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

May 22, 2017

Agricultural Aerial Spraying Electronic Devices

Specialist's Factual Report
by Bill Tuccio, Ph.D.

1. EVENT

Location:	Zamora, California
Date:	July 23, 2016
Aircraft #1:	Air Tractor AT-502B
Registration:	N502WC
Operator:	Farm Air
Aircraft #2:	Air Tractor AT-502B
Registration:	N5044N
Operator:	Growers Air Service
NTSB Number:	WPR16FA148AB

On July 23, 2016, about 0745 Pacific daylight time (PDT), an Air Tractor AT-502B, N502WC, and an Air Tractor AT-502B, N5044N, collided in-flight near Zamora, California. N502WC was operated by Farm Air as an aerial application flight under the provisions of 14 *Code of Federal Regulations* (CFR) Part 137. The commercial pilot, the sole occupant, was fatally injured and the airplane was destroyed. N5044N was operated by Growers Air Service, and was operated as an aerial application flight under the provisions of 14 CFR Part 137. The commercial pilot, the sole occupant, received minor injuries and the airplane sustained substantial damage. Visual meteorological conditions prevailed and company flight plans had been filed for both flights.

2. DETAILS OF INVESTIGATION

The National Transportation Safety Board (NTSB) Vehicle Recorder Division received the following devices:

Device 1:	Hemisphere Satloc G-4
Device 1 Serial Number:	A1217-160356-0038
Aircraft:	N502WC
Device 2:	Satloc M3 CPU
Device 2 Serial Number:	0547-23096-0003
Aircraft:	N5044N

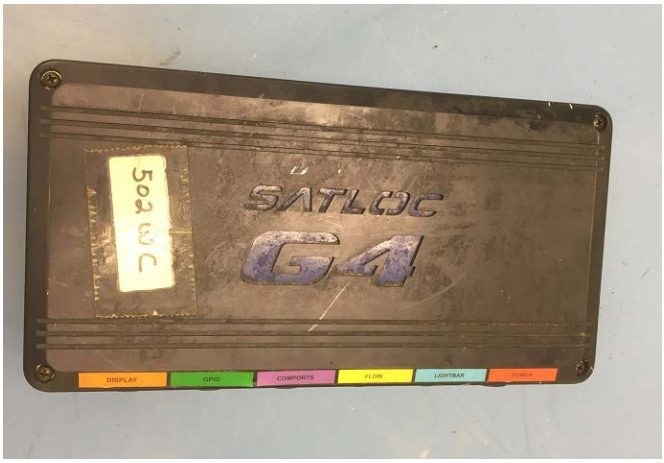
2.1. Satloc Device Description

Satloc devices (both the G-4 and M3) are part of an on-board control system designed to programmatically control agricultural, aerial spray operations based on vendor and user specified prescription maps. Satlocs can drive a cockpit mounted lightbar guidance system and a real-time graphic moving map display providing visual guidance to the pilot. Flow rates can be pilot selected or based on mapping created using a proprietary software package called MapStar that runs on a desktop computer. Satlocs are capable of recording historical information in a Windows-based operating system format to non-volatile memory:[1] in the case of the G-4, to an internal eSata drive, and in the case of the M3, to an internal, compact flash (CF) card. Satlocs are are now supported by the Satloc division of AgJunction.

2.2. Hemisphere Satloc G-4 Data Recovery

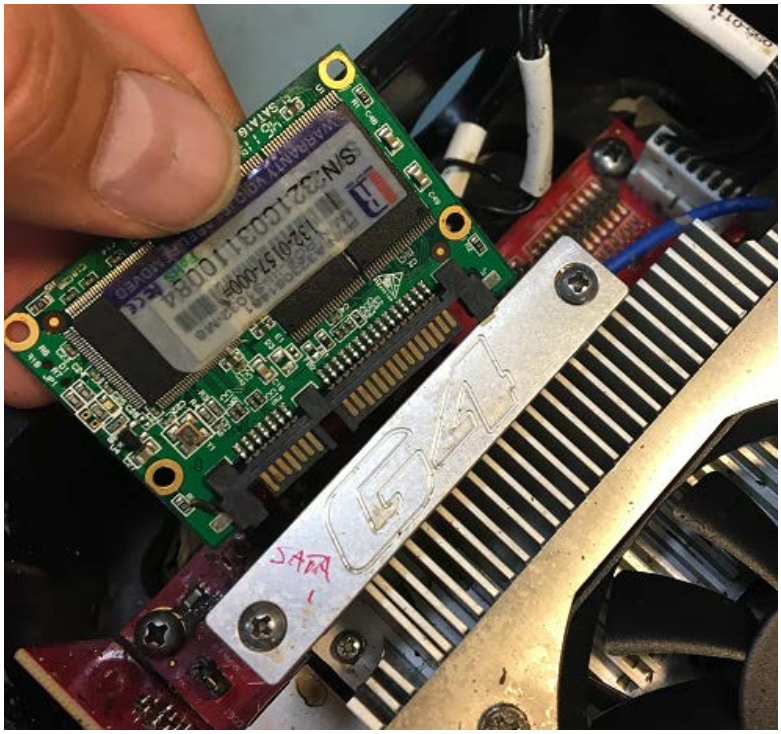
Upon arrival at the Vehicle Recorder Division, an exterior examination revealed the device had sustained minor damage, as shown in figure 1. The device was opened, and the eSata “1” solid-state drive (shown in figure 2) was intact, removed, and downloaded. The pertinent historical log file was decoded using the manufacturer’s Mapstar software.

