



The European Organisation for Civil Aviation Equipment
L'Organisation Européenne pour l'Équipement de l'Aviation Civile

MINIMUM OPERATIONAL PERFORMANCE STANDARD FOR A RUNWAY OVERRUN AWARENESS AND ALERTING SYSTEM

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December 2017

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FOREWORD

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CHAPTER 1

PURPOSE AND SCOPE

1.1 INTRODUCTION

This document defines the Minimum Operational Performance Standards (MOPS) for a Runway Overrun Awareness and Alerting System (ROAAS). These standards specify system characteristics and requirements that should be useful to designers, manufacturers, installers, certification authorities and users of the Equipment.

The word "Equipment" as used herein includes all the functional components necessary to properly perform the intended function (including software and hardware). However all external components to the function which are cockpit or system specific, though necessary for a proper operation of the function at a system level, are out of the scope of the equipment requirements (e.g. cockpit controls, cockpit indicators, cockpit display, aural systems, inputs sensors).

1.2 MANDATING AND RECOMMENDATION PHRASES

1.2.1 Shall

In this document, the term "shall" is used to indicate a requirement for the ROAAS equipment or ROAAS manufacturer. Compliance with the particular specification is mandatory and no alternative may be applied.

Such requirements are numbered in sequence as "ROAAS_REQxx" and are associated to test conditions or procedures.

1.2.2 Should

The term "should" is used to denote a recommendation that would improve the ROAAS equipment, but does not constitute a requirement. The use of the word "Should" (and phrases such as "It is recommended that...", etc.) indicate that though the procedure or criterion is regarded as the preferred option, alternative procedures, specifications or criteria may be applied, provided that the manufacturer, installer or tester can provide information or data to adequately support and justify the alternative.

The resulting recommendation may also describe a desirable feature or performance of the ROAAS equipment, which does not constitute a minimum regarding the ROAAS functionality.

Recommendations resulting from the use of should are numbered in sequence as "ROAAS_RECOxx"

The use of "should" in appendices does not imply a recommendation.

1.2.3 May

The term "may" is used to denote an acceptable implementation

1.2.4 Must

The term "must" is used in explanatory text, installation guidance, and graphics to explain or illustrate necessary conditions. The use of the term "must" does not by itself indicate a requirement for the ROAAS equipment.

1.2.5 Confirm

The term "confirm" is used in the description of test procedures when a standardized process is being referred to. The associated requirements are to be found in that referred standard and are expected to have been met by the equipment/hardware/software or by the development process used.

1.2.6 Verify

The term "verify" is used in the description of test procedures to indicate a required result of the test.

1.3

DOCUMENT CONTENTS

CHAPTER 1 of this document provides information needed to understand the rationale for equipment characteristics and requirements stated in the remaining chapters. It describes typical equipment applications and operational goals (refer also to Appendix A), as envisioned by the members of WG-101, and establishes the basis for the standards stated in CHAPTER 2 and CHAPTER 3. Definitions and assumptions essential to proper understanding of this document are also provided in this chapter.

CHAPTER 2 contains general design requirements for the Equipment. This includes reliability, availability and integrity requirements, with safety considerations.

CHAPTER 3 describes minimum performance requirements for the ROAAS function.

CHAPTER 4 describes the minimum required performances of the ROAAS when taking into account environmental conditions. This includes a selection of the most relevant conditions to be considered, selected in the ED-14() / DO-160() standard. Requirements in this chapter are mainly related to hardware and interfaces.

CHAPTER 5 describes test procedures proposed for demonstrating the stated requirements, in standard conditions. Different types of testing are considered, and suggestions are made for demonstration of each requirement. Tests described in this chapter are applied to ROAAS equipment in laboratory/bench conditions

CHAPTER 6 describes installed equipment performance requirements. The proposed demonstrations are considered after installation of the ROAAS in an aircraft and aim at confirming the system functionality within this environment, including human machine interface effects and pilot-in-the-loop demonstrations.

Appendix A to Appendix D are used to present additional material useful to the understanding of requirements or test procedures

1.4

APPLICATIONS

Compliance with this MOPS by manufacturers, installers and users is recommended as a means of assuring that the equipment will satisfactorily perform its intended function(s) under all conditions normally encountered in routine aeroplane operations.

This MOPS is designed to ensure that equipment compliant to it will get the necessary regulatory approval (this is generally facilitated by the recognition of such standard by the relevant authorities as an acceptable means of compliance with the applicable regulations).

NOTE: *Due to the fact that a ROAAS is a new function (at the time of first publication) that may be implemented in many different ways, the present document may at times go beyond equipment specifications and address system related requirements. In that sense, this document may be considered as more than a usual MOPS (although this does not preclude its use as a basis for regulatory requirements such as an ETSO).*

This MOPS applies to a specific defined function. The equipment(s) housing this function may have additional features related to that function for which there is no specified minimum performance requirement.

Any regulatory application of this document in whole or in part is the sole responsibility of appropriate government agencies.

As the measured values of equipment performance characteristics may be a function of the method of measurement, standard test conditions and methods of test are recommended in this document.

The work of WG-101 was performed for large aeroplanes applications (defined as regulated by CS-25/14 CFR part 25). However, nothing would prevent a further extension to smaller aeroplanes such as those certificated under CS-23/14 CFR part 23.

1.5 SYSTEM OVERVIEW

1.5.1 Principles

A typical ROAAS is expected to use runway database information, measured aircraft state data, aircraft performance knowledge, and runway condition, to provide flight crews with increased situational awareness about the possibility of exceeding the runway end during approach and landing.

The ROAAS is an alerting system, which is intended as a "safety net". The system does not guarantee successful recovery from a runway overrun risk due to natural variability in some factors such as pilot response, actual aircraft performance, runway condition knowledge and database coverage limitations.

ROAAS modes realize the desired functionality with different sets of parameters during different phases of flight. The phases of flight defined for ROAAS result in the definition of corresponding modes, as a minimum "In-Air" and "On-Ground" (see A.1).

