



## **MK XXII** Helicopter–Enhanced Ground Proximity Warning System Pilot's Guide

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**INTRODUCTION** The MK XXII Helicopter Enhanced Ground Proximity Warning System brings state-of-the-art technology in Terrain Display, Situational Awareness, Terrain, and Obstacle Warning and Advisory Callouts to the Rotorcraft Pilot. The MK XXII is lightweight, compact and rugged computer that is easily installed in modern Helicopters.

Based on 30 years experience in the development and advancement of Ground Proximity Warning Systems for Air Transport, Regional and Commuter Airlines, Military aircraft and Corporate Aviation, Honeywell brings this vital safety technology to all segments of helicopter operations. Using our proprietary world-wide terrain database, obstacle database, runway/helipad database, state-of-the-art GPS technology, and proven Terrain Display with Alerting and Warning functions, the MK XXII provides the Helicopter Pilot with superior *Situational Awareness* with respect to terrain and known obstacles. In addition, the MK XXII contains the most advanced alerting and warning functionality to warn the pilot of danger with respect to terrain, man-made obstacles and other primary scenarios associated with the dangers of Controlled Flight Into Terrain (CFIT).

**This Pilot's Guide outlines the basic requirements for system operation and recommended procedures for use of the MK XXII by the Helicopter Pilot. This Guide does NOT supersede FAA Approved Data or FAA Flight Manual Supplements, or FAA Required Procedures. Each pilot should be thoroughly familiar with his or her aircraft, its systems, and FAA and/or company requirements for that aircraft as equipped with the MK XXII Helicopter Enhanced Ground Proximity Warning System.**



MK XXII COMPUTER

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**WHAT IS THE  
HELICOPTER-  
ENHANCED  
GROUND  
PROXIMITY  
WARNING  
SYSTEM?**

The Honeywell MK XXII is a small lightweight computer that can be installed in most modern turbine helicopters in which a Terrain Avoidance & Warning System is applicable.

The MK XXII computer is compact and rugged, and can be mounted in any orientation to meet the requirements of the aircraft and space limitations.

The MK XXII uses information from an existing GPS (already in the aircraft) or internal GPS receiver contained in the MK XXII computer. The MK XXII receives inputs from several sources in the aircraft. They include the following:

Radio Altitude and DH	Engine Torque	Magnetic Heading
Roll and Pitch Attitude	Airspeed	GPS Position
Baro. Altitude and V/S	OAT	Weight on Wheels
Ground Speed and Track	GPS Signal Quality	Display Range
Localizer and Glideslope	Gear Position	GPS Altitude

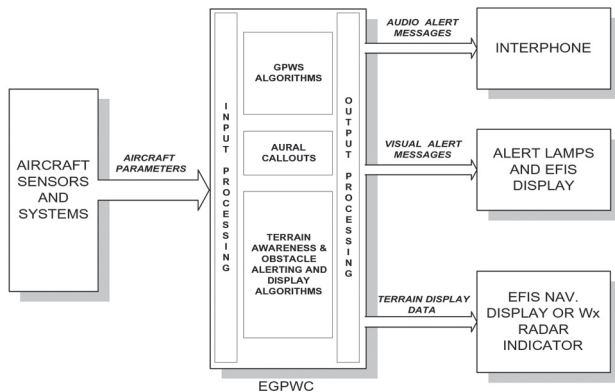
These may differ depending on aircraft and installation.

The terrain database, obstacle database and alerting / warning functionality are contained in the MK XXII computer.

Outputs generated by the MK XXII are:

- Terrain / Obstacle Display
- Voice Alerts / Warnings / Callouts
- Visual Cautions / Warnings

Several operational features of the MK XXII are optional and selectable by the customer at the time of initial installation. Refer to your Aircraft flight Manual Supplement for detailed information.



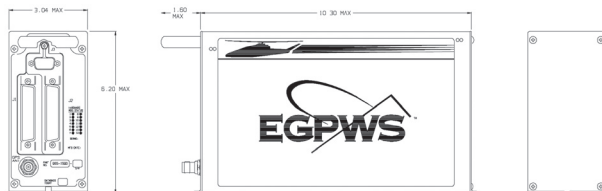
**MK XXII  
HELICOPTER  
ENHANCED  
GROUND  
PROXIMITY  
WARNING  
SYSTEM**

During normal flight operations, the MK XXII remains essentially silent. Using GPS, Radio and Barometric Altitude, Airspeed, Altitude Rate, Pitch and Roll Attitude, Magnetic Heading and Temperature data in combination with its various database information the MK XXII provides the pilot with a display of the aircraft position relative to surrounding terrain and known obstacles, thereby providing unprecedented *Situational Awareness* for the pilot. Pilot workload in interacting with the system during normal flight is minimal.

Should the aircraft fly into danger where a conflict with terrain or a known obstacle is imminent, the MK XXII will provide a combination of annunciator lights, color display and aural alerts to the pilot. The MK XXII also provides alerts and warnings for excessive rates of decent, bank angle and inadvertent descents or altitude loss after take-off. The MK XXII also warns against descending below the glideslope on an ILS and against high pitch attitudes near the ground for tail strike.

Pilot reactions to alerts, warnings and advisories differ according to weather conditions, visibility, and type of alert, phase of flight and aircraft performance considerations. Pilots should be thoroughly familiar with FAA, company, or other approved operational procedures as required by their aircraft and type of operation. Pilots should train to react properly to MK XXII alerts and warnings just as one would train to react to any engine failure or any other emergency situation.

## PHYSICAL DESCRIPTION



MKXXII EGPWS  
WEIGHT = 3.9 LBS MAX

## MK XXII FUNCTIONS AND FEATURES

### AIRCRAFT POSITION

The MK XXII always knows where it is relative to the ground. It continually compares its GPS position to the terrain database.

The MK XXII uses the Global Positioning System (GPS) information from either an aircraft-installed GPS receiver, or an internal GPS receiver contained in the MK XXII computer itself. It is necessary for the pilot to be aware of the actual position source being used by the EGPWS, as the optional internal GPS is **not** used for navigation of the aircraft.

GPS signals arrive at an antenna on the aircraft and are then processed by the MK XXII computer to provide both horizontal (lateral) and vertical position (altitude) information. This position in space is then compared to the terrain and obstacle database information contained in the MK XXII computer to produce a “virtual” picture which can then be displayed to provide *Situational Awareness* for the pilot.

Information from GPS and other aircraft systems are used by the MK XXII to calculate track, ground speed, vertical velocity and signal accuracy. This provides a complete picture of not only the aircraft position in three dimensions, but also an excellent picture of the aircraft’s flight path and the health of the Enhanced Ground Proximity Warning System.

When the GPS view of the satellites is momentarily obstructed by terrain shadowing or when in a turn, the EGPWS will go into a dead reckoning mode for up to 60 seconds. If the satellite shadowing lasts longer than 60 seconds the “Terrain INOP” light will be illuminated and the “Be Alert Terrain INOP” voice message given.

This total package of information is used to provide Terrain Displays for the pilots, and to provide alerting and warning functionality which protects the pilot and passengers from possible conflicts with terrain, known obstacles, and other scenarios associated with the dangers of Controlled Flight Into Terrain (CFIT).



