Future Safety

Offshore Helicopter Terrain Awareness Warning System Alert Envelopes

CAP 1519

Published by the Civil Aviation Authority, 2018
Civil Aviation Authority,
Aviation House,
Gatwick Airport South,
West Sussex,
RH6 0YR.

Version 1.1 First published July 2017
Version 1.2 November 2017
Version 1.3 This edition published September 2018

Enquiries regarding the content of this publication should be addressed to:
FSTechnicalSupportTeam@caa.co.uk

The latest version of this document is available in electronic format at www.caa.co.uk

Contents

Foreword

Controlled Flight Into Terrain (CFIT) has been identified as a major cause of helicopter accidents world-wide, predominantly at night or during flight under degraded visual conditions. Helicopter Terrain Awareness & Warning Systems (HTAWS) are employed to warn flight crews of terrain, obstacles or descent rates which may be hazardous and thereby assist in preventing CFIT.

Over land, the “look-ahead” or Enhanced Mode is generally considered to provide satisfactory alerts utilising GPS position and a terrain database. However, operational experience from offshore Commercial Air Transport (CAT) in support of oil and gas exploitation has shown that current HTAWS are not optimised for those operations. Some current HTAWS are unable to display fixed obstacles such as large oil platforms with sufficient accuracy. Even if the accuracy is sufficient, keeping the obstacle database sufficiently up to date is impractical due to the large number of mobile obstacles.

Addressing the issues associated with the Enhanced Mode would be difficult and probably impractical, however there is scope for improving the Classic Modes which utilise aircraft flight parameters such as height and rate of descent. This has been achieved using flight data extracted from helicopter operators’ Flight Data Monitoring programmes to develop alert envelopes which would warn crews of hazardous flight profiles while constraining the alert rate to an acceptable level.

Revision history

Version 1.3 September 2018

In this edition CAP 1519 Version 1.2 has been updated to:

- clarify on page 10 that only offshore oil and gas installations should be removed from the offshore obstacle database;
- increase the allowed height loss for Mode 3A from 10% to 20% on page 12 following test experience reported by Honeywell/Sikorsky; and
- add a sentence to Mode 7 on page 15 to explicitly allow Mode 7 to be disabled during OEI operations.

The amended text has been underlined in red.

This Revision history page has also been addded.

Version 1.2 November 2017

Updated to allow the possibility that some of the functionality specified can be implemented in aircraft systems outside of HTAWS.

Version 1.1 July 2017

First published.

Background

HTAWS was introduced on 3rd generation offshore helicopters with the intent of replicating the improvement in safety performance realised when TAWS was mandated for aeroplanes (FAA final rule issued March 2000[1]). Experience has shown, however, that HTAWS has not provided the safety improvements expected in offshore operations.

RTCA Minimum Operating Standards (MOPS) for HTAWS exist in DO 309, dated 13th March 2008. The DO 309 HTAWS does not have a radio altimeter input and therefore does not provide Classic Modes or the height alerting functionality required by the offshore helicopter operating rules noted below. Such HTAWS are analogous to aeroplane Class B TAWS. TSO C194 and ETSO C194 address the Technical Requirements for HTAWS but, again, do not contain any requirements for the Classic Modes. Therefore, there are no standards or certification requirements directly relating to the Classic Mode alert envelopes for helicopters, i.e. the equivalent of aeroplane Class A TAWS.

The operational regulations requiring a radio altimeter with a voice warning were embodied in Europe under JAR OPS 3.660 and then adopted in EASA CAT.IDE.H.145 (see appendix). Class A HTAWS is mandated by EASA for helicopters first issued with an individual C of A after 31st December 2018 under SPA.HOFO.160(c)[2], although there is currently no formal definition for Class A HTAWS. Helicopter CAT operations under 14 CFR Part 135 do not have a requirement for a low height alert device as 135.154 only refers to “airplanes”. 14 CFR135.160 “Radio Altimeters for rotorcraft operations” requires RADALT for rotorcraft after 24th April 2017. 14 CFR 135.605 requires helicopter air ambulance, a subset of Commercial Air Transport, to have HTAWS that meets TSO-C194 after 24th April 2017.

