

MODEL REGULATION AND GUIDANCE MATERIAL ON GROUND PROXIMITY WARNING SYSTEM (GPWS)

1 PURPOSE

The purpose of this guidance is to assist States' in developing appropriate regulations to require aircraft operators to comply with ICAO Standards on equipping aeroplanes with Ground Proximity Warning System (GPWS); and guidance material to assist aircraft operators in implementing appropriate training programme and procedures relating to GPWS.

2 BACKGROUND

Accident statistics indicate that over half of all accidents happen during approach and landing, with Controlled Flight Into Terrain (CFIT) as the leading cause of commercial aircraft fatalities. A CFIT accident occurs when an airworthy aircraft under the control of the flight crew is flown unintentionally into terrain, obstacles or water, usually with no awareness of the impending collision on the part of the crew.

ICAO's first action in this regard can be traced to 1978, when requirements for equipping commercial air transport aircraft with GPWS were introduced in Part I of Annex 6 to the Chicago Convention. This led to a significant decrease in the number of CFIT occurrences, but not to their complete elimination. 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, there have been no CFIT accidents involving aircraft equipped with this technology. However, not all aeroplanes have GPWS equipment installed and there has been an average of five CFIT accidents a year for the past 10 years.

3 REFERENCES

- a) ICAO Annex 6 Part I Amendment 21 and 27: Operation of Aircraft – International Commercial Air Transport – Aeroplanes
- b) ICAO Annex 6 Part II Amendment 22: Operation of Aircraft - International General Aviation – Aeroplanes
- c) COSCAP-South East Asia Advisory Circular No. CSEA 001 – Guidance for Operators on Training Programmes for the use of Terrain Awareness and Warning System
- d) COSCAP-South East Asia Advisory Circular No. CSEA 019 – Reduced Effectiveness of TAWS/EGPWS Equipment

4 MODEL REGULATIONS

A model regulation as adapted from ICAO Annex 6 Part I and Part II is provided in Annex A to assist States in their development of appropriate regulation on mandating GPWS equipage.

5 GUIDANCE MATERIAL

In addition to equipping airplanes with the necessary GPWS equipment, it is essential that operators have in place a training programme to ensure flight crew can respond effectively to GPWS warnings; are aware of factors that can reduce effectiveness of GPWS and are trained to mitigate the effects of GPWS degradation. Furthermore, operators should also have procedures in place to ensure that GPWS software/databases are current and GPWS equipment remains serviceable at all times.

As such, two model advisory circulars as adapted from COSCAP-South East Asia's advisory circulars are provided in Annex B and Annex C to assist States in formulating appropriate guidance material for supporting their operators in developing the necessary training programme and procedures.

6 ACTION BY STATES

States may or may not have promulgated regulations to mandate the equipage of GPWS equipment by aircraft operators in their State. States that have yet to do so are recommended to initiate action to mandate the equipage of GPWS equipment. In addition to complying with the ICAO standards, States are encouraged to consider adopting the ICAO recommended practices as appropriate.

In order for the operators to derive the greatest safety benefit from GPWS equipage, States are advised to issue guidance material to assist their operators in implementing the necessary training programme and procedures relating to GPWS.

As part of the States' inspection programme, States are recommended to conduct compliance checks on its operators to ensure all aspects of GPWS implementation are carried out satisfactorily.

Model Regulation on Ground Proximity Warning System (GPWS)

1 Statutory basis

- 1.1 This regulation is promulgated under the statutory authority in [*State's applicable civil aviation legislation/regulation(s), air navigation order(s) or regulatory standard(s)*]

2 Scope

- 2.1 This regulation describes the requirements for operators to equip their aeroplanes with Ground Proximity Warning System (GPWS).
- 2.2 This regulation establishes the minimum acceptable requirements; the operators can establish more stringent requirements.
- 2.3 Further guidance material on this subject is contained in [*State's applicable guidance material*].

3 Applicability

- 3.1 All aircraft operators shall meet the requirements set forth in this regulation.

4 Effective Date

- 4.1 This regulation is effective from [*date*].

5 References

- 5.1 ICAO Annex 6 Part I: Operation of Aircraft – International Commercial Air Transport – Aeroplanes
- 5.2 ICAO Annex 6 Part II: Operation of Aircraft - International General Aviation – Aeroplanes
- 5.3 [*Applicable regulatory and/or guidance material by the State*]

6 Requirements for aeroplanes to be equipped with ground proximity warning system (GPWS)

6.1 International Commercial Air Transport

- (1) No person shall operate a turbine-engined aeroplane of a maximum certificated take-off mass in excess of 5,700kg or authorised to carry more than nine passengers, unless that aeroplane is equipped with a ground proximity warning system which has a forward looking terrain avoidance function.