Figure 1. Satloc G-4, as received.



[1] Non-volatile memory is memory that does not need power to retain information.

Figure 2. Satloc G-4 eSata solid-state "1" drive.



2.2.1. Hemisphere Satloc G-4 Data Description

The data extracted included logs from May, 2015, through the accident flight log on July 23, 2016. The accident flight log contained 5,872 points recorded once per second between 0624:08 and 0739:49 PDT. According to the manufacturer, there is a delay in the recording logic such that up to 10 seconds of data may be lost when power is interrupted.

2.2.2. Hemisphere Satloc G-4 Parameters Provided

Table 1 describes data parameters recovered and validated from the device.

Table 1: Satloc G-4 Data Parameters

Parameter Name	Parameter Description
Date	Date for recorded data point (MM/DD/YYYY)
Time	Time (PDT) for recorded data point (HH:MM:SS)
Latitude	Recorded Latitude (degrees)
Longitude	Recorded Longitude (degrees)
Altitude	Recorded Altitude (feet[2])
Groundspeed	Recorded groundspeed (miles per hour)

[2] For this report, the source of the altitude was not determined.

2.3. Satloc M3 CPU Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an exterior examination revealed the unit had sustained minor damage, as shown in figure 3. The compact flash card, shown in figure 4, was removed and the contents downloaded. Additionally, the internal 1GB SATA flash drive, shown in figure 5, was removed; however, download attempts were unsuccessful.

Figure 3. Satloc M3 CPU.

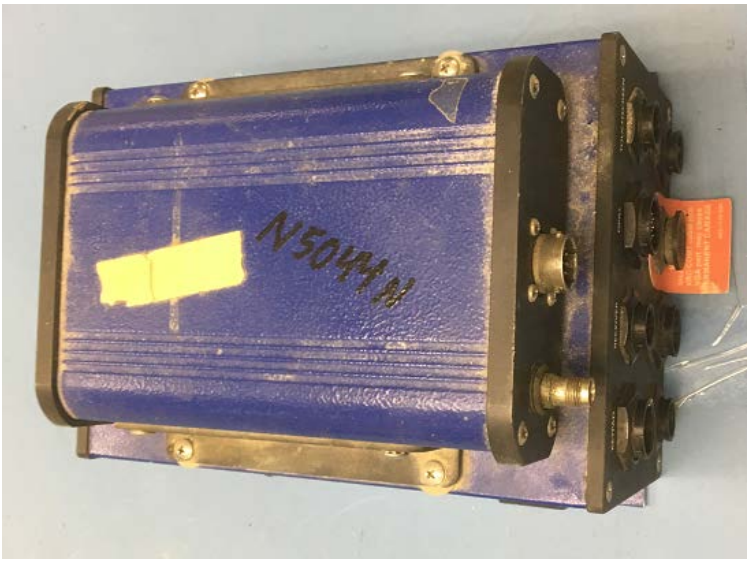


Figure 4. Compact flash card from Satloc M3 CPU.

Figure 5. Satloc M3 CPU internal 1GB flash drive.

2.3.1. Satloc M3 CPU Data Description

The compact flash card contained 95 log files from June, 2016, through the date of the accident on July 23, 2016. The accident day file only contained ground operations between 0531 and 0532 (time zone not verified). According to the manufacturer, the Satloc M3 was an older generation unit and only copied data from volatile memory to non-volatile memory when a new log was started, which typically was the result of a pilot action. Further, the manufacturer indicated the 1GB internal SATA drive contained no data and only contained operating system related files.

2.4. Overlays and Corresponding Tabular Data

The weather and lighting conditions shown in figures 6 and 7 are not necessarily representative of those at the time of the accident. The overlays were created using Google Earth. Only data from N502WC (the aircraft with the Satloc G-4 installed) were recovered.

Figure 1 and 2 show the recovered data on a satellite overlay. The data ended as N502WC was travelling eastbound at about 143 miles per hour (mph).

The corresponding tabular data used to create these two overlays are provided in electronic (*.csv) format as attachment 1 to this report.

Figure 6. N502WC entire accident flight recording.

Figure 7. N502WC end of accident flight recording.