Use of ROAAS does not replace pilot actions, or alleviate flight crew's responsibilities, for managing approach and landing including, but not limited to: Time-of-Arrival landing distance assessment, stabilized approach criteria, flare and landing technique, proper use of deceleration devices or actual braking performance monitoring.

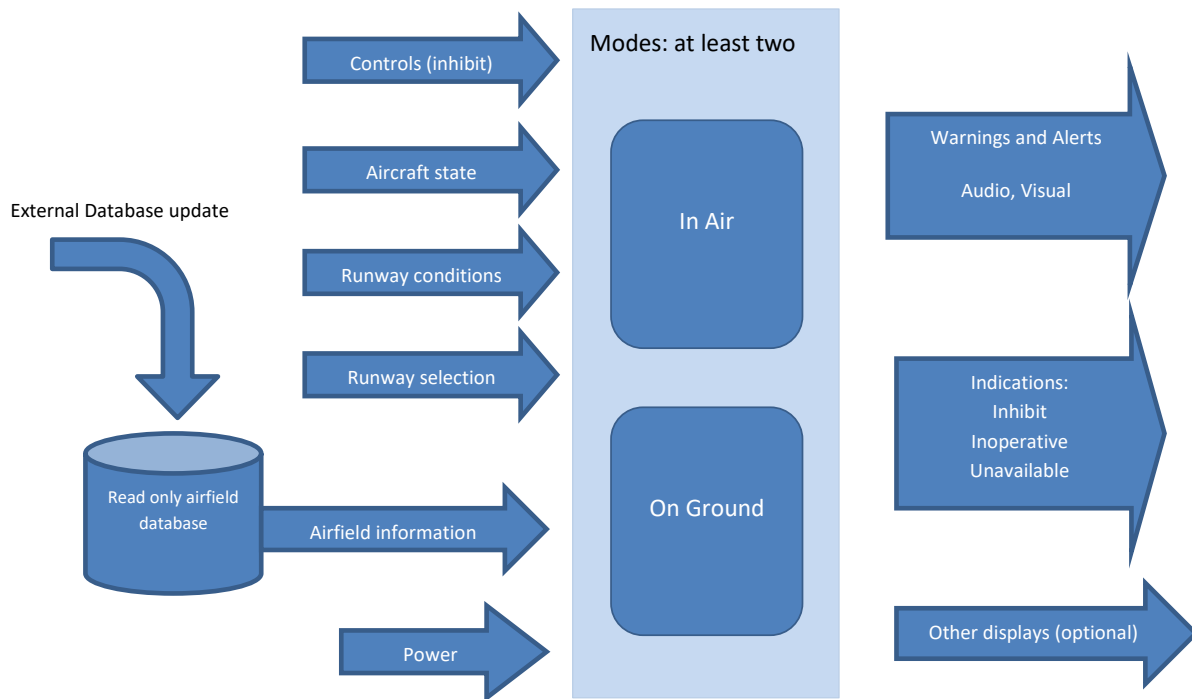


FIGURE 1: ROAAS CONTEXT DIAGRAM

1.5.2 ROAAS operation

1.5.2.1 ROAAS States

The ROAAS can take two states:

Active: ROAAS can, in case of an estimated runway overrun risk, raise alerts to the flight crew (alert is "triggered").

Inactive: ROAAS cannot raise any alert.

ROAAS inactive state results from several conditions (one of these being sufficient, but not mutually exclusive):

- **Out of domain:** by design, ROAAS does not raise any alert because no mode (see below) meets its conditions for arming at that time.
- **Inhibited:** ROAAS doesn't emit any alert because the flight crew chooses to prevent it, or a system external to ROAAS has sent an inhibition command. The inhibition logic is left to design choices of the aircraft manufacturer.
- **Unavailable:** ROAAS doesn't emit any alert because all or part of the necessary inputs or outputs for calculations are not available (for example: no data relative to the runway on which aircraft is currently landing) or the data quality of one or more input does not meet the stated requirements (e.g. GPS accuracy).
- **Inoperative:** ROAAS doesn't emit any alert because a ROAAS internal failure has occurred, as detected by the system self monitoring or outside monitoring function.

1.5.2.2 ROAAS Modes

A "Mode" of ROAAS is defined as a set of parameters determining a specific functional behavior of the system (this may include messages, indications, or algorithms, etc...).

Modes can be:

- **armed** (the corresponding set of parameters is used and alerts can be raised with these parameters) or
- **disarmed** (the set of parameters is not used by the system),

depending on sets of conditions to be met (arming conditions when not armed and disarming conditions when armed) regarding the aircraft state and position, and operation type (e.g. steep approach).

The definition of a mode and its arming and disarming conditions are left to the ROAAS manufacturer's design choices.

NOTE 1: For the ROAAS to be **Active**, there must be at least one **Armed** mode. However, a mode may remain **Armed** while ROAAS is **Inactive**, e.g. when the ROAAS has been inhibited by the crew, or while circumstances lead to an "Unavailable" condition (possibly temporary).

NOTE 2: Subject to design specificities, it is expected that some modes will be exclusive, particularly those generating warning level alerts, associated with messages which would be inappropriate in other conditions (e.g. In-Air and On-Ground with incompatible aural messages [see §3.1.4.3 and 3.1.6.3]). Following this concept, "Classes" of modes may be defined: each class contains exclusive modes, i.e. which cannot be armed at the same time. Several classes may be defined, reflecting the possibility of having more than one mode armed at the same time (see examples in section 1.5.2.3)

NOTE 3: Transition between modes: subject to design specificities, disarming one mode when conditions are met and arming another mode in sequence (e.g. exiting "In-Air" mode then entering "On-Ground" mode) may require time delays which will be taken into account by the ROAAS manufacturer, and will not necessarily cause the system to declare itself temporarily inactive.

1.5.2.3 Operation diagram

The following diagram graphically describes the relationships between ROAAS states.

