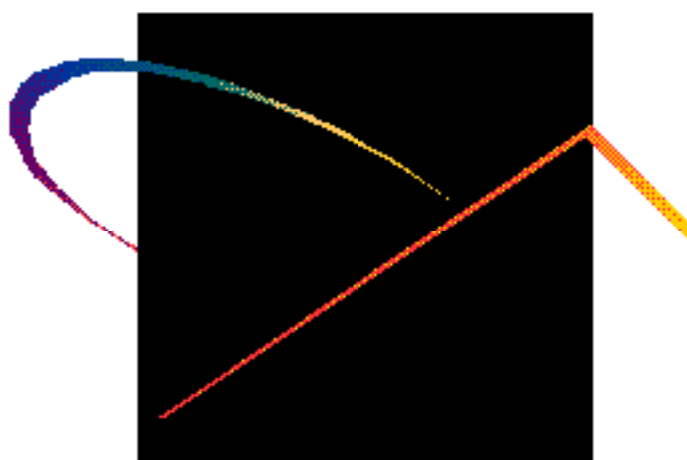


**MK V and MK VII**



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Enhanced Ground Proximity Warning System Pilot Guide



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## TABLE OF CONTENTS

<b>SECTION 1</b> Introduction .....	2
<b>SECTION 2</b> System Description .....	5
<b>SECTION 3</b> Operational Procedures .....	44
<b>SECTION 4</b> Definitions .....	56
Request for Information .....	58

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SECTION 1  
Introduction

This Pilot Guide describes the functions and operation of the MKV and MKVII Enhanced Ground Proximity Warning System (EGPWS).

The document is divided into four sections. Section 1 is this introduction and the following brief description of the EGPWS and its features. Section 2 provides a functional description of the EGPWS. This includes descriptions of the various system modes, Built-In Test (BIT) and monitoring functions, and system features. Section 3 provides general operating procedures to follow when the system gives a caution or warning (alert). Section 4 provides definitions of terms used in this manual.

This guide does not supercede FAA approved data, Flight Manuals, individual Operations Manuals, requirements, or procedures. Pilots should be thoroughly familiar with their own company policies, system configuration, requirements, and procedures with respect to the operation of aircraft with the EGPWS.

The information in this document is intended as a general explanation of the AlliedSignal EGPWS. It contains a general description of system performance assuming identified options are active, and highlights deviations in system performance resulting when a feature is disabled.

What is the EGPWS?

The EGPWS is a terrain awareness and alerting system providing terrain alerting and display functions with additional features.

The EGPWS uses aircraft inputs including geographic position, attitude, altitude, airspeed, and glideslope. These are used with internal terrain, obstacles, and airport databases to predict a potential conflict between the aircraft flight path and

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terrain or an obstacle. A terrain or obstacle conflict results in the EGPWS providing a visual and audio caution or warning alert.

Additionally, the EGPWS provides alerts for excessive glideslope deviation, too low with flaps or gear not in landing configuration, and optionally provides bank angle and altitude callouts based on system program pin selection. Detection of severe windshear conditions is also provided for selected aircraft types when enabled.

The EGPWS incorporates several “enhanced” features:

- **Terrain Alerting and Display (TAD)** provides a graphic display of the surrounding terrain on the Weather Radar Indicator, EFIS, or a dedicated display. Based on the aircraft’s position and the internal database, the terrain topography (within the display range selected) that is above or within 2000 feet below the aircraft altitude is presented on the system display. This feature is an option, enabled by program pins during installation.
- **“Peaks”** is a TAD supplemental feature providing additional terrain display features for enhanced situational awareness, independent of the aircraft’s altitude. This includes digital elevations for the highest and lowest displayed terrain, additional elevation (color) bands, and a unique representation of 0 MSL elevation (sea level and its corresponding shoreline). This feature is an option, enabled by program pins during installation.
- **“Obstacles”** is a feature utilizing an obstacle database for obstacle conflict alerting and display. EGPWS caution and warning visual and audio alerts are provided when a conflict is detected. Additionally, when TAD is enabled, Obstacles are graphical displayed similar to terrain. This feature is an option, enabled by program pins during installation.

- 
- A process feature called **Envelope Modulation** utilizes the internal database to tailor EGPWS alerts at certain geographic locations to reduce nuisance warnings and provide added protection.
  - A **Terrain Clearance Floor** feature adds an additional element of protection by alerting the pilot of possible premature descent. This is intended for non-precision approaches and is based on the current aircraft position relative to the nearest runway. This feature is enabled with the TAD feature.
  - An **Aural Declutter** feature reduces the repetition of warning messages. This feature is optional, and may be disabled by system program pins during installation.
  - **Geometric Altitude**, based on GPS altitude, is a computed pseudo-barometric altitude designed to reduce or eliminate altitude errors resulting from temperature extremes, non-standard pressure altitude conditions, and altimeter miss-sets. This ensures an optimal EGPWS alerting and display capability.

Some of these features have been added to the EGPWS as the system evolved and are not present in all Enhanced Ground Proximity Warning Computer (EGPWC) part numbers. For specific effectivity, refer to an applicable Airplane Flight Manual (AFM) or EGPWS Airplane Flight Manual Supplement (AFMS) or contact AlliedSignal for assistance.

#### Physical Description

The EGPWC is packaged in a 2 MCU ARINC 600-6 rack mounted enclosure weighing less than 8 lbs. No special vibration isolation mounting or forced air-cooling is required.

115 VAC (400 Hz.) or 28 VDC versions of the EGPWC are available. Units are also available with an internal GPS receiver for required GPS data when another GPS source is not available.

For more detailed descriptions and information, contact AlliedSignal.

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## SECTION 2

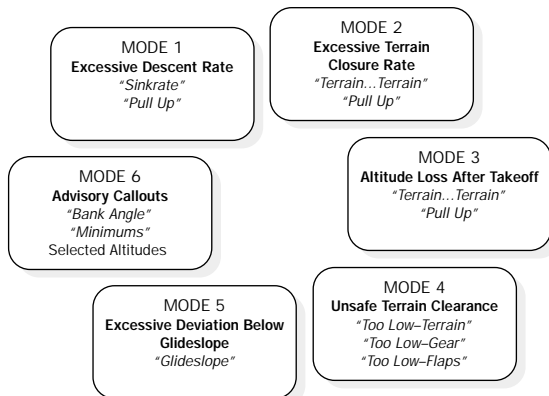
### System Description

<b>Enhanced Ground Proximity Warning System</b> .....	6
EGPWS Database .....	6
<b>Basic Functions:</b>	
Mode 1 - Excessive Descent Rate .....	8
Mode 2 - Excessive Closure to Terrain .....	9
Mode 3 - Altitude Loss After Takeoff .....	12
Mode 4 - Unsafe Terrain Clearance .....	13
Mode 5 - Excessive Glideslope Deviation .....	18
Mode 6 - Advisory Callouts .....	20
Mode 7 - Windshear Alerting .....	24
<b>Enhanced Functions:</b>	
Envelope Modulation .....	26
Terrain Clearance Floor .....	26
Terrain Look Ahead Alerting .....	27
Terrain Alerting and Display .....	29
Standard TAD .....	29
Peaks .....	32
Geometric Altitude .....	36
Aural Message Priority .....	37
<b>System Inputs</b> .....	39
<b>System Outputs</b> .....	40
<b>Options</b> .....	41

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## Enhanced Ground Proximity Warning System

The EGPWS incorporates the functions of the basic Ground Proximity Warning System (GPWS). This includes the following alerting modes:



Additionally, Windshear alerting (Mode 7) is provided for specific aircraft types. Mode 7 provides windshear caution and/or warning alerts when an EGPWS windshear threshold is exceeded.

## EGPWS Database

The EGPWS adds to these 7 basic functions the ability to compare the aircraft position to an internal database and provide additional alerting and display capabilities for enhanced situational awareness and safety (hence the term "Enhanced" GPWS).

The EGPWS internal database consists of four sub-sets:

1. A worldwide terrain database of varying degrees of resolution.
2. An obstacles database containing cataloged obstacles 100 feet or greater in height located within North America and portions of the Caribbean (expanding as data is obtained).
3. A worldwide airport database containing information on hard-surface runways 3500 feet or longer in length. For a specific list of the airports included, refer to AlliedSignal document 060-4267-000 or access on the Internet at website [www.egpws.com](http://www.egpws.com).

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4. An Envelope Modulation database to support the Envelope Modulation feature discussed later.

AlliedSignal is constantly striving to improve the EGPWS database in content, resolution, and accuracy. Notification of a Database update is accomplished by Service Bulletin. Database updates are distributed on PCMCIA data cards and downloaded via a card slot in the front panel of each EGPWC. Contact AlliedSignal for additional information.

Because the overwhelming majority of “Controlled Flight Into Terrain” (CFIT) accidents occur near an airport, and the fact that aircraft operate in close proximity to terrain near an airport, the terrain database contains higher resolution grids for airport areas. Lower resolution grids are used outside airport areas where aircraft enroute altitude make CFIT accidents less likely and terrain feature detail is less important to the flight crew.

With the use of accurate GPS or FMS information, the EGPWS is provided present position, track, and ground speed. With this information the EGPWS is able to present a graphical plan view of the aircraft relative to the terrain and advise the flight crew of a potential conflict with the terrain or obstacle. Conflicts are recognized and alerts provided when terrain violates specific computed envelope boundaries on the projected flight path of the aircraft. Alerts are provided in the form of visual light annunciation of a caution or warning, audio annunciation based on the type of conflict, and color enhanced visual display of the terrain or obstacle relative to the forward look of the aircraft. The terrain display is provided on the Weather Radar Indicator, EFIS display, or a dedicated EGPWS display and may or may not be displayed automatically. The following sections provide functional descriptions of the EGPWS basic and enhanced functions and features, and system input and output requirements.

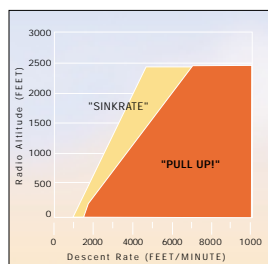
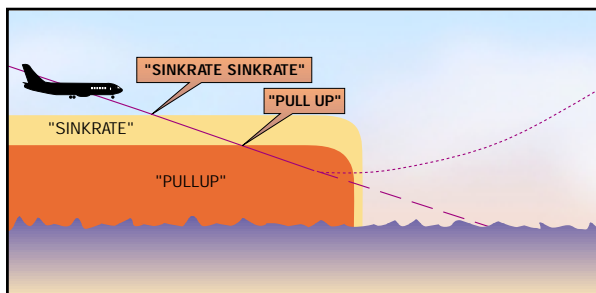


## BASIC FUNCTIONS:

### MODE 1

#### Excessive Descent Rate

Mode 1 provides alerts for excessive descent rates with respect to altitude AGL and is active for all phases of flight. This mode has inner and outer alert boundaries as illustrated in the diagram and graph below.



Penetration of the outer boundary activates the EGPWS caution lights and **"SINKRATE, SINKRATE"** alert enunciation. Additional **"SINKRATE, SINKRATE"** messages will occur for each 20% degradation.

Penetration of the inner boundary activates the EGPWS warning lights and changes the audio message to **"PULL UP"** which repeats continuously until the inner warning boundary is exited.

