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USA

Minimum Operational Performance Standard (Mops) for a Wireless Avionics Intra-Communication System

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FOREWORD

This document was prepared by Special Committee 236 (SC-236) jointly with EUROCAE WG-96 and approved by the RTCA Program Management Committee (PMC) on June 26, 2025 and the EUROCAE Council on July 1, 2025

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 Standards Development Organization 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 advisory circulars.

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EXECUTIVE SUMMARY

In 2015, the World Radio Conference approved WRC-15 Resolution 424 Use of Wireless Avionics Intra-Communications in the frequency band 4 200 - 4 400 MHz.

The United States Federal Aviation Administration (FAA) and the European Union Aviation Safety Agency (EASA) requested that RTCA, Inc. and EUROCAE form a special committee to develop standards and guidance for the introduction of Wireless Avionics Intra-Communications (WAIC) using spectrum within the 4 200 - 4 400 MHz protected aviation band also allocated to radio altimeters.

RTCA Special Committee 236 (SC-236) and EUROCAE Working Group 96 (WG-96) included representatives from consumer electronic, avionics manufacturers, aircraft manufacturers, airlines, aircraft operators, regulatory agencies, and related industry associations.

Members of SC-236/WG-96, participating in the WAIC Correspondence Group for the Frequency Spectrum Management Panel (FSMP) of the International Civil Aviation Organization (ICAO), developed and presented Standards and Recommended Practices (SARPs) for WAIC to inform national regulators on the revised use of 4 200 - 4 400 MHz spectrum for aviation use.

The ICAO Frequency Spectrum Management Panel (FSMP) requested that technical means of compliance with those SARPs should be specified in RTCA and EUROCAE standards.

SC-236/WG-96 previously created and published DO-378A/ED-260A “Minimum Aviation System Performance Standard (MASPS) for Coexistence of Wireless Avionics Intra-Communication Systems within 4 200 - 4 400 MHz” [14][15] to document the technical means of compliance to the ICAO SARPs for non-interference between aircraft.

This report addresses the specific Terms of Reference to create the Minimum Operational Performance Standard (MOPS) for WAIC equipment to accomplish wireless communications while ensuring non-interference with avionics aboard the same aircraft, in particular, to radio altimeters and other WAIC systems.

There are two aspects to the equipment characteristics and installation guidance in this report. The first aspect defines the minimum WAIC radio RF characteristics for intra- or inter-system communications. The second aspect defines a reference system architecture and minimum equipment characteristics necessary to mitigate the cybersecurity vulnerabilities associated with the use of WAIC for communicating within or between aircraft safety systems.

On June 26, 2025, the RTCA, Inc. Program Management Committee approved the publication of this document and directed RTCA, Inc. to include the three dissents received, the committee’s responses, and the statement from member organizations supporting the committee’s resolution of the comments. This information can be found in Appendix D.

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1 PURPOSE AND SCOPE

1.1 Introduction

This document contains Minimum Operational Performance Standards (MOPS) for Wireless Avionics Intra-Communications (WAIC) radio characteristics and Secure Communications for Autonomous Avionics Systems across Shared Media Networks. This MOPS specifies characteristics that should be useful to designers, manufacturers, installers, and users of the equipment.

Compliance with this standard assures that the equipment can provide secure communications while ensuring that WAIC equipment can safely coexist with other radio systems on the crewed or uncrewed aircraft in which it is installed. The solution offered is done in two components: RF radio characteristics and a reference security architecture.

Section 1 of this document provides information needed to understand the rationale for equipment characteristics and requirements in the remaining sections. It describes typical equipment operations and operation goals and establishes the basis for the standards in Sections 2 through 3. Definitions and assumptions essential to proper understanding of this document are also provided in this section.

Section 2 contains the minimum performance requirements for the WAIC radio equipment and a secure computing platform. These requirements specify the required performance under standard environmental conditions. Also included are recommended bench test procedures necessary to demonstrate equipment compliance with the stated minimum requirements.

