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

May 16, 2016

Other Devices

Specialist's Factual Report
by James Cash

1. EVENT

Location:	Holland, Minnesota
Date:	July 27, 2015
Aircraft:	Steve Christensen Wheeler Express
Registration:	N3FC
Operator:	Private
NTSB Number:	CEN15FA321

On July 27, 2015, about 2013 central daylight time, a Steve Christensen Wheeler Express airplane, N3FC, was substantially damaged after impacting terrain near Holland, Minnesota. The pilot and two passengers were fatally injured. The airplane was registered to and operated by a private individual under the provisions of 14 Code of Federal Regulations Part 91 as a personal flight. Day visual meteorological conditions prevailed for the flight, with no flight plan filed. The local flight departed from Pipestone Municipal Airport (PQN), Pipestone, Minnesota.

2. DETAILS OF INVESTIGATION

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

Device 1:	Chelton (Sierra Flight Systems) EFIS-2000
Device 1 Serial Number:	401109
Device 2:	Appareo Stratus 2
Device 2 Serial Number:	221820
Device 3:	Garmin GPSMAP 195
Device 3 Serial Number:	61004615

2.1. Device 1: Chelton (Sierra Flight Systems) EFIS-2000 Device Description

The Chelton cockpit display is panel mounted unit that incorporates several functions into one unit. The display incorporates a solid state Air Data and Attitude Heading Reference System (ADAHRS) that provides the pilot with an electronic presentation of the aircraft's altitude, airspeed, attitude, vertical speed, and heading. Additionally the

display includes a multi-channel global positioning satellite receiver (GPS) that drives several ground presentation and navigation function on the display. The unit also presents various engine and aircraft system information to the pilot via the display. This information includes engine RPM, temperatures, oil pressure and temperature, fuel quantities, flow and pressure.

The unit contains an internal memory card that stores information the unit uses to generate the various displays. Additionally, the unit has a data logging function, which is used by the manufacturer for maintenance and diagnostics. Maintenance and diagnostic information recording consists of system information, event data and flight data. The unit is able to display the terrain/map information, approach chart information and other aircraft/operational information depending on the specific configuration and options that are installed

The unit generates new data file container for each power-on cycle. The oldest file is dropped and replaced by a new recording once the storage limit has been reached. The Chelton unit records a complete set of data once every second to the internal memory card

2.1.1. Chelton (Sierra Flight Systems) EFIS-2000 Data Recovery

Upon arrival at the Vehicle Recorder Division, an exterior examination revealed the unit had sustained significant impact damage. The unit was disassembled to remove the internal memory card. The memory card was mechanically damaged and was slightly bent along its longitudinal axis.

The memory card recovered was a standard 512 Mb PCMCIA[1] solid-state memory card. The card's case was opened and the internal memory and circuit card was examined. The internal circuit card and memory appeared to be undamaged. The card was mounted into a PCMCIA to USB playback reader. The card failed to mount or respond when connected to a lab's PC workstation.

An identical replacement blank PCMCIA memory card was obtained from Chelton. The 4 memory chips from the accident card were transplanted to the new replacement card. The memory card mounted correctly and the recorded log files were downloaded normally. Time for the display can either be derived from the received GPS signals or can be manually set by the pilot.

2.1.2. Chelton (Sierra Flight Systems) EFIS-2000 Data Description

The data extracted included 5 power file containers or flights from June 29, 2015,[2] through July 27, 2015. The accident flight was the last file container; recorded starting at 19:52:00 CDT and ending at 20:13:00 CDT on July 27, 2015 (1214 once per second records).

[1] Personal Computer Memory Card International Association (**PCMCIA**)
[2] All dates and times are referenced to Central daylight Savings Time (CDT).