**Note:** "Pull Up" may be preceded by "Whoop, Whoop" in some configurations based on the audio menu option selected.

If a valid ILS Glideslope front course is received and the aircraft is above the glideslope centerline,

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MODE 1  
Continued

the outer (sinkrate) boundary is adjusted to desensitize the sinkrate alerting. This is to prevent unwanted alerts when the aircraft is safely capturing the glideslope (or repositioning to the centerline) from above the beam.

If the Aural Declutter feature is disabled, the sinkrate alert boundary remains fixed and the aural message **“SINKRATE”** repeats continuously until the outer boundary is exited.

The EGPWS offers a Steep Approach option for given aircraft types that desensitizes the alert boundaries to permit steeper than normal approaches (e.g., MLS or GPS) without unwanted alerts.

MODE 2  
Excessive  
Closure to  
Terrain

Mode 2 provides alerts to help protect the aircraft from impacting the ground when rapidly rising terrain with respect to the aircraft is detected. Mode 2 is based on Radio Altitude and on how rapidly Radio Altitude is decreasing (closure rate). Mode 2 exists in two forms, 2A and 2B.

MODE 2A

Mode 2A is active during climbout, cruise, and initial approach (flaps not in the landing configuration and the aircraft not on glideslope centerline). If the aircraft penetrates the Mode 2A caution envelope, the aural message **“TERRAIN, TERRAIN”** is generated and cockpit EGPWS caution lights will illuminate. If the aircraft continues to penetrate the envelope, the EGPWS warning lights will illuminate and the aural warning message **“PULL UP”** is repeated continuously until the warning envelope is exited.

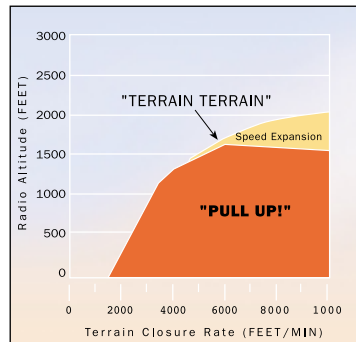
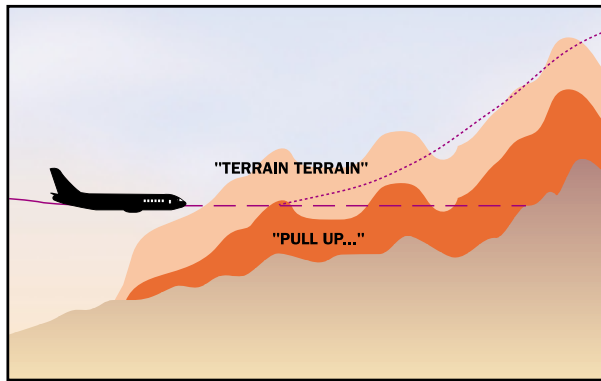
Note: “Pull Up” may be preceded by “Whoop, Whoop” in some configurations based on the audio menu option selected.

Upon exiting the warning envelope, if terrain clearance continues to decrease, the aural message **“TERRAIN”** will be given until the terrain clear-

MODE 2A  
Continued

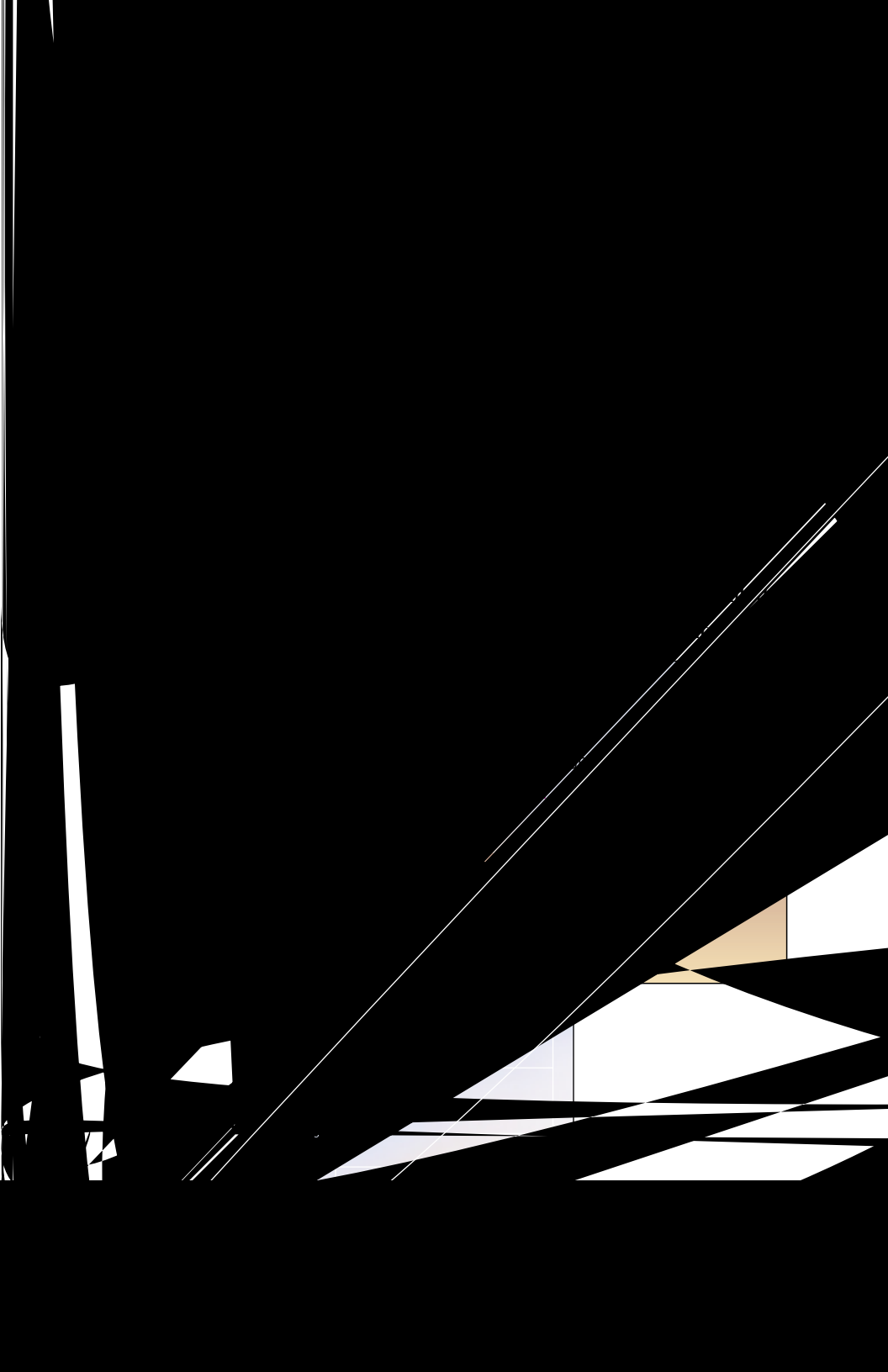
ance stops decreasing. In addition, the visual alert will remain on until the aircraft has gained 300 feet of barometric altitude, 45 seconds has elapsed, or landing flaps or the flap over-ride switch is activated.

The graph below shows how the upper boundary of the Mode 2 alert envelope varies as a function of the aircraft speed. As airspeed increases from 220 knots to 310 knots, the boundary expands to provide increased alert times at higher airspeeds.



MODE 2B

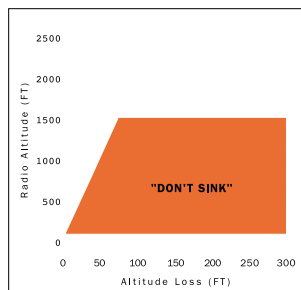
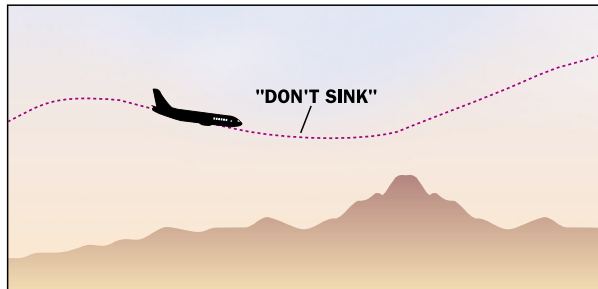
Mode 2B provides a desensitized alerting envelope to permit normal landing approach maneuvers close to terrain without unwanted alerts. Mode 2B is automatically selected with flaps in the landing configuration (landing flaps or flap over-ride selected) or when making an ILS approach with Glideslope and Localizer deviation less than 2 dots.



MODE 3  
Altitude  
Loss After  
TakeOff

Mode 3 provides alerts for significant altitude loss after takeoff or low altitude go-around (less than 245 feet AGL) with gear or flaps not in the landing configuration. The amount of altitude loss that is permitted before an alert is given is a function of the height of the aircraft above the terrain as shown below. This protection is available until the EGPWS determines that the aircraft has gained sufficient altitude that it is no longer in the takeoff phase of flight. Significant altitude loss after takeoff or during a low altitude go-around activates the EGPWS caution lights and the aural message **"DON'T SINK, DON'T SINK"**. The aural message is only enunciated twice unless altitude loss continues. Upon reestablishing a positive rate of climb, the EGPWS caution lights extinguish and the aural alert will cease.

If the Aural Declutter feature is disabled, the warning is enunciated continuously until positive climb is established.



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MODE 4  
Unsafe  
Terrain  
Clearance

Mode 4 provides alerts for insufficient terrain clearance with respect to phase of flight, configuration, and speed. Mode 4 exists in three forms, 4A, 4B, and 4C.

- Mode 4A is active during cruise and approach with the gear and flaps not in the landing configuration.
- Mode 4B is active during cruise and approach with the gear in the landing configuration and flaps not in the landing configuration.
- Mode 4C is active during the takeoff phase of flight with either the gear or flaps not in the landing configuration.

Mode 4 alerts activate the EGPWS caution lights and aural messages.

To reduce nuisance alerts caused by over-flying another aircraft, the upper limit of the Mode 4A/B alerting curve can be reduced (from 1000) to 800 feet. This occurs if the airplane is above 250 knots with gear and flaps not in landing configuration and a sudden change in Radio Altitude is detected. This is intended to eliminate nuisance alerts while flying a holding pattern and an aircraft over-flight occurs (with 1000 foot separation).

MODE 4A

Mode 4A is active during cruise and approach with gear and flaps up. This provides alerting during cruise for inadvertent flight into terrain where terrain is not rising significantly, or the aircraft is not descending excessively. It also provides alerting for protection against an unintentional gear-up landing.

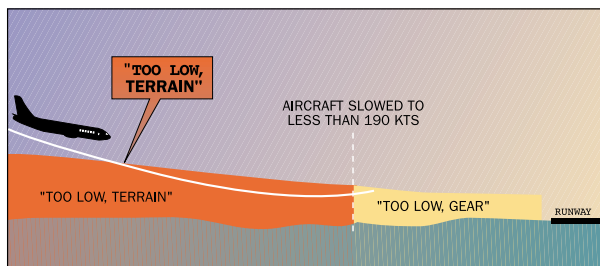
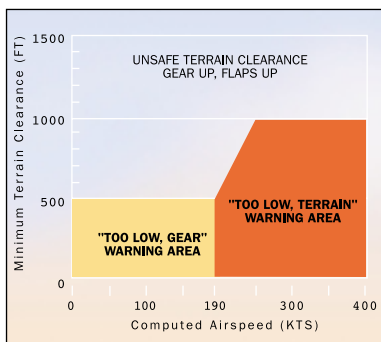
Below 1000 feet AGL and above 190 knots airspeed, the Mode 4A aural alert is **“TOO LOW TERRAIN”**. This alert is dependent on aircraft speed such that the alert threshold is ramped between 500 feet at 190 knots to 1000 feet at 250 knots.