[1] Part 121.354 Amdt. 121-273; Eff. 3/29/2001

[2] Commission Regulation (EU) 2016/1199 of 22 July 2016 amending Regulation (EU) No. 965/2012

In addition to the above, the UK Air Accidents Investigation Branch has issued a number of Safety Recommendations to EASA regarding HTAWS for offshore operations in its reports on helicopter accidents. These recommendations include:

- Safety Recommendation 2011-061: Timeliness of warnings
- Safety Recommendation 2011-062: Frequency of nuisance warnings
- Safety Recommendation 2011-063: Quality of obstacle database
- Safety Recommendation 6016-013: Installation of HTAWS on all offshore CAT helicopters with a mass >3,174 kg or MOPSC >9 passengers manufactured before 31 December 2018.

NB: Helicopters first issued with a C of A after this date will be mandated to have HTAWS under Commission Regulation (EC) 2016/1199 as of 22 July 2016.

Purpose

This document contains a standard for the alert envelopes that should be provided by Class A HTAWS employed in offshore (maritime) Commercial Air Transport operations. It does not replace or supersede any requirements for HTAWS during onshore operations. Its main purpose is to support the early, voluntary implementation of improvements to current, non-mandated HTAWS. The improvements have been developed in response to operational experience and a number of UK Air Accident Investigation Branch Safety Recommendations.

This standard may also be adopted as the minimum acceptable standard for HTAWS required under Commission Regulation (EU) 2016/1199 of 22 July 2016, pending the development of ‘formal’ MOPs either by RTCA or EUROCAE.

The document defines the alert envelopes that contain the flight conditions about which the helicopter flight crew should be warned during offshore oil and gas operations. This document specifies the system characteristics that should be applied by designers, manufacturers, installers and helicopter flight crew. Manufacturers may use alternative methods or systems to provide warnings and alerts provided that the envelopes specified in this document are fully protected offshore, and that alert rates in excess of the target defined in this standard are not generated.

Research methodology

An evidence based approach to determining the optimum alert envelopes has been taken using data derived from a helicopter operator's Flight Data Monitoring (FDM) programme. The project analysed flight data from EC225 and Sikorsky S76A+ aircraft which were selected to provide as broad a spectrum of aircraft technological standards and style of offshore operations as possible. The project found that although technological and operational differences existed between these two helicopter types, effective generic alert envelopes could be successfully defined for almost all Classic Modes. Following completion of the original research, further analysis of FDM data from Sikorsky S92 and Leonardo AW139 operations has confirmed the suitability of the alert envelopes for these types as well. In addition, analysis of FDM data from further helicopter operators has confirmed the general applicability of the envelopes for offshore operations.

It was judged that an alert rate of 1in 100 flights would be acceptable to flight crews and would not unduly compromise the effectiveness of the alerts. This enabled the warning times for existing Classic Mode envelopes to be significantly enhanced, and those for the new alert envelopes developed to be optimised. Setting the alert envelopes at the 99th centile also supported current offshore Standard Operating Procedures, where a Pilot Monitoring should intervene shortly before an alert is generated.

The research is reported in FlightDataPeople report ref. 150922, dated September 2015, published by the UK CAA in CAP 1538.

Alert envelopes

Accident and incident scenarios experienced during operations have shown that a HTAWS employed in offshore CAT operations should, as a minimum, incorporate the alert envelopes described below. These envelopes were developed with due consideration being given to existing HTAWS. Equipment manufacturers should ensure that the flight conditions below are protected in their specific implementation.

Additional envelopes may be included, although equipment manufacturers should take care to ensure that excessive alert rates (more than 1 in 100 flights) are not generated. It is considered desirable that the Enhanced Mode remains operational during offshore operations, however, it is anticipated that it will be necessary to remove offshore oil and gas installations from the obstacle database in order to meet the target for alert rate.

