NATIONAL TRANSPORTATION SAFETY BOARD
Vehicle Recorder Division
Washington, D.C. 20594

June 5, 2013

Enhanced Ground Proximity Warning System

Specialist's Factual Report
By Bill Tuccio

1. EVENT SUMMARY

Location: Amarillo, Texas
Date: December 14, 2012
Aircraft: Beechcraft E-90
Registration: N67PS
Operator: Private
NTSB Number: CEN13FA105

On December 14, 2012, about 1805 central standard time, a Beechcraft E-90 airplane, N67PS, impacted terrain following an inflight break-up near Amarillo, Texas. The commercial rated pilot and passenger were fatally injured. The airplane was substantially damaged. The airplane was registered to O'Neal Aviation LLC, Colorado Springs, Colorado, and operated by a private individual. Instrument meteorological conditions prevailed and an instrument flight plan was filed for the 14 *Code of Federal Regulations* Part 91 personal flight. The flight originated from the Rick Husband International airport (KAMA), Amarillo, Texas, about 1750, and was destined for the Fort Worth Meacham Airport (KFTW), Fort Worth, Texas.

2. ENHANCED GROUND PROXIMITY WARNING SYSTEM DATA GROUP

An enhanced ground proximity warning system (EGPWS) data group was not convened.

3. DETAILS OF EGPWS INVESTIGATION

The Safety Board's Vehicle Recorder Division received the following EGPWS:

Recorder Manufacturer/Model: **Bendix/King KGP 560 GA-EGPWS**
Recorder Serial Number: **3415**

3.1. Bendix/King GA-EGPWS Description

The EGPWS non-volatile memory (NVM) does not continuously record, rather the EGPWS device stores data to NVM only when certain criteria are met. The readout process at the manufacturer's facility produces several files of flight history data that encompass operational, documentary, fault, and warning information.

The flight history data warning file outputs performance data as related to the operation of the aircraft. These data do not continuously record, rather if an alert or warning related to the EGPWS function activates, the unit retains data points for 20 seconds prior to the

activation of the warning and 10 seconds afterwards. The EGPWS parameters are only sampled 1 time per second, but the actual time of occurrence can be anywhere within the second.

The download file structure of the warning data includes a standard EGPWS parameter listing, not all of which are applicable to the accident aircraft, N67PS. Other parameters listed (such as flaps) did not record any information, as they were not wired to send data to the EGPWS in this installation. Some of the data points contained in the file are denoted with an asterisk. According to a Honeywell representative, the asterisk indicates invalid data as evaluated by the EGPWS logic. In some cases, the data coming from the original aircraft source is correct, just not considered reasonable by the programming of the EGPWS. EGPWS parameters referenced in this report can be found in Table 1.

One of the parameters recorded in the warning file is "RecID". When an alert is present, the normally recorded value, "DATA," is supplemented by another line at the same time sample which indicates the alert mode detected and usually corresponds to an aural annunciation in the cockpit by the unit.

3.2. Bendix/King GA-EGPWS Condition

The device was damaged in the event. The extent of the damage is shown in figure 1, with the side data plate expanded. The device was disassembled, and the internal board containing the NVM was found to be intact, as shown in figure 2. Figure 2 also annotates the U8 and U24 NVM chips, which were removed from the internal board and the chips' memory images downloaded by the NTSB for decoding by the EGPWS manufacturer.

