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

September 13, 2018

Non-Volatile Memory (NVM) Factual Report

by Joe Gregor

A. EVENT

Location:	Ruthton, Minnesota
Date:	August 19, 2016
Aircraft:	Thrush Aircraft Inc. S2R T660
Registration:	N40499
Operator:	Arnt Aerial Spraying Inc.
NTSB Number:	CEN16LA326

B. SUMMARY

On August 19, 2016, about 0810 central daylight time, a Thrush model S2R-T660 agricultural airplane, N40499, was destroyed when it impacted a tower guy wire and the ground during spraying operations near Ruthton, Minnesota. The pilot was fatally injured. The aircraft was registered to and operated by Arnt Aerial Spraying, Inc. under the provisions of 14 Code of Federal Regulations Part 137 as an aerial application flight. Visual meteorological conditions prevailed for the flight, which was not on a flight plan.

C. DETAILS OF INVESTIGATION

On September 6, 2016,[1] the NTSB Vehicle Recorder Laboratory received the following devices from the S2R T660 (N40499):

NVM Manufacturer/Model:	Hemisphere GPS MD M3 Bantam
Serial Number:	1335-HH06129-0071
NVM Manufacturer/Model:	Hemisphere Intelliflow Controller
Serial Number:	1327-05915-LN1-028
NVM Manufacturer/Model:	SATLOC Display

[1] The Hemisphere GPS MD M3 Bantam was received on January 29, 2018.

Serial Number:	1339022
NVM Manufacturer/Model:	SATLOC Light Bar
Serial Number:	B1340-PAR-00037

Hemisphere Devices

The Hemisphere GPS MD M3 Bantam and Intelliflow Controller are part of a GPS-based flight system designed to programmatically control aerial spray application using vendor and user specified mapping. The M3 Bantam records and retains a limited set of aircraft flight information on an internally mounted non-volatile[2] Compact Flash (CF) memory card. The Intelliflow Controller does not record any flight information.

Satloc Devices

The Satloc Display and Light Bar are part of an on-board control system designed to programmatically control spray rates based on vendor and user specified mapping. They interface with the Hemisphere M3 Bantam and Intelliflow Controller to provide control over flow rates and spray routes. Neither unit records flight data.

NVM Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an exterior examination revealed that the units had sustained minimal damage. The internal CF card was removed from the M3 Bantam (see figures 1 – 2) and imaged using standard computer forensic tools. Flight log files corresponding to the data of the accident were recovered and decoded using the manufacturer's proprietary *MapStar* software.

NVM Data Description

Figures 3 – 4 are Google earth overlays of the track log recovered from the Hemisphere MD M3 Bantam.[3] Figure 3 shows N40499 departing from the operating field near the bottom of the figure and flying north to the application site. Figure 5 shows the flight path during the application process. Red lines indicate flight during non-spray periods, and green lines indicate flight while spraying. The data is buffered in volatile memory[4] continuously during recording, and periodically written to the CF card. The length of the data buffer will vary depending on the internal processor workload, but can be on the order of 10-20 seconds, or longer. This data is permanently lost when power is interrupted to the M3 Bantam, as occurred in this accident.

Tabular data corresponding to this flight is provided in attachment 1 to this report. A key to this tabular data is given in appendix A.

[2] Non-volatile memory does not require continuous power to retain data.
[3] Weather and seasonal conditions will generally vary from those extant at the time of the accident.
[4] Volatile memory requires a continuous application of power to retain data. Any power interruption will result in complete and irreversible data loss.

Figure 1. External view of the Hemisphere GPS MD M3 Bantam.