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**AIRCRAFT  
ALTITUDE**

The MK XXII uses barometric pressure, Radio Altitude and a special GPS “derived-altitude” developed by Honeywell called “*Geometric Altitude.*” It provides more accurate altitude information, which is using the same Mean Sea Level (MSL) reference as the terrain, obstacle and runway/helipad databases in the system. The blending functionality of “Geometric Altitude” means it is much less susceptible to errors induced by the pilot, cold temperature or malfunctions in altimeter systems. (The pilot is NOT required to enter an altimeter setting specifically for the MK XXII system).

Where aircraft are routinely operated in extreme temperature conditions (either hot or cold), the blending formula of “Geometric Altitude” provides an even more accurate vertical position to the MK XXII. This prevents serious discrepancies between actual altitude and “Geometric Altitude” under extreme temperature conditions, especially during rapid climbing or descending flight profiles.

**SIGNAL  
QUALITY**

The MK XXII computer continually monitors the information it receives for reasonability and assigns these inputs a quality value. This value is used to modify the caution and warning Look-Ahead envelope.

**SOFTWARE  
AND  
DATABASE  
LOADING**

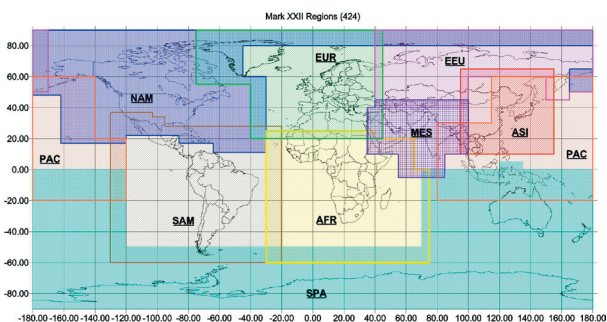
Software and the Terrain and Obstacle Databases are loaded from a PCMCIA card with the Smart Cable Loader. This is a lightweight unit that does not require any external power. Separate cards are available for Software and database updates. The Database card contains all the terrain data and known obstacles data (where available) used by the MK XXII. Instructions for update procedures of the Database card are discussed later in this guide.



SMART CABLE, PART NUMBER 951-0386-001

## TERRAIN, OBSTACLES & RUNWAY DATABASE

Terrain data is supplied from the same proprietary database used by other Honeywell EGPWS products, and is divided into nine overlapping regions that cover the world. (See picture below). The terrain data is divided into grid patterns of various sizes, from areas about 600 feet square resolution to areas of about 5 NM square. This allows a large area of data to be stored in the unit, and allows high-resolution for areas where the more accurate where the data is available. For a current description of the high-resolution Database coverage contact the Honeywell Database department through the Internet web site at <http://www.egpws.com>.



Data for known obstacles such as towers, buildings, antennas, etc. are contained on the same data card as the terrain and airport data. Presently, obstacles are included for North America (NAM), parts of Europe (EUR), portions of the South Pacific (SPA), portions of the Pacific (PAC) and portions of the Middle East (MES) regions. As more reliable information becomes available, Honeywell will expand the capability to provide alerting and warning for obstacles in other areas of the world.

Obstacles in the database are those known man made obstructions more than 100 feet AGL, so obstacles of lower height will not produce MK XXII "Obstacle" alerts or warnings. They may actually produce a "Terrain" alert. The Terrain and Obstacle database information should be accurate to within 25 feet.

### CAUTION

**Wires are not presently included in the MK XXII database.**

As the data becomes available, Honeywell will be adding power lines to the Obstacle Database. Operators with access to Power Line data or with unique obstacles within their operational area should contact the Honeywell Database department through the Internet web site at <http://www.egpws.com>.

**COCKPIT  
CAUTION  
AND  
WARNING  
LIGHTS**

Runway information in the MK XXII computer contains all known public runways with a published IAP. This data is used to adjust the alerting and warning functions of the MK XXII so as to provide a dynamic system that is essentially free of nuisance or unwanted warnings. For a complete list of airports included in the database, please visit our <http://www.egpws.com/database> website.

An Amber Caution and a Red Warning light is provided near the center of each pilots field of view. In some cases a single set of lights is mounted near the center of the Glareshield. Two lamp formats are selectable at installation time, however Lamp Format 2 is the preferred format and is what is used throughout this manual. Both formats are shown in the table below. Light nomenclature will vary. In my aircraft the nomenclature is:

Amber Caution Light \_\_\_\_\_

Red Warning Light \_\_\_\_\_

<b>Mode/Aural Message</b>	<b>Format 1</b>	<b>Format 2</b>
Mode 1 "Sink Rate"	Warning	Caution
Mode 1 "Pull Up"	Warning	Warning
Mode 2 "Terrain Terrain"	Warning	Caution
Mode 2 "Pull Up"	Warning	Warning
Mode 3 "Don't Sink"	Warning	Caution
Mode 4 "Too Low Terrain"	Warning	Caution
Mode 4 "Too Low Gear"	Warning	Caution
Mode 5 hard and soft "Glideslope"	Caution	Caution
Mode 6 Callouts	None	None
Mode 6 "Bank Angle"	None	None
Mode 6 "Tail Too Low"	None	None
Terrain "Caution Terrain"	Warning	Caution
Terrain "Warning Terrain"	Warning	Warning
Obstacle "Caution Obstacle"	Warning	Caution
Obstacle "Warning Obstacle"	Warning	Warning

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## COCKPIT SWITCHES

### TERRAIN INHIBIT SWITCH

The MK XXII requires the installation of a “**Terrain Inhibit**” switch. When engaged by the pilot, this switch will inhibit the Terrain and Obstacle alerts and warnings, however the Terrain Display will remain operational. The purpose of the “**Terrain Inhibit**” switch is to allow aircraft to operate in VFR conditions in areas that are close to high terrain and or in metropolitan areas of high rise buildings. The “**Terrain Inhibit**” switch should be **NOT engaged** for most normal operations. If you find that you need to use this switch during your normal operations please contact Honeywell at <http://www.egpws.com> or product support **(800) 813-2099**. A “**Timed Audio Inhibit**” Switch may be used as an alternative to this switch.

### TIMED AUDIO INHIBIT SWITCH

As an alternative to the Terrain Inhibit switch an “**Audio Inhibit**” switch can be installed. This momentary activated switch allows the pilot to turn off all MK XXII audio warnings for 5 minutes. Resetting the switch will also restore the audio immediately. The Audio Inhibit switch is intended for EMS and SAR operations where the aircraft may be operating very close to terrain. Under normal operations this switch **should never be needed**. The visual warnings are not inhibited. If you find that you need to use this switch during your normal operations please contact Honeywell at <http://www.egpws.com> or product support **(800) 813-2099**.

### LOW ALTITUDE SWITCH

To allow for helicopter operations that require low altitude flight a “**Low Altitude**” function is enabled with a switch. This function is designed for flight at low altitude in VFR conditions. When this function is engaged

- Mode 1 is inhibited
- Mode 2 warning boundaries are significantly reduced
- Mode 3 warnings are inhibited above 100 feet AGL
- Mode 4 warning boundaries are significantly reduced
- Mode 6 “**Altitude Altitude**” callout enabled
- Terrain Advisory look ahead distances are reduced.

