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Minimum Operational Performance Standard for Offshore Helicopter Terrain Awareness and Warning System (HTAWS)

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FOREWORD

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- 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
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1 PURPOSE AND SCOPE

1.1 INTRODUCTION

This document defines the Minimum Operational Performance Standards (MOPS) for an Offshore Helicopter Terrain Awareness and Warning System (Offshore HTAWS). These standards specify system characteristics that are intended to be useful to designers, manufacturers, installers, and users of Offshore HTAWS.

The term “Offshore HTAWS” as used herein includes all the functional components necessary to properly perform the intended function. However, all external components to the function which are cockpit, aircraft, or system specific, though necessary for proper operation of the function at a system level, are out of the scope of the system requirements (e.g. cockpit controls, cockpit indicators, cockpit displays, aural systems, inputs, and sensors). Note that any databases that might be required by the Offshore HTAWS are not considered to be part of the system as defined in this document.

1.2 MANDATE AND RECOMMENDATION PHRASES

1.2.1 Shall, Should and May

	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 (if not followed)	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

Note: These definitions only apply to Sections 2, 3, 4 and 5.

1.2.2 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 Offshore HTAWS.

1.2.3 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

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standard and are expected to have been met by the system / hardware / software or by the development process used.

1.2.4 Verify

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

1.3 DOCUMENT CONTENTS

SECTION 1 of this document provides information needed to understand the rationale for Offshore HTAWS characteristics and requirements stated in the remaining sections. It describes typical system applications and operational goals (refer also to Appendix A), as envisioned by the members of WG-110/SC-237, and establishes the basis for the standards stated in SECTION 2 and 3. Definitions and assumptions essential to proper understanding of this document are also provided in this section.

SECTION 2 contains general design requirements for the Offshore HTAWS. This includes reliability, availability and integrity requirements, with safety considerations.

SECTION 3 describes minimum performance requirements for Offshore HTAWS. Requirements are identified with OHTAWS_REQXX and bullets directly below the requirements, if applicable, provide conditions to be met. Additional information related to requirements are contained in NOTES. Recommendations are identified as RECOMMENDATION.

SECTION 4 describes the minimum required performance of Offshore HTAWS 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 section are mainly related to hardware and interfaces.

SECTION 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 section are applied to Offshore HTAWS in laboratory/bench conditions.

SECTION 6 describes installed performance requirements. The proposed demonstrations are considered after installation/activation of Offshore HTAWS in an aircraft and are aimed at confirming the system functionality within this environment, including human machine interface effects and “man in the loop” demonstrations.

Appendix A provides considerations for the design of HTAWS auditory alerts.

Appendix B provides guidance of how aircraft-specific Mode 7A airspeed versus engine torque envelopes are developed.

Appendix C provides guidance of how aircraft-specific Mode 7B vortex ring state protection envelopes are developed.

Appendix D contains the acronyms and glossary of terms.

Appendix E includes the WG-110/SC-237 membership.

1.4 APPLICATIONS

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

An offshore operation means a helicopter operation that has a substantial portion of any flight conducted over open sea areas to or from an offshore location. An offshore operation includes, but is not limited to, a helicopter flight for the purpose of:

- support of offshore oil, gas and mineral exploration, production, storage and transport; or
- support of offshore wind turbines and other renewable-energy sources; or
- support of ships including sea pilot transfer.

An 'offshore location' is a location or destination on a fixed or floating offshore structure or vessel, and includes helidecks, helicopter hoist operations areas and operating sites. 'Offshore locations' include, but are not limited to:

- helidecks;
- shipboard heliports; and
- winching areas on vessels or renewable-energy installations.

This MOPS is designed to ensure that compliant Offshore HTAWS systems 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 Offshore HTAWS is a new function (at the time of first publication) that may be implemented in many different ways, the present document goes beyond equipment specifications and addresses 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 ETSO/TSO).