This standard specifies only the aural alerts required. Where provided, visual alerts should be consistent with the design philosophy of the aircraft type on which the HTAWS is to be installed.

Offshore Envelope 1

Replaces Classic Mode 1 when the offshore mode is selected. Provides protection against excessive descent rate using input parameters of ALTRATE and Radio Height. Aural alerts are provided as detailed in Table 1 and Figure 1.

NB: ALTRATE is required as both barometric descent rate and terrain closure rate (derived from radio height) are unsuitable due to the effects of helideck edge crossing. ALTRATE is the vertical speed parameter from the Attitude & Heading Reference System (AHRS) comprising a hybrid of barometric and inertial data with long term error-elimination provided by rate of change of pressure altitude performed within the AHRS using Air Data Computer (ADC) data. The weighting of the hybrid is primarily inertial and so, unlike barometric descent rate, does not suffer from ground effect or rotor downwash. Since there is no contribution from radio altitude, it is also not affected by the ‘spike’ in terrain closure rate experienced as the helicopter passes over the edge of the helideck.

X Axis ALTRATE (ft/min)	Y Axis Radio Height (ft)
“Sink rate” caution	
- 600	0
-1,000	750
-10,000	1,000
“Pull up” warning	
-700	0
-1,200	500
-10,000	600

Table 1: Offshore Envelope 1 parameters

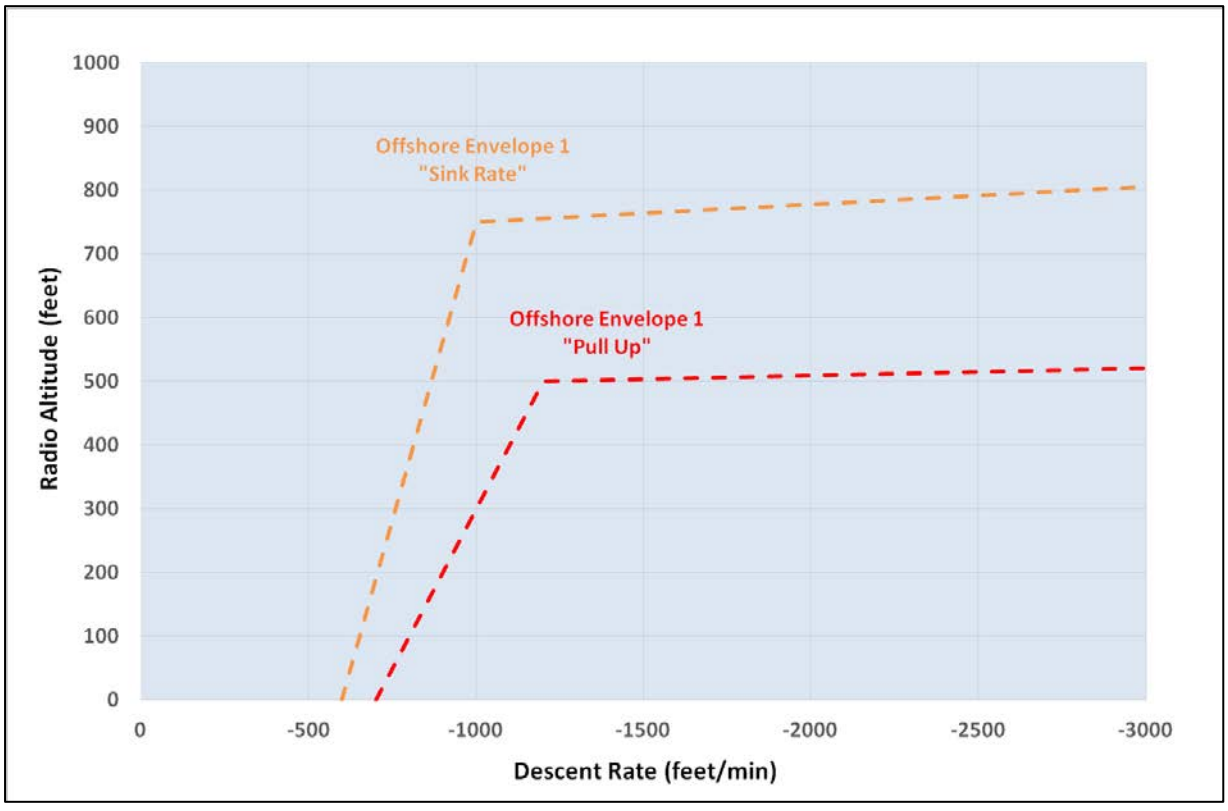

Figure 1: Offshore Envelope 1 thresholds

Classic Mode 2

Present in current HTAWS to provide protection against unsafe terrain closure rate, but inhibited while the Enhanced Mode is active. In addition, Mode 2 does not provide any significant additional protection above that conferred by Offshore Envelope 1 during over water operations as the surface of the water essentially forms a flat plane. Classic Mode 2 is therefore redundant as far as offshore operations are concerned.

Offshore Envelope 3

Replaces Classic Mode 3 when the offshore mode is selected. Provides protection against inadvertent loss of height or airspeed after take-off using input parameters of Radio Height and Indicated Airspeed (IAS). Offshore Envelope 3 is enabled after take-off or go-around when landing gear is not in the landing configuration, or when the airspeed exceeds 50 kts. The envelope should remain enabled for the take off phase of flight which is assumed to cease 60 seconds after activation of the envelope.

