

Approach-and-Landing Briefing Note

6.3 - Response to GPWS - Pull-Up Maneuver Training

Introduction

A typical awareness and training program for the reduction of approach-and-landing accidents involving controlled-flight-into-terrain (CFIT) should include the following:

- Educate flight crews on the factors that may cause CFIT;
- Ensure that horizontal situational awareness and vertical situational awareness is maintained at all times (SOPs);
- Ensure that flight crews attain proficiency in the execution of the approach procedures and techniques recommended for their aircraft type;
- Provide pilots with an adequate understanding of the capability and limitations of the GPWS and EGPWS / TAWS installed on their aircraft; and,
- Ensure that pilots are proficient in performing the terrain avoidance maneuver required in response to a GPWS or EGPWS / TAWS warning (**Figure 3** and **Figure 4** and applicable FCOM / QRH).

Statistical Data

CFIT events account for approximately 45 % of all approach-and-landing accidents and are the leading cause of fatalities.

Figure 1 shows that 70 % of CFIT events could have been avoided by:

- Installation of a GPWS; or,
- An immediate and adequate response to the GPWS warning.

Factor	% of Events
GPWS installed: - late crew response; or, - inadequate crew response	40 %
GPWS installed: - no warning	30 %
GPWS not installed	30 %

Table 1
GPWS Factors in CFIT Events
(Circa 1996)

Training Program Outline

The transition training and recurrent training should emphasized the following, during descent and approach:

- Strict adherence to SOPs (e.g., standard calls) to re-inforce the horizontal situational awareness and vertical situational awareness;
- Optimum use of automated systems and cockpit displays.

The CFIT prevention-training program recommended hereafter further supports these objectives.

This program is designed to be integrated into the standard transition-training course and/or recurrent-training course developed by Airbus Industrie or developed by the airline's training department.

The recommended program consists of:

- A classroom briefing or a self-briefing session based on the contents of:
 - the Airbus Industrie CFIT Education and Training Aid;
 - the relevant *Approach-and-Landing Briefing Notes* and presentations;
 - the description and operations of the applicable model of GPWS and EGPWS / TAWS (FCOM and QRH).

- The Airbus Industrie CFIT video program, illustrating the terrain escape maneuver techniques applicable to conventional aircraft and protected aircraft, respectively.

- Exercises to be incorporated in simulator training sessions during transition training and/or recurrent training.

Three typical exercises are described hereafter.

- Additional briefing material to point out the risk of CFIT during step-down non-precision approaches and the advantages of using a constant-angle stabilized profile.

Briefing Note *7.2 - Flying Constant-Angle Non-Precision Approach* provides expanded information on the benefits associated with constant-angle non-precision approaches.

Simulator Requirements for CFIT Prevention Training

- Terrain should be included in the database in the vicinity of the airports selected for training.

The terrain database should extend over an area of 25-30 NM radius centered on the airfield reference point.

This simulator visual system should be able to display the terrain features.

- The capability should be provided to insert an "electronic mountain" from the instructor panel at a selected point ahead of the aircraft's present position, on its projected flight path.

Nevertheless, inserting an electronic mountain at an airport that does not feature such terrain may result in the trainee dismissing the (E)GPWS / TAWS warning (assuming a spurious warning), thus resulting in negative training.

The slope and height of the mountain should be tailored to the particular aircraft performance capability at a representative weight (e.g. maximum landing weight), so that maximum performance is required to avoid impact.

The slope of the mountain should therefore be adjustable up to at least 17 °, depending on the climb gradients that can be achieved in the escape maneuver.

- To prevent negative training, the simulator must realistically represent handling qualities and performance as the speed reduces to stick-shaker speed (or minimum speed, as applicable).

Simulator Exercises

All (E)GPWS / TAWS modes should be demonstrated.

The objective should be to gain an understanding of the parameters and limitations of the (E)GPWS / TAWS installed on the aircraft type.

These exercises can be performed in either a fixed-base simulator (FBS) or a full-flight simulator (FFS).

The following scenarios, to be performed in the FFS, are designed to introduce CFIT awareness and to demonstrate and practice the correct response to (E)GPWS / TAWS warnings.

These scenarios may be modified in accordance with the individual airline's training requirements or operating environment.

Avoidance Maneuver in VMC

Objectives:

Demonstrate:

- (E)GPWS / TAWS warnings and that response must be immediate;
- Pilot pull-up technique (with special reference to pitch force, as applicable, and pitch attitude); and,
- Crew coordination aspects.

