intended to be a HUD-approval document. The HUD is separately certified and will remain subject to all applicable rules and guidance for the category of aircraft and operation. This MASPS pertains only to those HUD items specific and unique to EVS/EFVS.

A HUD-equivalent display as per 14 Code of Federal Regulations (CFR) Part 91.176 is allowable within the regulation. The equivalent display requirements are defined as those for a HUD, including system requirements and demonstration of all safety and performance

 © 2024 RTCA, Inc.

aspects. At this time, this MASPS assumes only a HUD and proof that these requirements can be met by a display other than a HUD is not presumed. Additional requirements or elements may be required for the use of an equivalent display, such as a head-worn display, and are not articulated within this document. For simplicity, the term “equivalent display” will not be used across this entire document.

The scope of this MASPS is focused on standards for equipage eligibility to meet the definitions, intended functions, and operational applications as defined in 14 CFR §1.1, §91.176, §121.651, §125.381, and §135.225. Similar references are found in EU Regulations, such as (EU) 2023/1020, (EU) 2021/2237, (EU) No. 965/2012, and ED Decision 2022/012/R.

It should be noted that the European Union Aviation Safety Agency (EASA) terminology and operational credit may differ from that of the United States. EASA’s operational concept and corresponding requirements may also be slightly different from those of the Federal Aviation Administration (FAA). Notable differences are highlighted where appropriate.

1.3 Background

EVS is an electronic means to provide a display of the external scene topography (the natural or engineered features of a place or region especially in a way to show their relative positions and elevation) through the use of imaging sensors, such as a forward looking infrared, millimeter wave radiometry, millimeter wave radar, low light level image intensifying.

Per 14 CFR §1.1, an Enhanced Flight Vision System (EFVS) is an installed aircraft system which uses an electronic means to provide a display of the forward external scene topography (the natural or manmade features of a place or region especially in a way to show their relative positions and elevation) through the use of imaging sensors, including but not limited to forward-looking infrared, millimeter wave radiometry, millimeter wave radar, or low-light level image intensification. An EFVS includes the display element, sensors, computers and power supplies, indications, and controls.

Unlike an EFVS, an EVS does not necessarily provide the additional flight information/symbology required by 14 CFR §91.176, might not use a HUD or an equivalent display, and might not be able to present the image and flight symbology in the same scale and alignment as the outside view. As such, an EVS cannot be used as a means to determine enhanced flight visibility or to identify the required visual references and descend below DA/DH or MDA.

A notional diagram for EVS is shown in the shaded area of Figure 1-1. The EVS imagery is presented on a cockpit display (head-up or head-down) and it may or may not include symbology overlay (e.g., aircraft state data).

An EFVS shares similarity with EVS technology (see Figure 1-1), but an EFVS meets specific equipage and performance requirements to conform with 14 CFR Part §91.176.

The EFVS was developed to provide pilots with a means to meet the requirements to continue the approach below the published Decision Altitude (DA), Decision Height (DH) or Minimum Descent Altitude (MDA) of an instrument approach procedure when flight visibility is otherwise not sufficient. The EFVS is an alternate means to comply with the visibility requirements of the visual segment of the instrument approach procedure.

© 2024 RTCA, Inc.

This document provides the MASPS for the intended function of an EVS for obstacle, object, terrain, and situation awareness and for the intended function of an EFVS to conduct an EFVS operation.

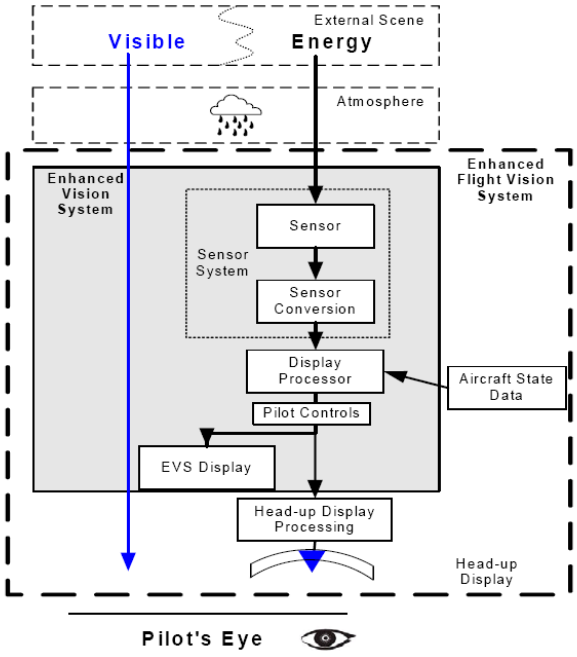


Figure 1-1: EVS / EFVS diagram

(Dashed lines indicate individual system boundaries.)