This MOPS applies only to the specific functions defined herein. The Offshore HTAWS system may have additional features related to these functions 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 system 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-110/SC-237 was performed for helicopter applications (defined as regulated by CS-27 / 14 CFR Part 27 or CS-29 / 14 CFR Part 29).

1.5 SYSTEM OVERVIEW

1.5.1 Principles

A typical Offshore HTAWS is intended to provide the flight crew with aural and visual alert aids aimed at reducing the risk of a CFIT accident through increased awareness of the aircraft state relative to the terrain and hazardous flight conditions. Offshore HTAWS is intended as a supplement to, as opposed to a replacement for, HTAWS provided in accordance with RTCA DO-309.

Offshore HTAWS is an alerting system, which is intended as a "safety net". The system does not guarantee successful recovery from a conflict due to factors such as pilot response and actual aircraft performance.

Figure 1-1 shows a typical Offshore HTAWS as defined in the document. A dashed line in the figure represents optional components.

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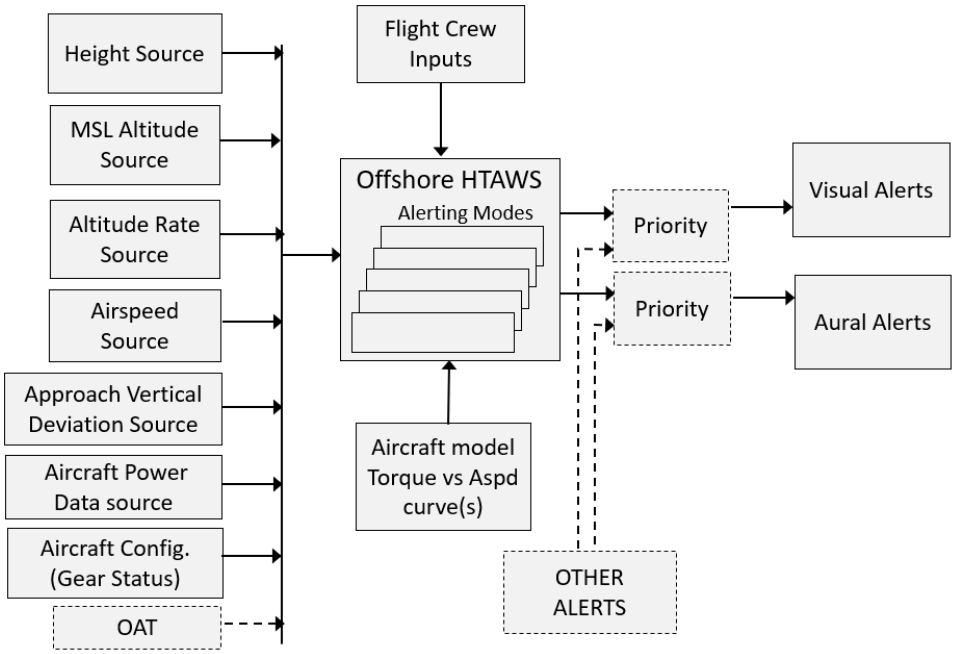


Figure 1-1: Offshore HTAWS Context Diagram

A typical height source would be a radio altimeter (also known as radar altimeter) although other technologies may be used. Since tides and sea state can significantly impact the geo-position of the surface level, it is important for the offshore modes that actual distance to the current state of the surface be measured.

A typical altitude rate source will employ a blended solution of inertial and barometric data, or a blended combination with GNSS based vertical speed to achieve an accurate source of altitude rate data. An altitude rate derived primarily from changes in barometric pressure altitude is typically inadequate due to errors created by main rotor downwash effects at the static port vents which tend to be particularly prevalent at lower airspeeds. Use of radio altimeter for descent rate should be avoided due to the effects on this parameter of crossing the edge of the helideck. See CAP1538 [Ref 09].

The aircraft power data will typically include total torque, mast torque, engine torques, and other engine and drive system-related data necessary to determine autorotation state, OEI conditions, and additional information related to the torque versus airspeed protection mode.