Briefing:

Explain the objectives, point out that this is a training exercise that is not intended to be a realistic operational situation; describe the pull-up technique required for the particular aircraft type (**Figure 3** or **Figure 4** and applicable FCOM and QRH).

Initial conditions:

Establish initial approach configuration and speed, at or near the maximum landing weight, in a shallow descent or in level flight.

Procedure:

Insert an "electronic mountain" ahead of the aircraft, talk to flight crew throughout the maneuver insisting on an immediate and aggressive response.

Ensure proper crew coordination, with PNF calling radio altitudes and trend (e.g. "300 ft decreasing").

Continue maneuver at maximum performance until mountain is cleared (**Figure 2**).

The duration of the maneuver should be long enough for the pilot to demonstrate proficiency at maintaining the maximum climb performance.

Repeat the exercise, as needed, until crew proficiency is achieved.

Debriefing:

Review the exercise, as appropriate.

(E)GPWS / TAWS Warning in IMC

Objectives:

To re-inforce and confirm correct response to (E)GPWS / TAWS in IMC, including pilot technique and crew coordination.

Briefing:

Although the trainees will know in advance that the exercise is to be performed, explain that it is intended to simulate an inadvertent descent below MSA due to loss of situational awareness (e.g., because of a lateral navigation error, an incorrect altitude selection, an incorrect non-precision approach procedure or any other factors).

Initial conditions:

Establish either one of the two following scenarios:

- Initial approach configuration and speed, at or near the maximum landing weight, in a shallow descent or in level flight (as in the first scenario).

or

- Landing configuration, V APP, at or near the maximum landing weight, on a typical 3-degree glide path.

Procedure:

Insert an "electronic mountain" ahead of the aircraft; talk to flight crew throughout the maneuver insisting on an immediate and aggressive response.

Ensure proper crew coordination, with PNF calling radio altitudes and trend (e.g. "300 ft decreasing...").

Continue maneuver at maximum performance until terrain is cleared (**Figure 2**); the maneuver should be long enough for the pilot to demonstrate proficiency at maintaining the maximum climb performance.

Repeat the exercise, as needed, up to proficiency.

Debriefing:

Review the exercise, as appropriate.

Unexpected (E)GPWS / TAWS warning

This scenario should be included in the LOFT session that is normally programmed at the end of the transition course, and also during recurrent training LOFT sessions.

Objectives:

To maintain crew awareness of the CFIT hazard, and to confirm crew proficiency in responding to a (E)GPWS / TAWS warning.

Briefing:

None.

Initial conditions:

Establish either clean configuration or initial-approach configuration and the associated maneuvering speed, at maximum landing weight, in level flight or descending.

Procedure:

Clear the aircraft to descend to an altitude below the MSA or provide radar vectors towards high ground.

If flight crew take corrective action before any (E)GPWS / TAWS warning (as expected), an "electronic mountain" can be inserted at a later stage in the session at an appropriate time.

Verify the crew response to (E)GPWS / TAWS, and the crew coordination during the avoidance maneuver.

Debriefing:

Review the exercise, as appropriate.

Summary of key points

The following key points should be highlighted when discussing CFIT awareness and response to a (E)GPWS / TAWS warning:

- Horizontal situational awareness and vertical situational awareness must be maintained at all times (**Figure 1** and **Figure 2**);
- Preventive actions must be (ideally) taken before (E)GPWS / TAWS warning;
- Response by PF must be immediate (**Figure 2**);
- PNF must monitor and call the radio altitude and its trend throughout the terrain avoidance maneuver;
- Pull-up maneuver must be continued at maximum climb performance until warning has ceased and terrain is cleared, as indicated by a steadily increasing radio-altimeter reading (**Figure 2**).

Associated Briefing Notes

The following Briefing Notes should be reviewed along with the above information to complete the CFIT awareness and training program:

- *1.1 - Operating Philosophy - SOPs,*
- *1.2 - Optimum Use of Automation,*
- *2.3 - Effective Crew/ATC Communications,*
- *3.1 - Altimeter Setting - Use of Radio Altimeter,*
- *3.2 - Altitude deviations,*
- *5.2 - Terrain Awareness,*
- *7.1 - Flying Stabilized Approaches,*
- *7.2 - Flying Constant-angle Non-precision Approaches,*
- *7.3 - Acquisition of Visual References,*
- *7.4 - Flying Visual Approaches.*

Regulatory References

- ICAO – Annex 6 – operation of Aircraft, Part I – International Commercial Air Transport – Aeroplanes, Appendix 2, 5.23.
- FAR 91.223 – Terrain awareness and warning system (TAWS).
- FAR 121.354 - Terrain awareness and warning system (TAWS).
- FAR 121.360 – Ground proximity warning system (GPWS) – Glide slope deviation alerting system.