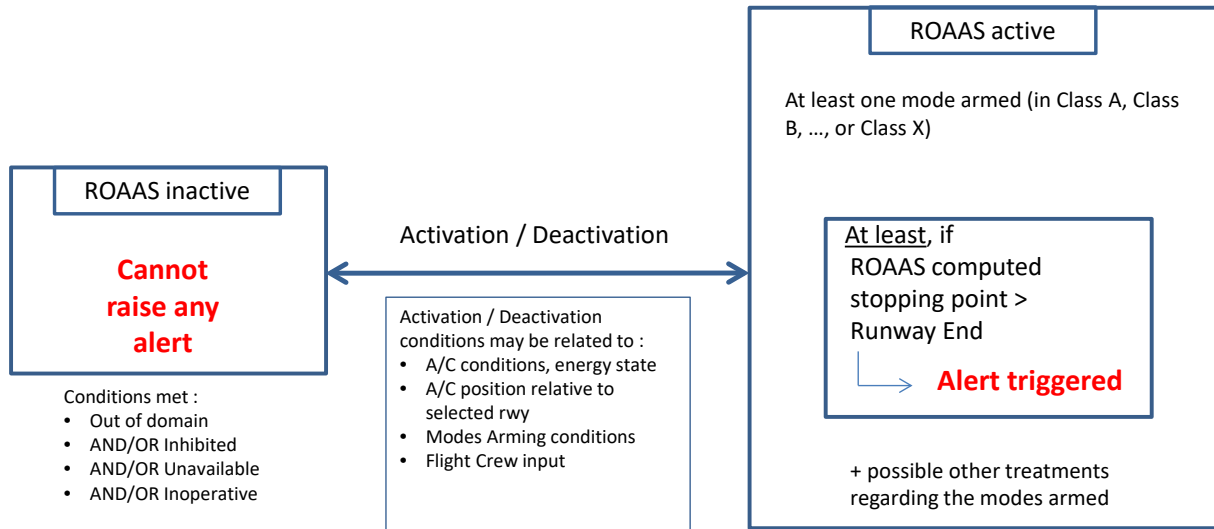


FIGURE 2: ROAAS STATES

An example of possible classes of modes is shown in the diagram below with two classes of modes: warning alerting and caution alerting. One mode of warning may be armed at the same time as one mode of caution, but two warning modes cannot be armed at the same time (e.g "nominal approach" and "on ground").

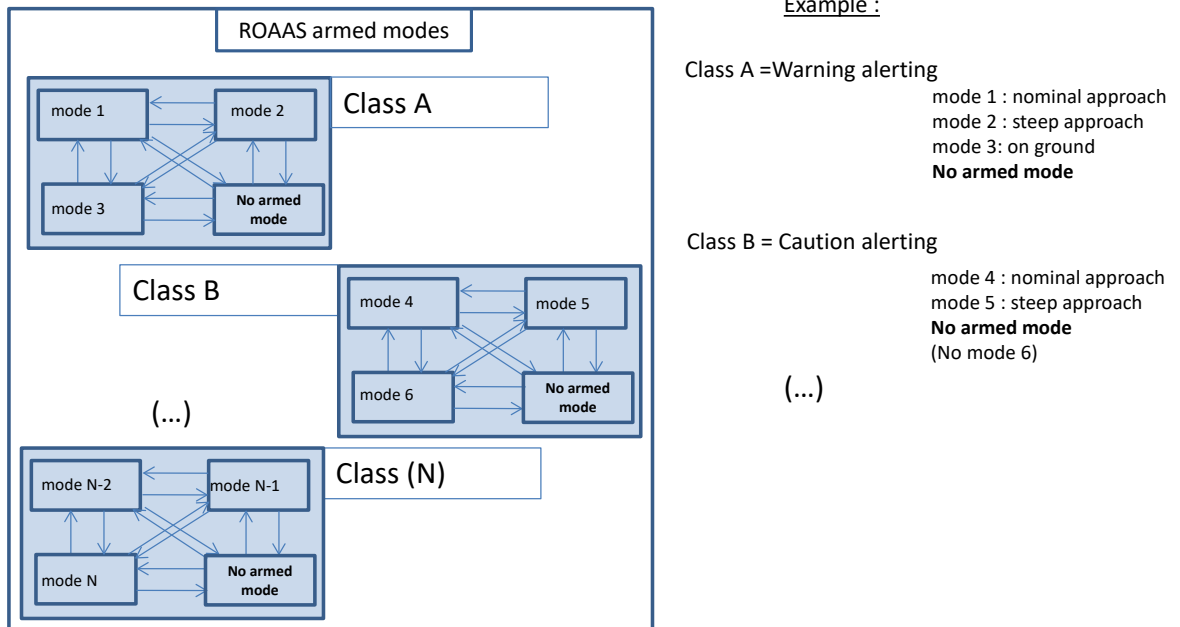


FIGURE 3: CLASSES OF MODES

NOTE: The minimum definition of a ROAAS in this MOPS is one class containing two exclusive modes: In-Air and On-Ground with warning level alerts. (See ROAAS_REQ19).

Refer to [A.6] for an example system timeline.

1.5.3 Concept of Operations

Subject to variations in specific design, during a flight mission a ROAAS is expected to:

- be powered up with the aircraft.
- complete a self-test and then continue to monitor its system performance for the rest of the flight.
- receive information on the intended runway for landing by selection from a runway database.
- accept, as necessary, information relative to runway conditions at arrival and possibly modifications to runway data.

As the aircraft approaches the destination runway, a ROAAS is expected to:

- automatically become active when conditions are reached in the approach phase (arming conditions of at least one mode are met).
- generate alerts as appropriate per intended function, in the mode adapted to the current phase of flight, subject to priority of alerts in the cockpit.
- transition between modes automatically.
- become inactive after landing has been completed, or after go-around has been initiated (exit criterion for In-Air modes).
- remain inactive until the aircraft again approaches a destination runway in flight.
- automatically declare itself unavailable or inoperative based on the self-monitoring of its performance, when faults or inaccuracies are detected.
- become inhibited at crew's decision, or following an aircraft system logic.
- indicate its status to the crew when the function is in an inhibited state.
- indicate its status to the crew when the function is in the unavailable or inoperative state.