Low Altitude operation is defined as operation below 500 feet AGL. There are other circumstances where the use of the Low Altitude Mode is appropriate. Those include operation in a high-density metropolitan environment with high rise buildings, operation below 1250 feet AGL when the GPS is not operational or is providing poor accuracy. Also airport maneuvering where airspeeds exceed 50 knots and some IFR Offshore Platform approach procedures.

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**LOW  
ALTITUDE  
SWITCH**  
CONTINUED

**CAUTION**

**The pilot must maintain visual contact with all terrain and obstacles at all times when using the Low Altitude mode. The Low Altitude mode must not be engaged during IFR conditions. The “look down” angle is reduced with “Low Altitude” engaged. Warning time is greatly reduced. Noted exception is Offshore Platform IFR approaches.**

**GLIDESLOPE  
CANCEL  
SWITCH**

If an active ILS is being received, the MK XXII will monitor the aircraft position relative to the glideslope and give the pilot an aural and visual warning if the aircraft descends more than 1.3 dots below the center of the beam. If the pilot is going to intentionally descend below the glideslope, the “**Glideslope Cancel**” switch may be used to prevent unnecessary warnings.

The Glideslope warning will rearm when the aircraft climbs above 2000 feet radio altitude, descends below 50 feet or the pilots tunes a frequency other than the active ILS.

**TERRAIN  
AWARENESS  
DISPLAY**

The MK XXII can be interfaced with Weather Radar, EFIS or Multifunction displays. Graphical display of MK XXII terrain and obstacle data is the most important enhancement to *Situational Awareness*. This is especially true for helicopters. In addition to showing terrain ahead of the aircraft, (depending on configuration settings and display types) the MK XXII shows MSL altitude, range in NM, and the elevations of the highest and lowest terrain features shown on the display. Normally, the top of the display is oriented to true heading. When true heading is not available, the display will orient to true track. The color and intensity of the terrain displayed instantly alerts the pilot to areas of dangerous terrain and conversely to areas of less precipitous terrain. (Refer to the MK XXII System Installation Manual for a list of supported displays). Range of the Terrain Display is selectable by the pilot from 2.5 NM to 160 NM, again depending upon the display type installed in the aircraft.

**AUTO RANGE**

If an alert occurs and the range is not already set at 5 NM, the MK XXII will automatically change the range to 5 NM or 10 NM, as determined by configuration settings at time of installation. If the Low Altitude Mode is selected the range will be set to 2.5 NM (or 5 NM or 10 NM). This feature is referred to as “**Auto Range**” and is not supported by all displays.

If the displays do not support “Auto Range”, the pilot should set the range to 2.5 NM when in the “Low Altitude Mode”.

## POPUP MODE

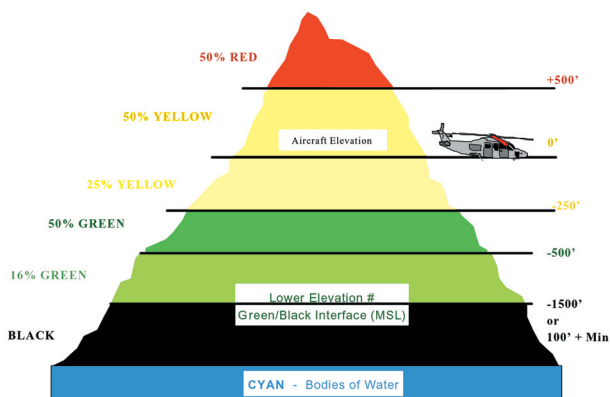
If the primary MK XXII display is being used for something else, i.e. radar, when an alert is triggered the display will automatically “Popup” and switch to the MK XXII Terrain display. This feature is referred to as “Auto Popup” and is not supported by all displays.

If the displays do not support “Auto Popup”, the audio warnings and annunciator lights will still function normally.

## DISPLAY COLORS

The MK XXII will adjust colors on the Terrain Display automatically as the aircraft altitude changes. The Terrain Display also transitions between the lower altitude “relative” display and the higher altitude “peaks” display automatically, so no pilot action is required.

The figure below shows the Terrain Display color patterns when the aircraft is at lower altitudes. These colors will vary slightly depending on the type of display.



The most important function of the MK XXII is to provide the pilot with easily interpreted information about terrain/obstacles relative to the aircraft, and thus increase the pilot's *Situational Awareness*.

**DISPLAY  
COLORS**

CONTINUED

In brief, when using the Terrain Display during flight, the normal presentation of green, yellow and red colors indicate:

<b>GREEN</b> colors	Terrain/Obstacles are below the aircraft altitude. Safe terrain/obstacle clearance is indicated.
<b>YELLOW</b> colors	Terrain is very near or above the aircraft altitude. <b>THE AIRCRAFT MAY NOT HAVE SAFE TERRAIN CLEARANCE.</b>
<b>RED</b> color	Terrain is well above the aircraft altitude ( <i>at least 500 feet higher</i> ) <b>THE AIRCRAFT DOES NOT HAVE SAFE TERRAIN CLEARANCE. THE AIRCRAFT MAY NOT BE ABLE TO ESCAPE THIS TERRAIN.</b>

**PEAKS MODE**

This refers to the style of the terrain display when the aircraft is more than 250 feet above all terrain in the display area. It is a combination of up to three green shades that allows the pilot to see where terrain features are, such as valleys and mountain tops, that are below the aircraft.

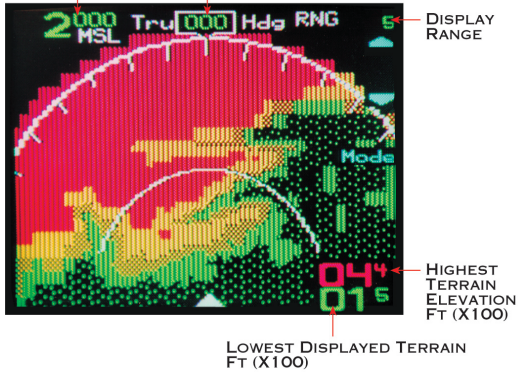
The chart below outlines all the various colors used by the MK XXII Terrain Display and their function in providing *Situational Awareness* to the pilot. Some display types may not support all colors listed, or may display colors in slightly different densities than those listed, but the MK XXII is designed to present the most appropriate Terrain Display capable on the various display types which are usable by the system.

<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 500 feet above aircraft altitude.
50% Yellow Dots	Terrain/Obstacle that is between aircraft altitude and 500 feet above.
25% Yellow Dots	Terrain/Obstacle that is between aircraft altitude and 250 feet below.
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 250 feet of aircraft altitude.
50% Green Dots (Peaks only)	Terrain/Obstacle that is 250 feet below to 500 below aircraft altitude. 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 (Peaks only)	Terrain/Obstacle that is 500 to 1500 feet below aircraft altitude. 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	Area having sea level elevation (0 feet MSL).
Magenta Dots	Unknown terrain. No terrain data in the database for the magenta area shown.