Appendices - Figures

Figure 1

CFIT – An Encounter Avoided

Quito – Ecuador – March 92

Figure 2

CFIT – An Encounter Avoided

Quito – Ecuador – March 92

Crew response to RA Alert Light and GPWS Warning

Figure 3

Response to GPWS Warning

Conventional Aircraft Models

Figure 4

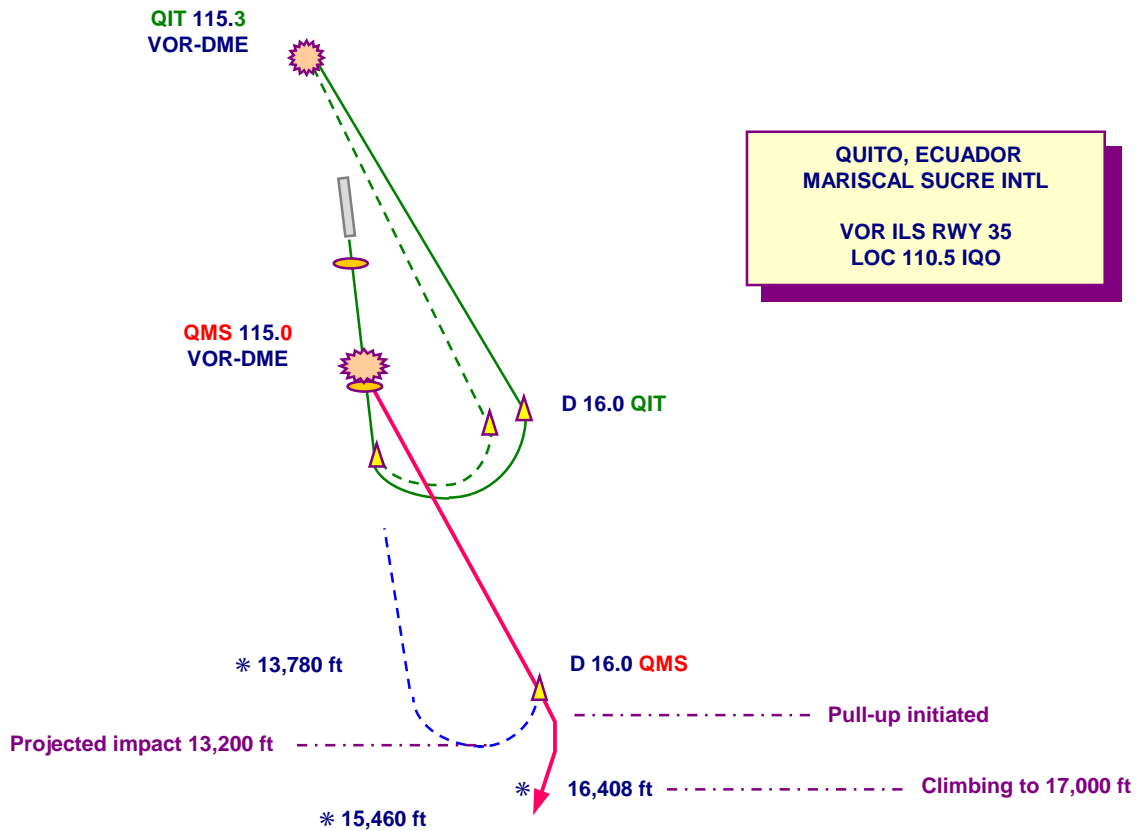
Response to GPWS Warning

Fly-by-wire Protected Aircraft Models

Figure 5

Response to GPWS Warning

(Typical Profiles)



- ILS approach RWY 35 - Night time - IMC - Rain
- QMS VOR-DME (115.0) tuned instead of QIT (115.3)
- Procedure turn flown with reference to QMS, hence 12 NM further south
- Crew alerted by 2500-ft radio-altimeter light
- Crew responded to GPWS MK II warning: Terrain - Terrain - Pull up ! Pull up !
- GPWS warning remained activated during 40 seconds
- High terrain was avoided by only 150 ft RA