MODE 4A  
Continued

Below 500 feet AGL and less than 190 knots airspeed, the Mode 4A aural alert is **"TOO LOW GEAR"**.

For either Mode 4A alert, subsequent alert messages occur only if penetration of the envelope increases by 20%. EGPWS caution lights extinguish and aural messages cease when the Mode 4A alert envelope is exited.

If the Aural Declutter feature is disabled, mode 4A alert messages are repeated continuously until the Mode 4A envelope is exited.



MODE 4B

Mode 4B is active during cruise and approach, with gear down and flaps not in the landing configuration.

Below 1000 feet AGL and above 159 knots airspeed, the Mode 4B aural alert is **"TOO LOW TERRAIN"**. This alert is dependent on aircraft

MODE 4B  
Continued

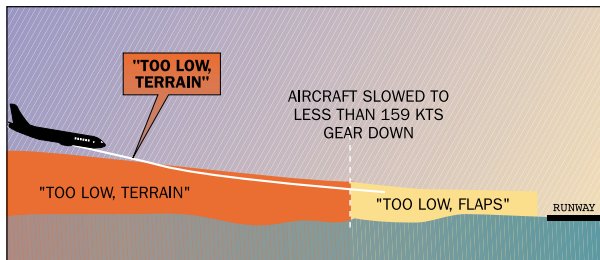
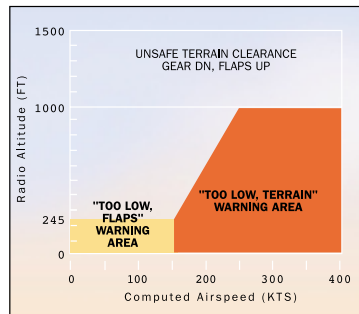
speed such that the alert threshold is ramped between 245 feet at 159 knots to 1000 feet at 250 knots.

Below 245 feet AGL and less than 159 knots airspeed, the Mode 4B aural alert is **"TOO LOW FLAPS"**. For turboprop and select turbofan aircraft, the **"TOO LOW FLAPS"** warning curve is lowered to 150 or 200 feet AGL and less than 148 knots.

If desired, the pilot may disable the **"TOO LOW FLAPS"** alert by engaging the Flap Override switch (if installed). This precludes or silences the Mode 4B flap alert until reset by the pilot.

For either Mode 4B alert, subsequent alert messages occur only if penetration of the envelope increases by 20%. EGPWS caution lights extinguish and aural messages cease when the Mode 4B alert envelope is exited.

If the Aural Declutter feature is disabled, mode 4B alert messages are repeated continuously until the Mode 4B envelope is exited.





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**MODE 4C** The Mode 4C alert is intended to prevent inadvertent controlled flight into the ground during takeoff climb into terrain that produces insufficient closure rate for a Mode 2 alert. After takeoff, Mode 4A and 4B provide this protection.

Mode 4C is based on an EGPWS computed Minimum Terrain Clearance (MTC) floor, that increases with Radio Altitude. It is active after takeoff when the gear or flaps are not in the landing configuration. It is also active during a low altitude go-around if the aircraft has descended below 245 feet AGL.

At takeoff the Minimum Terrain Clearance (MTC) is zero feet. As the aircraft ascends the MTC is increased to 75% of the aircraft's Radio Altitude (averaged over the previous 15 seconds). This value is not allowed to decrease and is limited to 500 feet AGL for airspeed less than 190 knots. Beginning at 190 knots, the MTC increases linearly to the limit of 1000 feet at 250 knots.

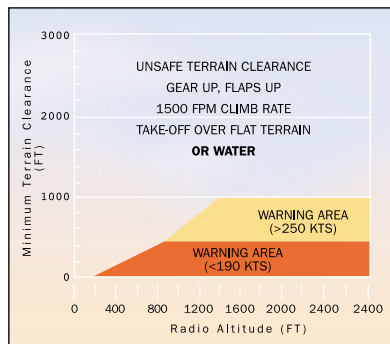
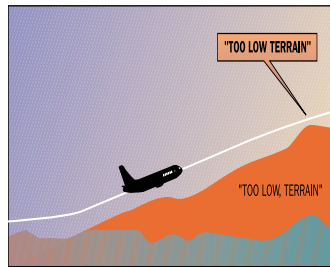
If the aircraft's Radio Altitude decreases to the value of the MTC, the EGPWS caution lights and the aural message **"TOO LOW TERRAIN"** are provided.

EGPWS caution lights extinguish and aural messages cease when the Mode 4C alert envelope is exited.

If the Aural Declutter feature is disabled, mode 4B alert messages are repeated continuously until the Mode 4B envelope is exited.

## MODE 4C

Continued



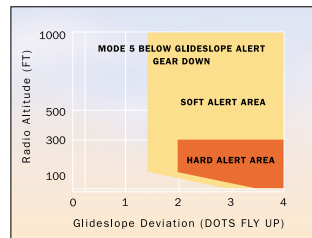
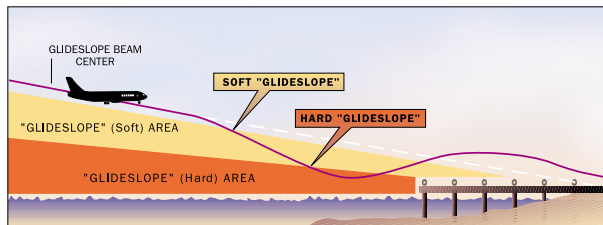
Excessive  
Deviation  
Below  
Glideslope

Mode 5 provides two levels of alerting for when the aircraft descends below glideslope, resulting in activation of EGPWS caution lights and aural messages.

The first level alert occurs when below 1000 feet Radio Altitude and the aircraft gets 1.3 dots or greater below the beam. This turns on the caution lights and is called a “soft” alert because the audio message “GLIDESLOPE” is enunciated at half volume. 20% increases in the glideslope deviation cause additional “GLIDESLOPE” messages enunciated at a progressively faster rate.

## MODE 5 Continued

The second level alert occurs when below 300 feet Radio Altitude with 2 dots or greater glideslope deviation. This is called a “hard” alert because a louder **“GLIDESLOPE, GLIDESLOPE”** message is enunciated every 3 seconds continuing until the “hard” envelope is exited. The caution lights remain on until a glideslope deviation less than 1.3 dots is achieved.



To avoid unwanted Below Glideslope alerts when capturing the localizer between 500 and 1000 feet AGL, alerting is varied in the following ways:

- Below Glideslope alerts are enabled only if the localizer is within 2 dots, landing gear and flaps are selected, Glideslope Cancel is not active, and a front course approach is determined.
- The upper altitude limit for the alert is modulated with vertical speed. For descent rates above 500 FPM, the upper limit is set to the normal 1000 feet AGL. For descent rates lower than 500 FPM, the upper limit is desensitized (reduced) to a minimum of 500 feet AGL.

---

MODE 5  
Continued

Additionally, both alert levels are desensitized below 150 feet AGL, to allow for normal beam variations nearer the ground, and reduce the possibility of nuisance alerts.

If the Aural Declutter feature is disabled, messages are repeated continuously until the Mode 5 envelope is exited.

Mode 5 alerts can be canceled by pressing the Glideslope Cancel switch (if installed). The EGPWS will interpret this switch one of two ways depending on the installation configuration.

- A *standard* glideslope cancel switch allows for manually canceling Mode 5 alerting any time below 2000 feet AGL. This is automatically reset when the aircraft descends below 30 feet or climbs above 2000 feet AGL.
- An *alternate* glideslope cancel switch allows for manually canceling Mode 5 alerting at any time and any altitude. The cancel is reset by again pressing the cancel switch, or automatically if gear or flaps are raised, or the aircraft is on the ground. Due to the nature of the alternate cancel switch, this method requires that there be a cockpit annunciation that glideslope cancel is in effect.

EGPWS Mode 5 alerts are inhibited during backcourse approaches to prevent nuisance alerts due to false fly up lobes from the Glideslope. The EGPWS determines a backcourse operation if either: 1) the aircraft's magnetic track is greater than 90 degrees from the runways approach course, or 2) a glideslope inhibit discrete is set.

**MODE 6  
Advisory  
Callouts**

Mode 6 provides EGPWS advisory callouts based on the menu-selected option established at installation (set by program pin configuration). These callouts consist of predefined Radio Altitude based voice callouts or tones and an excessive bank angle warning. There is no visual alerting provided with these callouts.

**Altitude  
Callouts**

The following is a list of each of the possible altitude callouts or tones:

<b>CALLOUT</b> .....	<b>Occurs at (feet AGL)</b>
“RADIO ALTIMETER” .....	2500
“TWENTY FIVE HUNDRED” .....	2500
“FIFTEEN HUNDRED” .....	1500
“ONE THOUSAND” .....	1000 <sup>a</sup>
“FIVE HUNDRED” .....	500 <sup>a</sup>
Five Hundred Tone (2 second 960 Hz) .....	500
“FOUR HUNDRED” .....	400
“THREE HUNDRED” .....	300
“TWO HUNDRED” .....	200
“APPROACHING MINIMUMS” .....	DH+80
“APPROACHING DECISION HEIGHT” .....	DH+100
“PLUS HUNDRED” .....	DH+100
“FIFTY ABOVE” .....	DH+50
“MINIMUM” .....	DH
“MINIMUMS” .....	DH
“DECIDE” .....	DH
“ONE HUNDRED” .....	100
One Hundred Tone (2 second 700 Hz) .....	100
“EIGHTY” .....	80
“SIXTY” .....	60
“FIFTY” .....	50
“FORTY” .....	40
“THIRTY FIVE” .....	35
Thirty Five Tone (1 second 1400 Hz) .....	35
“THIRTY” .....	30
“TWENTY” .....	20
Twenty Tone (1/2 second 2800 Hz) .....	20
“TEN” .....	10
“FIVE” .....	5
“ZERO” .....	0

a. May be Barometric Altitude above the field elevation for some aircraft types.

In some cases a callout is stated twice (e.g., “MINIMUMS, MINIMUMS”) but in all cases a given callout is only enunciated once per approach.

---

MODE 6  
Continued

Decision Height (DH) based callouts (Approaching Minimums, Minimums, etc.) require the landing gear to be down and occur when descending through the Radio Altitude corresponding to the selected DH. These also have priority over other altitude callouts when overlapping. For example, if DH is set to 200 and both “TWO HUNDRED” and “MINIMUMS” are valid callouts, then only “MINIMUMS” will be called out at 200 feet AGL.

DH plus based callouts (e.g., Approaching Minimums) are only applicable for aircraft providing a Decision Height altitude to the EGPWS. Consequently, not all EGPWS installations can utilize these callout options.

Due to the variety of altitude callout choices available, it is not possible to identify every combination in this guide. Refer to an appropriate Airplane Flight Manual or EGPWS Airplane Flight Manual Supplement for callout identification in a specific application or contact AlliedSignal.