The two displays below represent typical examples of mountainous terrain and peaks mode.

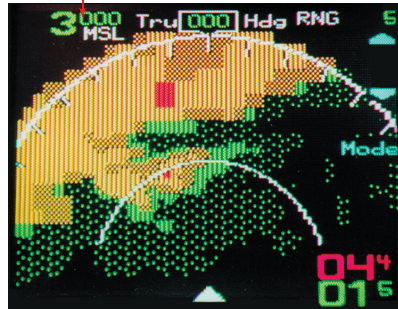
MK XXII TERRAIN DISPLAY AT 2,000 FEET MSL APPROACHING A RIDGE 20 NM SOUTH OF ASHEVILLE, NC

AIRCRAFT ALTITUDE HEADING



SAME AS ABOVE AT 3,000 FEET MSL. NOTE OBSTACLES (TOWERS) IN RED.

AIRCRAFT ALTITUDE



On some terrain displays, an indication of MSL or GSL (Geodetic Sea Level) altitude will appear. This altitude is the reference altitude for the display and the terrain awareness algorithm. This reference altitude is based on internally calculated Geometric Altitude (*see page 9*) and NOT corrected barometric altitude. It represents the aircraft's calculated true height above sea level (MSL) and serves as the reference altitude for color coding of the terrain display (*see above*) and the altitude input to the look-ahead algorithm. Because it is primarily comprised of GPS altitude, this reference altitude will often differ from cockpit displayed corrected barometric altitude. This altitude is not to be used for navigation. It is presented to provide the crew with additional situational awareness of true height above sea level, upon which terrain alerting and display is based.

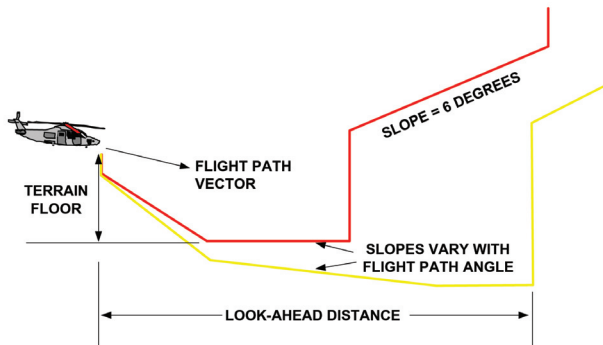


**CELL  
EXPANSION**

When flying with the range set at greater than 10 NM it can be difficult using the display to determine where a nearby threat may be relative to the aircraft. This is due to the size of the threat vs. the amount of terrain displayed. To relieve this problem the MK XXII will increase the size of the grids that contain an obstacle or terrain threat. This feature is called “Cell Expansion”. Cell Expansion is not used when the display range is less than or equal to 10 NM.

**“LOOK-AHEAD”  
ALERTING  
AND  
WARNING**

Using aircraft position, altitude and flight path information, the MK XXII provides an envelope of protection for the aircraft that is independent from the Terrain Awareness Display. This “Look-Ahead” function compares the aircraft flight path to terrain and obstacle database information, and distance to known runways. The illustration below is a general representation of the “Look-Ahead” functionality.



**NORMAL OPERATION LOOK AHEAD = 1.1 NM AT 120 KTS**

**LOW ALTITUDE LOOK AHEAD = 0.75 NM AT 120 KTS**

**–CAUTION–**

**FLIGHT PATH ANGLE LOOK DOWN IS REDUCED IN  
THE LOW ALTITUDE MODE**

When the “Look-Ahead” function detects a terrain or obstacle threat approximately 30 seconds ahead of the aircraft, the voice alert “**Caution Terrain, Caution Terrain**” (or “**Caution Obstacle, Caution Obstacle**”) is given, and a bright, solid yellow “*threat area*” is shown on the Terrain Display. Should the aircraft flight path continue toward the *threat area*, the alert message would repeat approximately every 7 seconds.

“LOOK-  
AHEAD”  
ALERTING  
AND  
WARNING  
CONTINUED

If the aircraft flight path approaches to within approximately 20 seconds of a *threat area*, the voice message “**Warning Terrain, Warning Terrain**” (or “**Warning Obstacle, Warning Obstacle**” will be given continuously and the *threat area* on the Terrain Display will be shown in a bright, solid red color.

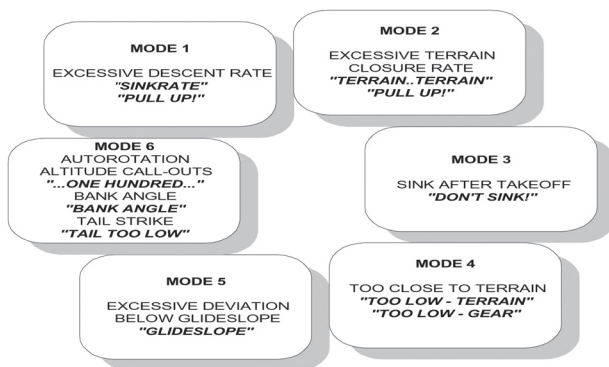
GPS signal quality, Low Altitude Mode and rate and direction of turn modify the Look-Ahead envelope. The MK XXII uses turn rate and direction to predict the aircraft flight path in the turn and “looks around the corner” for terrain/obstacles. Forward airspeed will also modify the look-ahead envelope. Below 100 knots, the envelope is reduced until it is completely inhibited at 70 knots or less. The preceding speeds are for “fast” helicopter configurations, “slow” configurations use the range 90 knots to 60 knots for envelope reduction.

TERRAIN  
FAILURE

Failure of the Terrain awareness functions will result in a “**TERRAIN INOP**” light and the aural message “**Be Alert Terrain INOP**” This can happen when GPS shadowing occurs during turns and/or flight in mountainous terrain.

NON-  
DATABASE  
MODES

The following diagram shows the six modes that provide a warning that is not associated with the map or the database.

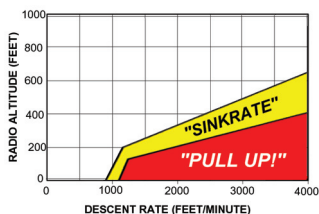


MODE 1 –  
EXCESSIVE  
RATE OF  
DESCENT  
ALERTING  
AND  
WARNING

The MK XXII uses altitude rate from the Air Data Computer and Radio Altitude to detect when the aircraft is descending toward terrain at a high rate for its relative altitude above terrain. The MK XXII will provide alerting and warning to the pilot.