Figure 1
CFIT – An Encounter Avoided
Quito – Ecuador – March 92

Drawing adapted from " Flight Into Terrain And the Ground Proximity Warning System " by Don Bateman

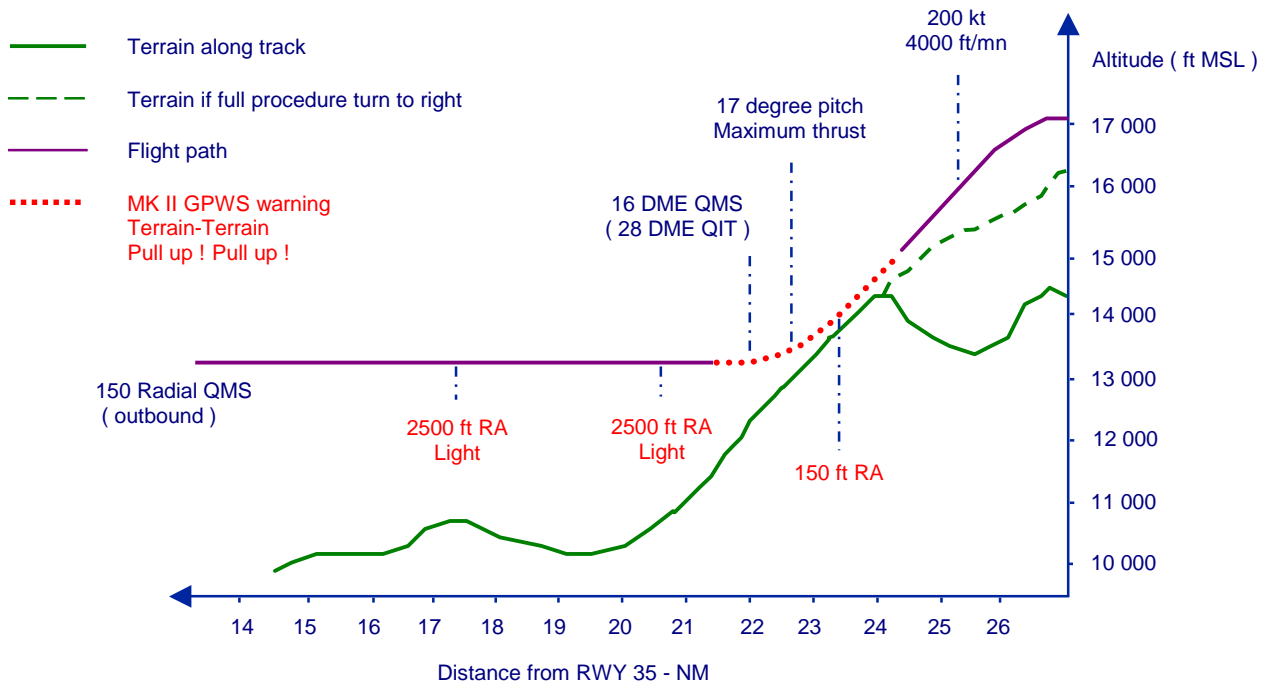


Figure 2
CFIT – An Encounter Avoided
Quito – Equador – March 92
Crew response to RA Alert Light and GPWS Warning

Drawing adapted from " Flight Into Terrain And the Ground Proximity Warning System " by Don Bateman

- “ WHOOP WHOOP PULL UP “
Simultaneously :
 - PITCH ATTITUDE AT LEAST 20° NOSE UP
Use stick shaker boundary as upper limit
 - THROTTLES FULL FORWARD
 - A/THR DISCONNECT
 - AUTOPILOT DISCONNECT
 - BANK WINGS LEVEL
 - SPEEDBRAKES CHECK RETRACTED
- **When flight path is safe and GPWS warning has ceased :**
 - Decrease pitch attitude and accelerate
- **When speed above V_{LS} (as applicable) and V/S positive :**
 - Clean up aircraft as required

Figure 3
Response to GPWS Warning – Conventional Aircraft Models

- “ WHOOP WHOOP PULL UP “ - “ TERRAIN TERRAIN WHOOP WHOOP PULL UP “
Simultaneously :
 - AP OFF
 - PITCH PULL UP
Pull up to full back stick and maintain
 - THRUST LEVERS..... TOGA
 - SPEEDBRAKES CHECK RETRACTED
 - BANK WINGS LEVEL or adjust
- **When flight path is safe and GPWS warning has ceased :**
 - Decrease pitch attitude and accelerate
- **When speed above V_{LS} and V/S positive :**
 - Clean up aircraft as required

