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

April 10, 2013

17 - GPS Factual Report

by Sean Payne

1. EVENT

Location:	Deming, New Mexico
Date:	February 27, 2013, 12:30 Mountain Standard Time (MST)
Aircraft:	Cessna 150M
Registration:	N9172U
Operator:	Private
NTSB Number:	CEN13LA179

1.1 GROUP - No Group

1.2 SUMMARY

On February 27, 2013, at about 1230 mountain standard time, a Cessna 150M, N9172U, impacted terrain near Florida, New Mexico. The pilot, the sole occupant on board, was fatally injured. The airplane was substantially damaged. The airplane was registered to and operated by the pilot under the provisions of 14 Code of Federal Regulations Part 91 as a personal flight. Visual meteorological conditions prevailed at the time of the accident, and no flight plan had been filed. The local flight originated from Belen (E80), New Mexico, about 1100, and reportedly was en route to El Paso (KELP), Texas.

2. DETAILS OF INVESTIGATION

The NTSB Vehicle Recorder Laboratory received the following devices:

GPS Manufacturer/Model:	Lowrance AIRMAP 2000c
Serial Number:	100682893
GPS Manufacturer/Model:	Lowrance AIRMAP 600c
Serial Number:	101059931

2.1. Lowrance AIRMAP 2000c Device Description

The Lowrance AIRMAP 2000c is a WAAS[1]-capable, battery operated hand-portable 12-channel mapping GPS unit equipped with a 320 x 240 pixel color LCD display, soft key controls, and support for custom maps. The unit has the capability of performing E-6B[2] calculations. It contains a slot for a multi-media card (MMC) or Secure Digital (SD) FLASH[3] memory card. This card may be used to transfer and store custom map, waypoint[4], route[5], and trail[6] data to and from a desktop PC to the GPS unit. A serial interface using NMEA 0183[7] communication protocols is mounted in the back of the GPS unit, but the internal operating software does not support the download of saved data via this serial port.

The Lowrance AIRMAP 2000c can store up to 100 routes composed of up to 100 waypoints each. The unit can also store trail data composed of up to 10,000 latitude-longitude points per trail. Up to 100 individual trails may be named and saved by the user. Once the limit has been reached for recording continuously updated trail data, older latitude/longitude points are overwritten with new data on a first-in, first-out basis. The Lowrance AIRMAP 2000c may be programmed to update trail data in one of three ways: automatically, by time, or by distance traveled. The default 'automatic' mode only updates trail data when the GPS unit senses that position has changed by at least 0.1 miles, or that direction has changed by 2 degrees or more. Updating by time may be set to record a new latitude/longitude point every 1 to 9,999 seconds. Updating by distance may be set to record a new latitude/longitude point whenever the distance traveled from the last update exceeds anywhere from 0.01 miles to 9.99 miles. All recorded data is stored internally in non-volatile memory[8], and may be copied to a MMC or SD card inserted in a card slot in the battery compartment. The data is stored in a Lowrance proprietary *.usr file format. This

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[1] Wide Area Augmentation System. WAAS is based on a network of approximately 25 ground reference stations that covers a very large service area. Signals from GPS satellites are received by wide area ground reference stations (WRSs). Each of these precisely surveyed reference stations receive GPS signals and determine if any errors exist. Each WRS in the network relays the data to the wide area master station (WMS) where correction information is computed. The WMS calculates correction algorithms and assesses the integrity of the system. A correction message is prepared and uplinked to a geosynchronous satellite via a ground uplink system (GUS). The message is then broadcast from the satellite on the same frequency as GPS (L1, 1575.42MHz) to receivers on board aircraft (or hand-held receivers) which are within the broadcast coverage area of the WAAS. WAAS-capable receivers are capable of basic GPS accuracy to approximately 7 meters vertically and horizontally.

[2] E-6B refers to mechanical and electronic tools assisting common flight related computations.

[3] FLASH Memory is a form of re-writeable, non-volatile memory that can retain data without external power - provided that the chip is not heated beyond the data retention temperature limit as stated in the datasheet.

[4] Geographical point specified by a set of latitude and longitude data along with descriptive information.

[5] An ordered list of waypoints.

[6] Linked list of latitude and longitude data representing the position of the aircraft as a function of time.

[7] NMEA, National Marine Electronics Association. NMEA Standard 0183 is an ASCII-based serial communication protocol.

[8] Non-volatile memory is semiconductor memory that does not require external power for data retention.

card may be read using a standard desktop PC running the Microsoft Windows operating system.