Smart 500  
FT. Callout

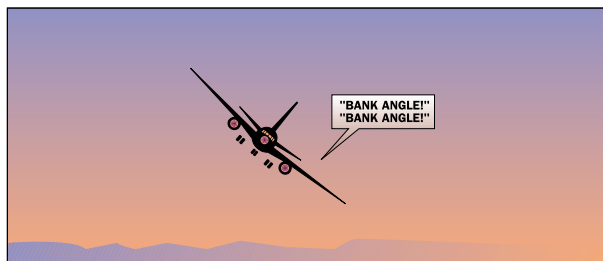
Another option that may be enabled in the installation is a feature called Smart 500-Foot Callout. This is intended to assist pilots during a non-precision approach by enunciating “**FIVE HUNDRED**” feet independent of the altitude callout menu selection discussed above. The EGPWS determines a non-precision approach when Localizer or Glideslope are greater than 2 dots deviation (valid or not) or a back-course approach is detected.

This feature has the distinction of adding the 500-foot callout during non-precision approaches and removing the 500-foot callout on precision approaches when part of the callout option.

MODE 6  
Continued

Bank Angle  
Callout

The callout **"BANK ANGLE, BANK ANGLE"** advises of an excessive roll angle. The EGPWS provides several excessive bank angle envelopes supporting Air Transport, Business, or Military aircraft types (only Air Transport and Business are addressed below).

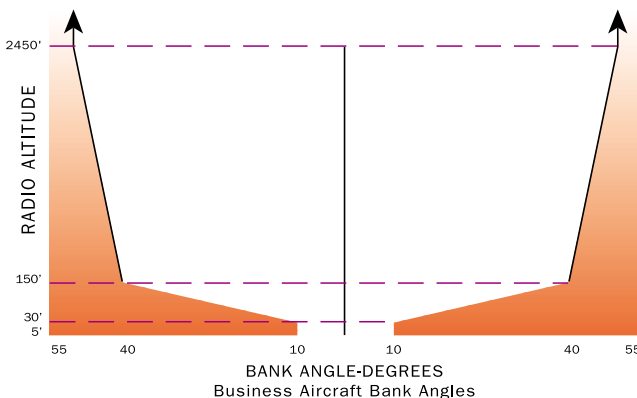


Business  
Bank Angle

One envelope is defined for turbo-prop and jet business aircraft (see graph below). Bank angles in excess of:

- $\pm 10^\circ$  between 5 and 30 feet,
- $\pm 10$  to  $40^\circ$  between 30 and 150 feet,
- $\pm 40$  to  $55^\circ$  between 150 and 2450 feet,

produce the bank angle advisory (shaded area). Bank angle advisories are inhibited below 5 feet.

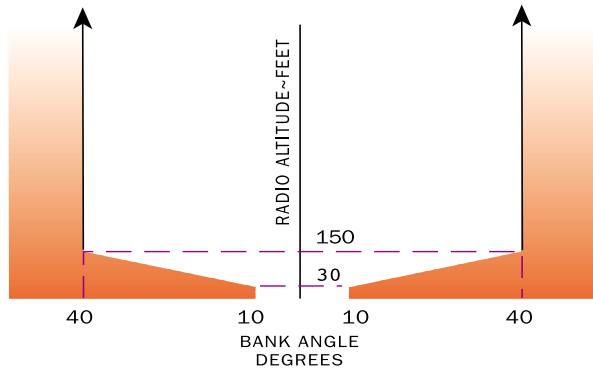


Air Transport  
Bank Angle

Three envelopes are defined for Air Transport aircraft. These are identified as Basic Bank Angle, Bank Angle Option 1, and Bank Angle Option 2 advisories.

**MODE 6**  
Continued

The Air Transport Basic Bank Angle limits are similar to the Business Aircraft Bank Angle limits except above 150 feet the bank limit remains at 40 as shown below.



Bank Angle Option 1 provides bank angle advisory thresholds at 35, 40, and 45 independent of altitude. In this case, an advisory at 35 is provided and another is not given unless 40 is exceeded and then again only if 45 is exceeded. If the roll rate exceeds the audio callout time, then the bypassed limit is not indicated. Also, when any one of the thresholds is exceeded, the bank angle must reduce below 30 for the process to reset before additional Bank Angle Advisories can be provided.

For example, if greater than 40 is obtained before the 35 callout is complete, another callout is provided only if 45 is obtained or the bank angle is reduced to less than 30 and then again increases to 35).

Bank Angle Option 2 provides a combination of the Basic Bank Angle and Bank angle Option 1. The Basic Bank Angle limits are provided below 130 feet, and Bank Angle Option 1 is provided above 130 feet.

Any one of these three Bank Angle limits can be selected by program pin if the aircraft type is defined as an Air Transport aircraft.



MODE 7  
Windshear  
Alerting

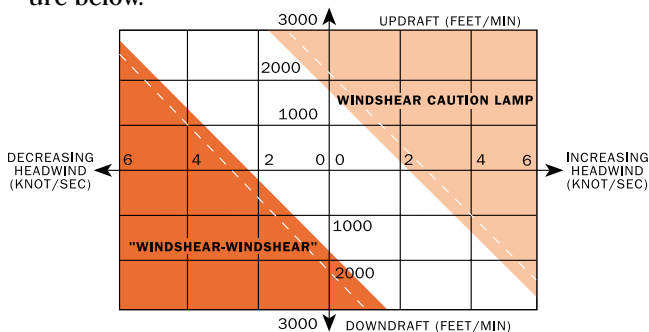
Mode 7 is designed to provide alerts if the aircraft encounters windshear. Two alerting envelopes provide either a Windshear Caution alert or a Windshear Warning alert each with distinctive aural and visual indications to the flight crew.

EGPWS windshear is provided for certain (not all) aircraft types and is a function of certain additionally required input signals and enabled internal detection algorithms. These are established during the initial installation and addressed in the appropriate Airplane Flight Manual (AFM) or EGPWS Airplane Flight Manual Supplement (AFMS).

Windshear  
Caution

Windshear Caution alerts are given if an increasing headwind (or decreasing tailwind) and/or a severe updraft exceed a defined threshold. These are characteristic of conditions preceding an encounter with a microburst.

A Windshear Caution results in illumination of amber Windshear Caution lights and the aural message "CAUTION, WINDSHEAR". This lights remain on for as long as the aircraft is exposed to conditions in excess of the caution alert threshold. The Windshear Caution envelope is illustrated in the figure below.



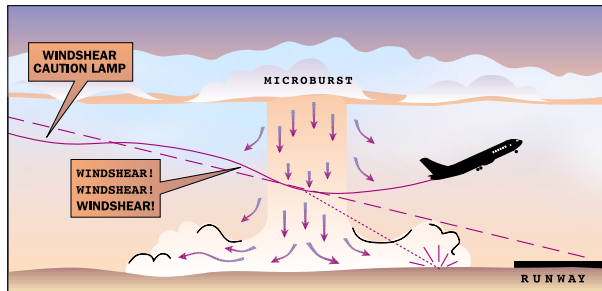
The Windshear Caution alerting can be disabled by EGPWS program pin selection so that only Windshear Warning alerts are provided.

MODE 7  
Continued

Windshear  
Warning

Windshear Warning alerts are given if a decreasing headwind (or increasing tailwind) and/or a severe downdraft exceed a defined threshold. These are characteristic of conditions within or exiting an encounter with a microburst.

Windshear Warning results in illumination of red Windshear Warning lights and an aural siren followed by the message “WINDSHEAR, WINDSHEAR, WINDSHEAR”. The lights remain on for as long as the aircraft is exposed to conditions in excess of the warning alert threshold. The aural message will not repeat unless another separate windshear event is encountered. The threshold is adjusted as a function of available climb performance, flight path angle, airspeeds significantly different from normal approach speeds, and unusual fluctuations in Static Air Temperature (typically associated with the leading edge of a microburst). The Windshear Warning envelope is illustrated in the figure below.



Mode 7 Windshear alerting is active under the following conditions:

- During takeoff; from rotation until an altitude of 1500 feet AGL is reached,
- During approach; From an altitude of 1500 feet down to 10 feet AGL,
- During a missed approach; until an altitude of 1500 feet AGL is reached.

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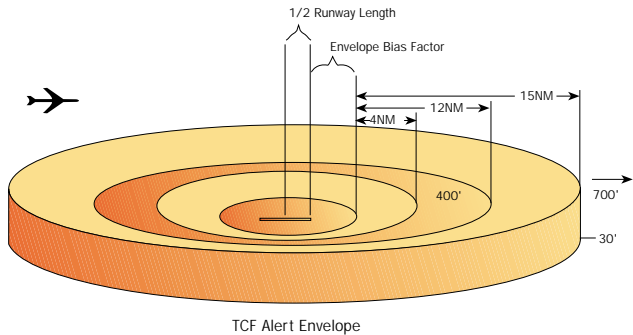
## ENHANCED FUNCTIONS:

**Envelope Modulation** Due to terrain features at or near certain specific airports around the world, normal operations have resulted in nuisance or missed alerts at these locations in the past. With the introduction of accurate position information and a terrain and airport database, it is possible to identify these areas and adjust the normal alerting process to compensate for the condition.

An EGPWS Envelope Modulation feature provides improved alert protection and expanded alerting margins at identified key locations throughout the world. This feature is automatic and requires no flight crew action.

Modes 4, 5, and 6 are expanded at certain locations to provide alerting protection consistent with normal approaches. Modes 1, 2, and 4 are desensitized at other locations to prevent nuisance warnings that result from unusual terrain or approach procedures. In all cases, very specific information is used to correlate the aircraft position and phase of flight prior to modulating the envelopes.

**Terrain Clearance Floor** The Terrain Clearance Floor (TCF) function (when enabled) enhances the basic GPWS Modes by alerting the pilot of descent below a defined “Terrain Clearance Floor” regardless of the aircraft configuration. The TCF alert is a function of the aircraft’s Radio Altitude and distance (calculated from latitude/longitude position) relative to the center of the nearest runway in the database (all hard surface runways greater than 3500 feet in length). The TCF envelope is defined for all runways as illustrated below and extends to infinity, or until it meets the envelope of another runway. The envelope bias factor is typically  $\frac{1}{2}$  to 2 nm and varies as a function of position accuracy.



TCF alerts result in illumination of the EGPWS caution lights and the aural message **“TOO LOW TERRAIN”**. The audio message is provided once when initial envelope penetration occurs and again only for additional 20% decreases in Radio Altitude. The EGPWS caution lights will remain on until the TCF envelope is exited.

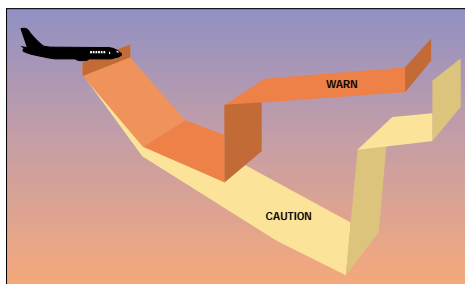
### Terrain Look Ahead Alerting

Another enhancement provided by the internal terrain database, is the ability to look ahead of the aircraft and detect terrain or obstacle conflicts with greater alerting time. This is accomplished (when enabled) based on aircraft position, flight path angle, track, and speed relative to the terrain database image forward the aircraft.