There are two alert envelopes; Offshore Envelope 3A detects a loss of height after take-off and Offshore Envelope 3B detects a loss of airspeed after take-off.

Offshore Envelope 3A loss of height after take-off caution

A height loss in excess of 20% of the current Radio Height (or equivalent alternative trigger, such as barometric altitude) will generate the aural caution “Don’t Sink”.

Offshore Envelope 3B loss of airspeed after take-off caution

A reduction in airspeed to below 55kts after having attained 60kts will generate the aural caution “Check Airspeed”. The caution will remain active until airspeed exceeds 60kts.

Offshore Envelope 4

Replaces Classic Mode 4 when the offshore mode is selected. Provides protection against unsafe terrain clearance using input parameters of Radio Height, Indicated Airspeed (IAS) and landing gear position.

Offshore Envelope 4A too low gear/terrain caution

Provides low height aural caution ("Too Low Gear" or "Too Low Terrain") with landing gear retracted (Radio Height < 350ft and landing gear not locked down) as detailed in Table 2.

IAS (kts)	Caution
<100	**"Too Low Gear"**
≥100	**"Too Low Terrain"**

Table 2: Offshore Envelope 4A parameters

NB1: The height threshold is set to 350ft in order to provide timely alerts when operating to elevated helidecks offshore. A different height threshold may be adopted (e.g. via pin programming) where operationally appropriate.

NB2: The airspeed threshold at which the caution changes from "Too Low Terrain" to "Too Low Gear" may be adjusted (e.g. via pin programming) to be compatible with the aircraft's configuration warning system.

Offshore Envelope 4B too low terrain caution

Provides low height aural caution with landing gear deployed.

X Axis IAS (kt)	Y Axis Radio Height (ft)
"Too Low Terrain" caution	
80	0
120	160
Vne	160

Table 3: Offshore Envelope 4B parameters

NB: The height threshold is set to 160ft for airspeeds greater than 120kts, corresponding to the maximum for Classic Mode 6A. A different height threshold, but not less than 100ft (the minimum permitted for Classic Mode 6A), may be adopted (e.g. via pin programming) where operationally appropriate.