2.1.1. Lowrance AIRMAP 2000c Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an exterior examination revealed that the unit had sustained significant impact damage, as shown in figures 1 and 2. An interior inspection revealed damage to various components, including two broken and missing inductors, multiple broken wires and some screen damage. The SST 39VF1601 FLASH memory chip shown in figure 3, which contains the non-volatile memory, was identified on the printed circuit board. The chip was removed and the binary contents read. The track history was successfully extracted from the binary contents.

Figure 1. Photo of damaged Lowrance AIRMAP 2000c.

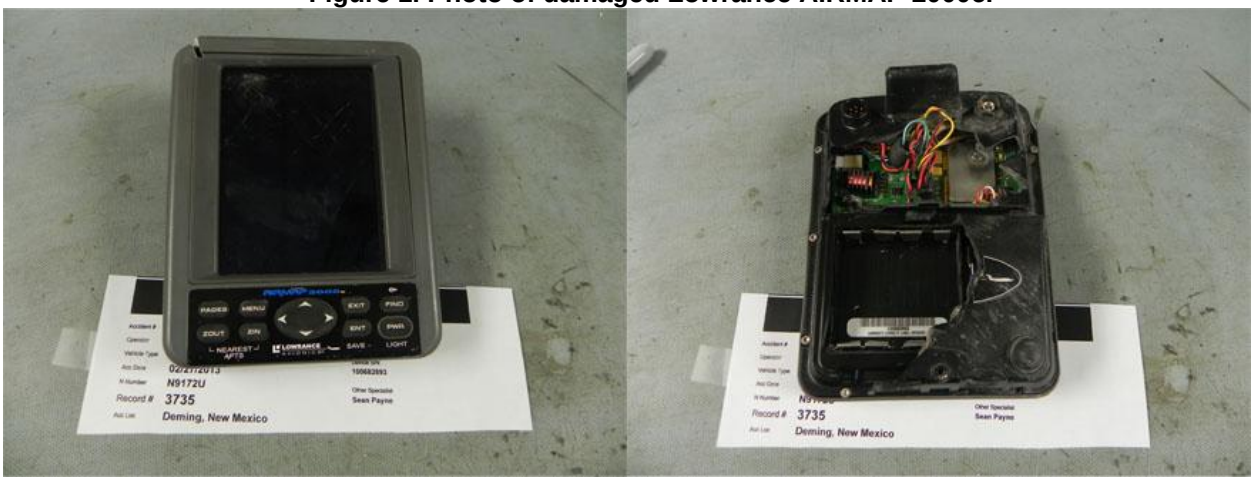


Figure 2. Interior damage to Lowrance AIRMAP 2000c.