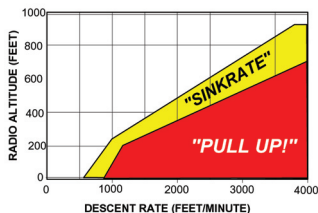
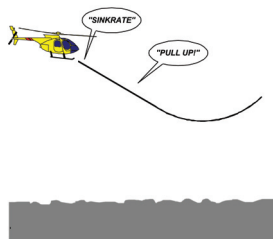
**MODE 1 –  
EXCESSIVE  
RATE OF  
DESCENT  
ALERTING AND  
WARNING  
CONTINUED**

The graph below represents the envelope of protection provided for Excessive Rate of Descent scenarios:



PN 965-1595-xxx

EXCESSIVE RATE OF DESCENT ALERTING AND WARNING - MODE 1



PN 965-1590-xxx

EXCESSIVE RATE OF DESCENT ALERTING AND WARNING - MODE 1

Initially, the voice alert **“Sink Rate”** will be heard, and the amber caution alert annunciator lamp will illuminate. If the aircraft continues in the high rate of descent, the **“Sink Rate-Sink Rate”** voice alert will be repeated at an increasing frequency.

Should the aircraft penetrate the warning boundary, the voice alert **“Pull Up”** will be heard continuously and the red warning annunciator lamp will illuminate.

In both cases, as the pilot reacts to decrease the high rate of descent and the aircraft flight path exits the alerting/warning envelope, the annunciator lamp will extinguish and the voice alerts will cease.

Sometimes, the alerting and warning functionality for excessive rate of descent may be overridden by the terrain “Look-Ahead” functionality. This is normal as the “Look-Ahead” function has a higher priority in the MK XXII alerting/warning logic. (See the Alerting/Warning Priority chart later in this guide.)

*Mode 1 is inhibited if no Engine Torque input is configured at time of installation. Mode 1 is also inhibited during a detected autorotation on aircraft with a torque input or when Low Altitude is selected. The Mode 1 voices are inhibited during a Timed Audio Inhibit.*

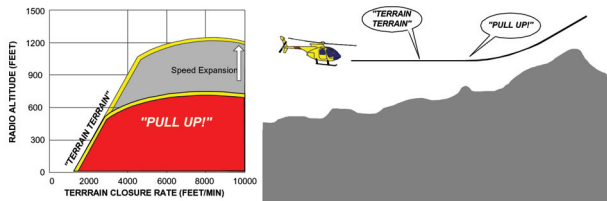
**MODE 2 -  
EXCESSIVE  
TERRAIN  
CLOSURE  
RATE**

Mode 2 provides alerts when the aircraft is closing with the terrain at an excessive rate. It is not necessary for the aircraft to be descending in order to produce a Mode 2 alert, level flight (or even a climb) towards obstructing terrain can result in hazardous terrain closure rate. The Terrain Closure Rate variable is computed within the EGPWS computer by combining Radio Altitude and Vertical Speed.

Mode 2 has two sub-modes, referred to as Mode 2A and Mode 2B, the active sub-mode being determined by aircraft configuration and airspeed.

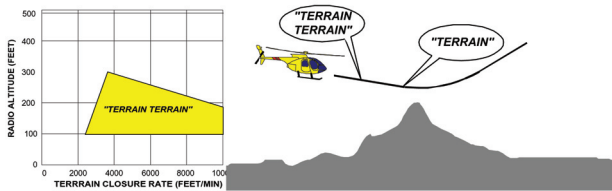
Mode 2 uses an integrity view, which indicates how well Terrain Awareness & Display, and Geometric Altitude functions are performing in conjunction with the terrain data integrity. When these conditions are satisfied Mode 2 functions are inhibited.

*Mode 2 is inhibited by the Low Altitude Mode and during an Autorotation. The Mode 2 voices are inhibited during a Timed Audio Inhibit.*



MODE 2A - EXCESSIVE TERRAIN CLOSURE RATE

Mode 2A is enabled when the conditions for enabling Mode 2B are not satisfied (see below). If the aircraft penetrates the Mode 2A alerting envelope, the aural message **“Terrain Terrain”** is generated initially, and the amber caution lights are illuminated. If the aircraft continues to penetrate the envelope, then the aural message **“Pull Up!”** is repeated continuously until the warning envelope is exited and the red warning lights are illuminated. As shown in above, the upper boundary of the Mode 2A alert envelope varies as a function of aircraft speed. As airspeed increases from typically 90 knots to 130 knots, the boundary expands to provide increased alert times at higher airspeeds. Expansion airspeeds are varied for some aircraft types.



MODE 2B - EXCESSIVE TERRAIN CLOSURE RATE

**MODE 2 -  
EXCESSIVE  
TERRAIN  
CLOSURE  
RATE**

CONTINUED

Mode 2B provides a “desensitized” alert envelope, permitting normal landing approach maneuvering close to the terrain without producing unwanted alerts. Mode 2B is enabled for three conditions:

- Whenever the Landing Gear is down or for fixed gear aircraft, when less than 80 knots and less than 200 ft. AGL.
- If the aircraft is performing an ILS approach and is within  $\pm 2$  dots of the Glideslope centerline.
- For the first 60 seconds after takeoff.

When the Mode 2B warning envelope is penetrated, the aural message “*Terrain...*” is repeated until the envelope is exited and the amber caution lights are illuminated.

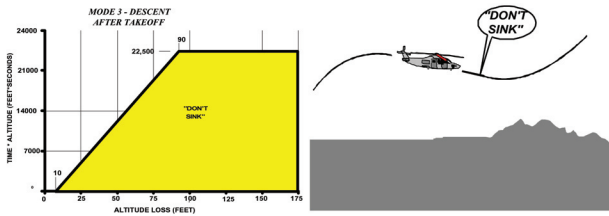
**MODE 3 -  
INADVERTENT  
DESCENT  
/ LOSS OF  
ALTITUDE  
AFTER  
TAKE-OFF**

Mode 3 provides alerts when the aircraft loses a significant amount of altitude immediately after takeoff or during a missed approach. Mode 3 is enabled after takeoff or go-around when landing gear is not in landing configuration, or when the air-speed is greater than 50 knots. The mode stays enabled until the EGPWS computer detects that the aircraft has gained sufficient altitude that it is no longer in the takeoff phase of flight which in normal conditions is about 60 seconds.

The Altitude Loss variable is based on the Altitude value from the time of the beginning of the inadvertent descent. The amount of altitude loss, which is permitted before an alert is given, is a function of the height of the aircraft above the terrain and the length of time since takeoff.

If the aircraft penetrates the Mode 3 boundary, the aural message “**Don’t Sink**” is generated, the amber caution lights are illuminated. The visual enunciators remain active until a positive rate of climb is re-established.

The graph below shows this alerting envelope:



INADVERTENT DESCENT / LOSS OF ALTITUDE AFTER TAKE-OFF – MODE 3

As the pilot adjusts the flight path of the aircraft and a positive rate of climb is re-established, the voice alert “**Don’t Sink**” will cease and the amber caution annunciator lamp will extinguish.

Note: To prevent nuisance “Don’t Sink” warnings while maneuvering around an airport where airspeeds may exceed 50 knots it is recommended that the **Low Altitude Mode** be selected.