Using only torque to detect the autorotation state could result in valid alerts being undesirably inhibited during a low power condition. Alternative or additional parameters (e.g. N1) should be considered.

Aircraft configuration data includes gear-up versus gear-down status and weight-on-gear conditions.

Smoothing of the input data may be performed in Offshore HTAWS to minimize nuisance alerts. The test procedures presented in this MOPS are based on steady state inputs and are designed to ensure that delays to alert onset resulting from input data smoothing do not contribute to the Offshore HTAWS failing to provide alerts in a timely fashion. The alert envelopes presented in this MOPS are not applicable to increasing rates, and additional delays to alert onset may be experienced if increasing rates are used.

The actual architecture of the Offshore HTAWS is not defined or constrained by this document. It is envisioned that various implementations are possible, including standalone

LRUs, software modules within multi-function equipment, and hybrid implementations between these two extremes.

1.5.2 Concept of Operations

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

- be powered up with the aircraft;
- complete a self-test and then continue to monitor its system health for the rest of the flight;
- receive information on the flight parameters and aircraft configuration; and
- provide a means to manually activate/deactivate the Offshore HTAWS system; and optionally automatically activate/deactivate the Offshore HTAWS system when appropriate.

When active, Offshore HTAWS is expected to automatically:

- arm the appropriate modes without additional action by the flight crew;
- where appropriate, disarm applicable modes during emergencies without additional action by the flight crew;
- trigger alerts as appropriate per intended function, in the mode adapted to the current phase of flight, subject to priority of alerts in the cockpit;
- disarm appropriate modes after landing and remain in this state as long as the aircraft is on the ground; and
- indicate its status to the crew when any function is in an inhibited, unavailable or inoperative state.

1.6 COMPOSITION OF SYSTEM

The Offshore HTAWS may optionally be designed with additional features. Any aural messages generated by those additional features must be appropriately prioritized relative to the aural messages from the basic features. Note that aural messages from the optional features are allowed to have a higher priority than the aural messages from the basic features. Due to the fact that the additional features will impact the basic features, additional features must at least meet the same qualification testing, software verification, and validation requirements as the basic features.

A recommended optional feature is the ability to initiate a ground test of all possible aural alert messages. This will allow flight crew to familiarize themselves with the various aural alert sequences (tones and voices) which they might encounter without having to induce the condition in flight. For flight crew without ready access to an appropriately configured simulator set up for Offshore HTAWS alerts, this may be the only means to otherwise hear the alerts through a representative audio system and headset/helmet. This feature, if included, should be separate from the simple audio alert test intended to be performed during pre-flight.

1.7 DEFINITIONS AND ACRONYMS

Terms used within this document:

Activate. A term used to describe the operational status of the Offshore HTAWS system. The Offshore HTAWS system will only issue alerts when it is Active.

Advisory. The level or category of alert for conditions that require flight crew awareness and may require subsequent flight crew response.

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Alert. A generic term used to describe a flight deck indication meant to attract the attention of and identify to the flight crew operational or aircraft system condition. Alerts are classified at levels or categories corresponding to Warnings, Cautions, and Advisories.

Arming. Arming refers to the automatic switching on of a function by the system. For instance, Mode 3 might be armed when radio altitude becomes greater than 80 feet.

Attenson. A very short attention-getting sound. Used in aviation as an initial, non-verbal signal to alert flight crew.. An attenson is often followed by a verbal or non-verbal alert that is specific to the condition that initiated the signal.

Aural Alert. A discrete sound, tone, or verbal statement used to annunciate a condition, situation, or event.

Autorotation. Autorotation is a rotorcraft fight condition in which the lifting rotor is driven entirely by action of the air when the rotorcraft is in motion.

Caution. The level or category of alert for conditions that require immediate flight crew awareness and a less urgent subsequent flight crew response than a warning alert.