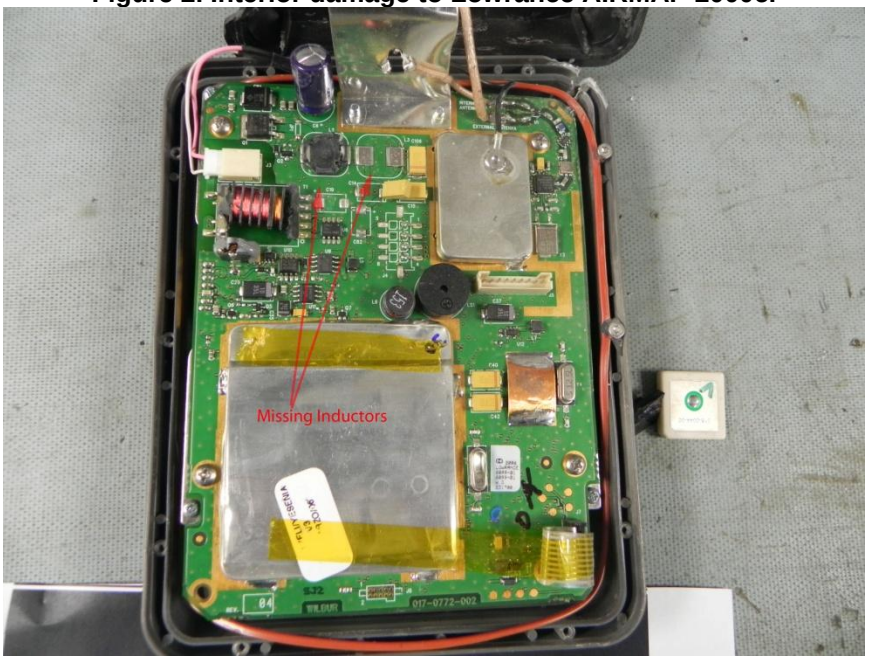
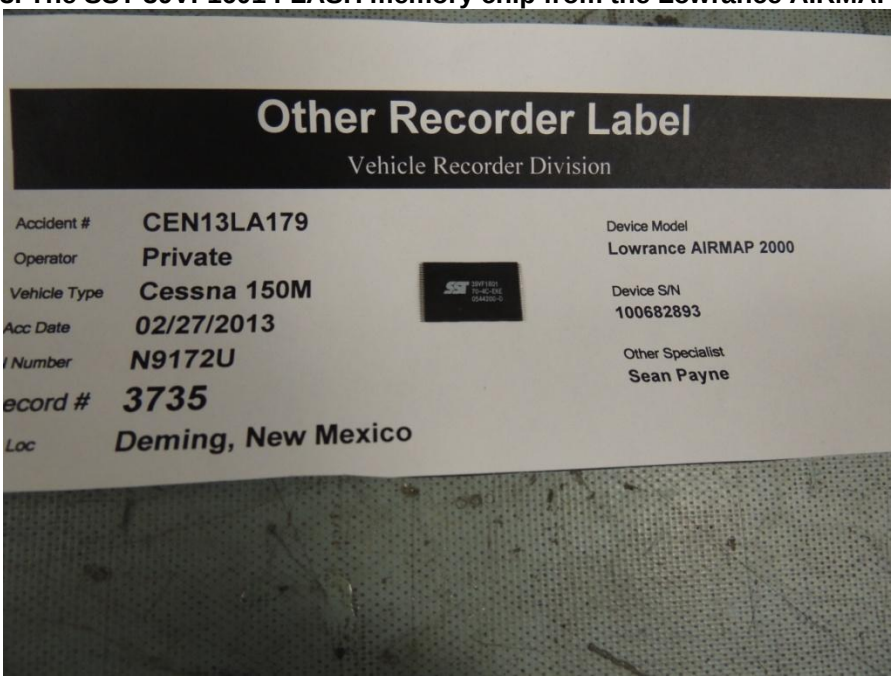


Figure 3. The SST 39VF1601 FLASH memory chip from the Lowrance AIRMAP 2000c.



2.1.2. Lowrance AIRMAP 2000c Data Description

The data extracted from the Lowrance AIRMAP 2000c included 37 trails which the unit refers to as sessions. The 37 sessions contained a total of 3,779 points. Since the AIRMAP 2000c records only a sequential history of latitude and longitude without a reference to time, groundspeed could not be calculated. The last trail recorded, session 37, contained 139 data points and was found to be from a single flight. This flight was subsequently determined to be the accident flight. Session 37 shows the aircraft taxiing to and departing from Runway 03 at Alexander Municipal Airport (E80), Belen, NM. The data shows the aircraft enroute along I-25 South towards El Paso, TX. The aircraft then altered course southwest to continue to follow I-25 and the data trail ends near the recorded latitude and longitude of the wreckage site. A detailed overview and overlay is provided in section 4 of this report.

2.2. Lowrance AIRMAP 600c Device Description

The Lowrance AIRMAP 600c is a battery operated hand-portable 16-channel GPS+WAAS receiver equipped with a Jeppessen Aviation database. It contains a slot for a multi-media card (MMC) or secure Digital (SD) memory card. This card may be used to transfer and store custom maps, waypoint, route, and trail data to and from a desktop PC to the GPS unit. A serial interface using NMEA 0183 communication protocols is mounted in the back of the GPS unit, and may be used to download saved data to a PC using the appropriate software.

The device can store up to 100 trail plots, each composed of up to 9,999 points (default is 2,000). Trail data is not date/time stamped and altitude is not recorded. Each trail

corresponds to a power cycle of the device. Once the maximum trail point setting is reached, the unit will overwrite the oldest data with the newest data. All recorded data is stored internally in *non-volatile memory*. The data may be downloaded to a PC running the appropriate software using the serial port built into the unit. The LCD display must be functional in order to access the menu structure and set up the unit for download.

2.2.1. Lowrance AIRMAP 600c Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an exterior examination revealed that the unit had sustained substantial damage to its display screen from impact forces. The unit was able to power on but displayed only broken white backlighting, rendering the unit un-useable. A chip level data recovery effort was attempted, but was not successful.

Figure 4. Photo of exterior damage to the Lowrance AIRMAP 600c.