2.2. Garmin GPSMAP 195 Device Description

The Garmin GPSMAP 195 is a battery-powered portable 12-channel GPS receiver with a monochrome display screen. The unit stores date, route-of-flight, and flight-time information for up to 50 flights. A flight record is triggered when groundspeed exceeds 30 knots and altitude exceeds 500 feet, and ends when groundspeed drops below 30 knots for 10 minutes or more. A detailed tracklog – including latitude, longitude, date, time, and GPS altitude information for an unspecified number of points – is stored within the unit whenever the receiver has a lock on the GPS navigation signal. Position is updated within the tracklog as a function of time or distance moved, depending on how the unit has been configured. Once the current tracklog memory becomes full, new information either overwrites the oldest information or recording stops, depending on how the unit is configured. Tracklog storage may be activated or de-activated at user discretion. All recorded data is stored in non-volatile memory[3]. The unit contains hardware and software permitting the download of recorded waypoint, route, and tracklog information to a PC via a built-in serial port using the NMEA 0183 version 2.0 protocol. An internal button-battery is used to back-up power to the internal memory and real-time clock during those periods when main power is removed.

2.2.1. Garmin GPSMAP 195 Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an exterior examination revealed the unit had not sustained any damage and the recorded information was extracted using the manufacturer's software without difficulty.

2.2.2. Garmin GPSMAP 195 Data Description

The data extracted included three track files from March 21, 2008 through March 23, 2008. The accident flight was not recorded on the GPS.

2.3 Device 3: Appareo Stratus Device Description

The Appareo Status device is a self-contained battery powered unit that contains an internal AHRS[4], GPS/WAAS[5] receiver, ADS-B[6] radar transponder receiver and weather receiver all in one compact unit. The unit communicates wirelessly with the pilot's I-Pad or I-Phone to display all of the acquired information. The pilot needs to have a particular software application called ForeFlight[7] installed on his laptop/I-Pad to view the Stratus data. In addition to communicating with the pilot's computer, the Stratus device records the same information internally on a non-volatile flash memory chip. The

[3] Type of solid state memory that does not require electrical power to retain information
[4] The Attitude Heading Reference System consists of a set of 3-axis gyroscope, accelerometers and heading reference sensors that enable the unit to compute the aircraft's pitch, roll and yaw motions.
[5] The Wide Area Augmentation System (**WAAS**) is an air navigation aid to augment the Global Positioning System (GPS), by improving its accuracy, integrity, and availability.
[6] Automatic dependent surveillance – broadcast (ADS–B) is a cooperative surveillance technology in which an aircraft determines its position via satellite navigation and periodically broadcasts it, enabling it to be tracked. The information can be received by air traffic control ground stations as a replacement for secondary radar. It can also be received by other aircraft to provide situational awareness and allow self-separation
[7] I-Pad app (program) that communicates wirelessly with the Appareo Status unit to display aircraft's attitude, navigation, weather, and traffic information

internal memory has the space to store over 13 hours of flight data that is sampled at a rate of 5 data records per second.

2.3.1 Appareo Stratus Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an exterior examination revealed the unit had sustained significant impact damage as a result of the accident. Several internal electronic components and circuit boards were smashed and dislodged from the main circuit board. Repair of the main circuit board was attempted but proved unsuccessful. The flash memory chip was identified and removed from the main circuit board. The chip was read using the labs chip reader. The resulting binary file was converted to engineering units using the labs conversion program that is based on documentation provided by Appareo. There were two sets of files obtained from the data recovery process. One file contained the position data that is based on the internal GPS receiver that is built into the Appareo Stratus unit. The other file consisted of the AHRS data which contains the pitch, roll, and yaw and 3-axis acceleration motion experienced by the device.

2.3.2 Appareo Stratus Data Description

The data recovered from the Appareo Stratus device consisted of data from old cross country flights around the state of North/South Dakota and Minnesota. The accident flight was not found in the data recovered from the unit.

3.0 Accident Flight Data

Figure 1 depicts the flight track of the accident flight from the takeoff from the Pipestone Municipal Airport, Pipestone Minnesota to the accident located near Holland Minnesota overlaid on a Google Earth map. Figure 2 depicts approximately the last minute of the flight track just prior to the accident location overlaid on a Google Earth map. Figure 3 and Figure 4 depicts the data recovered from the Chelton EFIS-2000 device for the entire accident flight from Pipestone to Holland Minnesota. Figure 5 and Figure 6 depicts the last 3 minutes of data recovered from the Chelton unit.

