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The Civil Aviation Authority of Thailand

Guidance Material for Ground Proximity Warning System (GPWS)

CAAT-GM-OPS-GPWS

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Table of Contents

Table of Contents	3
Abbreviations	4
0. Introduction.....	5
0.1 Background.....	5
0.2 Purpose.....	5
0.3 Applicability (is subjected to)	5
0.4 Reference (Refer regulation)	5
0.4.1 International Civil Aviation Organization (ICAO) Annex 6 Part I, Part II.....	5
0.4.3 CAAS – AC 121-6-2(Rev 0) Advisory Circular EFFECTIVENESS OF EGPSS/TAWS EQUIPMENT.....	5
0.4.4 CAAS – AC 121-9-9(Rev 0) GUIDANCE FOR TRAINING ON THE USE OF GROUND PROXIMITY WARNING SYSTEM (GPWS)	5
0.5 Definitions.....	6
1. General.....	7
2. Predictive Ground Proximity Warning System.....	9
3. Examples of Limitations of Current GPWS Equipment	11
3.1 Reduced Effectiveness.....	11
3.2 Unwanted Warnings.....	11
3.3 Other Limitations.....	12
4. Operations Manuals and Checklists	13
5. Effectiveness of GPWS	15
5.1 Software Update.....	15
5.2 Database Update	15
5.3 Altimetry-Based Errors	15
5.4 Actions by the AOC Holder	16
5.5 Summary.....	16
6. Training.....	17
6.1 General	17
6.2 Pilot Training.....	17
6.3 GPWS Academic Training	17
6.4 GPWS Manoeuvre Training	21
6.5 GPWS Initial Evaluation	22
6.6 GPWS Recurrent Training (Annual)	22
6.7 Reporting	22
7. Reporting and Follow-up of GPWS Alerts and Warnings	25
7.1 General	25
7.2 Report.....	25
7.3 Follow-up Action.....	26

Abbreviations

Abbreviations	Meaning
<i>AOCR</i>	Air Operator Certificate Requirements
<i>CAAT</i>	The Civil Aviation Authority of Thailand
<i>EGPWS</i>	Enhanced Ground Proximity Warning System
<i>FLTA</i>	Forward looking terrain avoidance
<i>FMS</i>	Flight management system
<i>GNSS</i>	Global navigation satellite system
<i>GPWS</i>	Ground Proximity Warning System
<i>ICAO</i>	International Civil Aviation Organization
<i>PDA</i>	Premature descent alert
<i>TAD</i>	Terrain awareness and display
<i>TAWS</i>	Terrain awareness systems

0. Introduction

0.1 Background

Guidance Material (GM) for Ground Proximity Warning System (GPWS) are issued by the Director-General of The Civil Aviation Authority of Thailand from time to time to provide practical guidance or certainty in respect of the statutory requirements for aviation safety. GM contain information about standards, practices and procedures acceptable to CAAT. A GM may use in accordance with AOCR Chapter 2 item 5.1 (i), Chapter 4, 2.6.13 (b), 3.3.2 (b) (xiii), Chapter 10 item 15, Appendix B 2.1.30 (a), GAR Part I Chapter 5 GA-P1A.510, 510.1, 510.4 and HOR Chapter 4, Appendix C 1.6.13.

0.2 Purpose

The purpose of this publication is to provide to all concerned in the operation of aeroplanes information on, and guidance in the use of, ground proximity warning systems (GPWS). Legislation regarding the requirement to carry GPWS is to be found in the Thai Air Operator Certificate Requirements (AOCR). In compliance with ICAO Standards, Airworthiness Directives are issued from time to time which amplify the Order and set out amendments to regulatory requirements as equipment performance advances and as changes in aviation safety-related needs are identified.

This document includes information on the different categories of alerts or warnings which may be encountered in flight, together with advice concerning the appropriate flight crew response to each case. The various modes of protection afforded by the equipment are described. However, details of the operating envelopes of the systems are set out in manufacturers' handbooks or company Operations Manuals which should be studied by all personnel involved in the operation of aeroplanes equipped with GPWS. Information is also presented recommending the details which should be included in Checklists, Operations and Training Manuals.

0.3 Applicability (is subjected to)

This GM is applicable for the Thai's Operator conducting operations under Thai AOCR.

