Civil Aviation Safety Authority
of Papua New Guinea

Advisory Circular

AC91-16

Guidance for Training on the Use of Ground Proximity Warning Systems (GPWS)

Issue 1

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GENERAL

Civil Aviation Safety Authority Advisory Circulars (AC) contain information about standards, practices and procedures that the Director has found to be an Acceptable Means of Compliance (AMC) with the associated rule.

An AMC is not intended to be the only means of compliance with a rule, and consideration will be given to other methods of compliance that may be presented to the Director. When new standards, practices or procedures are found to be acceptable, they will be added to the appropriate Advisory Circular.

An Advisory Circular may also include Guidance Material (GM) to facilitate compliance with the rule requirements. Guidance material must not be regarded as an acceptable means of compliance.

PURPOSE

This advisory Circular provides guidance to demonstrate compliance with and information related to, requirements regarding the development and conduct of a training programme on the use of Ground Proximity Warning System (GPWS).

RELATED CAR

This AC relates specifically to Civil Aviation Rule Part 91.265.

CHANGE NOTICE

This AC replaces the Initial Issue dated 17 June 2021.

APPROVAL

This AC has been approved for publication by the Director of Civil Aviation

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1. Background

The introduction of ground proximity warning system (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 those aeroplanes that descend below a safe approach path when in a landing configuration.

A further step was taken with the development of GPWS with a forward looking terrain avoidance function, generally referred to as Enhanced GPWS (EGPWS) or Terrain Awareness and Warning System (TAWS) as known in the United States. With the advent of EGPWS/TAWS in 1996, there have been no CFIT accidents involving aircraft equipped with this technology. However, not all aeroplanes have GPWS equipment installed.

2. Performance Based Training Objectives

Pilot Training for GPWS may be organised in the four areas of:

a) Academic training
b) Manoeuvre training
c) Initial evaluation
d) Recurrent qualification

This AC 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.

Unless otherwise stated, the term “GPWS” in this AC refers to a Ground Proximity Warning System enhanced by a forward looking terrain avoidance function, which is the EGPWS or TAWS

2.1 GPWS Academic Training

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

2.1.1 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:

(a) System Operation

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

(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 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

The pilot should 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

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

(i) Navigation is not to be predicted 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

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 guide 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 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 the annunciation of the status of each selection.

2.1.2 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

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

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

The pilot should demonstrate knowledge of the following:

(i) 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); and
(ii) How to recognize uncommanded loss of the forward looking terrain avoidance function and what level of CFIT protection then remains (essentially, basic GPWS).

(d) Crew Co-ordination

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 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 ‘pop-up’ mode in the event that an alert is issued.)

(e) Reporting Requirements

The pilot should be aware of the requirements for reporting alerts to the controller and other authorities. The pilot should demonstrate the following:

(i) When, following recovery form a GPWS alert or caution, any transmission of information should be made to the appropriate 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

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.

2.2 GPWS Manoeuvre Training

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

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 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

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.

(iii) 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.

(iv) 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.

(v) 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.

2.3 GPWS Initial Evaluation

Pilot understanding of the academic training items should be assessed by means of a test.

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.

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).

A record should be made, after the pilot has demonstrated competence, of the scenarios that were practiced.

2.4 GPWS Recurrent Training (Annual)

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.

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

3. Reporting Procedures

3.1 Verbal Reports

Verbal Reports should be made promptly to 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 clearance; and

c) 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.

3.2 Written Reports

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).

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 GPWS alert should have been issued but was not.

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.

4. Other Practices

In order to obtain the greatest safety benefit from GPWS, an AOC holder whose aeroplane is required to be equipped with GPWS in accordance with CAR part 121 must establish practices directly related to the equipment in use. These include:

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 GPWS;
d. Enable the GPWS geometric altitude function (if available);
e. Enable the GPWS peaks and obstacles function (if available); and
f. Implement any applicable service bulletins issued by manufacturers.