1.5.4 Definitions of Distances

The following landing distances are defined below and used in the performance and test requirements:

- **Performance Landing Distance (PLD)**
The predicted distance required for the aircraft to land (if airborne) and come to a stop or come to a stop (if on the ground) as calculated by a representative aircraft performance model using OEM supplied landing techniques and performance data.
- **ROAAS Model Distance (RMD)**
The predicted distance required for the aircraft to land (if airborne) and come to a stop or come to a stop (if on the ground) as calculated by the on-aircraft ROAAS algorithm, given the current aircraft state (ground speed, glidepath deviation, etc).
- **Typical Landing Distance (TLD)**
The predicted distance required for the aircraft to land (if airborne) and come to a stop or come to a stop (if on ground) as calculated by a representative aircraft performance model utilizing aircraft performance data which has been modified to reflect operationally achievable landing distances. The TLD contains a safety margin to account for operator deviations and environmental variations.
Examples of how these definitions could be implemented are found in C.1.2.

1.6 COMPOSITION OF EQUIPMENT

A ROAAS would typically be composed of the following components:

- Computer(s) executing the functional software.
- Software.
- Runway characteristics database.
- Set of necessary sensors and avionics interfaces, providing the necessary aircraft parameters and systems status.
- Human Machine Interface:
 - o Visual and/or aural alerts, and optionally additional indications or displays.
 - o Pilot interface to set up and control the function, including means to inhibit the system.
- Aircraft characteristics definition

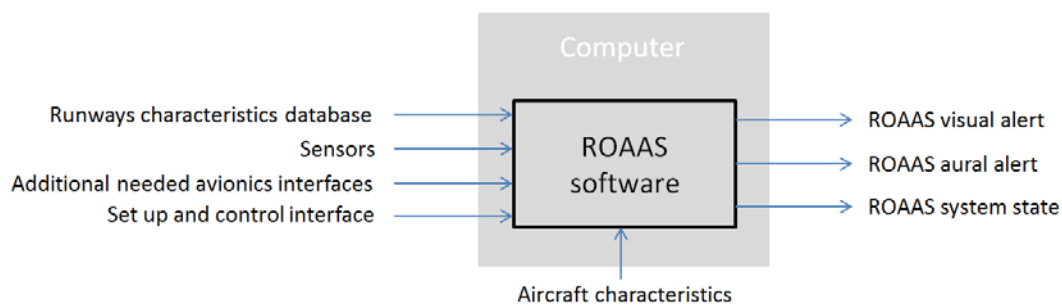


FIGURE 4: ROAAS INPUTS AND OUTPUTS

NOTE: *The projection of the above components on actual aircraft architecture is not defined in this document, but must be subject to the requirements resulting from the system safety analysis.*

Smoothing of the input data may be performed in the ROAAS equipment to minimize false or nuisance alerts. The test procedures presented in this MOPS are based on constant rate inputs and are designed to ensure that delays to alert onset resulting from input data smoothing do not contribute to the equipment failing to provide alerts in a timely fashion.

1.7 DEFINITIONS AND ACRONYMS

See Appendix B.

1.8 REFERENCE DOCUMENTS

- [1] Eurocontrol, European Action Plan for Prevention of Runway Excursion (EAPPRE), Eurocontrol, January 2013
- [2] EASA, RMT.0570, "Reduction of runway excursions" CRD to NPA 2013-09 – RMT.0570 – , 16.4.2015
- [3] EASA, CS-25 "Certification Specification for Large Aeroplanes"
- [4] FAA 14 CFR part 25 "Airworthiness standards: transport category airplanes"
- [5] EUROCAE/RTCA, ED-14() /DO-160 (), "Environmental conditions and test procedures for airborne equipment" (see note)
- [6] FAA, AC 25-32, "Landing Performance Data for Time-of-Arrival Landing Performance Assessment"
- [7] FAA, Order 8900.1, "Flight Standards Information Management System (FSIMS)"
- [8] FAA, SAFO 06012, "Landing Performance Assessments at Time-of-Arrival (Turbojets)"

- NOTE:** All regulatory documents (or standards) at applicable version for a given aircraft program (certification basis).
- NOTE:** Use of equivalent referenced documents (DO-xx/ED-yy) will be made according to the appropriate certifying authority.
- NOTE:** By convention empty parenthesis in document references indicate "at the applicable issue",

ROAAS is intended to reduce risk of overrun during landing by providing timely and distinctive alert(s) to the flight crew when the airplane is at risk of not being able to stop on the available distance to the end of the runway. [see 3.1.3.1]

ROAAS is intended to be a "safety net".

ROAAS intended function may be accomplished in different modes, adapted to different parts of the ROAAS intended operational domain.

See Appendix A.

The design requirements and guidelines presented in this document assume several system characteristics and applications as listed below:

- The ROAAS may be stand-alone or part of an integrated system.
- The ROAAS display, if included, can be stand-alone or part of an integrated display.
- A degree of cooperation exists between the ROAAS manufacturer and the OEM/ integrator.

1.12 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 CHAPTER 2 and CHAPTER 3.

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 will be used as one criterion in evaluating the acceptability of the alternate procedures. Users of this document must not infer performance requirements based on test procedures.

The order of tests specified 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 CHAPTER 2, CHAPTER 3 and CHAPTER 4 shall have been demonstrated as a precondition to satisfactory completion of the installed system tests of CHAPTER 6.

1.12.1 Environmental Tests

Environmental test requirements are specified in CHAPTER 4. 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 ED-14() / DO-160(), *Environmental Conditions and Test Procedures for Airborne Equipment*, will be used to demonstrate equipment compliance.

1.12.2 Bench Tests

Bench test procedures are specified in CHAPTER 5. These tests provide a laboratory means of demonstrating compliance with the requirements of CHAPTER 2 and CHAPTER 3. 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.

1.12.3 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 CHAPTER 6. 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 test 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:

1. With the aircraft on the ground and using simulated or operational system inputs.
2. 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.

1.13 ANTICIPATED FUTURE GROWTH

One area of potential future growth for the ROAAS technology is application of the overrun protection to the take-off phase, specifically to provide coverage during a rejected take-off (RTO).