0.4 Reference (Refer regulation)

- 0.4.1 International Civil Aviation Organization (ICAO) Annex 6 Part I, Part II
- 0.4.2 HKCAD – CAD 516 Ground Proximity Warning System (GPWS): Guidance Material
- 0.4.3 CAAS – AC 121-6-2(Rev 0) Advisory Circular EFFECTIVENESS OF EGPSS/TAWS EQUIPMENT
- 0.4.4 CAAS – AC 121-9-9(Rev 0) GUIDANCE FOR TRAINING ON THE USE OF GROUND PROXIMITY WARNING SYSTEM (GPWS)

0.5 Definitions

Term	Definition
<i>Alert</i>	A caution generated by the GPWS equipment.
<i>Basic GPWS</i>	A GPWS system which gives no indication of the mode triggered other than Mode 5.
<i>Predictive GPWS</i>	A GPWS system which contains a facility to enable the prediction of loss of required terrain clearance ahead of the aircraft and the generation of associated warnings.
<i>Standard GPWS</i>	A GPWS system which has no terrain-predictive function.
<i>Types of Warnings</i>	<p>Genuine - The equipment provides a warning in accordance with its technical specification.</p> <p>Nuisance - The equipment provides a warning in accordance with its technical specification, but the pilot is flying an accepted safe procedure.</p> <p>False - A fault or failure in the system causes the equipment to provide a warning that is not in accordance with its technical specification.</p> <p>NOTE: 'Unwanted' may be used to described both nuisance and false.</p>
<i>Warning</i>	A command generated by the GPWS equipment.

1. General

GPWS enhances safety. It is not a foolproof means of preventing collision with the ground. It can prevent some accidents, particularly those which could result from crew errors or distraction, inappropriate ATC instructions or navigation equipment malfunction. In sum, a timely alert or warning can be provided of unintentional closure with the ground.

The response to all alerts or warnings should be positive and immediate – recognition and action. Establishing the cause of GPWS activation should take second place.

There is a risk that repeated experience of unwanted warnings may so reduce crew confidence in the system that response to a warning in the real event may be less urgent than needed. Therefore, flight crews should report all alerts and warnings to the operator, thereby ensuring that appropriate analysis or remedial action can be taken. The reports will form a basis on which GPWS performance can be monitored both by the operators and by CAAT. By this means, problems of general concern should be detected at an early stage, and allow action to be taken and necessary advice or information disseminated to all concerned without delay. Details of reporting and follow-up action for GPWS alerts and warnings are given at Chapter 7.

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2. Predictive Ground Proximity Warning System

In accordance with ICAO standards, The Civil Aviation Authority of Thailand requires that all turbine-engine aeroplanes of a maximum certificated take-off mass in excess of 5 700 kg or authorized to carry more than nine passengers shall be equipped with a ground proximity warning system which has a forward-looking terrain avoidance function

In addition to the standard GPWS features, Terrain Awareness and Warning System (TAWS) provides:

- a) A forward-looking terrain avoidance function which gives look-ahead terrain and obstacle protection along and below the aeroplane's lateral and vertical flight path.
- b) descent alert function that detects when the aircraft is hazardously below the normal approach path to the nearest runway and provides a timely alert.

One manufacturer's solution to this ICAO requirement is the development of TAWS. The predictive function is achieved by feeding the aeroplane's known position, as determined by a Flight Management System (FMS) or by a Global Position System (GPS), to a terrain database, enabling the computer to predict terrain ahead and to the side of the aeroplane's flight path. Terrain features can then be displayed to the flight crew. TAWS therefore overcomes shortcomings associated with GPWS in that it produces earlier alerts and warnings of significant terrain that lie ahead at all stages of flight. Furthermore, with reference to terrain around an airfield, it can warn of descent below safe vertical profiles when the aircraft is in a landing configuration and where no ILS glideslope is present.

TAWS, which has been in use for some time, describes only one solution to the requirement for terrain prediction. Other solutions are now in the course of development or in production. A second solution – Enhanced GPWS (EGPWS) – is also in service and a third – Terrain Awareness and Display (TAD) – is also available.

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3. Examples of Limitations of Current GPWS Equipment

3.1 Reduced Effectiveness

- 3.1.1 As basic or standard GPWS (non-predictive) equipment does not look ahead, any warning when flight is towards high terrain ahead of the aircraft will be minimal and dependent upon the steepness of the ground. Hence a sheer cliff ahead of the aircraft will not generate any warning and any subsequent warning due to rising ground beyond the cliff will be delayed until the aircraft is over that ground.
- 3.1.2 Alerts and warnings are triggered in Modes 1 and 2, only when the aircraft is below 2450 feet above local terrain. The maximum time in these modes between triggering an alert or warning and contact with the ground if no corrective action is taken, is of the order of 20 seconds. However, this time will be reduced if excessive rates of descent exist or there is rising ground beneath the aircraft.
- 3.1.3 Cessation of a Mode 2 warning means only that the aircraft has cleared the terrain beneath it. There may still be rising terrain ahead of the aircraft.
- 3.1.4 Flight crew should be aware that, with standard GPWS equipment, if the aircraft is fully configured for landing, in the absence of electronic glideslope information, a normal rate of descent to the surface short of a runway will not trigger any alert or warning.