Tabular data recovered from the Chelton EFIS-2000 device used to generate figures 1 through 6 are included as Attachment 1. This attachment is provided in electronic comma-delimited (.CSV) format.

Figure 1 Accident Flight Overlaid on Google Earth

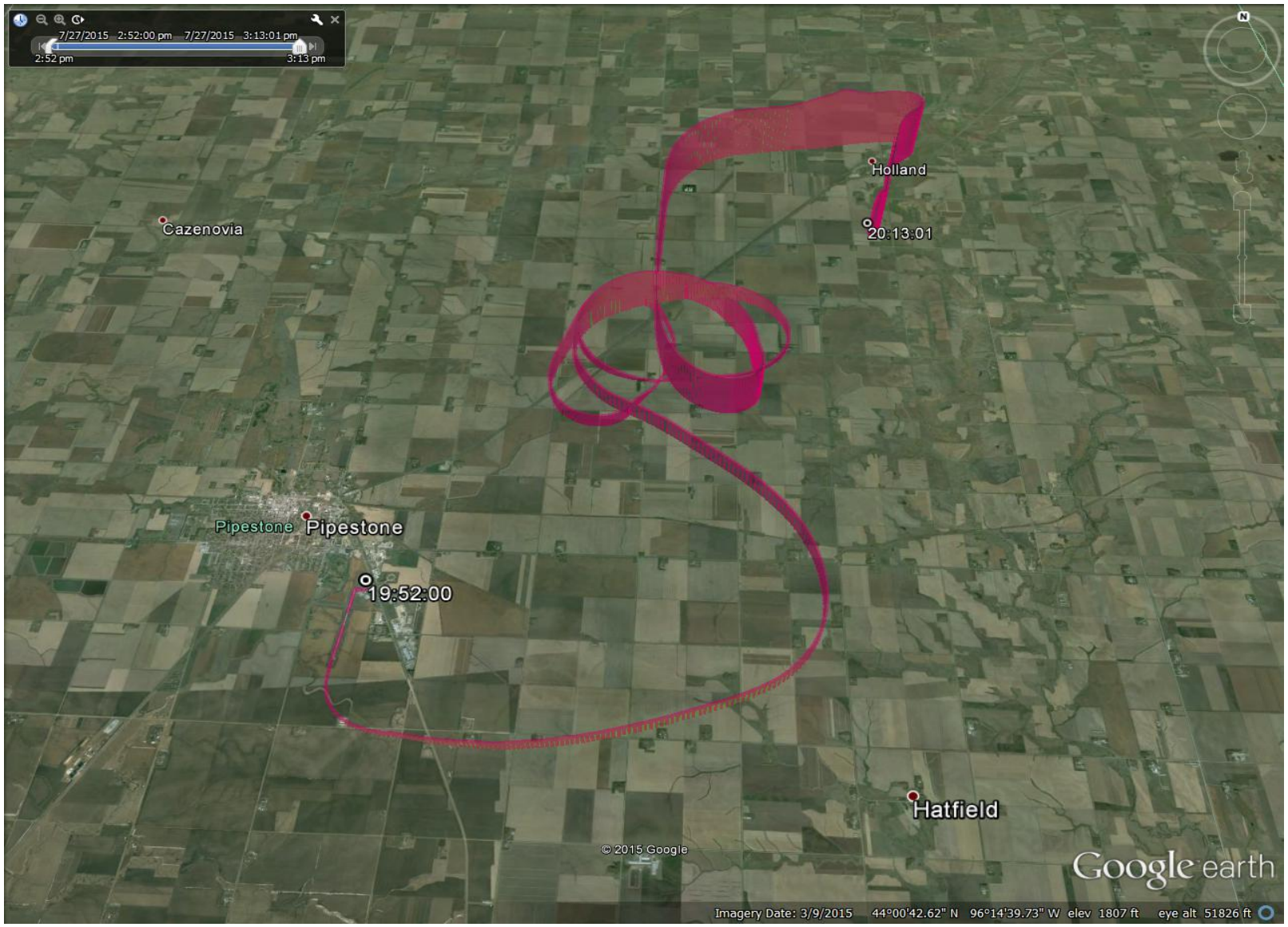

Figure 2 End of Accident Flight Overlaid on Google Earth

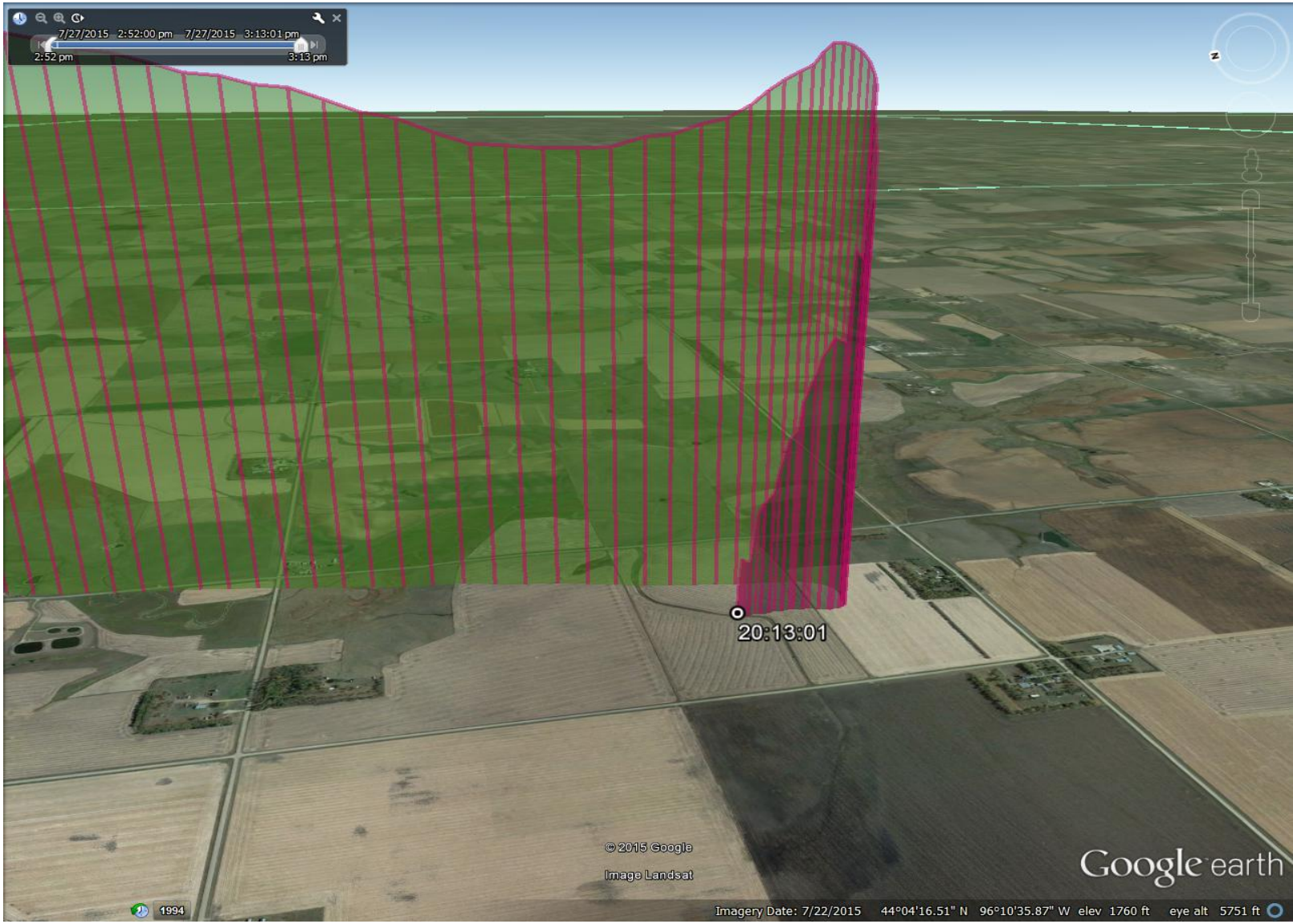