Extension of ROAAS capability regarding runway conditions (beyond minimum dry and wet) is another area of potential future growth. As this MOPS was in development, several new technologies and runway condition reporting methods were emerging that might provide potential tie-ins to ROAAS. The FAA released AC150/5200-30D, documenting a new method to report runway condition.

One other area being developed in the industry is a method to analyse the runway braking condition during braking, and automatically distribute the information to stakeholders (airports, ATC, airlines and/or other aircraft). This information could improve the accuracy of ROAAS predictions.

CHAPTER 2

GENERAL DESIGN REQUIREMENTS

2.1 INTRODUCTION

This chapter establishes the design considerations and general specification for the equipment comprising the ROAAS.

2.2 GENERAL REQUIREMENTS

2.2.1 ROAAS Combined with Other Aircraft Systems

This MOPS does not preclude combining the ROAAS with any other aircraft system. However, any such combination must not degrade the general performance requirements of the ROAAS, the general performance requirements of any system with which the ROAAS is combined, any technical performance specification stated elsewhere in this MOPS nor any technical performance standard for the other systems.

When ROAAS is integrated in existing flight deck systems, an interference analysis and associated alerting philosophy assessment must be carried out.

2.2.2 Airworthiness and Certification

Design and manufacturing of the equipment must provide for installation so as not to impair the airworthiness of the aircraft. This is a certification consideration applicable to any equipment installed on the aircraft, and therefore only a reminder.

Reminder of certification considerations:

ROAAS alerts and/or indications must be demonstrated to be compliant with EASA Certification Specifications (CS) 25.1322 () – Flight Crew Alerting (or corresponding certification requirements in the considered aircraft applicable certification basis).

2.2.3 System states control and annunciation

ROAAS_REQ1. ROAAS Equipment shall have a capability (e.g. a cockpit control) to allow the flight crew to manually inhibit the ROAAS.

ROAAS_REQ2. ROAAS shall provide a clear indication when the system is inhibited.

NOTE: *The annunciation of the inhibition status may be accomplished at the installation level. For instance, and depending on the overall cockpit philosophy for indication, the position of an inhibition switch could be used as the means to provide the inhibition indication to the flight crew (e.g. on non complex aircraft).*

ROAAS_REQ3. ROAAS shall provide a clear indication when the system is inoperative.

NOTE: *The annunciation of the inoperative status may be accomplished at the installation level.*

ROAAS_REQ4. ROAAS shall provide a clear indication when the system is unavailable.

NOTE: *The annunciation of the unavailability status may be accomplished at the installation level.*

NOTE: *This indication may be combined with the annunciation of inoperative status.*

NOTE: *For REQ2 to 4, flight phases and cockpit inhibition logics must be considered. It is left to the aircraft manufacturer to determine the appropriate manner to implement such status indications,*

2.2.4 Self-Test and Failure Indication

ROAAS_REQ5. ROAAS Equipment shall include a self-test function that provides indications of equipment condition during operation. This self-test function consists of continuous and initiated tests.

2.2.4.1 Continuous Self-Test

ROAAS_REQ6. During continuous self-test, ROAAS Equipment shall monitor the equipment itself, input signals, output signals, and input power in order to detect when the system has failed or can no longer perform the intended function.

NOTE: *Continuous self-test includes monitoring input signals for sufficient accuracy to allow the ROAAS to perform its intended function. Note that some system inputs such as horizontal and vertical position may have readily available accuracy information where others such as flap angle or glideslope deviation have no real-time accuracy information. The degree to which this accuracy monitoring is performed is left to the ROAAS manufacturer, who can assess which information is available on a given installation in association with the OEM.*

It is not the intent of the self-test function to impose a requirement for loop-back monitoring of the external aural alerting components (such as audio panels and speakers) or external visual displays (such as navigation displays).

ROAAS_REQ7. ROAAS Equipment shall provide the capability to annunciate failures detected by continuous self-test.

NOTE: *This requirement is similar to ROAAS_REQ3 but would cover failures that do not cause the ROAAS to be inoperative.*

2.2.4.2 Initiated Self-Test

These tests may be automatically initiated, e.g. at power up, or manually initiated e.g. for maintenance

ROAAS_REQ8. During initiated self-test, ROAAS Equipment shall verify system operation and provide means to verify integrity of aural and visual alerting, display outputs, and failure reporting capability.

NOTE: *Flight crew verification of the aural alerts, visual alerts, and displays during a self-test is an acceptable method for monitoring these outputs.*

NOTE: *Depending on the coverage of the continuous self-test, it may be acceptable to take credit for continuous self-test to meet this requirement.*

ROAAS_REQ9. ROAAS Equipment shall provide the capability to annunciate system-detected failures on initiated self-test

NOTE: *For automatically initiated self test, "No Indication" is acceptable for a successful test (quiet dark philosophy). For manually initiated self test, a positive indication of a successful result is expected. Actual details of implementation of this indication are left to the ROAAS and aircraft manufacturers..*

2.2.5 Automatic Mode Selection

ROAAS_REQ10. ROAAS Equipment shall arm and disarm the appropriate modes automatically throughout the flight without requiring any dedicated action by the flight crew.

NOTE: *The above requirement does not preclude having a control or controls which allow(s) a pilot to inhibit or modify all or part of the system during certain normal or abnormal situations.*

2.2.6 Awareness Alerting and/or Indications

ROAAS_RECO1 ROAAS may provide awareness to the pilot of the possibility of an overrun in order for the pilot to adjust the aircraft parameters when immediate pilot action is not required.

ROAAS_REQ11. If ROAAS provides an awareness capability, it shall be consistent with the Warning part of the alerting function.

NOTE: *Expected pilot actions following a ROAAS awareness annunciation or indication should not contradict a subsequent ROAAS warning level alert. See also 25.1322 AMC for guidance on consistent designs.*

2.2.7 Equipment Interfaces

ROAAS_REQ12. Equipment interfaces shall be described.

This includes all types of interfaces:

- Hardware interfaces.
- Software interfaces.
- Human Machine Interaction interfaces.