3.2 Unwanted Warnings

Caution: Where any doubt exists that the safety of the aircraft may be in jeopardy, the crew must take action as prescribed in this document relating to GPWS alerts and warnings.

- 3.2.1 Occasionally under certain normal and safe operating conditions an alert or warning may occur due to a combination of descent rate and rising ground, as could happen during ATC vectoring over hilly terrain.
- 3.2.2 A Mode 5 (glideslope) alert may be triggered when the aircraft is being flown outside the validity area of the glideslope signal, e.g. when visually maneuvering to land on a runway not provided with an ILS glideslope after making an ILS approach to another runway, or when executing an ILS back beam approach.
- 3.2.3 An alert or warning will be triggered if the aircraft is flown on an approach, below a predictable height, with the flap set in a position other than that normally used for landing.
- 3.2.4 Warnings may occur if a flap or a gear position signal is prevented from reaching the GPWS unit. Ferry flights with the gear locked down and certain circuit breakers pulled may give risk to this condition.
- 3.2.5 Nuisance warnings may be experienced by predictive ground proximity warning systems at certain airports. This can occur when an airport is not in the database, or when the terrain information around the airport utilised by the system is not accurate.
- 3.2.6 Some predictive ground proximity warning systems require barometric altitude referenced to Mean Sea Level (i.e. QNH) for correct operation of look-ahead alerting and terrain display. Barometric altitude referenced to airport elevation (QFE) or an error made in altimeter setting therefore, may cause nuisance alerts and incorrect terrain display.

3.3 Other Limitations

- 3.3.1 The terrain display of predictive GPWS is intended to serve only as a situational awareness tool and may not provide the accuracy and/or fidelity upon which to solely base terrain avoidance maneuvering decisions. Navigation should not, therefore, be predicated upon the use of the database terrain display.
- 3.3.2 Predictive GPWS database, displays and alerting algorithms may not account for man-made obstructions.

4. Operations Manuals and Checklists

Operations Manuals should contain, in their introduction to GPWS, information similar to that noted in chapter 1 above. The fact that a GPWS alert or warning tells the crew that the flight path of the aircraft may not be as *they suppose it to be*, should be emphasised.

Technical details of the system should contain brief descriptions of:

- a) The input sources, with particular reference to the Radio Altimeter (and Barometric Altimeter in the case of predictive systems);
- b) The 'Alert' and 'Warning' modes and their associated envelopes;
- c) The difference between alerts and warnings, along with the information and cautions relevant to the operator's equipment.
- d) Audio and visual indications of alerts and warnings;
- e) Any means by which indications are provided as to which Modes have been triggered;
- f) Limitations of the equipment (noted in chapter 5 above).

With regard to the limitations of GPWS, crews should be informed that:

- a) In certain conditions, they may have a minimal amount of time in which to respond if collision with the ground is to be avoided.
- b) Nuisance alerts or warnings may sometimes occur when aircraft are carrying out published Standard Terminal Approach procedures (STARs) or radar vectoring approaches at aerodromes where there is reduced ground clearance over steeply sloping terrain in the vicinity. In some cases ATC may be able to adjust routes and procedures to remove these difficulties. Failing such satisfactory adjustment, all alerts and warnings must be responded to immediately.
- c) Inhibition of the glideslope mode of the GPWS may also be desirable on occasions when a glideslope signal is present but the aircraft is deliberately being flown without reference to it as, for example, when a pilot breaks off an approach from an ILS equipped runway intending to land on another runway. Inhibition may also be required when gear or flap position inputs are known to be non-standard.
- d) For predictive GPWS, inhibition of terrain awareness modes may be necessary if:
 - the departure or destination airport is not in the GPWS airport database;
 - a QFE setting is entered into the Captain's or First Officer's altimeter;
 - a significant Flight Management System (FMS) position error is suspected;
 - an alert is issued and the crew can visually determine unequivocally, that no terrain threat exists (i.e., in daylight conditions and in clear sight of the surrounding terrain).
- e) Instructions on inhibition must include a statement that no person may deactivate the GPWS except in accordance with the procedures stated in the Operations Manual. It is essential that this is made clear as there have been accidents in which GPWS had been inhibited in order to silence what were genuine warnings.