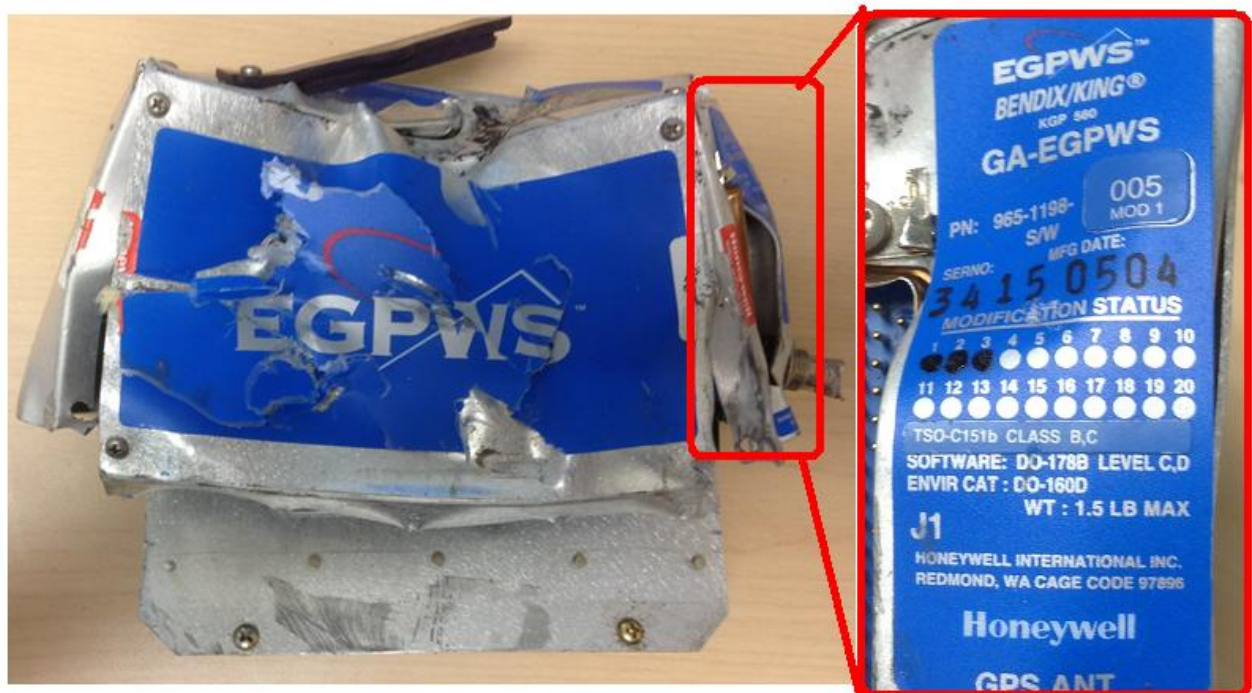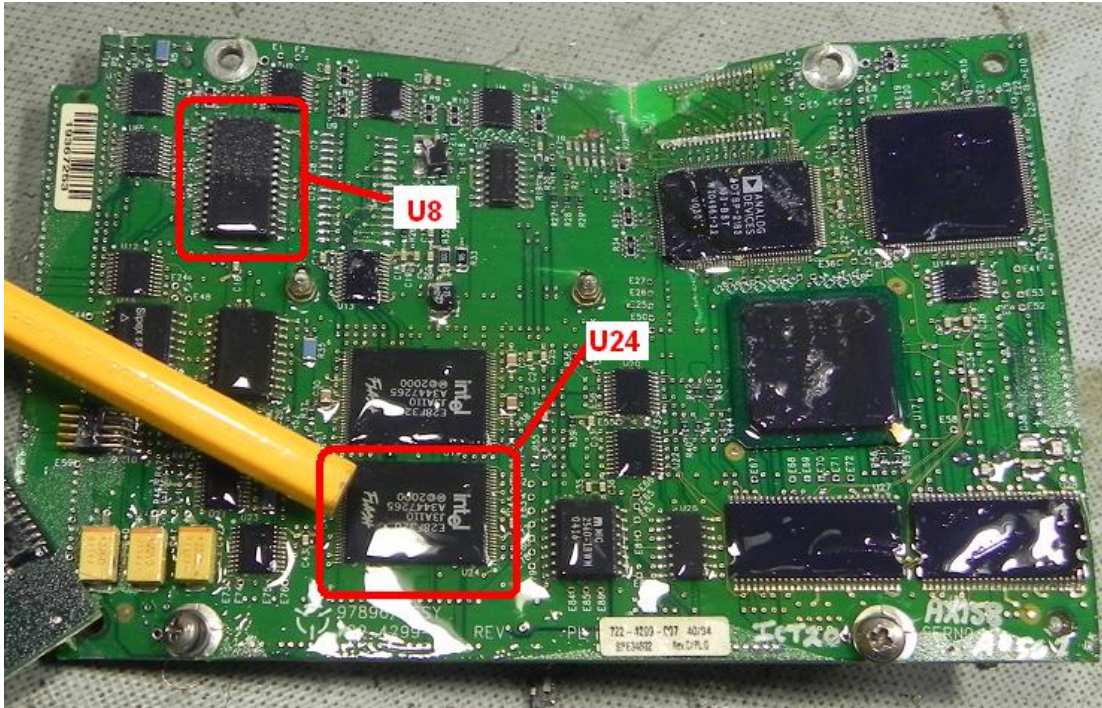**Figure 1. Damaged exterior of EGPWS.**

Figure 2. Internal board with NVM chips annotated.