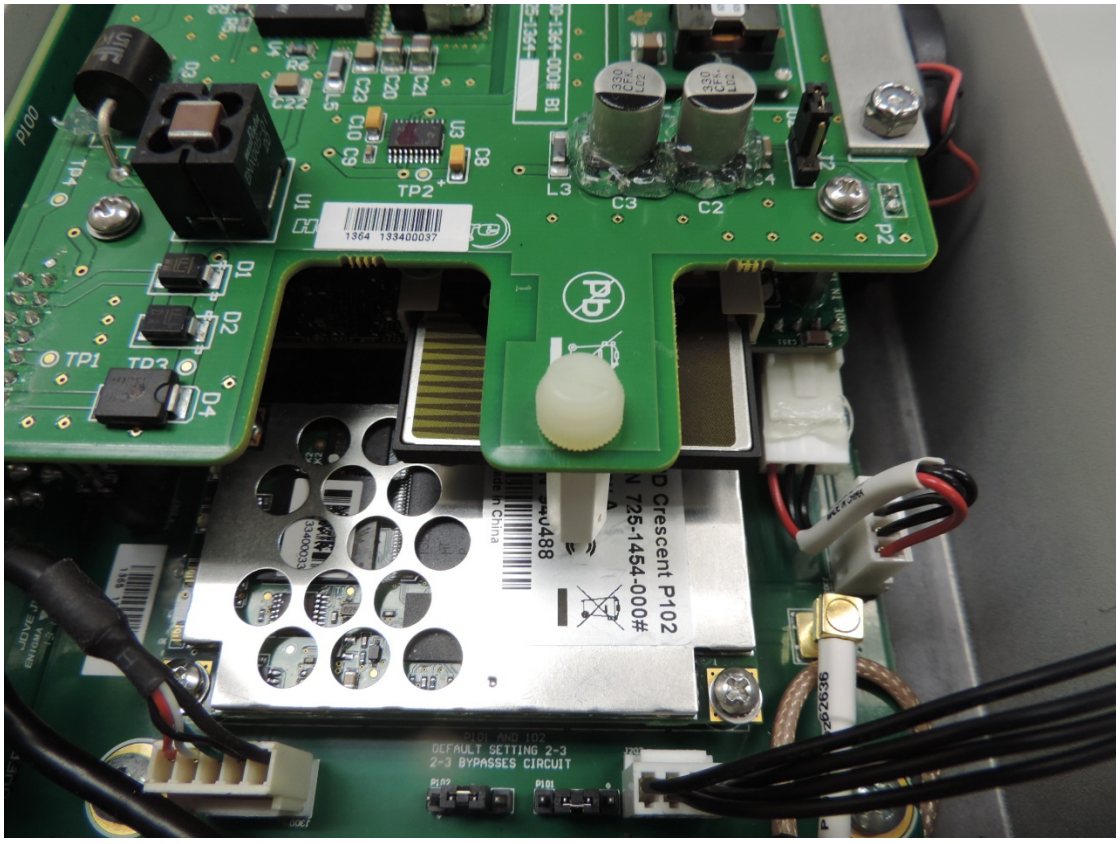

Figure 2. Internal view of the Hemisphere GPS MD M3 Bantam showing the CF Card.

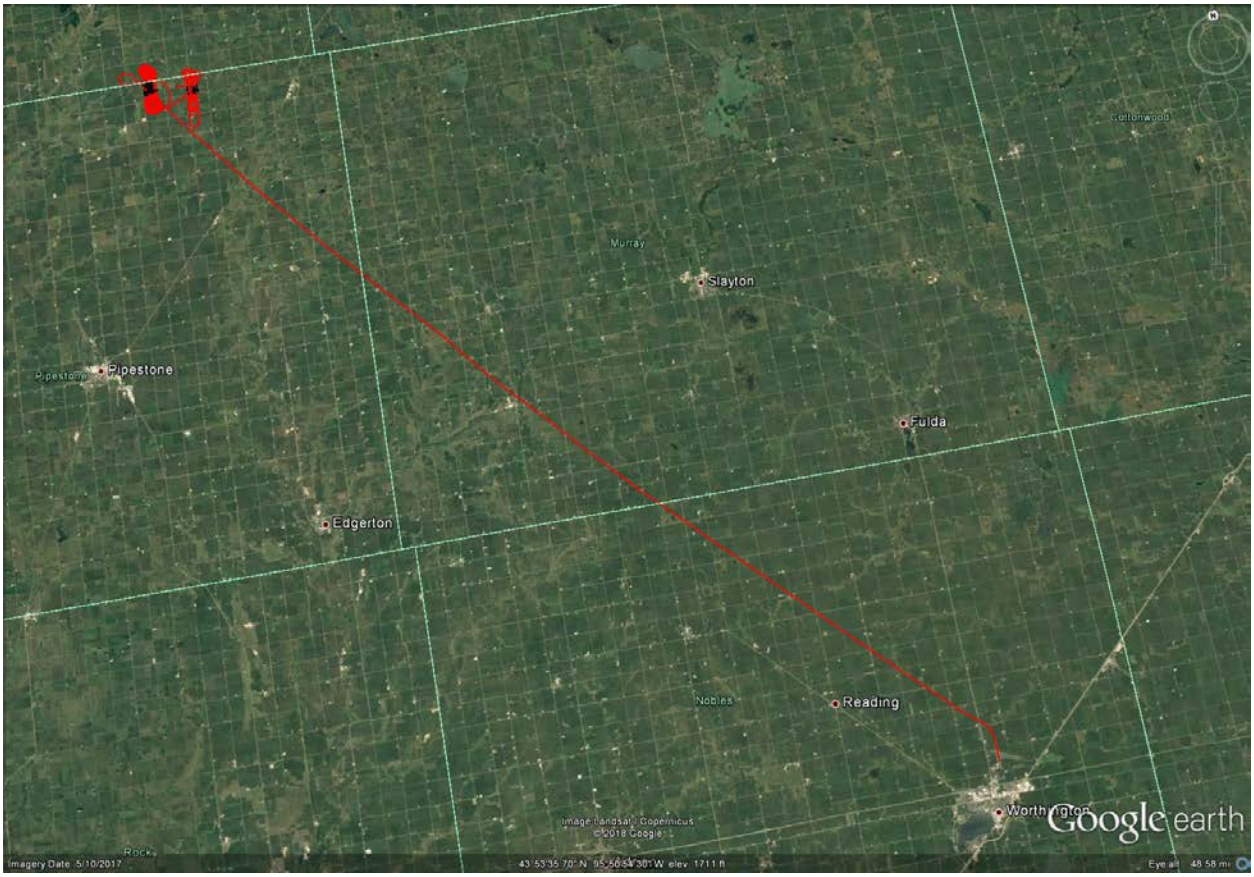

Figure 3. *Google Earth* 2-D overlay depicting the accident flight from takeoff to the end of the recording.