GPWS should be serviceable at dispatch and the Operations Manual should detail the pre-flight checks verifying that the system is functioning correctly. Minimum Equipment Lists should indicate when flights may be dispatched with unserviceable GPWS. Legislation provides that an aircraft may fly or continue to fly with an unserviceable GPWS until it first lands at a place at which it is practicable for the equipment to be repaired or replaced. It is CAAT view that the aircraft should not be permitted to fly for more than 2 calendar days-with unserviceable equipment nor should it depart from or transit through, an aerodrome where the equipment can be repaired or replaced. The aerodromes where equipment may be replaced or repaired and from which the aircraft shall not depart with unserviceable equipment shall be indicated in the Operations Manual.

The Operations Manual must clearly state the actions to be taken by flight crews following receipt of an in-flight alert or warning.

The Operations Manual should contain the requirements for crews to report all alerts or warnings. The method of reporting to the company and the criteria by which reports may be classified as Mandatory Occurrence Reports (MOR) should also be described. A brief description of the functions of the Operator and of CAAT in the handling of these reports should be included in the Operations Manual. Chapter 7 contains details of reporting and follow-up action.

5. Effectiveness of GPWS

5.1 Software Update

- 5.1.1 Perhaps the most easily rectified shortcoming involves the software utilised by EGPWS/TAWS. Software updates are issued regularly, yet industry sources reveal these are not being implemented by all AOC holders, or are not installed in a timely manner. Aside from the fact that updates are often available free of charge from equipment manufacturers, there is ample reason to perform this task since the use of current information is clearly critical to safety.
- 5.1.2 Application of software updates improves the characteristics of the equipment. Such improvements are possible on the basis of operational experience, and enable warnings in situations that occur closer to the runway threshold where previously it was not possible to provide such warnings.
- 5.1.3 Without information provided by the latest version of software, operation of EGPWS/TAWS may be compromised in specific situations. The flight crew, who has no convenient means of knowing the software status of the equipment on which they ultimately rely, may have a false sense of confidence in its capability.

5.2 Database Update

- 5.2.1 Similarly, it is crucial to regularly update the obstacle, runway and terrain database provided by manufacturers for use with their equipment, since the proper functioning of the EGPWS/TAWS may otherwise be jeopardised. Again, updates are issued for these databases on a regular basis, free of charge by equipment manufacturers. EGPWS/TAWS operation can also be undermined by the lack of suitable navigational input. The equipment was designed to function with a position update system, but not all installations are linked to GNSS receivers. While the required position data can be acquired by using an effective ground-based navaid network, the most reliable of which is provided by DME/DME, such support for area navigation systems is not available everywhere. Use of GNSS, accessible worldwide, eliminates the possibility of position shift, which is another source of false warnings (or worse, the failure to provide a genuine warning).
- 5.2.2 Collectively, these various shortcomings in the software, databases and procedures that support EGPWS/TAWS operation can degrade the value of the warning system, and clearly call for attention by national regulatory authorities, aircraft operators and manufacturers. To reduce the risk of CFIT as much as possible, countries around the world need to ensure that timely information of required quality on runway thresholds, as well as terrain and obstacle data, are provided for databases in accordance with the common reference systems.

5.3 Altimetry-Based Errors

- 5.3.1 Operation of EGPWS/TAWS is subject to altimetry-based errors, which are more prominent during cold weather operations. This problem can be avoided when the equipment, originally designed to work with the QNH altimeter setting, is operated together with GNSS provided geometric altitude. Additionally, use of the geometric altitude function prevents errors that arise from the use of the QFE altimeter setting for approach and landing.

5.4 Actions by the AOC Holder

- 5.4.1 In order to obtain the greatest safety benefit from EGPWS/TAWS and ensure that the system remains effective, the AOC holder should:
- a) update software to the latest available standard;
 - b) update databases to the latest available standard;
 - c) ensure that the GNSS position is provided to EGPWS/TAWS;
 - d) enable the EGPWS/TAWS geometric altitude function (if available);
 - e) enable the EGPWS/TAWS peaks and obstacles function (if available); and
 - f) implement any applicable service bulletins issued by manufacturers.
- 5.4.2 The AOC holder should also take other measures to ensure CFIT prevention through effective use of GPWS. These measures include, but are not limited to: crew training; use of standard operating procedures; crew reporting and AOC holder's investigation of spurious warnings; and implementation of a safety management system by the AOC holder.

5.5 Summary

- 5.5.1 While without doubt the reduction of CFIT accidents is a major achievement, the risk of a CFIT accident remains higher than it should be. The shortcomings or deficiencies in equipment and procedures necessary for the prevention of CFIT, as described above, call for action by AOC holders to ensure they update their systems, a task that can be achieved at very little cost; and to request manufacturers to provide AOC holders with the necessary service bulletins that affect EGPWS/TAWS operation.
- 5.5.2 The measures cited above can considerably reduce the risk of CFIT accidents by reducing the possibility that no warning will be given when a prompt warning is required. Equally important, they can lower the risk of CFIT by reducing the possibility of navigation and position shift errors and the occurrence of false warnings.