Controlled Flight into Terrain (CFIT). An accident or incident in which an airworthy aircraft, under the full control of the pilot, is unintentionally flown into terrain, obstacles, or water.

Deactivate. A term used to describe the operational status of the Offshore HTAWS system. The Offshore HTAWS system will not issue alerts when it is Deactivated.

Disarming. Disarming refers to the automatic switching off of a function by the system. For instance, Mode 3 might be disarmed 60 seconds after take-off.

Failure. An occurrence that affects the operation of a component, part, or element such that it can no longer function as intended. This includes both loss of function and malfunction.

Inhibiting. Inhibiting refers to a function being turned off based on a signal from outside the system. Typically, this will be based on a pilot-activated switch.

Nuisance Alert. An alert generated by a system that is functioning as designed but which is inappropriate or unnecessary for the particular condition.

Obstacle. A human-made structure relevant to aviation.

Terrain. Any type of surface (e.g. land or water).

Visual Alert. A visual indication that presents the flight crew with data on the exact nature of the alerting situation. Visual alerts are classified at levels or categories corresponding to Warnings, Cautions, and Advisories.

Warning. The level or category of alert for conditions that require immediate flight crew awareness and immediate flight crew response.

1.8 INTENDED FUNCTION & OPERATIONAL GOALS

Offshore HTAWS is intended to provide effective alerts for offshore operations. Due to the flight profiles utilised and the prevailing obstacle environment, alerting modes based on terrain databases and using forward-looking algorithms are not generally effective. Development of new alerting modes is therefore required to provide an acceptable level of protection.

The new alerting modes are intended to provide timely and distinctive alerts to the flight crew, based on defined envelopes, when the helicopter is at risk of impact with the terrain, or when the configuration and flight parameters are in an abnormal condition for that phase of flight which is likely to lead to a risk of impact with the terrain. These alerting modes

are optimised for the approach and departure phases of flight, as this is where the risk of impact with the terrain is highest for offshore operations.

The Offshore HTAWS should emphasise:

- alerting modes that support the operational profiles flown by offshore helicopters; and
- provision of timely alerts while minimizing occurrences of nuisance alerts

1.9 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 and SECTION 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 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. Civil Aviation Authorities should define whether alternate procedures are acceptable when approving the Offshore HTAWS system.

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 SECTIONS 2, 3 and 4 shall have been demonstrated as a precondition to satisfactory completion of the installed system tests of SECTION 6.

1.9.1 Environmental Tests

Environmental test requirements are specified in SECTION 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.

Where environmental conditions are not 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 compliance.

1.9.2 Bench Tests

Bench test procedures are specified in SECTION 5. These tests provide a laboratory means of demonstrating compliance with the requirements of SECTION 2 and SECTION 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 Offshore HTAWS design.

1.9.3 Installed Considerations

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

The installed Offshore HTAWS test procedures and their associated limits are specified in SECTION 6. Although bench and environmental test procedures are not included in the installed Offshore HTAWS tests, their successful completion is a precondition to completion of the installed test. In certain instances, however, installed Offshore HTAWS tests may be used in lieu of bench test simulation. Installed tests are normally performed under two conditions:

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

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2. With the aircraft in flight using operational system inputs appropriate to the Offshore HTAWS under test.

Test results may be used to demonstrate functional performance in the intended operational environment.

If the alerting envelopes provided in this document are used as references for flight tests of the Offshore HTAWS, an additional tolerance band below the lower tolerance limit of each bench test curve is necessary to accommodate the integration of the Offshore HTAWS into the aircraft. See SECTION 6 for further information.

1.10 ANTICIPATED FUTURE GROWTH

Anticipated future growth is not planned at the time of release of this MOPS. The MOPS was created to specifically address operations to offshore locations. Future revisions may be required to address new technologies or approach schemes or to address other offshore operations (e.g. search and rescue). A future Onshore HTAWS is envisioned but would be developed as a new MOPS.