3.3. Data Conversion

The U8 and U24 memory images were provided to the EGPWS manufacturer for decoding and the decoding process was observed by NTSB personnel. The U8 chip image, which contained configuration information, did not decode properly and was not used by this report. The U24 chip image did decode properly and was used by this report. The decoded files were provided to the NTSB.

3.4. Time Correlation

The downloaded files contain data logged based on hours of operation (operational time) of the individual EGPWS unit and have no reference to any other time base. In the data files, each power cycle is tagged with a sequential flight leg number. The accident flight was identified as flight leg 544. Only the warning data pertaining to the event flight, 544, were extracted for use in this report.

The data in the warning file for flight leg 544 began recording at operational time 851:33:14. The event that most likely triggered this recording was an excessive descent rate warning, which occurred at 851:33:34 The data logged continuously each second until the last recorded point in the file which occurred at operational time 851:33:36, a total of 23 seconds of recording.

3.5. Engineering Units Conversions

The operational data is converted during the readout process by Honeywell software and the files contain engineering units. Where applicable, changes to the conversions have

been made to ensure the parameters conform to the Safety Board's standard sign convention that climbing right turns are positive (CRT=+).[1]

3.6. Parameters Provided and Verified

Table 1 lists the EGPWS parameters provided and verified in this report, including the associated plot label.

Table 1. Verified and provided EGPWS parameters.

Plot Label	EGPWS Parameter	EGPWS File Name
1. Altitude-GPS (ft)	GPS Altitude (feet)	GPS Alt
2. Altitude-Tactical (ft)	Tactical Altitude (feet)	TACAlt
3. Altitude-Uncorrected(ft)	Uncorrected Altitude (feet)	Uncorr Alt
4. Flight Leg	Flight Leg	Flt Leg
5. Ground Spd (kts)	Ground Speed (knots)	Gspd
6. Latitude (deg)	Latitude (degrees)	Lat
7. Longitude (deg)	Longitude (degrees)	Long
8. Operating Time2	Operating Time	Oper Time
9. Position Source2	Position Source	Pos Src
10. Roll (deg)	Roll (degrees)	Roll
11. Track-Mag[a] (deg)	Track, Mag (degrees)	Mag Trk
12. Track-True[a] (deg)	Track, True (degrees)	Tru Trk
13. Altitude Rate (fpm)	Rate of Descent (feet per minute)	Alt Rte
14. Uncorr Alt Flag (discrete)	(See Note b)	(See Note b)
15. Terrain Elevation (ft)	EGPWS Terrain Elevation (feet)	Terr Elv

[a]The EGPWS recorded tracks from -179 to 180 degrees (North 0, East 90, South 180, West -90). The tracks were converted to the Safety Board's convention of 0 to 360 degrees.
[b]The EGPWS File Name parameter "Uncorr Alt," was prefixed by an asterisk for values that were invalid. The asterisk was used to create the Uncorr Alt Flag discrete parameter.

3.7. EGPWS Recorded Takeoff Information

The EGPWS also recorded takeoff event data. The most recent takeoff recorded by the EGPWS was flight leg 544. Table 2 contains the recorded takeoff data.

Table 2. EGPWS recorded takeoff data.

Operating Time (HH:MM:SS)	851:23:02
GPS Altitude (feet)	3602.0
Airport	KAMA
Latitude/Longitude	35.22326 / -101.70982

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[1] CRT=+ means that for any parameter recorded that indicates a climb or a right turn, the sign for that value is positive. Also, for any parameter recorded that indicates an action or deflection, if it induces a climb or right turn, the value is positive. Examples: Right Roll = +, Pitch Up = +, Elevator Trailing Edge Up = +, Right Rudder = +.

3.8. Overlays, Plots, and Corresponding Tabular Data

The following overlays and plots contain EGPWS data recorded during the December 14, 2012 event. Overlays were produced using Google Earth.

The overlay in figure 3 shows the relationship of the recorded EGPWS event to the KAMA airport. The recorded data was about 17 nautical miles southeast of the KAMA airport.

Figure 4 shows 22 seconds of recorded data in the descent. The aircraft descended from 13,966 feet to 5,904 feet, while the track turned to the right.

Figure 5 shows a plot of the EGPWS recorded data. The aircraft descent rates were in excess of 18,000 fpm, and after 19 seconds, the descent rate exceeded the approximate 32,000 fpm limit of the EGPWS Altitude Rate parameter.

The corresponding tabular data used to create these 3 figures are provided in electronic (*.csv[2]) format as Attachment 1 to this report.

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[2] Comma Separated Value format.

Figure 3. Google Earth overlay – departure airport and EGPWS data.