6. Training

6.1 General

- 6.1.1 This GM does not attempt to define how the training should be implemented. Instead, objectives are established that define the knowledge a pilot operating GPWS is expected to possess and the performance expected from a pilot who has completed GPWS training. However, the guidelines do indicate those areas in which the pilot receiving the training should demonstrate his/her understanding, or performance, using a real-time, interactive training device, i.e. a flight simulator. Where appropriate, notes are included within the performance criteria which amplify or clarify the material addressed by the training objective.
- 6.1.2 Unless otherwise stated, the term “GPWS” in this Chapter refers to a Ground Proximity Warning System enhanced by a forward looking terrain avoidance function, which is the EGPWS or TAWS.

6.2 Pilot Training

- 6.2.1 Pilot training for GPWS may be organised in the four areas of:
- academic training;
 - manoeuvre training;
 - initial evaluation; and
 - recurrent qualification.

6.3 GPWS Academic Training

- 6.3.1 This phase of the training is typically conducted in a classroom environment. The knowledge demonstrations specified in this section may be completed through the successful completion of written tests or by providing correct responses to non-real time computer-based training (CBT) questions.
- 6.3.2 Theory of operation – A pilot should demonstrate an understanding of GPWS operation and the criteria used for issuing cautions and warnings. This training should address the following topics:
- System operation

Objective: The pilot is knowledgeable of how GPWS functions.

Criteria: The pilot should demonstrate an understanding of the following functions of GPWS

- Surveillance
 - The GPWS computer processes data supplied from an air data computer, a radio altimeter, an ILS/MLS/MM (multimode) receiver, a roll attitude sensor, and flap and gear selector position sensors.
 - The forward looking terrain avoidance function utilises an accurate source of known aircraft position, such may be provided by a flight management system (FMS) or global positioning system (GPS), and an electronic terrain database. The source and scope of the terrain, obstacle and airport data, and features such as the terrain clearance floor, the runway picker, and geometric altitude (where provided) should all be described.

- GPWS outputs include a loudspeaker for voice announcements, visual alerts (typically amber and red lights), and a terrain awareness display (that may be combined with other displays). In addition, there are means for indicating the status of GPWS and any partial or total failures that may occur.

(ii) Terrain Avoidance

- Outputs from the GPWS computer provide visual and audio synthetic voice cautions and warnings to alert the flight crew about potential conflicts with terrain and obstacles.

b) Alert Thresholds

Objective: The pilot understands the criteria for issuing cautions and warnings.

Criteria: The pilot should be able to demonstrate an understanding of the methodology used by GPWS to issue cautions and alerts and the general criteria for the issuance of these alerts to include;

(i) Basic GPWS alerting modes:

- Mode 1: excessive sink rate;
- Mode 2: excessive terrain closure rate;
- Mode 3: descent after take-off or go-around;
- Mode 4: unsafe proximity to terrain; and
- Mode 5: descent below ILS glide slope.

(ii) Additional optional alert modes:

- Mode 6: radio height or bank angle
- Mode 7: windshear

(iii) GPWS cautions and warnings that alert the flight crew to obstacles and terrain ahead of the aircraft in line with or adjacent to its projected flight path (forward looking terrain avoidance (FLTA) and premature descent alert (PDA) functions).

c) GPWS Limitations

Objective: The pilot is aware of the limitations of GPWS

Criteria: The pilot should demonstrate a knowledge and understanding of GPWS limitations identified by the manufacturer for the equipment model installed. These may include:

- (i) Navigation is not to be predicated on the use of the terrain display;
- (ii) Unless geometric altitude data is provided, use of predictive GPWS functions is prohibited when altimeter subscale settings display QFE;
- (iii) Nuisance alerts can be issued if the aerodrome of intended landing is not included in the GPWS airport database;
- (iv) In cold weather operations, corrective procedures should be implemented by the crew unless GPWS has in-built compensation such as geometric altitude data;
- (v) Loss of input data to the GPWS computer could result in partial or total loss of functionality and there are means that inform the crew that functionality has been degraded and the consequences;

- (vi) Radio signals not associated with the intended flight profile (e.g. ILS glide path transmissions from an adjacent runway) may cause false alerts;
- (vii) Inaccurate or low accuracy aircraft position data could lead to false or non-annunciation of terrain or obstacles ahead of the aircraft; and
- (viii) MEL restrictions should be applied in the event that GPWS becomes partially or completely unserviceable. It should be noted that basic GPWS has no forward-looking capability.

d) GPWS Inhibits

Objective: The pilot is aware of the conditions under which certain functions of GPWS are inhibited.