NOTE: *This description by the ROAAS manufacturer is an input for the installation work described in CHAPTER 6.*

2.2.8 Fire protection

ROAAS_REQ13. All materials used shall be self-extinguishing except for small parts (such as knobs, fasteners, seals, grommets and small electrical parts) that would not contribute significantly to the propagation of a fire.

2.3 RELIABILITY, AVAILABILITY AND INTEGRITY

2.3.1 General Safety and reliability requirements

ROAAS is designed to be a “safety net” for runway overrun hazards. Its role is to assist the crew by providing a timely and adequate alert in case of risk of overrun, however the crew remains responsible for the final decision for safe flight and landings.

2.3.2 ROAAS equipment safety analysis

Failure cases may be design dependent, so proposed classifications will need to be confirmed through a proper “OEM ROAAS Equipment Safety Analysis” carried out as per applicable AMC25.1309.

As a result, the basic classifications to be considered at ROAAS Equipment level, are proposed as follows:

1. Detected or Undetected Loss of the ROAAS function, does not impact the aircraft behavior. Such unexpected event is considered as having no more than Minor effect.
2. Undue (False or Inadequate) Alert of the ROAAS effect is design dependent. Such unexpected event is considered as having no more than Major impact.

2.3.3 Reliability requirements for the ROAAS

The following proposed reliability requirements are compatible with the above proposed safety classification (in §2.3.2), and they shall be considered as a minimum to be reached by the ROAAS Equipment.

ROAAS_REQ14. The failure rate of the ROAAS to perform its intended function, with failure indication (detected loss of ROAAS) shall be shown to be no greater than 10^{-3} per flight hour (reliability design objective).

ROAAS_REQ15. The failure rate of the ROAAS to provide its intended function without a failure indication (Undetected loss of ROAAS) shall be shown to be no greater than 10^{-3} per flight hour (reliability design objective).

2.3.4 Safety requirements for the ROAAS

Certification requirements reminder:

The probability of false or inadequate alerts (undue alert) due to a failure of the ROAAS must be in accordance with criticalities established through the OEM ROAAS safety analysis.

NOTE: *The criticality of undue alerts is considered as no more than Major depending on the impact on the crew workload at a given flight phase.*

NOTE: *False or inadequate alerts effects and criticality analysis may consider different flight phases (take-off, cruise, final approach, end of deceleration...).*

NOTE: *Use of ROAAS in special operations (e.g. CAT III) may increase criticality*

Based on the worst case (Major classification) of Item 2 in section 2.3.2,

ROAAS_REQ16. The ROAAS Hardware shall be developed against DO 254()/Process level C or higher.

NOTE: *Development Assurance Level (DAL) may be limited to functions/hardware participating in the failure conditions considered above.*

Based on the worst case (Major classification) of Item 2 in section 2.3.2,

ROAAS_REQ17. ROAAS Equipment Software shall be developed against AC/AMC 20-115 () processes level C or higher.

NOTE: *DAL may be limited to functions/hardware participating in the failure conditions considered above.*

ROAAS_REQ18. A safety analysis of the ROAAS shall be performed taking also into account effect of data base errors. Database integrity aspects are addressed in EUROCAE ED-76() / RTCA DO-200 () (version in effect at initial certification or later version)

2.4 MAINTAINABILITY

[No specific requirement]

2.5 SOFTWARE AND HARDWARE DESIGN MANAGEMENT

As reminders of certification requirements already in effect:

Software design must follow the guidelines specified in document AC/AMC 20-115 ().

The software criticality level will depend on the particular equipment function and application (see [ROAAS_REQ17]).

Electronic Hardware design must follow the guidelines in document ED-80()/DO-254() "Design Assurance Guidance for Airborne Electronic Hardware".

The hardware criticality level will depend on the particular equipment function and application.

CHAPTER 3

MINIMUM PERFORMANCE SPECIFICATION UNDER STANDARD CONDITIONS

The following sections provide a detailed definition of the ROAAS functionalities.

The performance of an alerting function is defined by the capacity to trigger a timely alert and its ability to limit the occurrence of nuisance alerts. In the case of ROAAS, these alerting conditions are related to real time comparisons of the landing distance as estimated by the ROAAS model with other distances.

3.1

FUNCTIONALITY

3.1.1

Operational Domain

A description of flight phases or operational domain of the ROAAS is proposed in section A.1 of Appendix A.

ROAAS_RECO2 Each ROAAS integrator should clearly define and document for the final user the ROAAS operational domain, including all conditions for which ROAAS is expected to perform its intended function (or possibly express as limitations the parts of the aircraft flight domain where the ROAAS is not intended to perform its function), in terms of:

- Flight domain certified for landing for the aircraft in which ROAAS is installed.
- Runway surface conditions.
- Runway characteristics.
- Field elevation.
- Aircraft weight.
- Aircraft centre of gravity.
- Setting of high lift devices.
- Possible automated means of deceleration control.
- Glideslope angle and approach type.
- Atmospheric conditions.
- Aircraft system failures impacting landing performance which are compensated for.

ROAAS_REQ19. ROAAS shall as a minimum support two modes of operation: In-Air and On-Ground.

ROAAS_REQ20. ROAAS shall as a minimum provide accommodation for wet and dry runway surfaces

NOTE: *The aircraft manufacturer will need to define the “dry” and “wet” conditions being used in the performance model (several definitions are available).*

3.1.2

Runway Selector

ROAAS_REQ21. ROAAS equipment shall determine the “ROAAS selected runway” using at least one of the following methods:

1. pilot selected runway (including from external sources, e.g. acquisition of runway from the on board systems such as FMS, from already input navigation data / selection in an on board database).
2. an automatic runway selection function .

ROAAS_REQ22. ROAAS shall be unavailable if the aircraft is not landing on the ROAAS selected runway.

3.1.3 Runway Database

3.1.3.1 Runway end used for ROAAS

The following discussion uses the term "runway end"

The definition of runway end may vary by ROAAS manufacturer depending on the operational constraints and operations of the aircraft type. Appendix A gives further information on the terminology and definitions. Some ROAAS systems may use the "Landing Distance Available" in order to be consistent with the distance used for the flight preparation and performance calculations which may be shorter than the physical runway length. Other ROAAS manufacturers may use the physical end of runway pavement. In all cases, the ROAAS manufacturer must ensure that the "end of runway" used for ROAAS is suitable for aircraft operations and braking.