Section 3 describes the process for verifying compliance of installed equipment with aircraft-level requirements. Tests for the installed equipment are included when performance cannot be adequately determined through bench testing. Guidance is provided to demonstrate non-interference during operation and aircraft testing guidance is provided for equipment maintenance/ replacement.

Section 4 describes the operational performance characteristics for equipment installations and defines conditions that will assure that operations can be conducted safely and reliably in the expected operational environment. Guidance is provided for regulators regarding how security is maintained as systems are interconnected.

Section 5 is the membership list for the RTCA Special Committee and EUROCAE Working Group jointly responsible for producing this document.

Appendix A is a summary of the System Theoretic Process Assessment (STPA) and the security requirements derived therefrom. Appendix A is a normative part of this document as it establishes the security vulnerabilities associated with the use of wireless media for avionics communications.

Appendix B is a reference security architecture that addresses the vulnerabilities identified in Appendix A.

Appendix C is the requirements traceability matrix.

1.2 Architectural Overview

This Minimum Operational Performance Standard (MOPS) establishes 1) the characteristics of a radio capable of digital communications in the 4 200-4 400 MHz

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frequency band allocated for WAIC and, 2) the equipment requirements necessary to accomplish secure avionics communications across a network utilizing wireless communications media.

The frequency band 4 200 – 4 400 MHz is also used by radio altimeters. WAIC equipment and its installation needs to meet the requirements established by the forthcoming WAIC SARPs to ensure that a WAIC system installed on one aircraft does not interfere with a WAIC system or the radio altimeter system installed on another aircraft within radio range. The radio requirements and means of compliance in this MOPS provide protection to the intended function of the radio altimeter(s) installed on the aircraft subject to certification. The radio requirements and means of compliance in this MOPS also ensure that multiple WAIC networks installed onboard the same aircraft can fulfil their intended functions while sharing a common radio frequency resource.

Wireless communication is a novel approach to communicating between avionics components and systems installed on a single aircraft. SC-236/WG-96 performed a study to ascertain the security vulnerabilities that could exist when communicating over wireless communications media as compared to communicating over fixed, wired connections. The study was accomplished using a System Theoretic Process Assessment (STPA), as defined in DO-356A/ED-203A. [12][13] Wireless communications is inherently susceptible to intentional or unintentional disruption. Jamming is an intentional disruption by abnormal interference above Interference Tolerance Masks and, thereby, beyond the scope of MOPS safety/availability/continuity requirements for equipment. Jamming is a security issue that should be addressed at the systems level. The STPA process resulted in the derivation of twelve unique security requirements that, when satisfied, support a design that can achieve an acceptable level of security risk. The wireless communications STPA with its derived security requirements is documented in Appendix A.

Communications between systems implies the definition of common system communications and security features capable of communicating across system boundaries without violating the independent safety or security of those systems. Inter-system communications requires the definition of common system standards for network definition, management of system security boundaries, as well as secure communication protocols. The aircraft integrator is responsible for resolving the security vulnerabilities of communications between systems.

This MOPS intentionally specifies WAIC radio requirements separately from communications security to provide the widest possible latitude for system integrators to implement systems that use WAIC radios for intra-system communications and aircraft integrators that implement WAIC radios for inter-system communications.

Systems that use WAIC radios for intra-system communications may utilize architecture and security designs that do not comply with the requirements for inter-system communications documented herein, if 1) the derived security requirements documented in Appendix A have been satisfied; and 2) the characteristics of WAIC use within the system are documented for spectrum management use by aircraft integrators.

The reference architecture and security design in Appendix B offers one acceptable means of systemically satisfying the derived security requirements documented in Appendix A for communications across a shared wireless network. WAIC radios are one possible implementation of a shared network for wireless communications.

In the SARPs and MASPS the term WAIC ode is used to define an equipment with a WAIC radio component. In this document the terms WAIC node and WAIC radio and WAIC

transceiver are used interchangeably to describe a WAIC radio component with or without an associated computing platform.