- (2) No person shall operate a piston-engined aeroplane of a maximum certificated take-off mass in excess of 5,700kg or authorised to carry more than nine passengers, unless that aeroplane is equipped with a ground proximity warning system which provides warnings in sub-paragraphs (4)a. and (4)c., warning of unsafe terrain clearance and a forward looking terrain avoidance function.
- (3) A ground proximity warning system shall provide automatically a timely and distinctive warning to the flight crew when the aeroplane is in potentially hazardous proximity to the earth's surface.
- (4) A ground proximity warning system shall provide, unless otherwise specified herein, warnings of the following circumstances:
 - a. excessive descent rate
 - b. excessive terrain closure rate
 - c. excessive altitude loss after take-off or go-around
 - d. unsafe terrain clearance while not in landing configuration:
 - i. gear not locked down
 - ii. flaps not in a landing position; and
 - e. excessive descent below the instrument glide path

6.2 International General Aviation

- (1) No person shall operate a turbine-engined aeroplane of a maximum certificated take-off mass in excess of 5,700kg or authorised to carry more than nine passengers, unless that aeroplane is equipped with a ground proximity warning system which has a forward looking terrain avoidance function.
- (2) A ground proximity warning system shall provide automatically a timely and distinctive warning to the flight crew when the aeroplane is in potentially hazardous proximity to the earth's surface.
- (3) A ground proximity warning system shall provide, at a minimum, warnings of at least the following circumstances:
 - a. excessive descent rate
 - b. excessive altitude loss after take-off or go-around; and
 - c. unsafe terrain clearance
- (4) A ground proximity warning system installed in turbine-engined aeroplanes of a maximum certificated takeoff mass in excess of 5 700 kg or authorized to carry more than nine passengers for which the individual certificate of airworthiness was first issued after 1 January 2011 shall provide, as a minimum, warnings of at least the following circumstances:
 - a. excessive descent rate
 - b. excessive terrain closure rate
 - c. excessive altitude loss after take-off or go-around
 - d. unsafe terrain clearance while not in landing configuration:
 - i. gear not locked down
 - ii. flaps not in a landing position; and
 - e. excessive descent below the instrument glide path.

6.3 Operations Manual / Airplane Flight Manual

The Operations Manual and/or Airplane Flight Manual shall contain instructions and training requirements, including appropriate procedures for:

- (1) the use of the ground proximity warning system; and
- (2) proper flight crew reaction in response to the ground proximity warning system audio and visual warnings.

Guidance for Operators on Training Programme on the use of Ground Proximity Warning System (GPWS)

1 Purpose

- 1.1 This advisory circular (AC) is intended to assist operators who are required to develop and conduct training programme with regards to the use of Ground Proximity Warning System (GPWS).
- 1.2 The information contained within has not been tailored to any specific aeroplane or GPWS equipment, but highlights features which are typically available where such systems are installed. It is the responsibility of each individual operator to determine the applicability of the contents of this AC 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 AC 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 AC.

2 Background

- 2.1 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 that descend below a safe approach path when in a landing configuration.
- 2.2 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, there have been no CFIT accidents involving aircraft equipped with this technology. However, not all aeroplanes have GPWS equipment installed and there has been an average of five CFIT accidents a year for the past 10 years.
- 2.2 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 advisory circular (AC) contains performance based training objectives for Ground Proximity Warning System (GPWS) pilot training.
- 3.2 The scope of this AC 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 AC refers to a Ground Proximity Warning System enhanced by a forward looking terrain avoidance function.

4 Applicability

- 4.1 All operators who are required to operate aeroplanes equipped with GPWS as per *[applicable regulatory requirements]* should ensure the flight crew are provided with the minimum training and follow procedures as stipulated in this AC.

5 Effective Date

- 5.1 This AC is effective from *[date]*.

6 References

- 6.1 *[Applicable regulatory and/or guidance material by the State]*

7 Performance Based Training Objectives

7.1 GPWS Academic Training

This 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.

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 must 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 utilises 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 must 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:
 - 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;
 - Mode 5: descent below ILS glide slope (caution only).
- An additional, optional alert mode:
 - Mode 6: radio altitude call-out (information only).
- 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, 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 consequences understood.
- Radio signals not associated with the intended flight profile (eg 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 knowledge and understanding of the various GPWS inhibits including:

- A means of silencing voice alerts;
- A means of inhibiting ILS glide path signals (as may be required when executing a ILS back beam approach);

- 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 FLTA and 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 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 or 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 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).
- 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: 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 warnings 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.

7.2 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:

1) Response to Cautions

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

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

- To initiate a climb in the manner specified by the operator, and
- 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.

7.3 GPWS Initial Evaluation

- 1) Pilot understanding of the academic training items should be assessed by means of a written test.
- 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 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 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).
- 4) A record should be made, after the pilot has demonstrated competence, of the scenarios that were practiced.