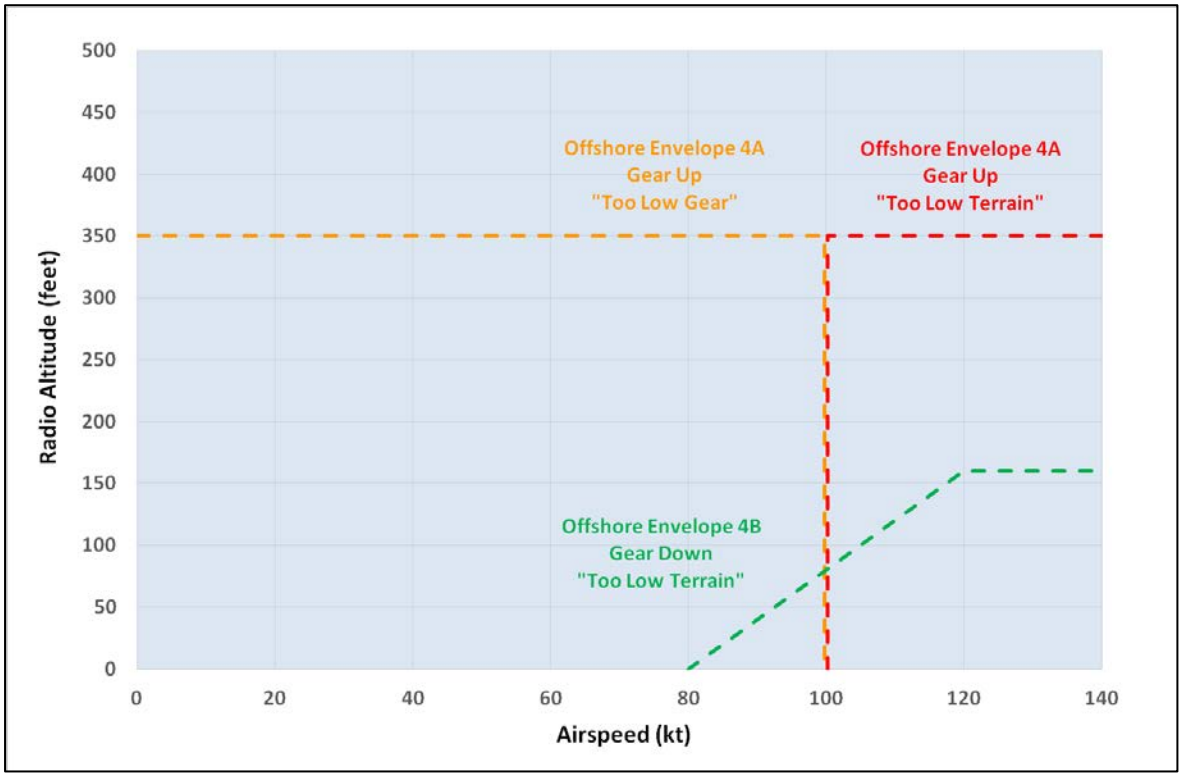

Figure 2: Offshore Envelope 4A and 4B thresholds

Classic Mode 5

Provides protection against unsafe descent below the glideslope using input parameters of Glideslope Deviation and Radio Height in current HTAWS. This mode is not required for offshore operations due to the absence of Instrument Landing Systems offshore, but a modified version of Mode 5 will likely be developed to support GPS-guided offshore approaches when introduced. In addition, consideration may be given to providing an alert when the aircraft deviates from the glide-path defined by the aircraft systems during a Non-Precision Continuous Descent Final Approach. No changes are required to Classic Mode 5 at this time.

Classic Mode 6

Provides the altitude call-outs required by EASA CAT.IDE.H.145 (see appendix) to protect against inadvertent drift down (slow descent). These comprise a fixed height aural call-out which can be set (by 'pin programming') anywhere between 100ft and 160ft, and a pilot selectable call-out. No changes to Mode 6 are proposed, however the fixed height alert should be set as high as practicable. Other aircraft specific alerts may be included under the aegis of Classic Mode 6.