1.3 Applications

The applications of WAIC systems are not strictly defined in this MOPS, as the intended function of WAIC equipment is not prescribed or limited to specific use cases. One goal of this standard is to provide the flexibility to use the requirements and guidance within to create WAIC equipment that meets the specific application needs of the system designers.

An additional goal of this MOPS is to assist manufacturers in their development of WAIC equipment, as well as government regulators to create a Technical Standard Order (TSO) or European Technical Standard Order (ETSO). This document is not intended to communicate all requirements necessary for WAIC equipment to be integrated into a WAIC system, or the requirements of that system to be integrated within an aircraft. While this MOPS contains information relating to spectrum usage by WAIC systems, it is not intended to specify the characteristics and limitations of a specific WAIC system installation.

1.4 Intended Function

The intended function of a shared media network is to provide media independent network communications between autonomous avionics systems. WAIC is one possible communication media type. Wireless media such as WAIC is an ethereal replacement for wire. Wireless networks are only usable for aircraft functions if the effects of loss or malfunction of the communications media can be assessed using appropriate function hazard categorizations such as contained in 14 Code of Federal Regulations (14 CFR) 23/25 and EASA - European Union Aviation Safety Agency Certification Specifications CS-23/25. Similarly the standard practices described in ASTM F3532 should be applied to assess the impact of using wireless networks for other types of aircraft.

The term “Endpoint”, as used in this MOPS, is defined as an application hosted in a secure computation environment. Intended aircraft functions hosted in Endpoints that make use of the shared network for information exchange must be individually assessed for the effects of the loss or malfunction based on appropriate function hazard categorizations such as contained in 14 Code of Federal Regulations (14 CFR) 23/25.1309. [23][24] Advisory Circulars (AC) 23.1309-1E [27] and AC 25.1309-1A [28] provide additional guidance to aid in this evaluation.

1.5 Operational Performance Goals (RESERVED)

1.6 Aircraft Vulnerabilities

RTCA DO-378/EUROCAE ED-260A - Minimum Aviation System Performance Standard (MASPS) for Coexistence of Wireless Avionics Intra-Communication Systems within 4 200 - 4 400 MHz [14][15] specifies the criteria and testing necessary to ensure non-interference of WAIC radios between aircraft, in compliance with the forthcoming ICAO Standards and Recommended Practices (SARPs) for Wireless Avionics Intra-Communication (WAIC) systems.

This document addresses the specific radio interference and security vulnerabilities associated with the use of wireless or other shared media for avionics system intercommunications within a single airframe. WAIC radio interference vulnerabilities are

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identified in section 2.2.2. Security vulnerabilities are identified in Appendix A-1. The security requirements derived from Appendix A.1 are satisfied by the example security architecture in APPENDIX B. The hardware requirements for a Secure Computing Platform capable of satisfying the security architecture requirements are captured in section 2.2.3.

1.7 Assumptions (RESERVED)

1.8 Test Procedures

The test procedures specified in this document are intended to be used as one means of demonstrating compliance with the performance requirements defined in Section 2.2. 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. Users of this document should not infer performance requirements based on test procedures.

The order of tests specified in subsection 2.2 suggests that the equipment 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 shall have been demonstrated as a precondition to satisfactory completion of the installed system tests of Section 3.

a. Environmental Tests

Environmental test requirements are specified in Subsection 2.3. The procedures and their associated limits are intended to provide a laboratory means of determining the electrical and mechanical performance of the equipment under environmental conditions expected to be encountered in actual operations.

Unless otherwise specified, the environmental conditions and test procedures contained in the latest revision of RTCA DO-160()/EUROCAE ED-14(), “Environmental Conditions and Test Procedures for Airborne Equipment”, will be used to demonstrate equipment compliance. [2][3]

b. Bench Tests

Bench test procedures are specified in Subsection 2.4. These tests provide a laboratory means of demonstrating compliance with the requirements of Subsection 2.2. Test results may be used by equipment manufacturers as design guidance, for monitoring manufacturing compliance, and in certain cases, for obtaining formal approval of equipment design.

c. Installed Equipment Considerations

Tests for the installed equipment are included when performance cannot be adequately determined through bench testing.