Criteria: The pilot should demonstrate knowledge and understanding of the various GPWS inhibits including:

- (i) A means of silencing voice alerts;
- (ii) A means of inhibiting ILS glide path signals (as may be required when executing a ILS back beam approach);
- (iii) A means of inhibiting flap position sensors (as may be required when executing an approach with the flaps not in a normal position for landing);
- (iv) A means for inhibiting the FLTA and PDA functions;
- (v) A means for selecting or deselecting the display of terrain information; and
- (vi) Together with appropriate annunciation of the status of each selection.

6.3.3 Operating Procedures – The pilot should demonstrate the knowledge required to operate the GPWS avionics and interpret the information presented by GPWS. This training should address the following topics:

a) Use of controls

Objective: The pilot can properly operate all GPWS controls and inhibits.

Criteria: The pilot should demonstrate the proper use of controls including:

- (i) The means by which, before flight, any equipment self-test functions can be initiated;
- (ii) The means by which GPWS information can be selected for display; and
- (iii) The means by which all GPWS inhibits can be operated and what the consequent annunciation means with regard to loss of functionality.

b) Display Interpretation

Objective: The pilot understands the meaning of all information that can be annunciated or displayed by GPWS.

Criteria: The pilot should demonstrate the ability to properly interpret information annunciated or displayed by GPWS including.

- (i) Knowledge of all visual and aural indications that may be seen or heard;
- (ii) Response required on receipt of a caution;
- (iii) Response required on receipt of a warning; and

- (iv) Response required on receipt that partial or total failure of GPWS has occurred (including annunciation that the present aircraft position is of low accuracy).
- c) Use of Basic GPWS or Use of the Forward Looking Terrain Avoidance Function Only

Objective: The pilot understands what functionality will remain following loss of the GPWS or of the forward looking terrain avoidance function.

Criteria: The pilot should demonstrate knowledge of the following:

 - (i) How to recognise uncommanded loss of the GPWS function, or how to isolate this function, and what level of CFIT protection then remains (essentially, the forward looking terrain avoidance function); and
 - (ii) How to recognise uncommanded loss of the forward looking terrain avoidance function, or how to isolate this function, and what level of CFIT protection then remains (essentially, basic GPWS).
- d) Crew Co-ordination

Objective: The pilot can adequately brief other crew members on how GPWS alerts will be handled.

Criteria: The pilot should demonstrate that the pre-flight briefing addresses procedures that will be used in preparation for responding to GPWS cautions and warnings including:

 - (i) What action will be taken, and by whom, in the event that a GPWS caution and/or warning is issued; and
 - (ii) How multi-function displays will be used to depict GPWS information at take-off, in the cruise, and for the descent, approach, landing (and any go-around). (This will be in accordance with procedures specified by the AOC holder, who will recognise both that it may be more desirable that other data is displayed at certain phases of flight, and that the terrain display has an automatic 'popup' mode in the event that an alert is issued.)
- e) Reporting Requirements

Objective: The pilot is aware of the requirements for reporting alerts to the controller and other authorities.

Criteria: The pilot should demonstrate the following

 - (i) When, following recovery from a GPWS alert or caution, any transmission of information should be made to the appropriate air traffic control unit; and
 - (ii) What written report is required to be made, how it is to be made, and whether any cross-reference should be made in the aircraft technical log and/or voyage report (in accordance with procedures specified by the AOC holder) following a flight in which the aircraft flight path has been modified in response to a GPWS alert, or if any part of the equipment appears not to have functioned correctly.
- f) Alert Thresholds

Objective: The pilot is knowledgeable of the criteria for issuing cautions and warnings.

Criteria: The pilot should be able to demonstrate an understanding of the methodology used by GPWS to issue cautions and warnings and the general criteria for the issuance of these alerts to include:

- (i) Awareness of the modes associated with basic GPWS including the input data associated with each; and
- (ii) Awareness of the visual and aural annunciations that can be issued by GPWS, and how to identify which are cautions and which are warnings.

6.4 GPWS Manoeuvre Training

6.4.1 The pilot should demonstrate the knowledge required to respond correctly to GPWS cautions and warnings. This training should address the following topics:

a) Response to Cautions

Objective: The pilot can properly interpret and respond to cautions.