Through sophisticated look ahead algorithms, both caution and warning alerts are generated if terrain or an obstacle conflict with “ribbons” projected forward of the aircraft (see following illustration). These ribbons project down, forward, then up from the aircraft with a width starting at 0 nm and extending out at 3 laterally, more if turning. The look-down and up angles are a function of the aircraft flight path angle, and the look-down distance a function of the aircraft’s altitude with respect to the

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nearest runway. This relationship prevents undesired alerts when taking off or landing. The look-ahead distance is a function of the aircraft's speed, and distance to the nearest runway.



A terrain conflict intruding into the caution ribbon activates EGPWS caution lights and the aural message **“CAUTION TERRAIN, CAUTION TERRAIN”** or **“TERRAIN AHEAD, TERRAIN AHEAD”**. An obstacle conflict provides a **“CAUTION OBSTACLE, CAUTION OBSTACLE”** or **“OBSTACLE AHEAD, OBSTACLE AHEAD”** message. The caution alert is given typically 60 seconds ahead of the terrain/obstacle conflict and is repeated every seven seconds as long as the conflict remains within the caution area. When the warning ribbon is intruded (typically 30 seconds prior to the terrain/obstacle conflict), EGPWS warning lights activate and the aural message **“TERRAIN, TERRAIN, PULL UP”** or **“OBSTACLE, OBSTACLE, PULL UP”** is enunciated with **“PULL UP”** repeating continuously while the conflict is within the warning area.

The specific aural message provided is established during the initial installation of the EGPWS and is a function of whether or not the terrain and obstacles features are enabled and the selected audio menu (via program pin selection).

Refer to an applicable AFM or EGPWS AFMS for specific application information or contact AlliedSignal for additional information.

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## Terrain Alerting and Display

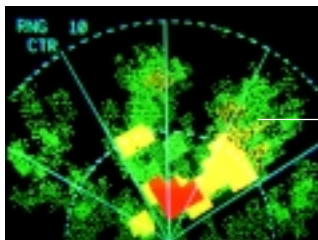
When a compatible Weather Radar, EFIS, or other display is available and enabled, the EGPWS Terrain Alerting and Display (TAD) feature provides an image of the surrounding terrain represented in various colors and intensities.

There are actually two types of TAD displays depending on the options selected. The first provides a terrain image only when the aircraft is 2000 feet or less above the terrain (“standard”). A second feature called “Peaks” enhances the standard display characteristics to provide a higher degree of terrain awareness independent of the aircraft’s altitude. In either case, terrain and obstacles (if enabled) forward of the aircraft is displayed. Obstacles are presented on the cockpit display as terrain, employing the same display-coloring scheme. Peaks and Obstacle functions are enabled by EGPWS program pin selection.

**NOTE:** With respect to standard or Peaks display, terrain and or obstacle presentation is always based on (and scaled for) the geographic area available for display. Consequently, terrain and/or obstacles outside of the selected display range and defined display sweep do not have any effect on the displayed image.

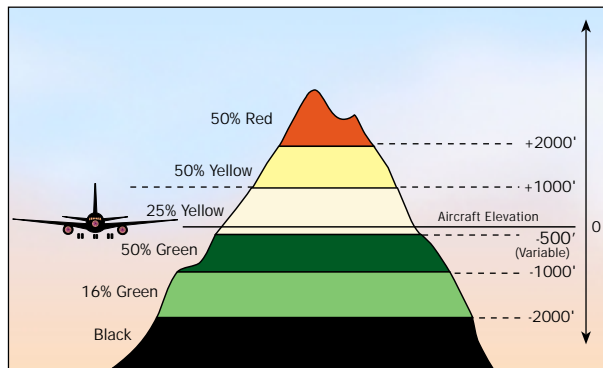
## Standard TAD

Standard TAD provides a graphical plan-view image of the surrounding terrain as varying density patterns of green, yellow, and red as illustrated in the following graphics. The selected display range is also indicated on the display, and an indication that TAD is active is either indicated on the display (e.g., “TERR”) or by an adjacent indicator.



TERRAIN IS SHOWN IN SHADES OF GREEN, YELLOW AND RED

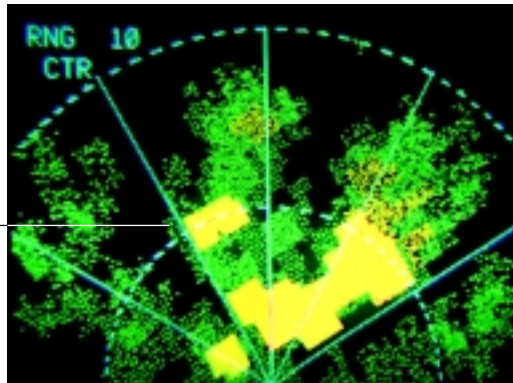
Each specific color and intensity represents terrain (and obstacles) below, at, or above the aircraft's altitude based on the aircraft's position with respect to the terrain in the database. If no terrain data is available in the terrain database, then this area is displayed in a low-density magenta color. Terrain more than 2000 feet below the aircraft, or within 400 (vertical) feet of the nearest runway elevation, is not displayed (black).



When a caution alert is triggered, the terrain (or obstacle) that created the alert is changed to solid yellow (100% density) as illustrated below.

60 Seconds from projected impact  
"Caution Terrain!"

Caution Terrain is solid Yellow

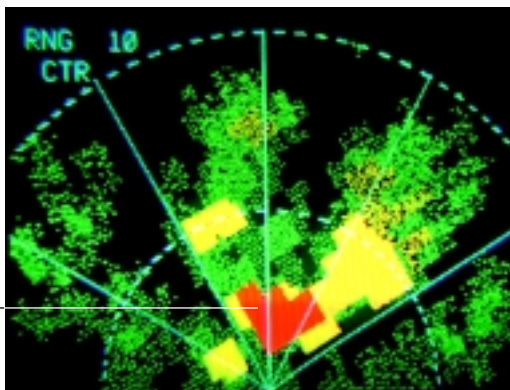


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When a warning alert is triggered, the terrain (or obstacle) that created the alert is changed to solid red (100% density) as illustrated below.

30 Seconds From  
projected impact  
"Terrain, Terrain,  
-Pull Up!"

Warning Terrain  
is Solid Red



**NOTE:** When a TAD caution or warning alert is active, the display image (cells) surrounding the target are enlarged (surrounding cells are illuminated). This allows a smaller terrain or obstacle (e.g., a single tower) to be better seen on the display.

The transition between green and yellow is below the aircraft in order to account for altimetry and/or terrain/obstacle height errors. Also, the transition altitudes between colors are biased upward proportional to the descent rate when greater than 1000 feet per minute. This provides approximately a 30-second advance display of terrain.

Essentially, pilots should note that any yellow or red painted terrain is at or above the aircraft's altitude and appropriate terrain clearance needs to be provided.

TAD "Pop-Up"  
and "Auto-  
Range"

Based on the display system used, there may be additional terrain display features. These are defined as installation options and allow for:

- Automatic display of terrain on the cockpit display ("TAD pop-up") in the event that a caution or warning alert is triggered as described in Ter-



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rain Look Ahead Alerting. In some cases, an active display mode must be selected first.

- “Auto-range” when Pop-up occurs. This provides for the automatic range presentation for terrain as defined for the display system configuration (typically 10 nm). In this case, if the terrain auto-range is different than the display system selected range, the displayed range value on the cockpit display is flashed or changed color until the range is manually reselected or terrain display is deselected.

#### “PEAKS”

“Peaks” has all the characteristics of the standard TAD but with additional terrain display features for enhanced situational awareness independent of the aircraft’s altitude. The principle additions are:

- The digital display of the highest and lowest terrain/obstacle elevations currently displayed,
- The display of additional solid or lower density color bands, including the addition of the graphic representation of sea level (0 feet MSL).

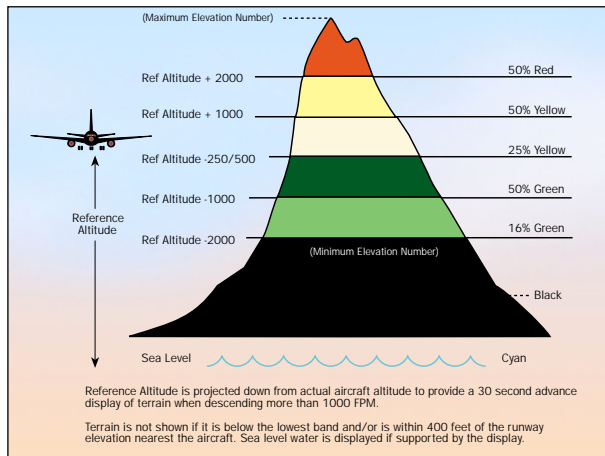
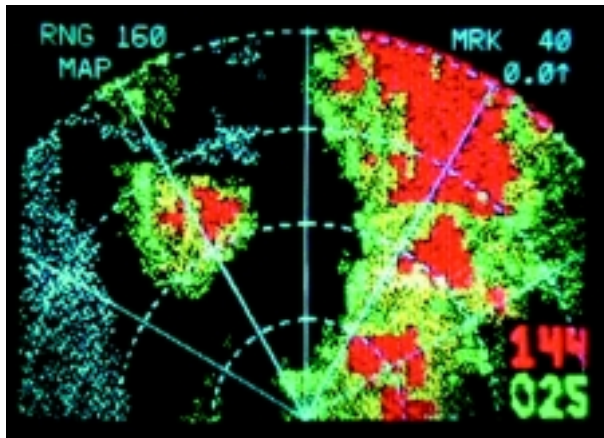
With Terrain Display selected on, digital values representing the highest terrain/obstacle elevation and the elevation for the bottom of the lowest color band are displayed. These are based on the range selected (terrain in view)

The location of the digital values can vary somewhat for the display used, but for this guide will be shown in the lower right corner of the display. These elevations are expressed in hundreds of feet above sea level (e.g., 125 is 12,500 feet MSL) with the highest elevation on top and the lowest on the bottom. However, in the event that there is no appreciable difference in the terrain/obstacle elevations (flat terrain), only the highest value is displayed. Additionally, the color of the elevation value is presented the same as the color of the terrain display containing that elevation (i.e., red if the

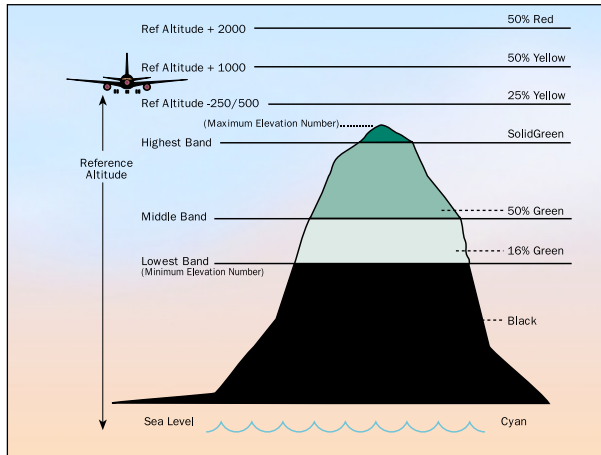
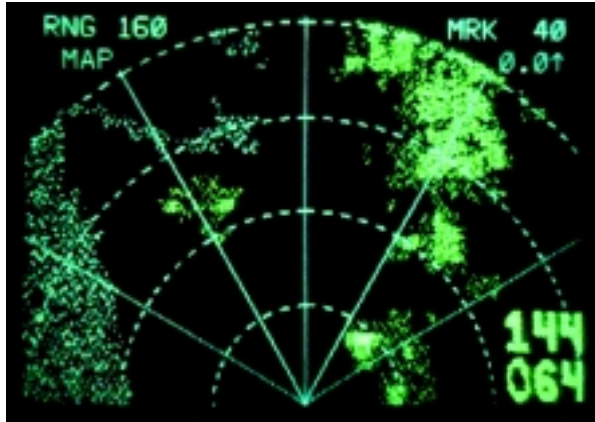
terrain/obstacle with that elevation is depicted as red in the terrain plan view, yellow if yellow, etc.). When the aircraft is 500 feet (250 with gear down) or less above the terrain in view (yellow or red is displayed), the Peaks color scheme is identical to the standard display, with the exception of the addition of sea level when supported by the display.