1.11 AIRCRAFT EQUIPMENT INFORMATION VULNERABILITIES

Aircraft equipment information vulnerabilities (such as cybersecurity risks) have been present for digital systems since the development of the personal computer (PC) in the late 70's and even longer for RF systems, and the advent of internet connectivity has substantially increased those risks. Internet and Wi-Fi connectivity have become popular as a means for aircraft or equipment manufacturers to update installed avionics software, to update databases, or provide an alternate means of communicating with the flight crew or cabin (e.g. in-flight entertainment or weather).

In most countries, the State provides oversight of safety-of-flight systems (sometimes referred to as "authorized services") which provide information to aircraft, such as ILS, VOR, GNSS, and DME, to name a few. This oversight is safety-based and addresses failure modes of the system. These failure modes can be characterized by fault trees and aligned to failure modes documented in a Functional Hazard Assessment. This approach does not account for malicious intent such as cybersecurity risks. In addition, the State typically does not provide oversight on "non-trusted" connectivity such as the Internet, Wi-Fi, or manufacturer-supplied equipment interfaces which permit input of externally supplied data into aircraft systems. A manufacturer may expose aircraft information vulnerability through equipment design or information may become vulnerable as a result of being connected to a common interface. Therefore, it is important that manufacturers consider aircraft information security risk mitigation strategies in their equipment design, particularly when the equipment is responsible for an interface between the aircraft and aircraft-external systems.

Apart from any specific performance requirements for aircraft information security in these MOPS, it is recommended that manufacturers look at a layered approach to mitigate aircraft information security risk that includes both technical (e.g., software, signal filtering) and physical strategies. From a technical perspective, for example, this could include signal-spoofing detection capabilities or more stringent, multi-factored authentication techniques such as passwords and digital certificates. From a physical perspective, for example, such as in an in-flight entertainment system in the cabin, a manufacturer could consider connectors that require special tools to remove to prevent passenger tampering and limited wiring connections to higher integrity systems or use of one-way digital busses. And finally, but just as important, manufacturers should consider supply chain risk management; for example, if a manufacturer is outsourcing software code development, are the contractor and its staff properly vetted?

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Civil Aviation Authorities (CAAs) have a regulatory interest when an applicant's design makes use of a non-trusted connectivity where the installation can potentially introduce aircraft information security vulnerability. This requires the applicant to address not only the information security vulnerabilities and mitigation techniques for the new installation, but to also consider how vulnerability could propagate to existing downstream systems. These techniques need to address the end-to-end signal flows for systems that are interconnected. Therefore, it is recommended that manufacturers reference their aircraft information security review and mitigation strategies in the equipment's installation manual so that the applicant can consider them in meeting the installation regulatory requirements.

1.12 REFERENCE DOCUMENTS

[Ref 01] EASA CS-29, "Certification Specification and Acceptable Means of Compliance for Large Rotorcraft"

[Ref 02] EASA CS-27, "Certification Specification and Acceptable Means of Compliance for Small Rotorcraft"

[Ref 03] 14 CFR Part 29, "Airworthiness Standards, Transport Category Rotorcraft"

[Ref 04] 14 CFR Part 27, "Airworthiness Standards, Normal Category Rotorcraft"

[Ref 05] FAA AC 29-2C, "Certification of Transport Category Rotorcraft"

[Ref 06] FAA AC 27-1B, "Certification of Normal Category Rotorcraft"

[Ref 07] ED-14() /DO-160(), "Environmental Conditions and Test Procedures for Airborne Equipment" (see note)

[Ref 08] DO-309, "Minimum Operational Performance Standards (MOPS) for Helicopter Terrain Awareness and Warning System (HTAWS) Airborne Equipment"

[Ref 09] CAP1538, "Class A Terrain Awareness Warning System (TAWS) for Offshore Helicopter Operations"

[Ref 10] CAP1747, "Class A HTAWS Warning Annunciation"

Note:

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

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