Criteria: The pilot should demonstrate that he understands the need, without delay:

- (i) To initiate action required to correct the condition that has caused GPWS to issue the caution and to be prepared to respond to a warning if this should follow;
- (ii) If a warning does not follow the caution, to notify the controller of the new position, heading and/or altitude/flight level of the aircraft, and what the commander intends to do next; and
- (iii) The proper response to a caution might require the pilot:
 - To reduce a rate of descent and/or to initiate a climb;
 - To regain an ILS glide path from below, or to inhibit a glide path signal if an ILS is not being flown;
 - To select more flap, or to inhibit a flap sensor if the landing is being conducted with the intent that the normal flap setting will not be used;
 - To select gear down; and
 - To initiate a turn away from the terrain or obstacle ahead and towards an area free of such obstructions if a forward looking terrain display indicates this to be a good solution and the entire manoeuvre can be carried out in clear visual conditions.

b) Response to Warnings

Objective: The pilot can properly interpret and respond to warnings.

Criteria: The pilot should demonstrate that he understands the need, without delay:

- (i) To initiate a climb in the manner specified by the AOC holder. (ii) To maintain the climb until visual verification can be made that the aircraft will clear the terrain or obstacle ahead or until above the appropriate sector safe altitude (if certain as to the location of the aircraft with respect to terrain) even if the GPWS warning stops. If, subsequently, the aircraft climbs up through the sector safe altitude but the visibility does not allow the crew to confirm that the terrain hazard has ended, checks should be made to verify the location of the aircraft and to confirm that the altimeter subscale settings are correct.
- (ii) Also, and when the workload permits, the crew should notify the controller of the new position and altitude/flight level, and what the commander intends to do next.
- (iii) The manner in which the climb should be made will reflect the type of aircraft and the method specified by the aircraft manufacturer (but reflected in the operations manual) for performing the escape manoeuvre. Essential aspects will include the need for an increase in pitch attitude, selection of maximum thrust, confirmation that external sources of drag (e.g.

spoilers/speed-brakes) are retracted, and respect of the stick shaker or other indication of eroded stall margin.

- (iv) GPWS warnings must never be ignored. However, the pilot's response may be limited to that appropriate for a caution only if the aeroplane is being operated by day in clear visual conditions, and it is immediately obvious to the pilot that the aircraft is in no danger in respect of its configuration, proximity to terrain or current flight path.

6.5 GPWS Initial Evaluation

- 6.5.1 Pilot understanding of the academic training items should be assessed by means of a test.
- 6.5.2 Pilot understanding of the manoeuvre training items should be assessed in a flight simulator (if available) equipped with GPWS visual and aural displays and inhibit selectors similar in appearance and operation to those in the aircraft the pilot will fly, and be assessed by a type rating instructor or type rating examiner.
- 6.5.3 The range of scenarios should be designed to give confidence that proper and timely response to GPWS cautions and warnings will result in the aircraft avoiding a CFIT accident. To achieve this objective, the pilot should demonstrate taking the correct action to prevent a caution developing into a warning and, separately, the escape manoeuvre needed in response to a warning. These demonstrations should take place when the external visibility is zero, though there is much to be learnt if, initially, the training is given in 'mountainous' or 'hilly' terrain with clear visibility. This training should comprise a sequence of scenarios, rather than be included in line orientated flying training (LOFT).
- 6.5.4 A record should be made, after the pilot has demonstrated competence, of the scenarios that were practised.

6.6 GPWS Recurrent Training (Annual)

- 6.6.1 GPWS recurrent training ensures that pilots maintain the appropriate GPWS knowledge and skills. In particular, it reminds pilots of the need to act promptly in response to cautions and warnings, and of the unusual attitude associated with flying the escape manoeuvre.
- 6.6.2 An essential item of recurrent training is the discussion of any significant issues and operational concerns that have been identified by the AOC holder. Recurrent training should also address changes to GPWS logic, parameters or procedures and to any unique GPWS characteristics of which pilots should be aware.

6.7 Reporting

6.7.1 Verbal Reports

- a) Verbal reports should be made promptly to the appropriate air traffic control unit:
 - Whenever any manoeuvre has caused the aircraft to deviate from an air traffic clearance;
 - When, subsequent to a manoeuvre that has caused the aircraft to deviate from an air traffic clearance, the aircraft has returned to a flight path that complies with the clearance; and
 - When air traffic control issue instructions that, if followed, would cause the crew to manoeuvre the aircraft towards terrain or obstacle that, it would appear from the display that a potential CFIT occurrence is likely to result.