**Note:** some displays do not support cyan (blue) and will not display sea level in this case.

The following illustrate the Peaks display at a low relative altitude.



The following illustrate the Peaks display at a high relative altitude.



When the aircraft is greater than 500 feet (250 with gear down) above the terrain in view (no yellow or red displayed), additional (green) color bands are presented. These added bands are computed and displayed as a function of the highest and lowest elevations in view.

The following table indicates the TAD colors and elevations (standard and Peaks).

<b>Color</b>	<b>Indication</b>
Solid Red	Terrain/Obstacle Threat Area – Warning.
Solid Yellow	Terrain/Obstacle Threat Area – Caution.
50% Red Dots	Terrain/Obstacle that is more than 2000 feet above aircraft altitude.
50% Yellow Dots	Terrain/Obstacle that is between 1000 and 2000 feet above aircraft altitude.
25% Yellow Dots	Terrain/Obstacle that is 500 (250 with gear down) feet below to 1000 feet above aircraft altitude.
Solid Green (Peaks only)	Shown only when no Red or Yellow terrain /Obstacle areas are within range on the display. Highest terrain/Obstacle not within 500 (250 with gear down) feet of aircraft altitude.
50% Green Dots	Terrain/Obstacle that is 500 (250 with gear down) feet below to 1000 below aircraft altitude.
(Peaks only)	Terrain/Obstacle that is the middle elevation band when there is no Red or Yellow terrain areas within range on the display.
16% Green Dots	Terrain/Obstacle that is 1000 to 2000 feet below aircraft altitude.
(Peaks only)	Terrain/Obstacle that is the lower elevation band when there is no Red or Yellow terrain areas within range on the display.
Black	No significant terrain/Obstacle.
16% Cyan (Peaks only)	Water at sea level elevation (0 feet MSL).
Magenta Dots	Unknown terrain. No terrain data in the database for the magenta area shown.

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TCF/TAD  
INOP and  
INHIBIT

The EGPWS TCF and TAD functions are available when all required data is present and acceptable. Aircraft position and numerous other parameters are monitored and verified for adequacy in order to perform these functions. If determined invalid or unavailable, the system will display Terrain inoperative or unavailable annunciations and discontinue the terrain display if active.

TAD/TCF functions may be inhibited by manual selection of a cockpit Terrain Inhibit switch. Neither loss nor inhibited TAD/TCF effects the basic GPWS functions (modes 1-7).

If Peaks is not active and TAD becomes unavailable due to position error, terrain inoperative or unavailable is not indicated if the aircraft is greater than 8000 feet above the highest terrain or obstacle within a 320nm radius. If indicated below the 8000-foot threshold, it is extinguished when the aircraft climbs above, and is again displayed once the aircraft descends below the 8000-foot threshold. This eliminates potentially longterm illumination of the condition during the high enroute phase of flight.

Geometric  
Altitude

Based on GPS altitude, geometric altitude is a computed pseudo-barometric altitude designed to reduce or eliminate errors potentially induced in Corrected Barometric Altitude by temperature extremes, non-standard pressure altitude conditions, and altimeter miss-sets. This ensures an optimal EGPWS Terrain Alerting and Display capability. Geometric Altitude also allows EGPWS operations in QFE environments without custom inputs or special operational procedures.

Geometric Altitude requires a MSL based GPS Altitude input with its associated Vertical Figure Of Merit (VFOM) and Receiver Autonomous Integrity Monitoring (RAIM) failure indication, standard (uncorrected) altitude, Radio Altitude, Ground Speed, Roll Angle, and aircraft position (Latitude and Longitude).

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Additionally, corrected Barometric Altitude, Static Air Temperature (SAT), GPS mode, and the number of satellites tracked are used if available.

The Geometric Altitude is computed by blending a calculated Non-Standard Altitude, Runway Calibrated Altitude (determined during takeoff), GPS Calibrated Altitude, Radio Altitude Calibrated Altitude (determined during approach), and Barometric Altitude (if available). Estimates of the VFOM for each of these are determined and applied in order to determine its weight in the final altitude. The blending algorithm gives the most weight to altitudes with a higher estimated accuracy, reducing the effect of less accurate altitudes. Each component altitude is also checked for reasonableness using a window monitor computed from GPS Altitude and its VFOM. Altitudes that are invalid, not available, or fall outside the reasonableness window are not included in the final Geometric Altitude value.

The Geometric Altitude algorithm is designed to allow continued operation when one or more of the altitude components are not available. If all component altitudes are invalid or unreasonable, the GPS Altitude is used directly. If GPS Altitude fails or is not present, then the EGPWS reverts to using Corrected Barometric Altitude alone.

The Geometric Altitude function is fully automatic and requires no pilot action other than the proper setting of Corrected Barometric Altitude on the Altimeter.

#### Aural Message Priority

Two or more messages may be activated simultaneously, so a message priority has been established. The following table reflects the priority for these message callouts. Messages at the top of the list will start before or immediately override a lower priority message even if it is already in progress.

Aural  
 Message  
 Priority  
 Continued

<b>MESSAGE .....</b>	<b>MODE</b>
“Windshear, Windshear, Windshear” <sup>d, j</sup> .....	7
“Pull Up” <sup>h, i, k</sup> .....	1, 2, TA
“Terrain, Terrain” .....	2, TA
“Obstacle, Obstacle” <sup>c</sup> .....	TA
“Terrain” .....	2
“Minimums” <sup>a, c</sup> .....	6
“Caution Terrain, Caution Terrain” <sup>c, f</sup> .....	TA
“Caution Obstacle, Caution Obstacle” <sup>c, g</sup> .....	TA
“Too Low Terrain” .....	4, TCF
Altitude Callouts <sup>c</sup> .....	6
“Speed Brake, Speed Brake” <sup>c</sup> .....	6
“Too Low Gear” .....	4A
“Too Low Flaps” .....	4B
“Sink Rate, Sink Rate” .....	1
“Don’t Sink, Don’t Sink” .....	3
“Glideslope” .....	5
“Approaching Minimums” <sup>b, c</sup> .....	6
“Bank Angle, Bank Angle” <sup>c</sup> .....	6
“Caution Windshear” <sup>c, d, e</sup> .....	7
“Autopilot” <sup>c</sup> .....	6
“Flaps, Flaps” <sup>c</sup> .....	6

**Notes:**

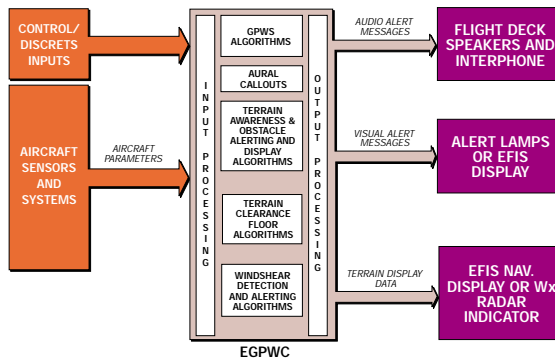
- a) May also be “Minimums, Minimums” or “Decide”.
- b) May also be “Approaching Decision Height”, “Fifty Above”, “Plus Hundred”.
- c) Message is dependent on aircraft type or option selected.
- d) Windshear detection alerts provided for some aircraft types.
- e) Caution alert if not disabled.
- f) May also be “Terrain Ahead, Terrain Ahead”.
- g) May also be “Obstacle Ahead, Obstacle Ahead”
- h) May also be “Terrain Ahead Pull Up”
- i) May also be “Obstacle Ahead Pull Up”
- j) May be preceded by siren.
- k) May be preceded by “Whoop, Whoop”

TA=Terrain Look-Ahead Alert

TCF=Terrain Clearance Floor

## System Inputs

The EGPWS uses various input signals from other on-board systems. The full compliment of these other systems is dependent on the EGPWS configuration and options selected. Systems providing Altitude, Airspeed, Attitude, Glideslope, and position are required for basic and enhanced functions. Accelerations, Angle-of-Attack (AOA), and Flap position is required for Windshear. Inputs are also required for discrete signal and control input.



The EGPWS utilizes signals from the following systems:

### Air Data

Uncorrected and corrected Barometric Altitude, Altitude rate, Computed Airspeed, True Airspeed, and Static Air Temperature are provided by Air Data system.

### Radio Altitude

Radio Altitude is provided by a Radio Altimeter system. Decision Height or Decision Height Altitude is provided by a Radio Altimeter system or ancillary system.

### FMS, IRS, AHRs, Accelerometer

Pitch and Roll Attitude, Latitude and Longitude Position, Body Normal and Longitudinal Accelerations, Magnetic and True Track Angles, Magnetic and True Heading, Inertial Altitude, Groundspeed, and mode.

Latitude and Longitude Position, True Track Angle,



Global Positioning System (GPS)	GPS Altitude, Groundspeed, Horizontal and Vertical Figure of Merit (VFOM/HFOM), Horizontal and Vertical Dilution of Precision (HDOP/VDOP), Horizontal Integrity Limit (HIL), and sensor status.
VHF Nav Receiver	Glideslope, Localizer, ILS Tuned, Selected Runway Heading. Display range, and if available the Hazard Bus from a Predictive Windshear System (PWS). If EFIS, the EFIS display mode is used in some configurations.
Terrain Display System	AOA, Stick Shaker Margin.
AOA Vane or Stall Warning	Discrete inputs are used for system configuration, signal/status input, and control input functions.
DisCRETES	EGPWS program pins are utilized to tell the system the type of aircraft and interface that it is in. These are defined and established during the EGPWS installation. EGPWS output functions are consequently the result of the program pin state read each time the EGPWS is powered on.  Signal/status discret es include signals such as Decision Height, Landing Flaps selected or Flap Position discret es, Landing Gear selected, Terrain Display Range, and status discret es such as Glideslope Valid, Localizer Valid, Radio Altitude Valid associated with analog signal inputs.  Control discret es control EGPWS functions. These include EGPWS Test, Glideslope Cancel, Glideslope Inhibit or Glideslope Backcourse, Terrain (display) select, Terrain Inhibit, Flap Over-ride, Audio Inhibit, Altitude Callout Enable, Steep Approach Enable, and ILS Tuned discret es.
System Outputs	The EGPWS provides both audio and visual outputs. Audio outputs are provided as specific alert phrases, and altitude callouts or tones provided by an EGPWS speaker and via the cockpit Interphone sys-

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tem for headset usage. Several audio output levels are available, established during the installation of the EGPWS. These EGPWS audio outputs can be inhibited by other systems having higher priority (i.e., windshear) or cockpit switches in some cases. The EGPWS also has the ability to inhibit other system audio such as TCAS.

