

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

November 1, 2013

Multi-Function Display(s) Factual Report

Specialist's Factual Report
By George Haralampopoulos

1. EVENT SUMMARY

Location: Winston Salem, North Carolina
Date: March 31, 2013
Aircraft: Lancair LC 42-550FG
Registration: N6506L
NTSB Number: ERA13FA184

On March 31, 2013, at 1250 Eastern daylight time, a Lancair LC42-550FG, N6506L, was destroyed when it collided with trees and terrain during a forced landing after a loss of engine power near Smith Reynolds Airport (INT), Winston-Salem, North Carolina. The certificated commercial pilot and pilot-rated passenger were fatally injured. Instrument meteorological conditions prevailed, and an instrument flight rules flight plan was filed for the flight which originated from Wilkes County Airport (UKF), North Wilkesboro, North Carolina, and destined for Warren Field Airport (OCW), Washington, North Carolina. The personal flight was conducted under the provisions of Title 14 Code of Federal Regulations Part 91.

2. DETAILS OF RECORDER INVESTIGATION

The NTSB Vehicle Recorder Laboratory received the following device(s):

Manufacturer/Model: Avidyne Multi-Function Display (MFD)
Serial Number: N/A

Manufacturer/Model: Avidyne Primary Flight Display (PFD)
Serial Number: N/A

2.1 Avidyne MFD Description

The MFD unit is able to display the pilot checklist, terrain/map information, approach chart information and other aircraft/operational information depending on the specific configuration and options that are installed. One of the options available is a display of comprehensive engine monitoring and performance data.

Each MFD contains a CF memory card located in a slot on the side of the unit. This memory card contains all of the software that the MFD needs to operate. Additionally, this card contains all of the checklist, approach charts, and map information that the unit uses to generate the various cockpit displays.

During operation, the MFD display receives information from several other units that are installed on the aircraft. Specifically, the MFD receives GPS position, time and track data from the aircraft's GPS receiver. The MFD may also receive information from the aircraft concerning altitude, engine and electrical system parameters, and outside air temperature. This data is also stored on the unit's CF memory card.

The MFD generates new data files for each MFD power-on cycle. The oldest file is dropped and replaced by a new recording once the storage limit has been reached. MFD data are sampled every six seconds, and is recorded to memory once every minute. If an interruption of power occurs during the minute between MFD memory write cycles, data sampled during that portion of a minute are not recorded.

2.1.1 Avidyne MFD Data Recovery

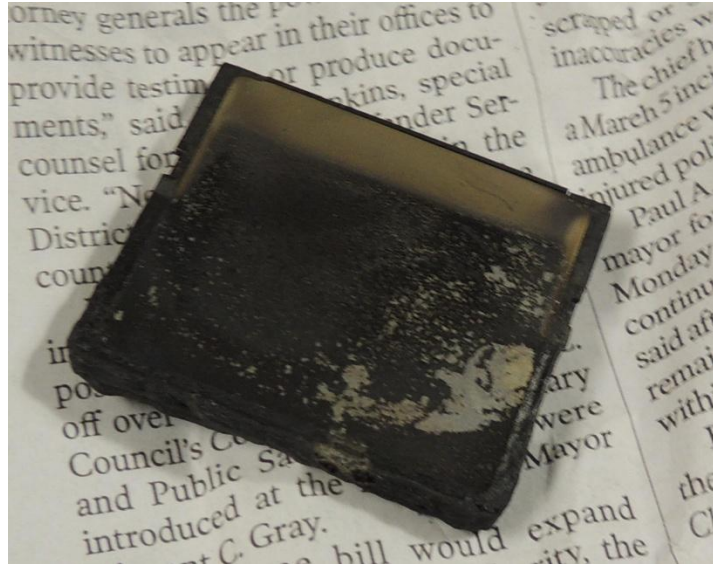
Upon arrival at the Vehicle Recorder Laboratory, an exterior examination revealed that the MFD had sustained major fire damage (figure 1). An interior inspection was performed and a Compact Flash (CF) card was located and removed from the MFD.

An inspection of the CF card showed major fire damage. The CF card was opened and the non-volatile memory flash chips were displaced from the CF cards primary circuit board (PCB) which was consistent with solder flow due to heat. The chips were re-soldered to the CF card (figure 2) and placed in an Avidyne test bench consisting of a surrogate MFD and PFD. The data from the CF card was then extracted by the manufacturer's recommended procedure.