*Mode 3 voices are inhibited while the Timed Audio Inhibit is active.*

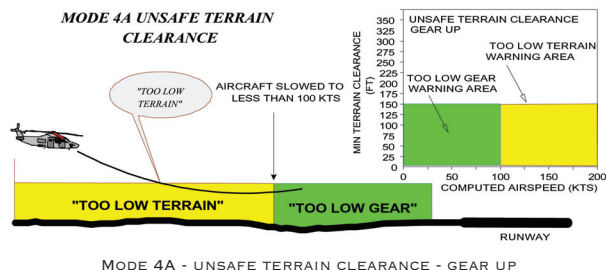
**MODE 4 -  
UNSAFE  
TERRAIN  
CLEARANCE**

Mode 4 provides alerts for insufficient terrain clearance with respect to phase of flight and airspeed. Mode 4 exists in three forms, 4A, 4B and 4C. Mode 4A is active during cruise and approach with the gear not in landing configuration. Mode 4B is also active in cruise and approach, but with the gear in landing configuration. Mode 4C is active during the takeoff phase of flight with the gear not in landing configuration. The amber caution light is illuminated during all Mode 4 warnings.

*Mode 4 voices are inhibited while the Timed Audio Inhibit is active.*

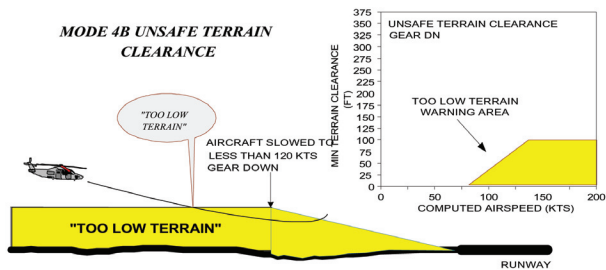
As shown in the figure below the standard boundary for Mode 4A is at 150 feet Radio Altitude. If the aircraft penetrates this boundary with the gear still up and less than 100 knots, the voice message will be **“Too Low Gear”**. Above 100 knots the voice message is **“Too Low Terrain”**.

For aircraft with a torque input, that can detect autorotation, during an Autorotation the gear warning boundary is raised to 400 feet AGL and the **“Too Low Terrain”** speed region is removed.



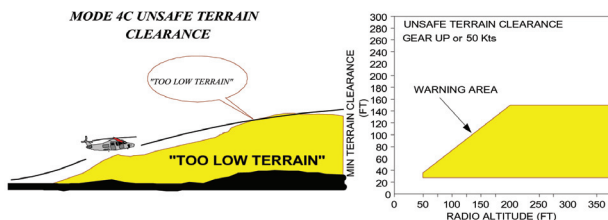
Fixed, non-retractable landing gear aircraft do not provide Mode 4A. When the landing gear is lowered, Mode 4B becomes active and the boundary decreases to 100 feet when above 120 knots (100 knots for fixed gear). As airspeed decreases below 120 knots (100 knots for fixed gear) the warning boundary decreases to 10 feet at 80 knots. The voice message is **“Too Low Terrain”**.

**MODE 4 -  
UNSAFE  
TERRAIN  
CLEARANCE  
CONTINUED**



MODE 4B - UNSAFE TERRAIN CLEARANCE - GEAR DOWN

Mode 4C is based on a minimum terrain clearance, or floor, that increases with Radio Altitude during takeoff. A value equal to 75% of the current Radio Altitude is accumulated in a long-term filter. Any decrease of Radio Altitude below the filter values with the gear up or airspeed greater than 50 knots will result in the warning “Too Low Terrain”. Mode 4C is illustrated in the figure below.



MODE 4C - UNSAFE TERRAIN CLEARANCE - AT TAKEOFF

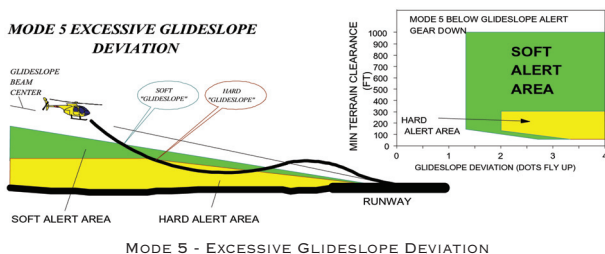
**MODE 5 -  
BELOW  
GLIDESLOPE**

Mode 5 provides two levels of alerting when the aircraft flight path descends below the Glideslope beam on front course ILS approaches with the gear down. The first alert activation occurs whenever the aircraft is more than 1.3 dots below the beam and is called a “soft” Glideslope alert. That is because the volume level of the “Glideslope” alert is approximately one half (-6 dB) that of the other alerts. On a normal approach where the aircraft is established on the glideslope prior to reaching 1000 feet AGL the upper warning boundary is 1000 feet AGL. However as long as the aircraft is in level flight the upper boundary is set at 500 feet AGL. The upper boundary will increase linearly to 1000 feet



**MODE 5 -  
BELOW  
GLIDESLOPE  
CONTINUED**

AGL as descent rate raises from 0 to 500 FPM or greater. This allows intercepting the Glideslope at less than 1000 feet AGL without getting nuisance warnings. A second alert boundary occurs below 300 feet Radio Altitude with greater than 2-dot deviation and is called “loud” or “hard” Glideslope alert because the volume level is increased to that of the other alerts. The amber Caution light is also illuminated during both soft and hard Glideslope alerts.



Mode 5 is enabled when all of the following are present: ILS selected with valid GS signal (flag not in view); valid Radio Altitude less than 1000 ft. AGL; Landing Gear Down (retractable gear helo only); Glideslope Cancel is off. The EGPWS computer must be sensing it is in the Approach Mode (not Takeoff) or the groundspeed is less than 40 kts. with the above conditions met.

In some installations the localizer signal is used to enable Envelope Modulation to prevent nuisance warnings at certain airports.

*The Glideslope voice is inhibited while the Timed Audio Inhibit is active.*

**MODE 6 –  
ALTITUDE  
CALL-OUTS**

Mode 6 provides aural callouts for descent below predefined altitudes and Minimums. No Caution or Warning lights are illuminated. The actual callouts are selected from a menu at installation time.

A “minimums-minimums” callout is provided based upon the decision height discrete with the landing gear down or less than 90 knots in fixed gear aircraft. When Low Altitude is selected or gear is up or greater than 90 knots in fixed gear aircraft the message “Altitude Altitude” is provided when transitioning below the selected decision height.

**MODE 6 –  
ALTITUDE  
CALL-OUTS**  
CONTINUED

An optional discrete input provides the ability to force the Mode 6 audio level to lower audio volume. This enables operators to control the Mode 6 volume level with activation of windscreen rain removal or if lower volume callouts are desired at all times.



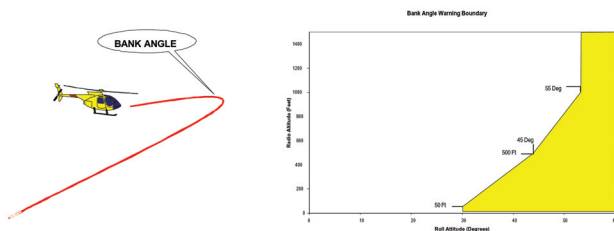
MODE 6 ALTITUDE CALLOUTS

ALTITUDE CALLOUTS SELECTED IN MY AIRCRAFT ARE:

- Minimums  Smart 500  200
- 100  50  40  30  20  10

**MODE 6 -  
EXCESSIVE  
BANK ANGLE**

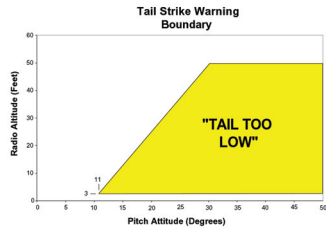
An excessive bank angle warning is provided based upon Radio Altitude, Roll Attitude and Roll Rate. The “**Bank Angle**” aural warning is given twice and then suppressed until the roll angle increases by an additional 20%.