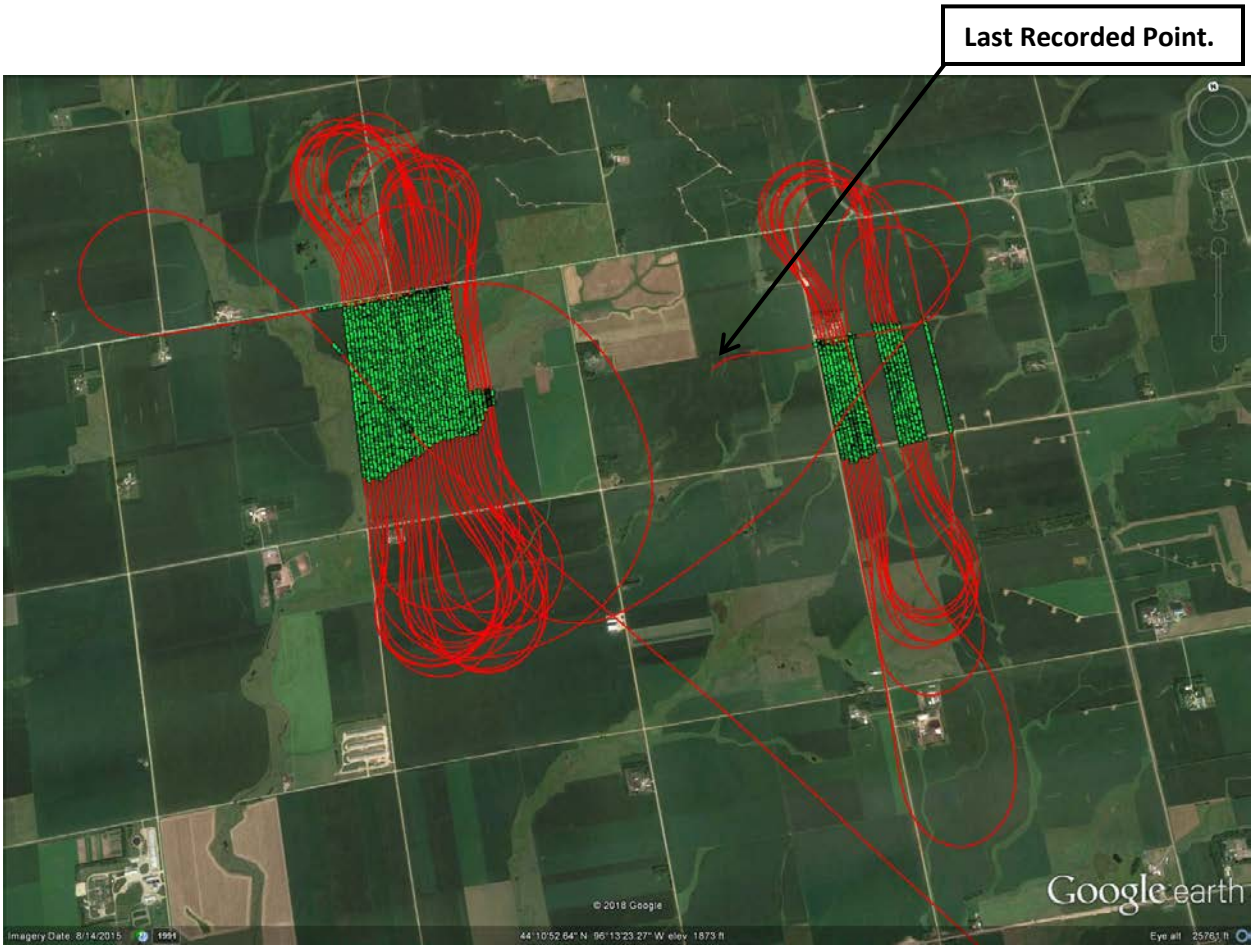

Figure 4. *Google Earth* 2-D overlay depicting the spray pattern followed during the accident flight.

APPENDIX A

Tabular data corresponding from a Hemisphere MD M3 Bantam (s/n 1335-HH06129-0071) recovered from a Thrush Aircraft Inc. S2R T660, N40499, that struck a tower during an agricultural application flight near Ruthton, Minnesota on August 19, 2016 is contained in Attachment 1 to this report

LEGEND

Date	Date of recorded data point
Time	Time (CDT) of recorded data point
Latitude	Latitude coordinate in degrees
Longitude	Longitude coordinate in degrees
GPS Ellipsoidal Altitude	Altitude above a mathematical reference ellipsoid representing an average position of the earth surface
GroundSpeed	Computed ground speed in mph
Course	Computed true course in degrees