The installed equipment test procedures and their associated limits are specified in Section 3. Although bench and environmental test procedures are not included in the installed equipment test, their successful completion is a precondition to completion of the installed test. In certain instances, however, installed equipment tests may be used in lieu of bench test simulation of such factors as power supply characteristics, interference from or to other equipment installed on the aircraft, etc. Installed tests are normally performed under two conditions:

With the aircraft on the ground and using simulated or operational system inputs.

With the aircraft in flight using operational system inputs appropriate to the equipment 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. 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).

1.9 Definitions and Terms

The terms “shall”, “must”, “will”, “should”, and “may” have been used in an inconsistent manner with regards to MOPS performance requirements. This has, at times, led to misunderstandings between applicants and certification authorities, leading, on occasion, to either unnecessary testing or the omission of an important test requirement. To correct this, RTCA, Inc. is requesting Special Committees to adhere to the following table definitions when identifying performance requirements and test procedures. This table should be retained in this Section as guidance to the user of the MOPS that the Special Committee is developing.

To ensure consistency of interpretation of performance requirements and test procedures contained in Section 2 of this MOPS, Table 1-1 is provided:

Table 1-1: Terms for use in Performance Requirements and Test Procedures

	Requirements	Good Industry Practice	Alternate Method
Word	Shall	Should	May
Meaning	Refers to a mandatory performance requirement or test procedure	Refers to a performance or test procedure recommendation that, although not mandatory, is considered good industry practice	Refers to an alternate approach for manufacturer consideration with regard to performance requirements and test procedures
Impact to Design	Could result in inability to meet intended function or interoperability with other equipment	Although not necessary to meet performance requirements, could result in a deficiency to the end user or installation problems if not followed	None. However, the alternate method should be followed in its entirety if the manufacturer chooses to use that method

In the text of performance requirements, the use of the words “must” and “will” is discouraged.

- WAIC System – A WAIC System consists of at least one WAIC Network. Requirements for non-interference and coexistence are levied on the WAIC system as a whole. WAIC System requirements in the MOPS are introduced to satisfy the RF

spectrum constraints identified in the MASPS that ensure non-interference between aircraft. Requirements levied on the WAIC system are the responsibility of the WAIC systems integrator.

- WAIC Network – A WAIC Network provides an onboard wireless communications solution. WAIC Network requirements are the responsibility of the WAIC systems integrator.
- WAIC Equipment – WAIC Equipment includes an embedded WAIC Radio and at least one other functional element (e.g., sensor, actuator, gateway, server, router, switch, etc.). Compliance with WAIC Equipment requirements is the responsibility of the WAIC equipment manufacturer.
- WAIC Radio – A WAIC Radio is a subcomponent of WAIC Equipment that provides the WAIC wireless communications interface to other WAIC Equipment. Specific implementation details of the WAIC Radio are intentionally limited in the MOPS to allow equipment designers the widest possible latitude in the development of wireless communications solutions within the WAIC spectrum compliance with WAIC Radio requirements is the responsibility of the WAIC equipment manufacturer.

1.10 Acronyms

AC	Advisory Circular
ACL	Access Control List
AEH	Airborne Electronic Hardware
AES	Advanced Encryption Standard
AFDX	Avionics Full DupleX
AFR	Adjacent Frequency Rejection
AIK	Attestation Indentity Key
AMC	Acceptable Means of Compliance
ARINC	Aeronautical Radio Corporation
ASID	Aircraft System Interface Definition
ASISP	Aircraft Systems Information Security/Protection
ASTM	American Society for Testing and Materials
BB	Baseband
BER	Bit Error Rate
BIOS	Basic Input/Output System
CAA	Civil Aviation Authority
CDMA	Code Division Multiple Access
CFR	Code of Federal Regulations
COS	Continued Operational Safety
CS	Certification Specification
CW	Continuous Wave
DAA	Direct Anonymous Attestation
DAH	Design Approval Holder
DAL	Design Assurance Level
DHCP	Dynamic Host Configuration Protocol
DME	Distance Measuring Equipment