EXCESSIVE BANK ANGLE

**MODE 6 –  
TAIL STRIKE**

A tail strike warning function is provided for applicable rotary wing aircraft based upon radio altitude, pitch attitude, pitch rate and barometric altitude rate. The voice message “**Tail Too Low**” is provided continuously while within the warning boundary. Unique warning boundaries are provided for applicable aircraft types. The typical warning boundary is shown below.



TAIL STRIKE – MODE 6

**GPWS  
FAILURE**

Failure of the Non Database modes will result in a “GPWS INOP” light.

**AUTO  
ROTATION**

The MK XXII uses engine torque sensing to detect an autorotation. Callouts during autorotation are selected via a menu. If the gear is not down by 400 feet the pilot will hear “**Too Low, Gear**”.

AUTO ROTATION CALLOUTS SELECTED IN MY AIRCRAFT ARE:

- 200  100  80  60  40  20  10

Note: Installation without a torque interface cannot detect autorotation and thus will not alter the "Too Low, Gear" warning altitude nor will Autorotation callouts be given.

---

**NORMAL  
PROCEDURES  
MK XXII  
SYSTEM  
SELF-TEST**

Prior to flight, the MK XXII should be tested for proper operation. Normally, this is done by the pilot during the BEFORE TAKE-OFF check. All aircraft power and systems should be up and running and the MK XXII “GPWS INOP” and “Terrain INOP” annunciator lamps should be off.

NOTE: Because the MK XXII requires GPS information to operate, it may be 2 to 5 minutes after power-up before the aircraft (or internal) GPS system has acquired satellites sufficient for proper operation. When this condition is satisfied, the MK XXII “Terrain INOP” lamp will turn off.

The MK XXII Self-Test is initiated by momentarily pressing the cockpit Self-Test button. The Self-Test results are annunciated, at 6db lower than the normal audio level selected for the aircraft, via the same audio system as the EGPWS alerts.

The Self-Test has six levels which are as follows:

- Level 1 = Go / No Go Testing- provides an overview of the current operational functions selected and provides an indication of their operational status
- Level 2 = Current Faults - provides a listing of the internal and external faults currently detected by the EGPWC
- Level 3 = EGPWS Configuration - indicates the current configuration by listing the current hardware, software, databases and Configuration Module options detected by the EGPWS
- Level 4 = Fault history - provides a historical record of the faults both internal and external detected by the EGPWS
- Level 5 = Warning History - provides a historical record of the warnings and cautions given by the EGPWS
- Level 6 = Discrete Test - provides annunciation of discrete input transitions to be used for maintenance support

To expedite the navigation of Self-Test levels and information two types of cancel sequences are supported. Pressing and holding the cockpit Self-Test button for less than 2 seconds is considered a Short Cancel. Pressing and holding the cockpit Self-Test button for more than 2 seconds is considered a Long Cancel.

Self-Test is inhibited if the MK XXII detects an “In Air” condition.

Short Level 1 Self-Test is intended to provide a confidence, Go / No Go, test to show that the EGPWS is fully operational.

Observe that the amber **TERRAIN INOP** and **GPWS INOP** lamps illuminate and remain illuminated for the duration of the test.

*Note: In some installations the lamps will turn off after 2 seconds.*

Observe that the **LOW ALT** lamp turns on momentarily (if installed).

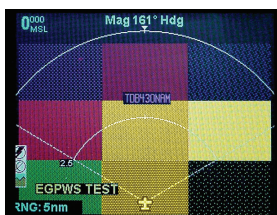
Observe that amber **GPWS** lamp turns on and the voice callout "**GLIDESLOPE**" is issued.

Observe that amber **GPWS** lamp turns off.

Observe that amber **G/S CANCEL** turns lamp on momentarily (if installed).

Observe that red **GPWS** lamp turns on and the voice callout "**PULL UP**" is issued.

Observe that the Terrain Display (if installed) test pattern is shown for 12 seconds.



For PN 965-1595-XXX, TDB XXXYYY indicates the loaded Terrain Database, where XXX is the version number, (i.e. 435) and YYY is the region identifier (i.e. NAM= North America)

Observe that the voice callout "**WARNING TERRAIN**" is issued.

Observe that red **GPWS** lamp turns off, followed by the amber **GPWS** lamp turning on briefly.

After that the Terrain Display (if installed) test pattern is removed and the amber **TERRAIN INOP** and **GPWS INOP** lamps extinguish.

This sequence indicates a proper and successful Level 1 Self-Test.

The Long Level 1 Self-Test is initiated by pressing and holding the cockpit Self-Test button until Self-Test voices start. This test provides the GO/NO GO, then issues all configured voices.

Level 2 Self-Test is initiated by pressing the cockpit Self-Test button within 3 seconds of the end of the Level 1 Self-Test.

During Level 2 Self-Test, a Short Cancel or Long Cancel terminates the Self-Test level and "**PRESS TO CONTINUE**" is announced for proceeding to Level 3 Self-Test.

**RECOMMENDED  
PROCEDURES  
FOR MK XXII  
WARNINGS  
IN FLIGHT**

**“PULL UP”**

If in Visual conditions during the day:

1. Evaluate aircraft flight path with respect to terrain.
2. Take corrective action as necessary to recover safe terrain clearance.
3. Advise Air Traffic Control as necessary.

If in Instrument conditions or at night where visual judgement of the situation is not assured:

1. Roll to 0 degrees of bank and simultaneously pitch up to the aircraft’s BEST ANGLE of CLIMB attitude and speed.
2. Apply Maximum Collective allowable.
3. Continue maximum climb until all visual and aural warnings cease.
4. Advise Air Traffic Control as necessary.

“Terrain Terrain Pull Up”	Condition: Aircraft flight path is in conflict with raising terrain Action: Adjust flight path as required away from threat until alert ceases
“Caution Terrain” or “Caution Obstacle”	Condition: Aircraft flight path is in conflict with terrain / obstacle. Action: Adjust flight path as required away from threat until alert ceases.
“Warning Terrain” or “Warning Obstacle”	Condition: Aircraft flight path is in conflict with terrain / obstacle. Action: Adjust flight path as required away from threat until alert ceases.
“Too Low Terrain” or “Too Low Gear”	Condition: Insufficient terrain clearance for phase of flight. Action: Adjust flight path to recover safe terrain clearance until alert ceases.
“Don’t Sink”	Condition: Aircraft is losing altitude during take-off / climb or missed approach. Action: Re-establish positive rate of climb.
“Sinkrate”	Condition: Rate of descent is EXCESSIVE for current height above terrain. Action: REDUCE RATE OF DESCENT.
“Pull Up”	Condition: Rate of descent is EXCESSIVE for current height above terrain. Action: REDUCE RATE OF DESCENT.
“Bank Angle Bank Angle”	Condition: High roll attitude at low altitude Action: Decrease roll attitude.
“Tail Too Low”	Condition: High nose attitude – Tail very close to ground Action: Lower Nose or Increase altitude.
“Altitude Altitude”	Condition: Flight below DH with gear up or Low Altitude mode active. Action: Verify aircraft altitude.