Figure 4
Response to GPWS Warning – Fly-by-wire Protected Aircraft Models

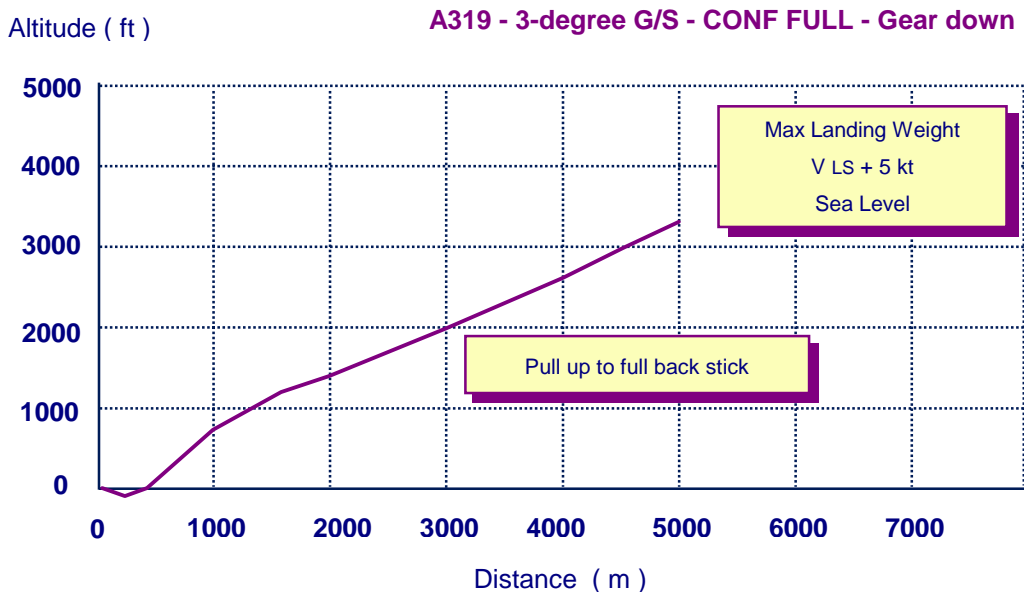
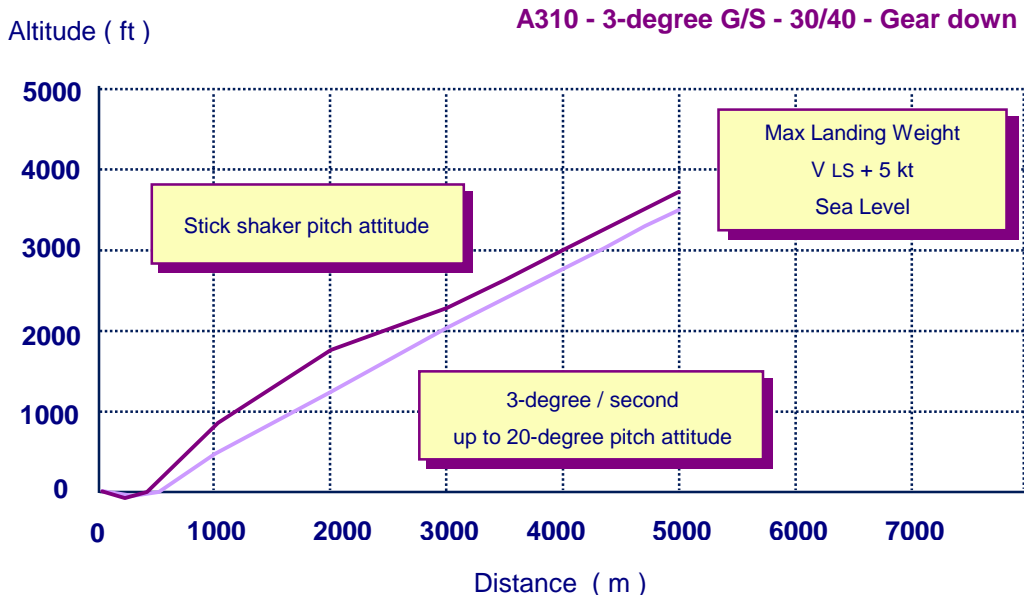


Figure 5
Response to GPWS Warning
(Typical Profiles)