Figure 3 Chelton EFIS-2000 Data of Entire Accident Flight

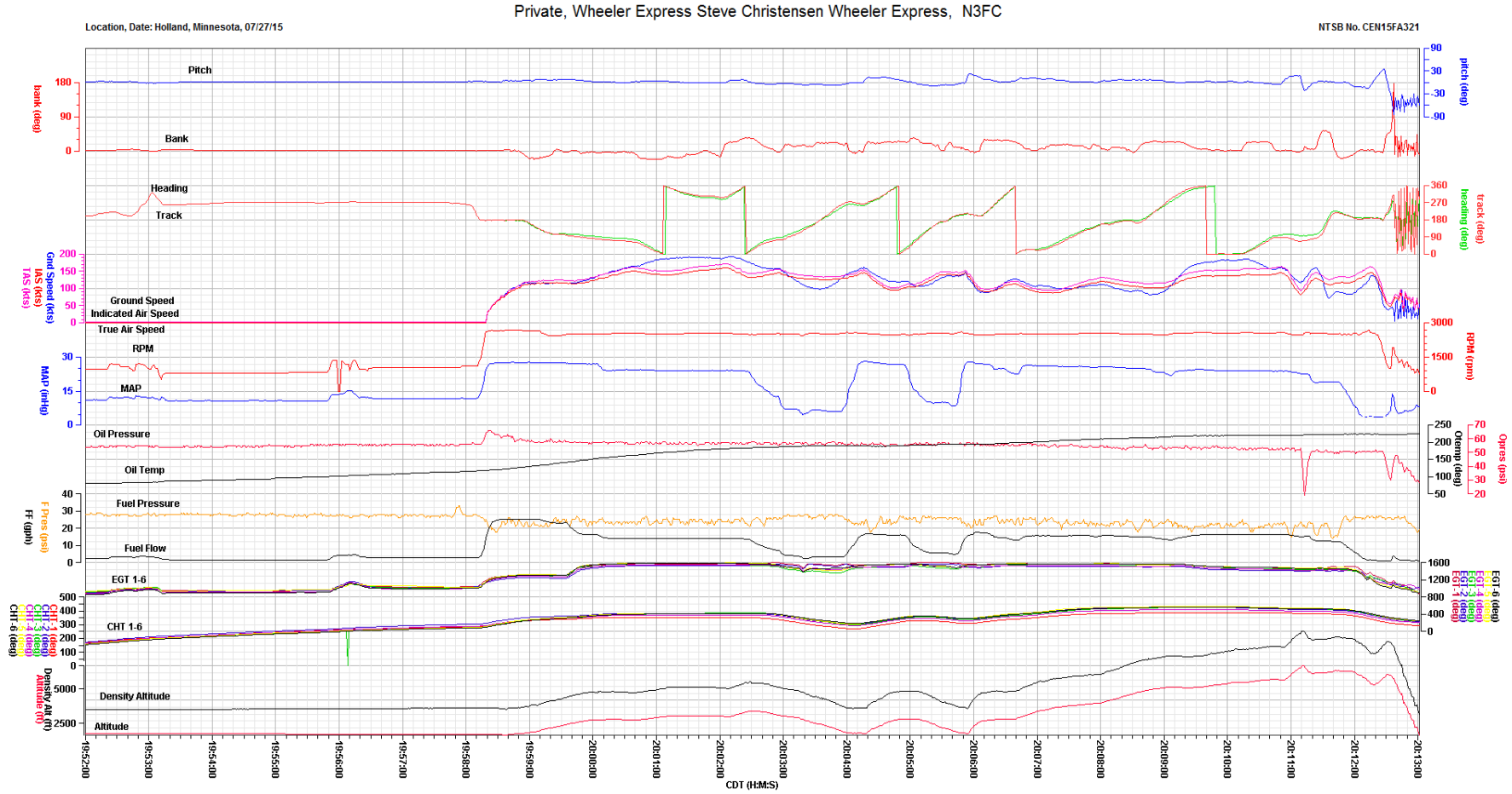

Figure 4 Chelton EFIS-2000 Data of Entire Accident Flight (cont)