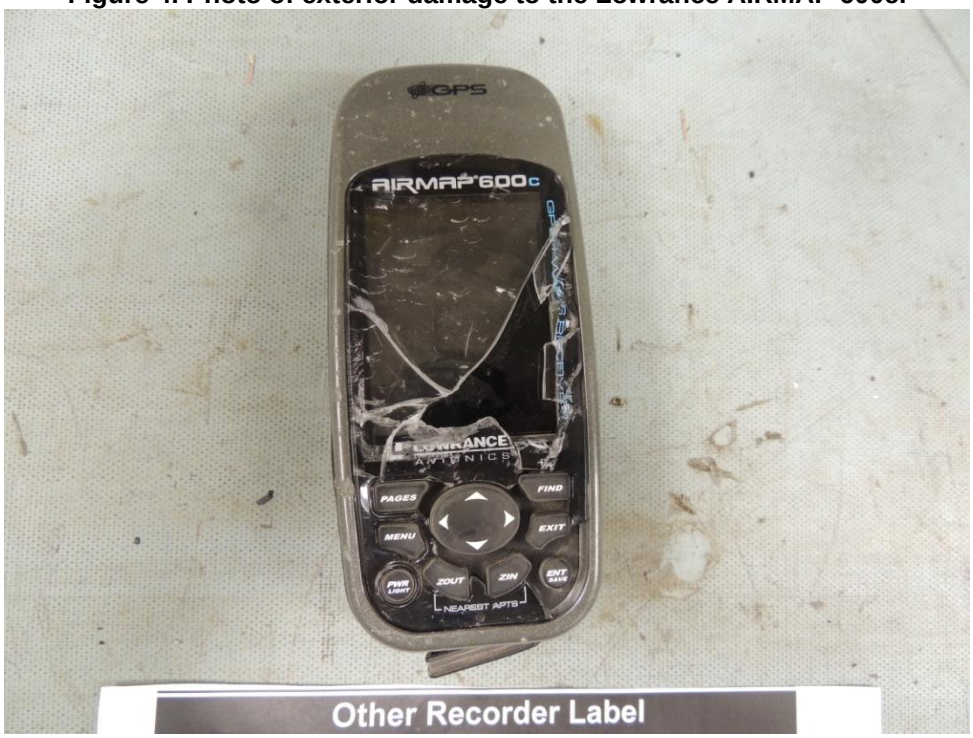


Figure 5. The interior condition of the Lowrance AIRMAP 600c.

