

SAFETY NOTICE

**SUBJECT: Guidance for Operators on Training Programme on
the Use of Ground Proximity Warning System (GPWS)**

GENERAL: Safety Notices (SNs) are issued by the Civil Aviation Authority – Macao, China to convey advisory information to Macao aviation entities to enhance safety. SNs contain safety-related recommendations, guidance and/or industrial best practices to specific subjects which may or may not have been addressed by established requirements and regulations.

RELATED REGULATIONS: Fifth Schedule of the Air Navigation Regulation of Macao (ANRM)
AC/OPS/025 – Training and Testing Requirements for Flight Crew Member and
Flight Operations Officer

AC/OPS/002 – Operations Manual Requirements

APPLICABILITY: This SN applies to all Macao operators who are required to operate aeroplanes equipped with GPWS.

CANCELLATION: This SN is the first SN issued on this subject.

REFERENCES: The following material was referred to for the development of this SN:

- ICAO Regional Aviation Safety Group – Asia and Pacific Regions (RASG-APAC) endorsed safety tools – Guidance for Operators on Training Programme on the Use of Ground Proximity Warning System (GPWS)

1. Introduction

1.1 Purpose

This Safety Notice is issued to assist operators who are required to develop and conduct a training programme with regard to the use of GPWS.

2. Background

2.1 The material described in this SN is based on materials developed by the Asia Pacific Regional Aviation Safety Team (APRAST) Controlled Flight into Terrain (CFIT) Sub-group which are based on the deliberations of the Commercial Aviation Safety Team. It is the responsibility of each individual operator to determine the applicability of the contents of this SN to each aeroplane and GPWS equipment installed, and their operation. Operators should refer to their Aeroplane Flight Manual (AFM) and/or

Flight Crew Operating Manual (FCOM) for information applicable to specific configurations. If there should be any conflict between the contents of this SN and those published in the other documents describe above, then information contained in the AFM or FCOM will take precedence over that contained in this SN.

- 2.2 The introduction of GPWS equipment in 1978 resulted in a significant reduction in Controlled Flight into Terrain (CFIT) accidents. However, CFIT accidents do still occur, not only to those aeroplanes that have no GPWS, but also to GPWS-equipped aeroplanes that encounter terrain rising too rapidly ahead of them or that descend below a safe approach path when in a landing configuration.
- 2.3 A further step was taken with the development of GPWS with a forward looking terrain avoidance function, generally referred to as enhanced GPWS and known in the United States as Terrain Awareness and Warning System (TAWS). With the advent of enhanced GPWS/TAWS in 1996, the number of CFIT accidents involving aircraft equipped with this technology was reduced drastically. However, not all aeroplanes have enhanced GPWS/TAWS equipment installed and there has been several CFIT accidents occurring every year. Accordingly to International Air Transport Association (IATA) Safety Report 2011, 90% of the CFIT accidents were related to aircraft not equipped with enhanced GPWS/TAWS.
- 2.4 In order to derive the greatest safety benefit from GPWS equipage, operators are required to develop the necessary training programme and procedures relating to GPWS.

3. Scope

- 3.1 This SN contains training objectives for GPWS pilot training.
- 3.2 The scope of this SN is designed to identify training objectives in the areas of: academic training; manoeuvre training; initial evaluation; and recurrent qualification. Under each of these four areas, the training material has been separated into those items which are considered essential training items and those which are considered desirable. In each area, objectives and acceptable performance criteria are defined.
- 3.3 No attempt is made to define how the training programme 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.
- 3.4 Unless otherwise stated, the term “GPWS” in this SN refers to a Ground Proximity Warning System enhanced by a forward looking terrain avoidance function.

4. Training Objectives

4.1 Overview

The objective of GPWS training is to ensure that pilots take appropriate action on alerts, and that they react promptly to warnings by applying maximum power and adjusting to the correct pitch attitude for the maximum gradient of climb. The GPWS ground training syllabus should involve a systematic progression through all modes, culminating in a demonstration of each audio alert or warning and the associated visual indications, together with the correct reaction.

GPWS pilot training should normally be carried out in a suitably equipped flight simulator. Careful consideration should be given to relevant regulations before the utilization of aircraft. Training should be directed towards recognizing and responding correctly and rapidly to a GPWS alert/warning.

4.2 GPWS Academic Training

This training is typically conducted in a classroom environment and could be done during the course of study to obtain the appropriate professional pilot licence. In addition, elements may be covered during type specific technical training in the course of a formal type endorsement course. 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. As part of the continual training, training materials may be issued when there are equipment/system changes and upgrades.

1) Theory of operation

The pilot should demonstrate an understanding of GPWS operation and the criteria used for issuing cautions and warnings. This training should address the following topics:

(a) System operation

Objective: To demonstrate knowledge of how GPWS functions.

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

(i) 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 utilizes an accurate source of known aircraft position, such as 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.

- Displays required to deliver 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, means should be provided for indicating the status of TAWS 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: To demonstrate knowledge 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 alerts and the general criteria for the issuance of these alerts to include:

- Basic GPWS alerting modes specified in the ICAO Standard and the ANRM:
 - Mode 1: excessive descent rate;
 - Mode 2: excessive terrain closure rate;
 - Mode 3: excessive altitude loss after take-off or go-around;
 - Mode 4: unsafe terrain clearance while not in landing configuration:
 - gear not locked down;
 - flaps not in a landing position; and
 - Mode 5: excessive descent below the instrument glide path.
- Any additional GPWS alerting modes.
- 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: To verify that 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. Items might include:

- Navigation is not to be predicated on the use of the terrain display.
- Unless geometric altitude data is provided, the use of predictive GPWS functions is prohibited when altimeter subscale settings display QFE.
- Nuisance alerts can be issued if the aerodrome of intended landing is not included in the GPWS airport database.