Offshore Envelope 7

Provides protection against loss of airspeed on approach using input parameters of Indicated Airspeed (IAS) and Total Torque. This envelope may be inhibited below a height of 50ft to avoid unwanted alerts during a rejected take-off following an engine failure. It may also be inhibited during OEI operations if necessary to allow CAT A profiles to be flown without generating unwanted alerts.

For optimum performance, Envelope 7 is tailored to individual helicopter types. It is recommended that the range of envelopes presented in Table 4 are provided, from which the most appropriate envelope for an individual helicopter type may be selected via pin programming. The envelopes established for the Leonardo AW139, Airbus Helicopters EC225 and Sikorsky S92 are highlighted in the table and are illustrated in Figure 3.

	Total Torque (%) at IAS = 60kt	Total Torque (%) at IAS = 20kt
	“Check Airspeed” caution	
SET 1	10	30
		35 **(AW139)**
		40
		45
		50
SET 2	15	30
		35 **(EC225)**
		40
		45 **(S92)**
		50

Table 4: Offshore Envelope 7 parameters

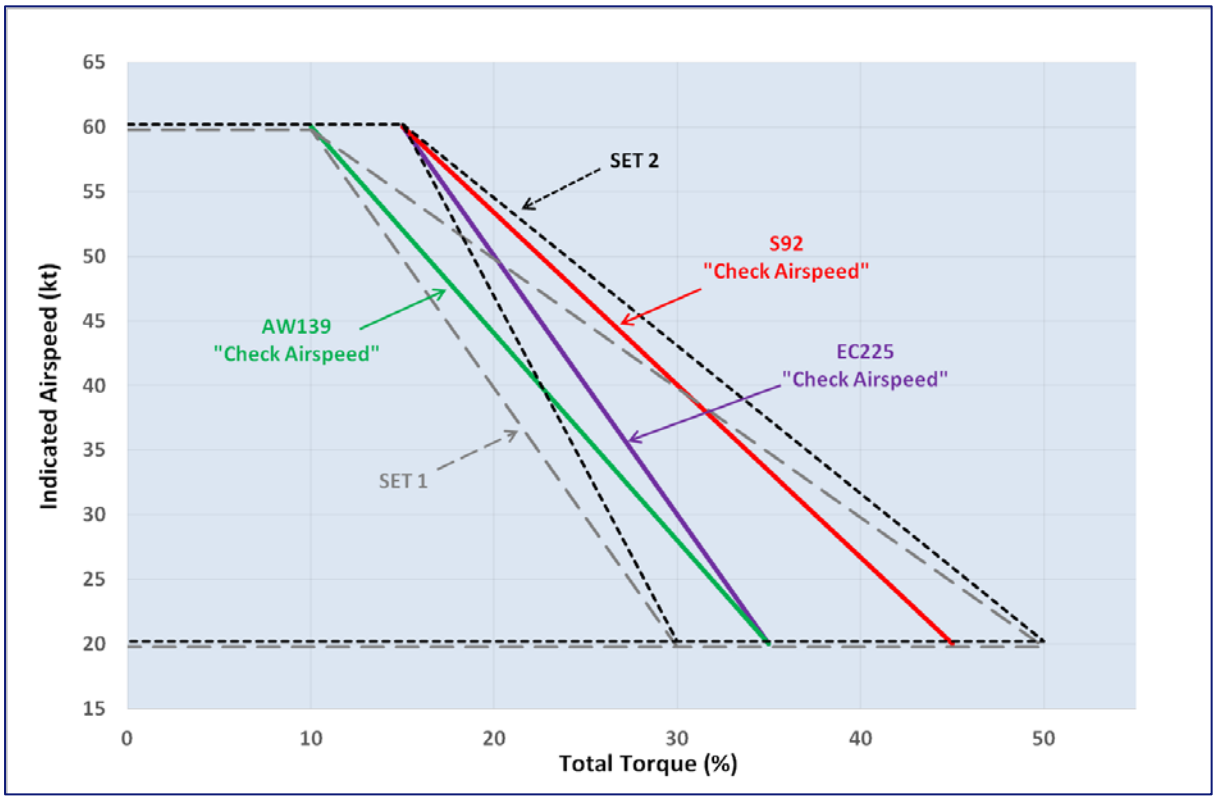

Figure 3: Offshore Envelope 7 thresholds

Offshore Mode Selection

If the manufacturer intends to have different onshore and offshore HTAWS alert envelopes, then some means must be provided to inform the system which set of alert envelopes are to be used throughout each flight. The system could automatically detect when the offshore mode is to be enabled, such as using a terrain database to detect crossing of the coastline, or it could be directed by manual crew selection. The means of engaging the offshore mode will be determined by the manufacturer taking into account the characteristics of the aircraft systems.

For outbound flights, the offshore mode could be selected / activated on crossing the coast line. For inbound flights, the onshore mode should be selected / activated at sufficient distance from the coast line for terrain avoidance alerts to be effective during approach to the coast line.

NB: Reversion from offshore mode back to onshore mode is not critical as the Enhanced Mode is active offshore and onshore, and the Offshore Envelopes are either additional to the Classic Modes or comprise more sensitive versions of them.

Appendix A

CAT.IDE.H.145 and supporting guidance

CAT.IDE.H.145 Radio Altimeters

(a) Helicopters on flights over water shall be equipped with a radio altimeter capable of emitting an audio warning below a pre-set height and a visual warning at a height selected by the pilot, when operating:

(1) Out of sight of the land;

(2) In a visibility of less than 1,500m;

(3) At night; or

(4) At a distance from land corresponding to more than 3 minutes at normal cruising speed.

AMC1 CAT.IDE.H.145 Radio Altimeters