7.4 GPWS Recurrent Training (Annual)

- 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.
- 2) An essential item of recurrent training is the discussion of any significant issues and operational concerns that have been identified by the operator. Recurrent training should also address changes to GPWS logic, parameters or procedures and to any unique GPWS characteristics of which pilots should be aware.

8 Reporting Procedures

8.1 Verbal Reports

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;
- 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.

8.2 Written Reports

- 1) Written reports should be submitted to [applicable 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).

- 2) 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 TAWS alert should have been issued but was not.

8.3 Within this AC, and with regards to reports:

- 1) The term '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.
- 2) The term '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;
- 3) The term 'genuine' means that GPWS issued an alert that was both appropriate and ' necessary.
- 4) 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 visual and/or aural cautions or warnings are annunciated.

9 Action by Operators

- 9.1 In order to obtain the greatest safety benefit from GPWS, operators who are required to operate aeroplanes equipped with GPWS as per *[applicable regulatory requirements]* should ensure the flight crew are provided with the minimum training and follow procedures as stipulate in this AC.
- 9.2 The operator is also required to maintain relevant records of all ground and simulator training provided to the flight crew for perusal by the CAA as and when required.

10 Contact Person and Information

- 10.1 Should you have any queries relating to the above, please contact *[name and designation]* at *[contact details, e.g. email address]*.

Guidance for Operators to Ensure Effectiveness of GPWS Equipment

1 Purpose

- 1.1 This advisory circular (AC) provides information to operators on factors that can reduce the effectiveness of ground proximity warning system (GPWS) equipment. Several low-cost but crucial measures can be taken by stakeholders to reduce the likelihood of false GPWS warnings or, more seriously still, the system's failure to provide a valid warning.
- 1.2 The information contained within has not been tailored to any specific aeroplane or GPWS equipment, but highlights features which are typically available where such systems are installed. It is the responsibility of each individual operator to determine the applicability of the contents of this AC 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 AC 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 AC.

2 Background

- 2.1 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 that descend below a safe approach path when in a landing configuration.
- 2.2 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, there have been no CFIT accidents involving aircraft equipped with this technology. However, not all aeroplanes have GPWS equipment installed and there has been an average of five CFIT accidents a year for the past 10 years.
- 2.3 In order to derive the greatest safety benefit from GPWS equipage, operators are encouraged to adopt necessary measures and practices as stipulated in this AC.

3 Scope

- 3.1 This advisory circular (AC) contains measures that will ensure the effectiveness of GPWS equipment.
- 3.2 This AC is designed to lower the risk of CFIT accidents by reducing the possibility that no warning will be given when a prompt warning is required; as well as reducing the possibility of navigation and position shift errors and the occurrence of false warnings.

- 3.3 Unless otherwise stated, the term “GPWS” in this AC refers to a Ground Proximity Warning System enhanced by a forward looking terrain avoidance function.

4 Applicability

- 4.1 All operators who are required to operate aeroplanes equipped with GPWS as per *[applicable regulatory requirements]* must establish procedures to ensure that the effectiveness of installed GPWS equipment is maintained to the required specifications.

5 Effective Date

- 5.1 This AC is effective from *[date]*.

6 References

- 6.1 *[Applicable regulatory and/or guidance material by the State]*

7 Software Update

- 7.1 Perhaps the most easily rectified shortcoming involves the software utilized by GPWS. Software updates are issued regularly, yet industry sources reveal these are not being implemented by all operators, or are not installed in a timely manner. Aside from the fact 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.

- 7.2 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.

- 7.3 Without information provided by the latest version of software, operation of GPWS 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.

8 Database Update

- 8.1 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 GPWS may otherwise be jeopardized. Again, updates are issued for these databases on a regular basis, free of charge by equipment manufacturers. GPWS 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).

- 8.2 Collectively, these various shortcomings in the software, databases and procedures that support GPWS 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.

9 Altimetry Based Errors

- 9.1 Operation of GPWS 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.

10 Action by Operators

- 10.1 In order to obtain the greatest safety benefit from GPWS, operators who are required to operate aeroplanes equipped with GPWS as per *[applicable regulatory requirements]* must establish certain practices directly related to the equipment in use. This includes:
- 1) Update software to the latest available standard;
 - 2) Update databases to the latest available standard;
 - 3) Ensure that the GNSS position is provided to GPWS;
 - 4) Enable the GPWS geometric altitude function (if available);
 - 5) Enable the GPWS peaks and obstacles function (if available); and
 - 6) Implement any applicable service bulletins issued by manufacturers.
- 10.2 It is essential that other measures be undertaken 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 operator investigation of spurious warnings; and implementation of a safety management system by the operator.

11 Contact Person and Information

- 11.1 Should you have any queries relating to the above, please contact *[name and designation]* at *[contact details, e.g. email address]*.