1.4 Structure of the Document

This MASPS is based on the RTCA Template and defines minimum aviation system performance standards, however, some restructuring away from the template was felt by the committee to be necessary as the EVS/EFVS MASPS are integrally tied to the Concept of Operations (ConOps) and associated regulatory requirements.

In Section 2, the approach and methodology used in the development of the EVS and EFVS MASPS is described. Section 2 contains the EFVS Concept-of-Operations (ConOps)/Operational Services and Environment Definition (OSED) and intended function since the MASPS requirements are built from these critical elements.

In Section 3, the minimum system performance requirements are presented. These requirements are developed as illustrated in Figure 1-2.

© 2024 RTCA, Inc.

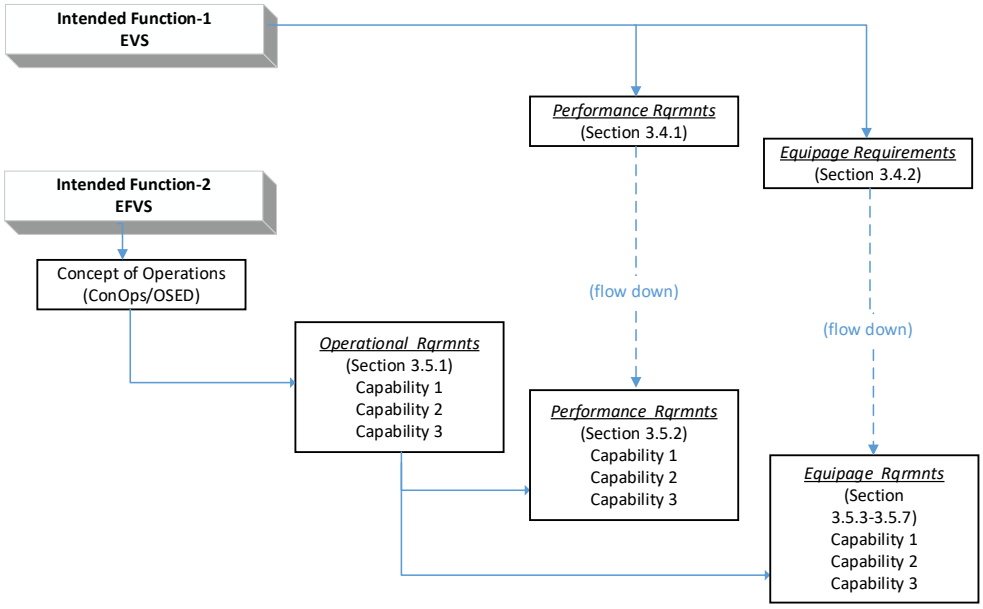


Figure 1-2: Hierarchy of Requirements for EVS and EFVS

Overarching performance and equipage requirements that pertain to the EVS intended function are defined in Section 3.4.

Additional requirements are layered upon these overarching requirements in Section 3.5 establishing the MASPS for EFVS. These EFVS requirements are built from the ConOps as found in Section 2.4.

In Section 4, Interoperability requirements for EFVS operations are presented.

In Section 5, the requirements for performance verification are given that would verify that the EVS and EFVS meets the intended function, performance, and the associated MASPS requirements.

1.5 Relationship to ICAO Documents

The standards of this MASPS provide definitions, intended functions, and operational applications derived primarily from the constructs and regulations established under the US Code of Federal Regulations (CFR).

The International Civil Aviation Organization (ICAO) provides general information regarding the applicability of the Standards and Recommended Practices for flight operations that includes EFVS equipment, HUDs, SVS, and CVS within ICAO Annex 6 Parts I, II, and III for Commercial Air Transport Aircraft, General Aviation and Helicopters.

1.6 References

1.6.1 RTCA and EUROCAE References

The table below lists RTCA and EUROCAE references cited in this document and other relevant DO and ED documents

RTCA	EUROCAE	Title
DO-160G	ED-14G	Environmental Conditions and Test Procedures for Airborne Equipment
DO-178(-)	ED-12(-)	Software Considerations in Airborne Systems and Equipment Certification
DO-254	ED-80	Design Assurance Guidance for Airborne Electronic Hardware
DO-315B	ED-179B	Minimum Aviation System Performance Standards (MASPS) for Enhanced Vision Systems, Synthetic Vision Systems, Combined Vision Systems and Enhanced Flight Vision Systems
DO-341		Minimum Aviation System Performance Standards (MASPS) for an Enhanced Flight Vision System to Enable All-Weather Approach, Landing and Roll-Out to a Safe Taxi Speed
DO-374		Safety, Performance and Interoperability Requirements Document Defining Take-off Minima by Use of Enhanced Flight Vision Systems
DO-375	ED-255	Minimum Aviation System Performance Standards (MASPS) for a Combined Vision Systems for Helicopter Operations
DO-390	ED-291	Test Procedures for Quantified Visual Advantage
DO-407	ED-326	Minimum Aviation System Performance Standards (MASPS) for Synthetic Vision Systems, Synthetic Vision Guidance Systems and Combined Vision Systems