ROAAS_REQ23. The ROAAS manufacturer shall define and document the "runway end" which is used for ROAAS overrun alerts.

The corresponding runway length is hereafter referred to as "ROAAS Runway Length" as necessary in further discussions where a distance is needed, rather than a point in space.

Refer to appendix A for additional details.

3.1.3.2 Airport/Runway Database Quality Requirements

Airport and runway information need to be accurate and of acceptable resolution in order for the system to perform its intended function.

ROAAS_REQ24. The ROAAS Manufacturer shall define the data quality requirements for the ROAAS runway database necessary to support intended function in accordance with ED-76()/DO-200().

NOTE: *The above requirement covers the following items:*

- *Accuracy.*
- *Resolution.*
- *Assurance Level.*
- *Traceability.*
- *Timeliness.*
- *Completeness.*
- *Format.*
- *Configuration control: any change of data sources.*

The ROAAS Manufacturer may use ED-99()/DO-272(), User Requirements for Aerodrome Mapping Information, for guidance to define data quality requirements.

NOTE: *Runway information is reported by each State, members of the ICAO, through the Aeronautical Information Service. Based on in-service operation of runway database, accuracy of reported runway information can be greater than the expected accuracy in ICAO annex 15 definition or some information can be missing.*

NOTE: *The Landing Distance Available is defined by local authority and can be voluntarily shorter than the general definition provided in the ICAO Annex 14.*

ROAAS_REQ25. The ROAAS Manufacturer shall stipulate that the processes for producing and updating ROAAS runway databases must meet the standards specified in ED-76()/DO-200().

ROAAS_REQ26. ROAAS equipment shall declare itself unavailable if the ROAAS selected runway data do not satisfy data quality requirement set by the ROAAS function manufacturer.

ROAAS_REQ27. Conformity of the database to the Database Quality Requirements (DQR) shall be stated by the database supplier.

ROAAS_REQ28. The equipment hosting the ROAAS runway database shall be capable of accepting database updates.

3.1.3.3

Runway Characteristics

ROAAS_REQ29. The ROAAS shall automatically obtain from the ROAAS runway database the characteristics of the "ROAAS selected runway" necessary to perform its intended function.

ROAAS_RECO3 These characteristics may include but are not limited to:

- Runway threshold position: latitude, longitude and elevation.
- Distance between runway threshold and runway end.
- Runway slope.
- Runway heading.
- Runway ID.

NOTE: *It is recognized that in order to limit nuisance or increase function availability, the ROAAS runway database manufacturer could modify official published data in the case of missing or erroneous data.*

NOTE: *In addition, it is allowed for a ROAAS runway database manufacturer to originate data using other sources or means instead of AIP data.*

This modification/origination process must be documented and approved by the appropriate certification Authority.

NOTE: *The runway slope can be computed based on the thresholds or runway ends difference of elevation or by other means.*

NOTE: *All data may be stored in the ROAAS runway database or derived from other stored data (e.g. FMS...). The ROAAS manufacturer will specify the data requirements to the ROAAS database supplier.*

Certification requirement reminder: The database quality requirements must be reviewed every time a new functionality is added to the ROAAS to ensure that the data are appropriate for the new function (as per ED-76()/DO 200()).

3.1.3.4

Runway data modification

The ROAAS may allow for the runway information to be updated or changed by the pilot or an external system.

Each ROAAS manufacturer will define the changes that may be allowed.

ROAAS_REQ30. Data entered by pilot or external system shall not modify the installed ROAAS runway database (unless during normal database update).

NOTE: *Pilot-entered data might be envisioned to handle NOTAM changes to the runway data, e.g. temporarily updating declared distances if these have not been included in the current cycle of the database. For that purpose, the ROAAS may include an interface allowing this update by the crew.*

3.1.4

ROAAS In-Air Alerting

Many runway overruns are due to the aircraft's energy state during the final approach. Excessive energy during the final approach may be due to one factor or the combination of several factors. Some of the factors that can cause excess energy are: change in wind conditions, aircraft high on approach, aircraft speed above nominal approach speed and flare longer than nominal.

NOTE: *What level of energy is "excessive" is relative, depending on aircraft type and deceleration capability.*

A ROAAS is designed to determine the distance required to land and stop based on the aircraft's energy state during the final approach and compare this with the distance remaining to the end of the runway selected for landing. If at any point there is a calculated risk of runway overrun due to the aircraft's energy state with respect to the selected landing runway, the ROAAS will alert the flight crew of the situation.

NOTE: *There may be many different methods to determine the risk of runway overrun from the aircraft's energy state and the selected landing runway. This MOPS does not prescribe the methodology to be used to determine runway overrun risk.*

3.1.4.1 Arming/Disarming

ROAAS_REQ31. The ROAAS In-Air mode shall automatically arm when arming conditions have been met.

ROAAS_REQ32. The ROAAS In-Air mode shall automatically disarm when disarming conditions have been met.

NOTE: *The Exit Point criteria (disarming of ROAAS In-Air mode) must be such that nuisance alerts are not created during a go-around.*

ROAAS_REQ33. The ROAAS In-Air mode shall disarm no later than the Committed to Stop point.

NOTE: *The intent of this requirement is to avoid triggering an alert which might result in an inappropriate crew response.*

ROAAS_RECO4 The In-Air mode Entry Point should be defined by the ROAAS manufacturer at an altitude no lower than that required for performing a go-around without touching down.

3.1.4.2 Alert Criteria

(Refer to 1.5.4 for definition of distances)

ROAAS_REQ34. With In-Air mode armed, and ROAAS active, ROAAS Equipment shall trigger a warning level alert when the ROAAS Model Distance (RMD) computation results in a stopping point that is beyond the end of the runway.

ROAAS_REQ35. For all points within the operational domain certified for ROAAS use, the ROAAS model distance (RMD) during final approach shall be longer than the performance landing distance (PLD) considering input parameter bias, pilot reaction and system delays.