6.7.2 Written Reports

- a) Written reports should be submitted to the Authority in accordance with the mandatory occurrence reporting requirements, whenever the aircraft flight path has been modified in response to a GPWS alert (false, nuisance or genuine).
- b) Written reports should be made in the aircraft technical log –
 - Whenever a GPWS alert has been issued and is believed to have been false; or,
 - If it is believed that a GPWS alert should have been issued but was not.

6.7.3 With regard to reports, the following terms have special meaning:

- a) **False** – means that GPWS issued an alert that could not possibly be justified by the position of the aircraft in respect to terrain, and it is probable that a fault or failure in the system (equipment and/or input data) has been the cause.
- b) **Nuisance** – means that GPWS issued an alert that was appropriate but not needed because the flight crew could determine by independent means that the flight path was at that time safe;
- c) **Genuine** – means that GPWS issued an alert that was both appropriate and necessary.

Note: These terms have value in assessing, only after the occurrence is over and to facilitate subsequent analysis, the adequacy of the equipment and the programs it contains. It is not intended that flight crew should attempt to classify an alert into any of these three categories when any GPWS visual and/or aural cautions or warnings are enunciated.

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7. Reporting and Follow-up of GPWS Alerts and Warnings

7.1 General

7.1.1 The possibility of false and nuisance warnings occurring from time to time cannot be ruled out. Departures from normal operating procedures may also result in genuine warnings. If these are allowed to continue unchecked there is a risk that a genuine warning may be unheeded or the response to it may be too slow. It is vital therefore, that all warnings are reported to the Company (and to CAAT if the incident falls into the scope of a 'reportable occurrence'), their cause established and steps taken to prevent their recurrence.

7.1.2 CAAT also needs to know of potentially hazardous occurrences, what remedial action was taken and, from time to time, what the general GPWS record is like, including situations where alerts or warnings should have been experienced but were not. This information is required so that the overall performance of GPWS can be monitored, any particular problems of general concern circulated and any action initiated to resolve or reduce 'across the board' problems.

7.2 Report

7.2.1 The Operations Manual should establish company procedures for submission by pilots of reports on all GPWS alerts or warnings (Modes 1-4 inclusive, "Windshear" modes when installed and those modes under TAWS) experienced in flight, or where a pilot considers that an alert or warning should have occurred but did not. The manual should also include information concerning the intended routing of such reports for operational and technical analysis, and for follow-up action as appropriate.

7.2.2 CAAT considers that a warning should be regarded as a 'Reportable Occurrence' in the following circumstances:

- a) When an aircraft comes into closer proximity to the ground than has been planned or anticipated.
- b) When any difficulty or hazard arises, or might have arisen, as a result of crew response to a warning; e.g. possible reduced separation from other traffic. This could include warnings of any Mode or Type (i.e. Genuine, Nuisance or False), where applicable.
- c) Where the incident is one of a number of similar occurrences which, though not individually reportable under the Occurrence Reporting Scheme, indicate the possibility of a genuine warning being ignored through repetition: for example:
 - (i) Warnings of any Mode where these occur on a number of occasions at a particular aerodrome.
 - (ii) False warnings associated with certain aircraft, or failure or malfunction of certain equipment in any part of the system. In such cases it is expected that the reporter will submit a single occurrence report together with supporting evidence of high frequency and/or rate when it is considered that a reportable situation has been reached.
- d) When a warning experienced in IMC or at night is established as having been triggered by a high rate of descent (Mode 1)
- e) Where the occurrence involves failure to select gear or land flap by the appropriate point on the approach (Mode 4)

- 7.2.3 An alert would not normally be regarded as a reportable occurrence. However, CAAT considers an alert should be reported if:
- a) When an aircraft comes into closer proximity to the ground than has been planned or anticipated.
 - b) any difficulty or hazard arises as a result (see 7.2.2(b) above); or
 - c) there is undue repetition (see 7.2.2(c) above);

7.3 Follow-up Action

- 7.3.1 On receiving a report, an operator should assess or confirm the type (Genuine, Nuisance or False) and the Mode of the alert or warning. He should also determine whether or not the report should be assessed as a 'reportable occurrence' and, if so, send a copy of the report to CAAT. In the interests of safety, the operator should retain one copy of each report he receives for at least 6 months, so that this may be available for analysis if required.
- 7.3.2 Further data may be needed to verify the nature of the alert or warning and its likely cause. This should be obtained as soon as possible after the occurrence. In apparently serious cases, it may be advisable to obtain a Flight Data Recorder read out. In such instances, CAAT should be advised when this has been done.
- 7.3.3 Once the nature of the warning and its probable cause have been determined, the operator shall take whatever remedial or preventative action may be appropriate. Ultimately, if the occurrence was reportable as a MOR, the operator shall advise CAAT of the action taken.