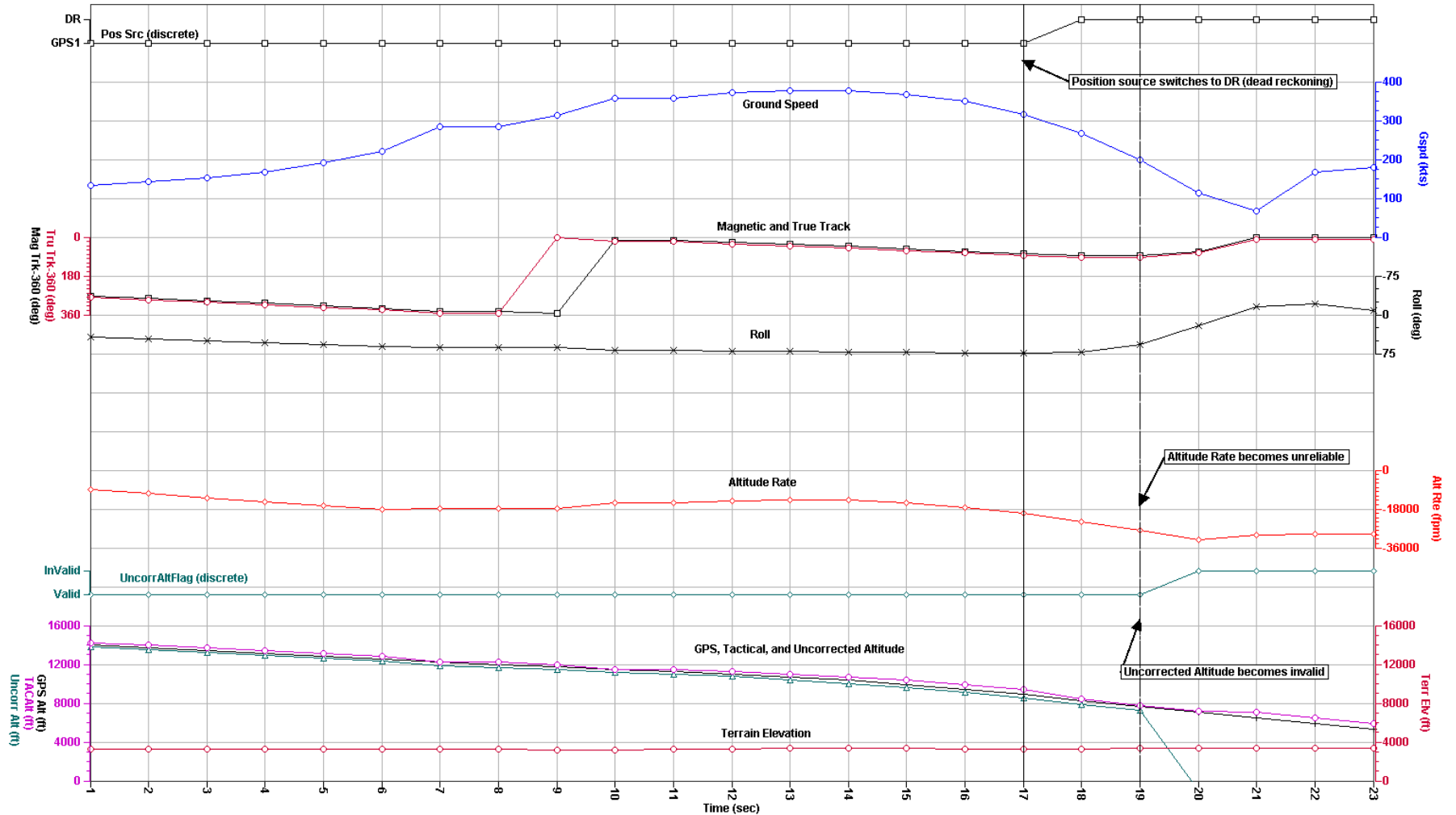**Figure 4. Google Earth overlay of EGPWS data from accident flight.**

Figure 5. Plot of EGPWS data – accident flight.

Beechcraft E-90, N67PS

Position source switches to DR (dead reckoning)

Ground Speed

Pos Src (discrete)

Magnetic and True Track

Roll

Altitude Rate becomes unreliable

Altitude Rate

UncorrAltFlag (discrete)

Uncorrected Altitude becomes invalid

GPS, Tactical, and Uncorrected Altitude

Terrain Elevation

EGPWS Accident Flight

National Transportation Safety Board