- In cold weather operations, corrective procedures should be implemented by the crew unless GPWS has in-built compensation such as geometric altitude data.
- Loss of input data to the GPWS computer could result in partial or total loss of functionality. Where means exist to inform the crew that functionality has been degraded, this should be known and the consequence understood.
- Radio signals not associated with the intended flight profile (e.g. ILS glide path transmissions from an adjacent runway) may cause false alerts.
- Inaccurate or low accuracy aircraft position data could lead to false or non-annunciation of terrain or obstacles ahead of the aircraft.
- 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) TAWS Inhibits

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

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

- A means of silencing voice alerts.
- 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).
- A means for inhibiting the forward looking terrain avoidance (FLTA) and premature descent alert (PDA) functions.
- A means for selecting or deselecting the display of terrain information.
- Together with appropriate annunciation of the status of each selection.

2) Operating Procedures

The pilot should demonstrate the knowledge required to operate the GPWS avionics and interpret the information presented by GPWS. This may be incorporated as part of a type endorsement course. This training should address the following topics:

(a) Use of controls

Objective: To verify that the pilot can properly operate all GPWS controls and inhibits.

Criteria: Demonstrate the proper use of controls including:

- The means by which, before flight, any equipment self-test functions can be initiated.

- The means by which GPWS information can be selected for display.
- The means by which all GPWS inhibits can be operated and what the consequent annunciation mean with regard to loss of functionality.

(b) Display Interpretation

Objective: To verify that a pilot understands the meaning of all information that can be annunciated for displayed by GPWS.

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

- Knowledge of all visual and aural indications that may be seen or heard.
- Response required on receipt of a caution.
- Response required on receipt of a warning.
- 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: To verify that a 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:

- How to recognize 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).
- How to recognize 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: To verify that the pilot adequately briefs 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:

- What action will be taken, and by whom, in the event that a GPWS caution and/or warning is issued.
- 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 operator, who will recognize 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: To verify that the pilot is aware of the requirements for reporting alerts to the controller and other authorities.

Criteria: The pilot should demonstrate the following:

- When, following recovery from a GPWS alert or caution, any transmission of information should be made to the appropriate air traffic control unit.
- 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 operator) 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: To demonstrate knowledge 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 warning and the general criteria for the issuance of these alerts to include:

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

4.3 GPWS Manoeuvre Training

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

1) Response to Cautions

Objective: To verify that the pilot properly interprets and responds to cautions.

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

- 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.

- 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.
- The proper response to a caution might require the pilot:
 - To reduce a rate of descent and/or initiate a climb;
 - To regain an ILS glide path from below, or to inhibit a flight 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;
 - 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.

2) Response to Warnings

Objective: To verify that the pilot properly interprets and responds to warnings.

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

- To initiate a climb in the manner specified by the operator.
- 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.
- 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.
- 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/speedbrakes) are retracted, and respect of the stick shaker or other indication of eroded stall margin.
- 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.

4.4 Initial Evaluation of GPWS Operations

This could be done as part of an initial type endorsement course. The following should be addressed.

- 1) A pilot's understanding of the formal academic training items should be assessed by proper means. This may be covered by the appropriate section in the technical examination.
- 2) A pilot's 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 the results assessed by a synthetic flight instructor, synthetic flight examiner, type rating instructor or type rating examiner.
- 3) The range of scenarios should be designed to give confidence that proper and timely responses to GPWS cautions and warnings will result in the aircraft avoiding a CFIT accident. To achieve this object, 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, through 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).
- 4) A record should be made, after the pilot has demonstrated competence, of the scenarios that were practiced.

4.5 GPWS Recurrent Training

- 1) GPWS recurrent training covering procedures in relation to all modes capable of being experienced in aeroplanes operated by an operator should be undergone by all pilots over a three-year period.
- 2) GPWS annual 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 attitude associated with flying the escape manoeuvre.
- 3) An essential item of annual recurrent training is the discussion of any significant issues and operational concerns that have been identified by the operator. Annual recurrent training should also address changes to GPWS logic, parameters or procedures and to any unique GPWS characteristics of which pilots should be aware.

5. Reporting Procedures

5.1 Verbal Reports

Verbal reports should be made promptly to the appropriate air traffic control unit:

- (a) Whenever any manoeuvre has caused the aircraft to deviate from an air traffic clearance;
- (b) 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 clearances;
- (c) When air traffic 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.

5.2 Written Reports

Written reports should be submitted to AACM and other applicable authority in accordance with the mandatory occurrence reporting requirements:

- (a) Whenever the aircraft flight path has been modified in response to a GPWS alert (false, nuisance or genuine).

Written reports should be made in the aircraft technical log:

- (a) Whenever a GPWS alert has been issued and is believed to have been false; or
- (b) If it is believed that a TAWS alert should have been issued but was not.

6. Action by operators

6.1 In order to obtain the greatest safety benefit from GPWS, operators who are required to operate aeroplane equipped with GPWS should ensure the flight crew are provided with the minimum training and follow procedures as stipulated in this SN.

6.2 The operator is also required to maintain relevant records of all ground and simulator training provided to the flight crew.

7. Recommended Actions

7.1 Operators are encouraged to note the information contained in this Safety Notice and review their policies, procedures and training to reflect the safety issues contained in this SN.

- End -