Figure 1. Avidyne MFD as recovered.



Figure 2. Avidyne CF card as recovered from MFD.



2.1.2 Avidyne MFD Data Description

The CF card contained 88 events from July 16, 2012 to March 31, 2013. The accident flight was identified by the file's date and time stamp, which contained 310 data points from 16:17:06 UTC to 16:48:30 UTC on March 31st 2013.

2.2 Avidyne PFD Description

The PFD unit includes a solid state Air Data and Attitude Heading Reference System (ADAHRS) and displays aircraft flight data including altitude, airspeed, attitude, vertical speed, and heading. The PFD unit has external pitot and static port inputs for altitude, airspeed, and vertical speed information. Each PFD contains two TSOP2 Flash memory devices mounted on a riser card. The flash memory stores information the PFD unit uses to generate the various PFD displays. Additionally, the PFD has a data logging function which is used by the manufacturer for maintenance and diagnostics.

The PFD samples and stores several data streams in a sequential fashion; when the recording limit of the PFD is reached the oldest record is dropped and a new record is added. Data from the ADAHRS is recorded at 5 Hz. Air data information such as pressure altitude, indicated airspeed, and a vertical speed are recorded at 1 Hz. Global Positioning System (GPS) and navigation display and setting are recorded at a rate of 0.25 Hz, and information about pilot settings of heading, altitude, and vertical speed references are recorded when changes are made.

2.2.1 Avidyne PFD Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an exterior examination revealed that the PFD had sustained major fire damage (figure 3). An interior inspection was

performed and the PCB containing the PFD's non-volatile flash memory chips was located. The flash memory chips are highlighted by a red box in figure 4. The memory chips were removed from the PCB and placed into a surrogate PFD PCB which was placed in an Avidyne test bench. The data from the PFD was then extracted by the manufacturer's recommended procedure.

Figure 3. Avidyne PFD as recovered.



Figure 4. Avidyne PCB containing two flash memory chips recovered from PFD.



2.2.2 Avidyne PFD Data Description

The PFD flight log contained data from March 1, 2013 to March 17, 2013. The incident event was identified from the PFD's date and time parameters from 10:12:00 UTC to 10:57:54 UTC on March 31st, 2013.

2.3 Time Correlation

The Avidyne MFD and PFD both receive their time from the aircraft's GPS receiver. Correlation of the MFD and PFD to the event local time, Eastern daylight time (EDT), was established by using both devices' respective recorded time parameters in UTC and then applying an additional 4 hour offset to change GMT to EDT. All times are listed in EDT for the rest of the report.

3.3 Engineering Units Conversions

The engineering units conversions used for the data contained in this report are based on documentation from the manufacturer. Where applicable, the conversions have been changed to ensure that the parameters conform to the NTSB's standard sign convention that climbing right turns are positive (CRT=+).¹

Appendix A lists the FDR parameters verified and provided in this report.

2.4 Plots and Corresponding Tabular Data

The following three figures are from the March 31st event. Figure 5 is a Google Earth overlay of the accident flight which shows the aircraft taking off from Wilkes County Airport at around 12:30:00 EDT to the last valid GPS point recorded at 12:49:14 EDT.

Figure 6 is a plot of the entire accident flight from 12:30:00 EDT to 12:48:30 EDT and contains aircraft engine parameters such as, Exhaust Gas Temperature, Cylinder Head Temperature, and Fuel Flow. At about 12:38:40 EDT the oil pressure starts to decrease and at about 12:46:00 EDT the EGTs begin to drop to zero followed by a drop in RPM.

Figure 7 is a plot of the entire accident flight from 12:30:00 EDT to 12:50:21 EDT and contains basic aircraft parameters and auto pilot states such as aircraft attitudes, accelerations, Flight Director, and Auto Pilot modes. Two time markers are used to show the Oil Pressure degradation, with the first time marker showing the Oil Pressure drop below 30 psi at 12:40:12 EDT and the second showing the Oil Pressure drop below 10 psi at 12:42:28 EDT.

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 = +.