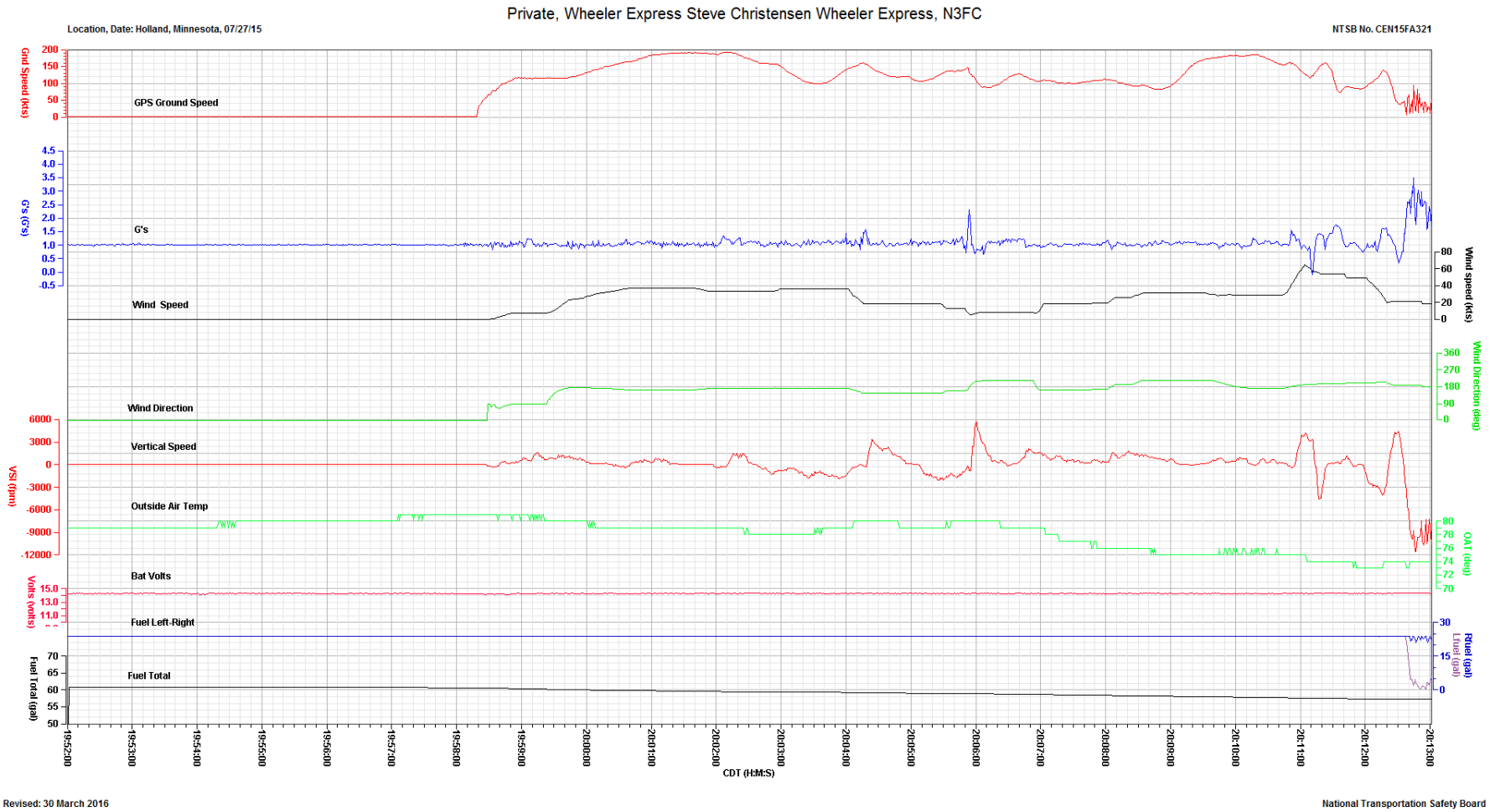

Figure 5 Chelton EFIS-2000 Data of Last 3 Minutes of Accident Flight