Audio warning device

(a) The audio warning required in CAT.IDE.H.145 should be a voice warning.

(b) The audio warning may be provided by a helicopter terrain awareness and warning system (HTAWS).

GM1 CAT.IDE.H.145 Radio Altimeters

Audio-voice-alerting device

(a) To be effective, the voice warning alert should be distinguishable from other warnings and should contain a clear and concise voice message.

(b) The warning format should meet the following conditions:

(1) The warning should be unique (i.e. voice);

(2) It should not be inhibited by any other audio warnings, except by higher priority alerts such as helicopter terrain awareness and warning system (HTAWS); and

(3) The urgency of the warning should be adequate to draw attention but not such as to cause undue annoyance during deliberate descents through the datum height.

(c) The criteria above can be satisfactorily met if the warning format incorporates all of the following features:

(1) A unique tone should precede the voice message; a further tone after the voice may enhance uniqueness and attract more attention without causing undue annoyance;

(2) The perceived tone and voice should be moderately urgent;

(3) The message should be compact as opposed to lengthy provided that the meaning is not compromised, e.g. ‘One fifty feet’ as opposed to ‘One hundred and fifty feet’;

(4) An information message is preferable (e.g. ‘One hundred feet’); messages such as ‘Low height’ do not convey the correct impression during deliberate descents through the datum height;

(5) Command messages (e.g. ‘Pull up, pull up’) should not be used unless they relate specifically to height monitoring (e.g. ‘Check height’); and

(6) The volume of the warning should be adequate and not variable below an acceptable minimum value.

d) Every effort should be made to prevent spurious warnings.

e) The height at which the audio warning is triggered by the radio altimeter should be such as to provide adequate warning for the pilot to take corrective action. It is envisaged that most installations will adopt a height in the range of 100-160 ft. The datum should not be adjustable in flight.

f) The preset datum height should not be set in a way that it coincides with commonly used instrument approach minima (i.e. 200 ft). Once triggered, the message should sound within 0.5 sec.

g) The voice warning should be triggered only whilst descending through the preset datum height and be inhibited whilst ascending.

GM2 CAT.IDE.H.145 Radio Altimeters

Radio altimeter display

An analogue type display presentation may be, for example, a representation of a dial, ribbon or bar, but not a display that provides numbers only. An analogue type display may be embedded into an electronic flight instrument system (EFIS).