Visual outputs provide discrete alert and status annunciations, and display terrain video when a compatible display system is available and enabled. The discrete visual alerts coincide with audio caution and warning alerts to achieve an optimum terrain alerting capability. Status annunciations provide information to the flight crew about the status of the EGPWS (e.g., GPWS INOP) or activation of selected functions. Terrain video is generated by the EGPWC based on the aircraft's current position relative to the surrounding terrain. This video is presented to a Weather Radar indicator, EFIS display, or a dedicated display unit.

## Options

The EGPWC uses program pin discrete inputs to define the installation configuration and option selection. The EGPWS has been designed for maximum flexibility while being tailored to specific aircraft equipment, sensors, and displays. The following list summarizes available Operator options (excluding sensor and equipment configuration options):

- **Flashing Lamps** – when selected causes alert annunciators to flash when active.
- **TAD and TCF Disable** – Suppresses all TAD and TCF alerting and display functions.
- **Altitude Callouts** – Selects desired altitude callouts from a menu of options.
- **Audio Output Level** – Selects desired audio output level High, Medium, or Low.
- **Alternate Mode 6 Volume** – Selected reduces

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Mode 6 volume (an additional) 3 dB.

- **Obstacle Awareness Enabled** – Enables obstacle alerting and display.
- **TAD Alternate Pop Up** – If TRUE, disables automatic terrain display when TAD or Obstacle alert is active.
- **Mode 6 Volume Reduction** – Selected reduces Mode 6 volume 6 dB.
- **Smart Callout Enable** – Enables the 500-foot smart callout. “Five Hundred” is called out at 500 feet Radio Altitude during non-precision approaches (if 500’ is part of the altitude callout option selected, this callout is not given on precision approaches).
- **Bank Angle Enable** – Enables Bank Angle alerts.
- **Windshear Caution Voice Disable** – Disables Windshear Caution voice alerts providing visual alerts only.
- **Audio Declutter Disable** – Disables the Audio Declutter function so that audio alerts are constant.
- **Audio Alerting Voice Select** – Selects the type(s) of voice that are used for audio alerts.
- **Lamp Format** – One of two lamp formats are available.
  - Lamp Format 1 provides only Mode 5 “Glideslope” alerts to the caution (amber) lamp output and all other alerts (except Windshear and Mode 6 callouts) to the warning (red) lamp output.
  - Lamp Format 2 provides all “Pull Up” warning alerts to the warning (red) lamp output and all caution alerts to the caution (amber) lamp output (Recommended).

**NOTE:** Windshear annunciations are provided by separate outputs and indications and is not affected by lamp format. Mode 6 advisories do not effect any

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annunciation and are not affected by lamp format.

- **Peaks Enable** – Enables the display of Peaks when a Peaks capable display system is configured.

Additional input discretes are used to control or define EGPWS operations:

- **EGPWS Self-Test** – Cockpit switch initiates EGPWS Self-Test on the ground. Typically part of EGPWS warning (red) lamp.
- **Glideslope Cancel** – Cockpit switch cancels Mode 5 Glideslope alerting. Typically part of EGPWS caution (amber) lamp.
- **Glideslope Inhibit** – Inhibits Mode 5 Glideslope alerting. Normally used for backcourse approaches.
- **Altitude Callout Enable** – Enables Mode 6 Callouts.
- **Mode 6 Low Volume** – Reduces Mode 6 volume (an additional) 6 dB. This is typically hardwired or connected to an external switch.
- **TAD and TCF Inhibit** – Cockpit switch to disable all TAD and TCF functions.
- **Audio Inhibit** – disables all EGPWS audio outputs.
- **Steep Approach Enable** – Enables Steep Approach (Mode 1 Excessive Descent Rate) alerts biasing.
- **Steep Approach Select** – Selects (activates) Steep Approach (Mode 1 Excessive Descent Rate) alerts biasing to reduce nuisance alerts.
- **Flap Over-Ride** – Cockpit switch to select landing flaps when not in the landing flap configuration.
- **PLI Select/Deselect** – Used for displaying or deselecting the display of EGPWS derived Pitch Limit Indicator (PLI) signals when a Windshear warning occurs.

For additional options information, refer to an appropriate Interface Control Document (ICD) or contact AlliedSignal.

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## SECTION 3

### Operational Procedures

System Constraints .....	45
System Activation .....	46
EGPWS Self Test .....	47
Normal Procedures .....	50
Caution Alerts .....	51
Warning Alerts .....	51
Glideslope Alerts .....	51
Advisory Callouts .....	52
Windshear Caution .....	52
Windshear Warning .....	52
Abnormal Procedures .....	53
Emergency Procedures .....	55

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System  
Constraints

System constraints for the EGPWS are:

- If terrain data is unavailable for a particular area, then Terrain and Obstacle alerting and display is not available for that area and the affected display area is colored MAGENTA.
- The display of terrain and obstacle information is intended to serve as a situational awareness tool. It does not provide the accuracy and/or fidelity to be the sole source for deciding terrain or obstacle avoidance. Navigation must not be predicated upon the use of the EGPWS terrain/Obstacle display.
- If there is no source of aircraft position data meeting the accuracy requirements for the TAD and TCF functions, then these enhanced functions are automatically inhibited with a resultant Terrain inoperative or unavailable indication.
- TAD/TCF functions should be manually inhibited when operating within 15 nm of an airport that is not in the airport database to avoid unwanted alerts.
- TAD/TCF functions should be manually inhibited during QFE operations if GPS data is unavailable or inoperative.
- TAD/TCF functions should be manually inhibited for ditching or other off-airport landings.
- When the TAD/TCF functions are inhibited and the EGPWS is otherwise functional, the EGPWS reverts to providing basic GPWS functions (Modes 1 to 6 and Windshear). In this state, the EGPWS may give little or no advance warning time for flight into precipitous terrain where there are few or no preceding obstructions. This particularly applies if:
  - The aircraft is in the landing configuration,
  - The aircraft is in a stabilized descent at a normal approach descent rate,
  - There is no ILS GLideslope signal being received by the EGPWS (not tuned, not available,

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or inoperative)

- Terrain clearance or descent rates that are not compatible with required minimum regulatory standards for Ground Proximity Warning equipment may cause unwanted alters.
- If enabled, the EGPWS uses onboard measurement of air mass parameters and aircraft acceleration for detection of windshear. This is a reactive system and cannot predict windshear, which may be ahead of the aircraft.
- The EGPWS terrain/obstacle database includes cataloged human-made obstructions 100 feet high or greater within North America and portions of the Caribbean (expanding). The database is not all-inclusive and newer, smaller, or unknown obstructions could be encountered.

Refer to an appropriate AFM or EGPWS AFMS for specific system limitations and procedures.

## System Activation

The EGPWS is fully active when the following systems are powered and functioning normally:

- EGPWS
- Radio Altimeter
- Air Data
- ILS or Glideslope Receiver
- IRS, AHRS, VG (attitude)
- GPS, FMS, or IRS (position)
- Landing gear
- Landing flaps
- Stall warning or AOA (windshear only)
- Weather Radar, EFIS, or a dedicated terrain display (if terrain/obstacle display enabled)

In the event that required data for a particular function is not available, then that function is automatically inhibited and annunciated (e.g. if position data is not available or determined unacceptable,

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TAD and TCF is inhibited, any active terrain display is removed, and “TERR INOP”, “TERR UNAVAIL” (or equivalent) is indicated).

Some installations utilize redundant systems so that if the primary source of data fails, the EGPWS continues on the secondary source.

EGPWS status annunciations are provided for GPWS inoperative (mode 1-6 functions), Terrain inoperative (TAD/TCF functions), and windshear inoperative.

Refer to an appropriate AFM or EGPWS AFMS for specific system and status requirements.

## EGPWS Self-Test

The EGPWS provides a Self-Test capability for verifying and indicating intended functions. This Self-Test capability consists of six levels to aid in testing and troubleshooting the EGPWS. These six levels are:

Level 1 – **Go / No Go Test** provides an overview of the current operational functions and an indication of their status.

Level 2 – **Current Faults** provides a list of the internal and external faults currently detected by the EGPWC.

Level 3 – **EGPWS Configuration** indicates the current configuration by listing the EGPWS hardware, software, databases, and program pin inputs detected by the EGPWC.

Level 4 - **Fault History** provides an historical record of the internal and external faults detected by the EGPWC.

Level 5 - **Warning History** provides an historical record of the alerts given by the EGPWS.

Level 6 - **Discrete Test** provides audible indication of any change to a discrete input state.

A level 1 Go/No Go Test is normally performed by flight crews as part of preflight checks. All levels are typically used for installation checkout and maintenance operations.



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A level 1 Test is used to verify proper operation of the EGPWS on the ground as follows:

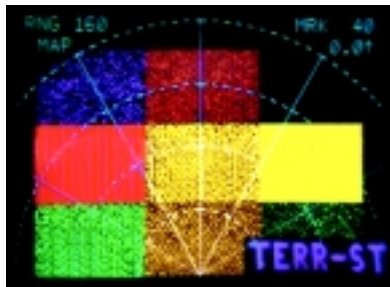
1. Ensure that adequate aircraft power is available and the EGPWS and associated systems are powered.
2. Ensure that any EGPWS inhibiting switches are in the normal (non-inhibiting) position.
3. Verify that EGPWS inoperative annunciations are extinguished. If an inoperative annunciation is indicated, perform the following EGPWS Self-Test (below) and then seek corrective action if the inoperative condition persists.
4. If a terrain display is enabled, select terrain to be displayed.
5. Momentarily depress the EGPWS Self-Test switch.

When a Self-Test is initiated, the EGPWC first checks for any configuration (installation or database) errors. If any are detected it is audibly enunciated and the test is terminated. If none detected, the test continues through a sequence resulting in turning on and off all system annunciators, enunciating specific audio messages, and if enabled, displaying a video test pattern on the terrain display (see illustration below). Any functions determined inoperative are also enunciated (e.g., “GLIDESLOPE INOP”). The Self-Test terminates automatically at its conclusion.

The following is a description of the expected results of a typical level 1 Self-Test. Actual annunciation nomenclature and sequence may differ depending on the installation.

- GPWS INOP, W/S INOP, and TERR INOP annunciators turn on.
- Amber caution (“BELOW G/S” or “GPWS”) annunciators turn on.
- “GLIDESLOPE” is announced over speaker.
- Amber annunciators turn off.
- G/S CANCEL annunciators turn on (if installed).

- G/S CANCEL annunciators turn off.
- Red warning (“PULL UP” or “GPWS”) annunciators turn on.
- “PULL UP” is announced over speaker.
- Red warning annunciators turn off.
- Red Windshear warning annunciators turn on.
- (Siren) “WINDSHEAR, WINDSHEAR, WINDSHEAR” is announced over speaker.
- Red Windshear warning annunciators turn off.
- Amber Windshear caution annunciators turn on (if installed and enabled).
- Amber Windshear caution annunciators turn off.
- Red warning (“PULL UP” or “GPWS”) annunciators turn on.
- “TERRAIN, TERRAIN, PULL UP” is announced over speaker.
- Terrain test pattern is displayed (see below).



- Red warning annunciators turn off.
  - GPWS INOP, W/S INOP, and TERR INOP annunciators turn off.
  - Terrain test pattern is turned off.
6. Verify expected indications and enunciations during test, repeating as necessary noting any erroneous conditions.