Note: (-) indicates any currently acceptable version

1.6.2 Other References

Throughout this document, references are made to either an applicable EASA or FAA document but perhaps not to both, even though the corresponding documents are essentially the same or very similar in content. Even though both appliable FAA and EASA references are not identified together elsewhere in this document, they are included below for completeness. Examples include EASA AMC 25-11 being similar to FAA AC 25-11, EASA ETSO-C87A being similar to FAA TSO-C87A.

Organization	Number	Title
EASA	AMC 25.1302	Installed Systems and Equipment for Use by the Flight Crew
EASA	AMC 25.1309	System Design and Analysis
EASA	AMC 25.1322	Flight Crew Alerting
EASA	AMC 25.1523	Minimum Flight Crew
EASA	AMC No. 1 to CS 25.1329	Flight Guidance System
EASA	AMC 25-11	Electronic Flight Deck Displays

 © 2024 RTCA, Inc.

Organization	Number	Title
EASA	CS-AWO Issue 02 or current	Certification Specifications and Acceptable Means of Compliance for All-weather Operations
EASA	ETSO-C87a	Airborne Low-Range Radio Altimeter
EASA	Regulation (EU) No 965/2012	ANNEX V (Part-SPA) Subpart E: Low Visibility Operations (LVO) And Operations With Operational Credits.
FAA	AC 20-115A	Airborne Software Development Assurance Using EUROCAE ED-12( ) and RTCA DO-178( )
FAA	AC 20-152A	Development Assurance for Airborne Electronic Hardware
FAA	AC 20-167A	Airworthiness Approval of Enhanced Vision System, Synthetic Vision System, Combined Vision System, and Enhanced Flight Vision System Equipment
FAA	AC 23.1309-1E	System Safety Analysis and Assessment for Part 23 Airplanes
FAA	AC 25-11(-)	Electronic Flight Displays
FAA	AC 25.773	Pilot Compartment View Design Considerations
FAA	AC 25.1302-1	Installed Systems and Equipment for Use by the Flightcrew
FAA	AC 25.1309-1A	System Design and Analysis
FAA	AC 25.1322-1	Flightcrew Alerting
FAA	AC 25.1329(-)	Approval of Flight Guidance Systems
FAA	AC 25.1523-1	Minimum Flight Crew
FAA	AC 27-1B	Certification of Normal Category Rotorcraft
FAA	AC 29-2C	Certification of Transport Category Rotorcraft
FAA	AC 90-106(-)	Enhanced Flight Vision Systems
FAA	AC 120-71(-)	Standard Operating Procedures and Pilot Monitoring Duties for Flight Deck Crewmembers
FAA	AC 120-118	Criteria for Approval/Authorization of All Weather Operations (AWO) for Take-off, Landing and Roll-out
FAA		Aeronautical Information Manual
FAA	TSO-C87A	Airborne, Low-Range Radio Altimeter
ICAO	Annex 6, Part I (with Amendment No. 48 and Corrigendum No. 1)	Annex 6 - Operation Of Aircraft - Part I - International Commercial Air Transport - Aeroplanes
ICAO	Annex 6, Part II (with Corrigendum No. 1)	Annex 6 - Operation Of Aircraft - Part II - International General Aviation - Aeroplanes
ICAO	Annex 6, Part III	Annex 6 - Operation Of Aircraft - Part III - International Operations - Helicopters
ICAO	Annex 10, Volume I	Aeronautical Telecommunications, Volume I Radio Navigation Aids, 8th Edition, July 2023

© 2024 RTCA, Inc.

Organization	Number	Title
SAE	ARP 4754(-)	Guidelines for Development of Civil Aircraft and Systems
SAE	ARP 4761(-)	Guidelines And Methods For Conducting The Safety Assessment Process On Civil Airborne Systems And Equipment
SAE	ARP 5287	Optical Measurement Procedures for Airborne Head Up Display (HUD)
SAE	ARP 5288	Transport Category Airplane Head Up Display (HUD) Systems
SAE	ARP 5589	Human Engineering Considerations for Design and Implementation of Perspective Flight Guidance Displays
SAE	AS 8055	Minimum Performance Standard for Airborne Head-Up Display (HUD)

Note: (-) indicates any currently acceptable version

© 2024 RTCA, Inc.