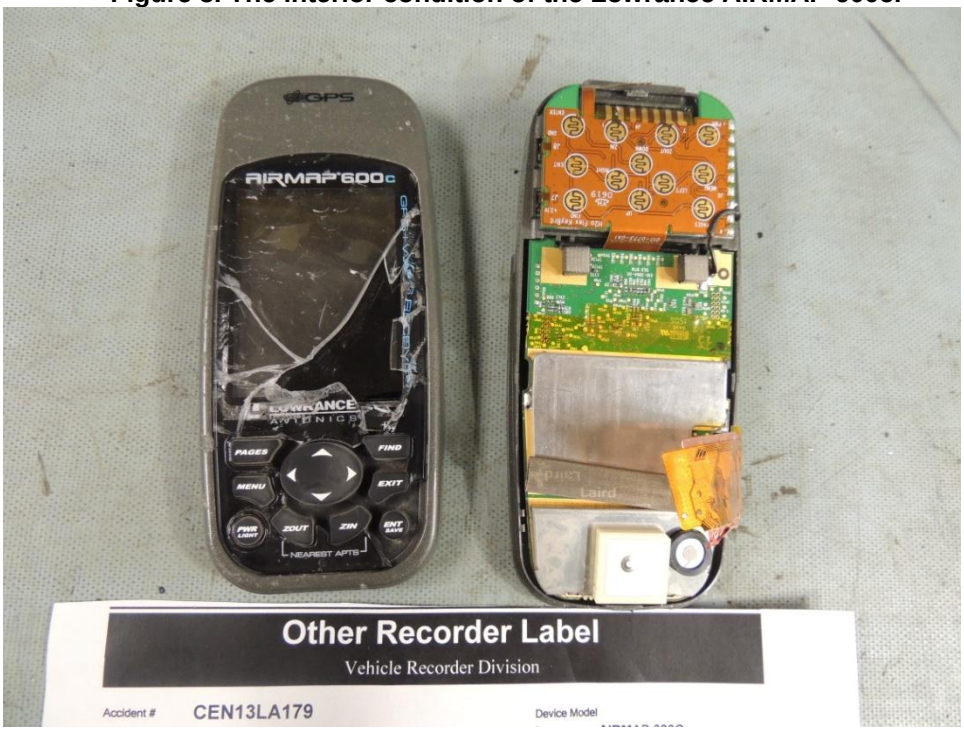
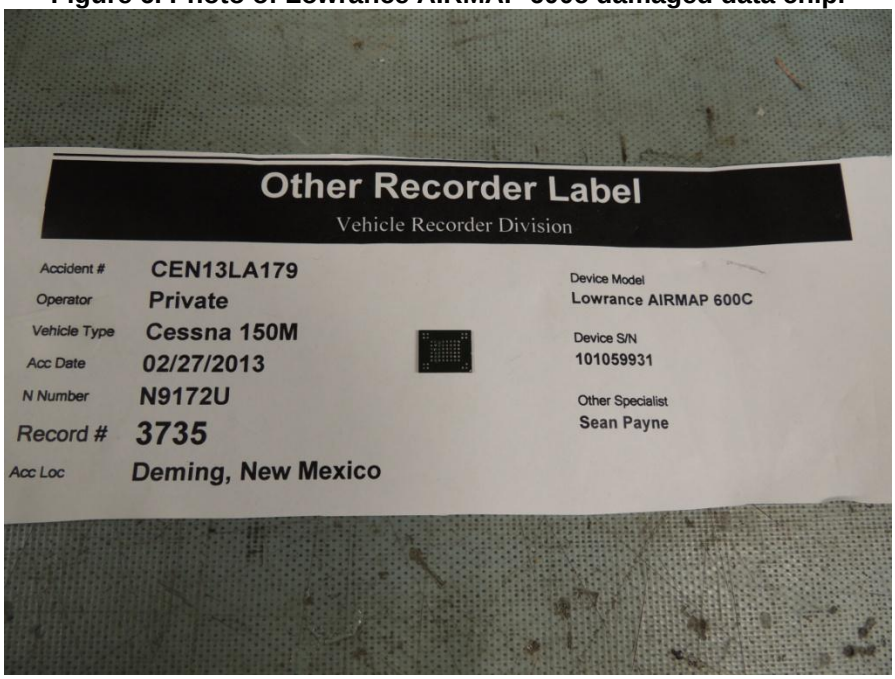


Figure 6. Photo of Lowrance AIRMAP 600c damaged data chip.



2.2.2. Lowrance AIRMAP 600c Data Description

No data was successfully recovered from the Lowrance AIRMAP 600c.

3. GPS Parameters Provided

Table 1 describes data parameters provided by the Lowrance AIRMAP 2000c. The 4 parameter output shows the session number, a data point record for a chronologically occurring number of data points and the latitude and longitude of the GPS receiver.

Table 1: GPS Data Parameters

Parameter Name	Parameter Description
Session	Zero-indexed counter for trail/flight number
Data PT	Zero-indexed counter for point number within each trail
Latitude	Recorded Latitude (degrees)
Longitude	Recorded Longitude (degrees)

4. OVERLAYS AND TABULAR DATA

All graphical overlays generated in this report were generated using Google Earth. No time information is displayed because it was not recorded by the Lowrance AIRMAP 2000c.

Figure 7 is a graphical overlay generated using Google Earth zoomed in to show the departure sequence of the accident flight. The tracks originate near the northeastern corner of the airport at a hangar complex. The aircraft taxis to Runway 03 and departs towards the north-northeast and then executes an immediate right turnout to the south.

Figure 8 is a graphical overlay generated using Google Earth zoomed out to show the aircraft's entire enroute segment. The aircraft appears to parallel I-25 for most of the enroute portion, then intercepts the Interstate as it turns southwest-bound toward the wreckage location.

Figure 9. is a graphical overlay generated using Google Earth zoomed in to show the flight's final waypoints. Theses tracks end just to the southeast of Interstate 25.

Tabular data used to generate figures 7 through 9 are included as Attachment 1. This attachment is provided in electronic comma-delimited (.CSV) format.

Figure 7. A Google Earth Overlay showing the aircraft departing Runway 03 at Alexander Municipal Airport (E80), Belen, NM.

Figure 8. A Google Earth overlay showing the enroute portion of the airplane's accident flight.

Figure 9. A Google Earth overlay showing the aircraft's final waypoints.