A successful test is accomplished if all expected indications are observed and no inoperative functions or display anomalies are indicated or observed.

Normal  
Procedures

For more specific information, refer to an applicable AFM or EGPWS AFMS, or contact AlliedSignal.

The EGPWS provides visual and/or audio alerts for detected:

- potentially dangerous terrain conditions (modes 1 – 4, TCF, TAD),
- below glideslope conditions (mode 5),
- descent below predefined altitudes or excessive bank angle (mode 6),
- severe windshear conditions (mode 7)

These consist of warning, cautionary, and advisory alerts based on the detection alert threshold penetration. The following list identifies the various alerts by type and mode:

ALERT	WARN	CAUT.	ADV.
(SIREN) “WINDSHEAR (3x)”	7		
Any “PULL UP”	1,2,TA		
“CAUTION WINDSHEAR”		7	
“TERRAIN, TERRAIN”		2, TA	
“OBSTACLE, OBSTACLE”		TA	
“TERRAIN”		2	
“APPROACHING MINIMUMS”			6
“MINIMUMS”			6
“CAUTION TERRAIN”		TA	
“CAUTION OBSTACLE”		TA	
“TOO LOW TERRAIN”		4, TCF	
“TOO LOW GEAR or FLAPS”		4	
Altitude callouts			6
“SINK RATE”		1	
“DON’T SINK”		3	
“GLIDESLOPE”		5	
“BANK ANGLE”			6

**NOTE:** Visual and audio indications may vary and procedures provided are representative. Refer to an applicable AFM or EGPWS AFMS for specific implementation.

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Caution  
Alerts

Recommended response to EGPWS alerts are as follows:

1. Stop any descent and climb as necessary to eliminate the alert. Analyze all available instruments and information to determine best course of action.
2. Advise ATC of situation as necessary.

Warning  
Alerts

1. Aggressively position throttles for maximum rated thrust. Apply maximum available power as determined by emergency need. The pilot not flying (if applicable) should set power and ensure that TO/GA power and modes are set.
2. If engaged, disengage the autopilot and smoothly but aggressively increase pitch toward “stick shaker” or Pitch Limit Indicators (PLI) to obtain maximum climb performance.
3. Continue climbing until the warning is eliminated and safe flight is assured.
4. Advise ATC of situation.

**NOTE:** Only vertical maneuvering is recommended unless operating in visual conditions and/or pilot determines, based on all available information, that turning in addition to the climbing is the safest course of action. Follow established operating procedures.

**NOTE:** Navigation must not be based solely on the use of the Terrain Awareness and Alerting Display (TAD).

Glideslope  
Alerts

Below Glideslope alerts consist of “soft” and “hard” alerts based on the degree of glideslope deviation and altitude. Respond to these alerts as necessary to correct the aircraft’s flightpath back to the Glideslope centerline or perform a missed approach.

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Advisory  
Callouts

Advisory callouts being advisory in nature are used to announce an event or condition (e.g., “Minimums”). Response to these callouts should be in accordance with standard operating procedures.

Windshear  
Caution

This alert generally occurs due to increasing performance windshearing conditions (i.e., increasing headwind, decreasing tailwind, and/or updraft). This alert is generally considered advisory in that the crew response is to be alert to the possibility of subsequent significant airspeed loss and down draft conditions. Coupled with other weather factors, the Windshear Caution should be considered in determining the advisability of performing a go-around.

Wind and gust allowances should be added to the approach speed, increasing thrust if necessary. It may be necessary to disengage autopilot or auto-throttle. Avoid getting low on the approach glidepath or reducing the throttles to idle.

Windshear  
Warning

When a Windshear warning occurs, the following procedures should be followed:

1. Immediately initiate the Windshear escape maneuver in accordance with established Windshear procedures.
2. Aggressively apply maximum rated thrust, disengage autopilot and/or auto-throttle if necessary.
3. Rotate smoothly to the go-around/take-off pitch attitude, allowing airspeed to decrease if necessary. Maintain wings level. Do not retract flaps or landing gear.
4. If the aircraft continues to descend, increase pitch attitude smoothly and in small increments, bleeding air speed as necessary to stop descent. Use Stall Warning onset (stick shaker) as the upper limit of pitch attitude.
5. Maintain escape attitude and thrust and delay retracting flaps or landing gear until safe climb-out is assured.

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**NOTE:** Engine overboost should be avoided unless the airplane continues to descend and airplane safety is in doubt. If overboost is required, adjust throttles back to maximum rated thrust as soon as safety has been assured.

Overboosting engines while at high angle of attack near airplane stall may cause engine stall, surge, or flameout.

Maintain escape attitude and thrust and delay retracting flaps or landing gear until safe climb-out is assured.

Abnormal  
Procedures

Partial system deactivation or compensation can be accomplished for abnormal procedures as follows:

Mode 1  
Excessive  
Descent  
Rates

If steep approaches are to be performed (4 or greater) EGPWS STEEP APPROACH should be enabled and selected for these operations. This may be accomplished automatically by on-board systems or manually selected by a cockpit switch. When active, Mode 1 alerts are desensitized to compensate for normally higher descent rates for these types of operation, eliminating related unwanted alerts. If implemented with a cockpit switch, this requires manual deactivation.

Mode 2  
Excessive  
Closure to  
Terrain

When required to operate in close proximity to terrain (less than 2500' above), Mode 2 alerts can be desensitized or overridden by activating the FLAP OVER-RIDE switch to eliminate related unwanted alerts. This requires manual deactivation.

Mode 4  
Unsafe  
Terrain  
Clearance

Mode 4 alerts can be reduced by activation of the FLAP OVER-RIDE switch. This is generally recommended when performing approaches with less than landing flaps selected. This requires manual deactivation.

Mode 5  
Descent  
Below  
Glideslope

Mode 5 Glideslope alerts can be manually canceled when below 2000 feet Radio Altitude (Standard G/S Cancel) by pressing the G/S Cancel switch (commonly part of the amber caution annunciators

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“BELOW G/S” or “GPWS”). This is typically selected when an unreliable Glideslope is expected or when maneuvering is required during ILS final approach. The G/S Cancel is automatically reset following landing or if the aircraft climbs above the 2000 feet.

In some cases, an Alternate G/S Cancel is available. This allows the Mode 5 alerting to be canceled at any time and any altitude. In this configuration, which is defined only for certain aircraft types or by program pin, pressing the G/S Cancel switch in the cockpit has the effect of inhibiting Mode 5 alerting. It can be manually reset by again pressing the G/S Cancel switch, or it is automatically reset following landing, if flap or gear state changes (i.e., down to up), or when the aircraft climbs above a predetermined altitude (defined for the aircraft type).

Because of the nature of this type of G/S Cancel, a cockpit indication of its activation is required.

Some aircraft may be configured with a G/S inhibit switch. This switch is separate from the one discussed above but also results in inhibiting Mode 5 alerting. This switch is intended for selection during back course approaches to eliminate unwanted alerts that may result. If a discrete back course signal is available from another system, this input to the EGPWC may be connected to that system for automatic Mode 5 inhibiting.

**NOTE:** Implementation of the Glideslope Cancel and/or Inhibit inputs to the EGPWS varies. Verify a particular application to determine the implementation used.

Terrain  
Alerting and  
Clearance  
Floor

Pressing the Terrain Inhibit switch inhibits TAD and TCF alerting and display, including Obstacles and Peaks when enabled. This is used when position accuracy is inadequate or when operating at airports not in the terrain database. Selection of Terrain Inhibit does not cause the Terrain Inoperative

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Emergency  
Procedures

annunciation unless the aircraft is wired for this to occur. Terrain Inhibit requires manual deactivation.

The EGPWS Flap or Gear Over-ride, TAD/TCF Inhibit, or other switches (as installed) may be used as required for an emergency situation (e.g., landing gear up).

For additional information refer to an applicable AFM or EGPWS AFMS or contact AlliedSignal.



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## SECTION 4

Definitions      Acronyms shall be interpreted as shown:

AFM	Airplane FLight Manual
AFMS	Airplane Flight Manual Supplement
AGL	Above Ground Level
AHRS	Attitude/Heading Reference System
AOA	Angle of Attack
ATC	Air Traffic Control
BIT	Built In Test
CFIT	Controlled Flight into Terrain
dB	Decibels
DH	Decision Height
EFIS	Electronic Flight Instrument System
EGPWC/S	Enhanced Ground Proximity Warning Computer/Systems
FAA	Federal Aviation Administration
FMS	Flight Management System
FPM	Feet Per Minute
F/W	Fail Warning
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
G/S	Glideslope
HDOP	Horizontal Dilution of Precision
HFOM	Horizontal Figure of Merit
HIL	Horizontal Integrity Limit
Hz	Hertz (cps)
ICD	Interface Control Document
ILS	Instrument Landing System
INOP	Inoperative
IRS	Inertial Reference System
IVS	Inertial Vertical Speed
MCP	Mode Control Panel
MCU	Modular Concept Unit
MFD	Multi Function Display
MLS	Microwave Landing System
MSL	Mean Sea Level
MTC	Minimum Terrain Clearance

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PCMCIA	Personal Computer Memory Card Industry Association
PLI	Pitch Limit Indicator
PPI	Plan Position Indicator
PWS	Predictive Windshear System
QFE	Corrected Baro. Altitude Relative To Field Elevation
RAIM	Receiver Autonomous Integrity Monitoring
SAT	Static Air Temperature
TA	Terrain Awareness
TAD	Terrain Alerting and Display
TCAS	Traffic Collision Avoidance System
TCF	Terrain Clearance Floor
TERR	Terrain
TO/GA	Takeoff/Go-Around
VDOP	Vertical Dilution of Precision
VFOM	Vertical Figure of Merit
VFR	Visual Flight Rules
VG	Vertical Gyro
VHF	Very High Frequency
WS	Windshear

Please detach and send back to AlliedSignal

Dear AlliedSignal EGPWS Customer:

This form is a request for information that will allow AlliedSignal to notify you of future updates to your Enhanced Ground Proximity Warning System. Please complete the information below and fax the information sheet to **AlliedSignal at 425-885-8722** or return via U.S. mail to:

AlliedSignal Aerospace  
Attn: Sandra Slick  
Mail Stop 40, Dept. 134  
P.O. Box 97001  
Redmond, WA 98073-9701

### Customer Information:

Customer Contact: \_\_\_\_\_

Company Name: \_\_\_\_\_

Shipping Address: \_\_\_\_\_  
\_\_\_\_\_

Phone Number: \_\_\_\_\_

Fax Number: \_\_\_\_\_

E-mail Address: \_\_\_\_\_

### Aircraft Information:

Aircraft Model \_\_\_\_\_

EGPWS Part Number \_\_\_\_\_ EGPWS Serial # \_\_\_\_\_

Aircraft Model \_\_\_\_\_

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**AlliedSignal Inc.**  
**Air Transport Avionics**  
15001 N.E. 36th Street • P.O. Box 97001  
Redmond, Washington USA 98073-9701  
GPWS Hotline: 1-800-813-2099  
Telephone: (425) 885-3711  
FAX: (425) 885-2061  
[www.agpws.com](http://www.agpws.com)

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**AlliedSignal Inc.**  
**General Aviation Avionics**  
400 North Rogers Road  
Clatha, KS USA 66062-1212  
Telephone: (913) 768-3000  
FAX: (913)-791-1302

006-08896-0002