Appendix C.1 provides a possible means to verify compliance with this requirement.

ROAAS_RECO5 For all points within the flight domain certified for ROAAS use, the ROAAS model distance for In-Air mode should not be greater than the typical landing distance (TLD) by more than a few percent

Appendix C.1 provides a possible means to verify compliance with this recommendation.

NOTE: *A value of 2% is proposed as a starting point for studying nuisance alerts.*

3.1.4.3 Aural Alert

ROAAS_REQ36. For a warning level ROAAS In-Air alert, ROAAS Equipment shall be capable of triggering an aural alert.

ROAAS_RECO6 The In-Air warning should consist of one of the following:

- "RUNWAY TOO SHORT".
- "OVERRUN GO-AROUND".
- "GO-AROUND".
- "OVERRUN".

NOTE: *These phrases are examples of both descriptive and prescriptive philosophies, which are known to be present in actual cockpits designs, and have been found acceptable.*

ROAAS_RECO7 The following messages are not recommended for the In-Air warning: "Unstable", "too high", "too fast", "too steep", or any deceleration related alert.

Certification reminder: If the ROAAS includes more than one level of alert, alerts must be easily distinguishable in the various levels (ref. AMC 25.1322 () or equivalent, 5(c)(4)(e), 5(c)(8), 6(b) or AC 25.1322-1 or equivalent, 5(c)(4), 5(c)(8), 6(b)). Some of the phrases recommended for Warning may be used at another level provided they are not used twice.

3.1.4.4 Visual Alert

ROAAS_REQ37. For a warning level ROAAS In-Air alert, ROAAS Equipment shall be capable of triggering a visual alert.

3.1.5 Transition between In-Air and On-Ground

The transition between the In-Air and On-Ground modes provides several complexities. The ROAAS manufacturer needs to minimize the risk of providing an undue alert during this critical phase of flight and associated high workload. At the same time, the ROAAS manufacturer must try to minimize or eliminate any discontinuities in protection where an overrun risk could occur without the flight crew being alerted in a timely manner.

ROAAS_RECO8 The ROAAS should continuously perform its intended function during the transition from the In-Air mode to the On-Ground mode.

ROAAS_REQ38. The In-Air mode shall be disarmed before On-Ground mode is armed.

3.1.6 ROAAS On-Ground Alerting

Many runway overruns are due to an aircraft's too high energy state when rolling on the runway. Lack or improper use of aircraft deceleration devices while on the ground may lead to excessive energy. The energy state of the aircraft and the risk of runway overrun are related through the aircraft's capability to dissipate the energy. The environmental conditions at landing may also impact the aircraft's ability to dissipate energy. Consequently, the "risk" of runway overrun based on a given energy state will vary by aircraft type and conditions.

3.1.6.1 Arming/Disarming

ROAAS_REQ39. ROAAS Equipment shall automatically arm the On-Ground mode when arming conditions have been met.

ROAAS_REQ40. ROAAS Equipment shall automatically disarm the On-Ground mode when disarming conditions have been met.

ROAAS_REQ41. ROAAS On-Ground mode shall be armed no later than the committed to stop point and no earlier than touchdown.

3.1.6.2 Alert Criteria

(Refer to 1.5.4 for definition of distances)

ROAAS_REQ42. While On-Ground and active, ROAAS equipment shall trigger a warning level alert when the ROAAS Model Distance (RMD) computation results in a stopping point that is beyond the end of the runway.

ROAAS_REQ43. For all points within the operational domain certified for ROAAS use, the ROAAS model distance (RMD) during On-Ground shall be longer than the performance landing distance (PLD) considering input parameter bias, pilot reaction and system delays.

Appendix C.1 provides a possible means to demonstrate this requirement.

3.1.6.3 Aural Alert

ROAAS_REQ44. For a warning level ROAAS On-Ground alert due to a predicted runway overrun risk, ROAAS equipment shall be capable of triggering an aural alert.

ROAAS_RECO9 The On-Ground warning should consist of at least one of the following:

- "RUNWAY TOO SHORT".
- Any directive related to the deployment of available stopping devices (brakes, reversers, ...).
- "OVERRUN".

NOTE: *These messages are examples of both descriptive and prescriptive philosophies, which are known to be present in actual cockpits designs, and have been found acceptable.*

ROAAS_REQ45. The following message shall not be used for the On-Ground warning:

- "GO-AROUND".

(Or any such reference to a go-around procedure).

3.1.6.4 Visual Alert

ROAAS_REQ46. For a warning level ROAAS On-Ground alert, ROAAS Equipment shall be capable of triggering a visual alert

3.2 SYSTEM PERFORMANCE

The ROAAS Equipment alerting operations have been described in the Equipment Performance section, above. That section contains conditions under which the ROAAS Equipment produces alerts. In order to perform these functions and interact with other aircraft systems, this System Performance section discusses system inputs and how the ROAAS Equipment interacts with the host aircraft system.

3.2.1 Aural and Visual Alerts

ROAAS_REQ47. ROAAS Equipment shall provide the required aural and visual alerts in a manner that clearly indicates to the flight crew that they represent the same event.

NOTE: *The ROAAS may accomplish the entire alerting function, or provide alert inputs to an external aircraft alerting system.*

ROAAS_REQ48. ROAAS Equipment shall be capable of accepting and processing airplane performance-related data and/or airplane dynamic data to provide the capability to update aural and visual alerts (if any) at least once per second.

NOTE: *The above requirement does not imply that an aural message that was in the process of being annunciated when the alert envelope was exited must be truncated in mid phrase*

3.2.2 Alert Performance - Unwanted Alerting Reduction

ROAAS_RECO10 Nuisance alerts should be minimized.

ROAAS_RECO11 ROAAS Equipment should be designed so that ROAAS nuisance alerts related to erroneous runway selection are minimized when the aircraft approaches airports with multiple runways.

ROAAS_RECO12 The exit point criteria of the On-Ground mode should be designed so that nuisance alerts are minimized when approaching the end of the runway.

Section C.2.3 gathers typical flight scenarios and approaches which may be used to test the ROAAS equipment.