**MK XXII  
ADDITIONAL  
INFORMATION  
AUDIO  
MESSAGE  
PRIORITY**

The highest priority voice message takes precedence, and may IMMEDIATELY interrupt any lower priority message as shown in the table below. If the aircraft is in a situation that meets more than one condition for an alert or warning at the same time, the higher priority message will be heard until that condition is resolved. If the lower priority condition is still in effect at that time, the lower priority voice message will be heard. Only ONE message is produced at any one time.

The following table shows the voice output that is activated for each callout, caution and warning condition. The messages are arranged from highest priority at the top, to lowest priority at the bottom of the table.

TABLE 1:  
VOICE MESSAGES

ALERT/WARNING CONDITION	AUDIO MENU	NOTES
MODE 1 PULL UP	PULL UP	1, 3
MODE 2 PULL UP PREFACE	TERRAIN TERRAIN	1, 2
MODE 2 PULL UP	PULL UP	1, 3
TERRAIN AWARENESS PREFACE	WARNING TERRAIN	1, 2
TERRAIN AWARENESS WARNING	WARNING TERRAIN	1, 3
OBSTACLE AWARENESS PREFACE	WARNING OBSTACLE	1, 2
OBSTACLE AWARENESS WARNING	WARNING OBSTACLE	1, 3
MODE 2 TERRAIN	TERRAIN	
MODE 6 MINIMUMS	MINIMUMS - MINIMUMS	
MODE 6 ALTITUDE	ALTITUDE ALTITUDE	
TERRAIN AWARENESS CAUTION	CAUTION TERRAIN (PAUSE) CAUTION TERRAIN	4
OBSTACLE AWARENESS CAUTION	CAUTION OBSTACLE (PAUSE) CAUTION OBSTACLE	4
MODE 4 TOO LOW TERRAIN	TOO LOW TERRAIN	
MODE 6 ALTITUDE CALLOUTS	SELECTED CALLOUTS	
MODE 4 TOO LOW GEAR	TOO LOW GEAR	
MODE 1 SINKRATE	SINKRATE Note: The basic warning is "SINKRATE (PAUSE) SINKRATE". However, if the Mode 1 Pull-up curve is violated only a single "Sinkrate" may occur prior to the pull up voice.	5
MODE 3 DON'T SINK	DON'T SINK (PAUSE) DON'T SINK	
MODE 5 GLIDESLOPE	GLIDESLOPE	
MODE 6 BANK ANGLE	BANK ANGLE (PAUSE) BANK ANGLE,	
MODE 6 TAIL STRIKE	TAIL TOO LOW	
TA&D INVALID ALERT	BE ALERT TERRAIN INOP	

Note 1: These are the only voices that can interrupt.

Note 2: The preface voices will always be given prior to the warning voice.

Note 3: Voice message is continuous.

Note 4: Voice message will repeat every 10 seconds.

Note 5: Long Self-Test will only issue a single "Sinkrate".

**MK XXII  
LAMPS &  
SWITCHES**

There are a variety of lamps and switches depending on the aircraft, displays and installer. The following is a list of possible lamps and switches:

LAMPS	SWITCHES
GPWS (Warning, Red)	Press to Test
GPWS (Caution, Amber)	G/S Cancel
Terr Inhib	Terrain inhibit
Audio Inhib	Audio inhibit
G/S (glideslope) canceled	Glideslope cancel
Low Alt	Low Altitude
GPWS Inop	
Terr Display	Terrain Select
Terr Inop	

**MK XXII  
SYSTEM  
LIMITATIONS /  
CONSTRAINTS**

- The MK XXII is a *Situational Awareness* tool, and an alerting and warning device. ***It is not to be used for navigation of the aircraft.***

- “**Low Altitude**” must not be engaged during IFR flight except as required for certain Instrument Approaches to Offshore Platforms.

- “**Low Altitude**” decreases the terrain look down angle.

The EGPWS uses greater than 50 knots as an indication of transition to forward flight with the intent of departure from the landing zone or airport. For local maneuvering in excess of 50 knots it is recommended that “**Low Altitude**” be selected.

- The MK XXII must have an operating source of GPS information, with enough satellites in view to provide GPS data within the accuracy requirements of the system.

- Without the optional Outside Air Temperature (OAT) input for corrections, “*Geometric Altitude*” may have errors during rapid climbs or descents in non-ISA conditions. This may affect alerting/warning times and proper altitude reference on the Terrain Display.

- The Terrain, Obstacle and Runway/Helipad database information is not all-inclusive.

- Wires are not included in the database.

- Airspeeds referred to in this manual may be GPS ground speed or Calibrated Airspeed from the Air Data Computer and may not precisely match cockpit indications.



**MK XXII  
DATABASE  
UPDATE  
PROCEDURES**

Load the PCMCIA database card as described in the paragraph below. Loading time will be approximately 70 minutes.

1. Load the PCMCIA database card with the EGPWS mounted in the aircraft.
2. Connect the Smart Cable (Honeywell PN 951-0386-001) to the EGPWS J3 connector.
3. Ensure that the 28 VDC circuit breaker to the EGPWS is ON and that the green **COMPUTER OK** LED on the EGPWS front panel is on.
4. Insert the PCMCIA card into the Smart Cable PCMCIA card slot.
5. NOTE: Precautionary notes on the PCMCIA card, regarding insertion and/or removal while power is applied, should be ignored since the EGPWS automatically handles the application and removal of PCMCIA card power.
6. While the loading is in progress, the amber **IN PROG** LED on the Smart Cable remains ON and the green **COMPUTER OK** LED on the EGPWS is OFF.
7. When loading is complete the green **XFER COMP** LED on the Smart Cable turns ON.
8. Remove the PCMCIA card from the Smart Cable slot.
9. After approximately 15 seconds the green **COMPUTER OK** LED comes ON to indicate that the contents of the PCMCIA card were successfully transferred.
10. Remove the Smart Cable connector from the EGPWS front panel J3 connector.

**MK XXII  
TECHNICAL  
SPECIFICATIONS**

Specification ..... Characteristic  
Applicable Documents ..... Terrain Awareness and Warning System  
TSO-C151a  
Temperature Range ..... -55°C to +70°C  
Humidity Range ..... Tested to 85% RH for 48 Hours  
Weight ..... 3.9 lbs.  
Power Requirements ..... 28VDC, 3 AMPS  
Altitude ..... Up to 55,000 feet  
Cooling ..... No forced cooling required

**MK XXII  
PRODUCT  
SUPPORT**

Contacts: GPWS Hot line  
Phone numbers: 800-813-2099  
Internet website: <http://www.egpws.com>

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