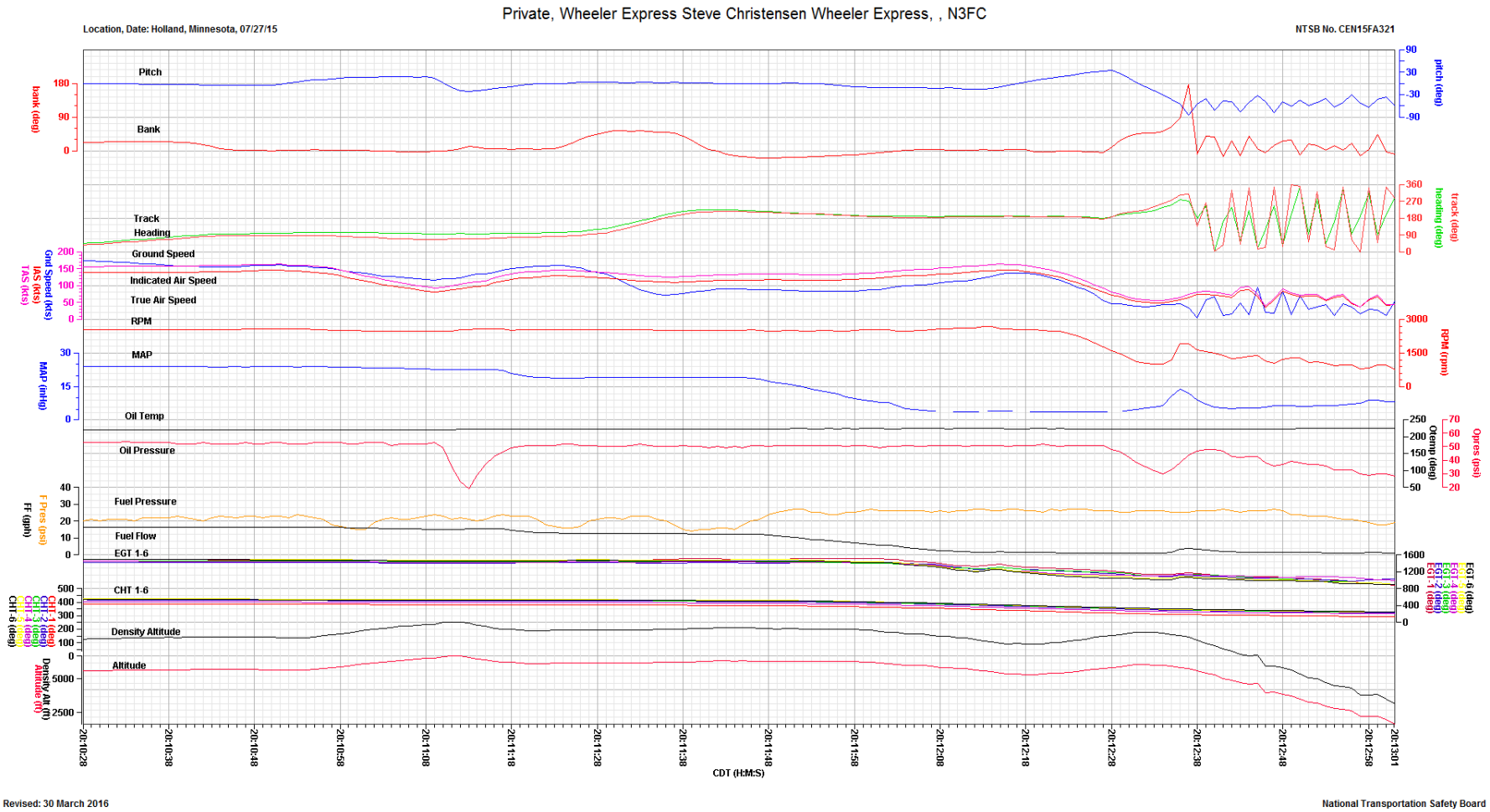

Figure 6 Chelton EFIS-2000 Data of Last 3 Minutes of Accident Flight (cont)