These figures are configured such that right turns are indicated by the trace moving toward the bottom of the page, left turns towards the top of the page, and nose up attitudes towards the top of the page.

The corresponding tabular data used to create these four plots are provided in electronic (*.csv²) format as Attachment 1 to this report.

² Comma Separated Value format.

Figure 5. Google Earth overlay of aircraft flight path.

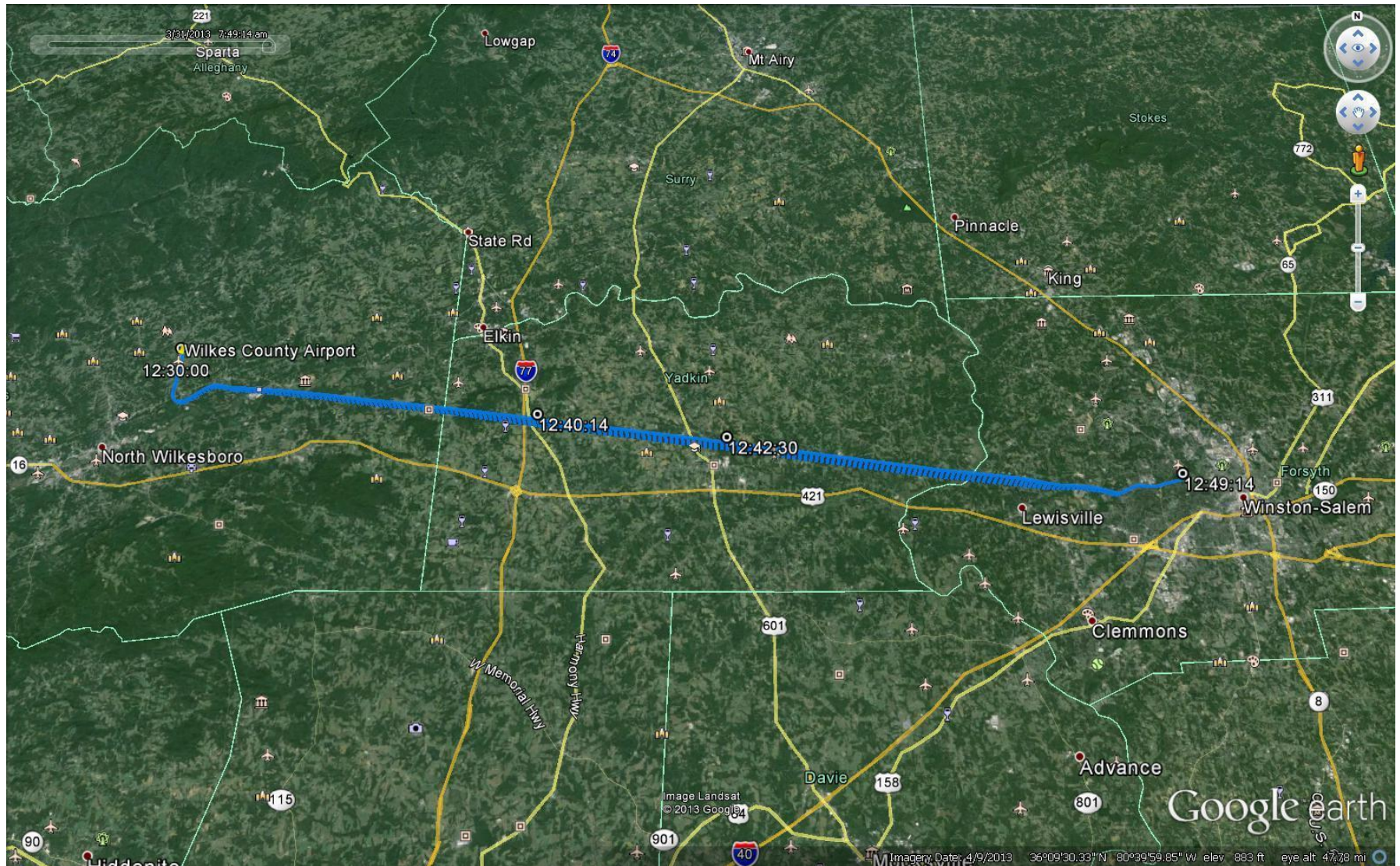
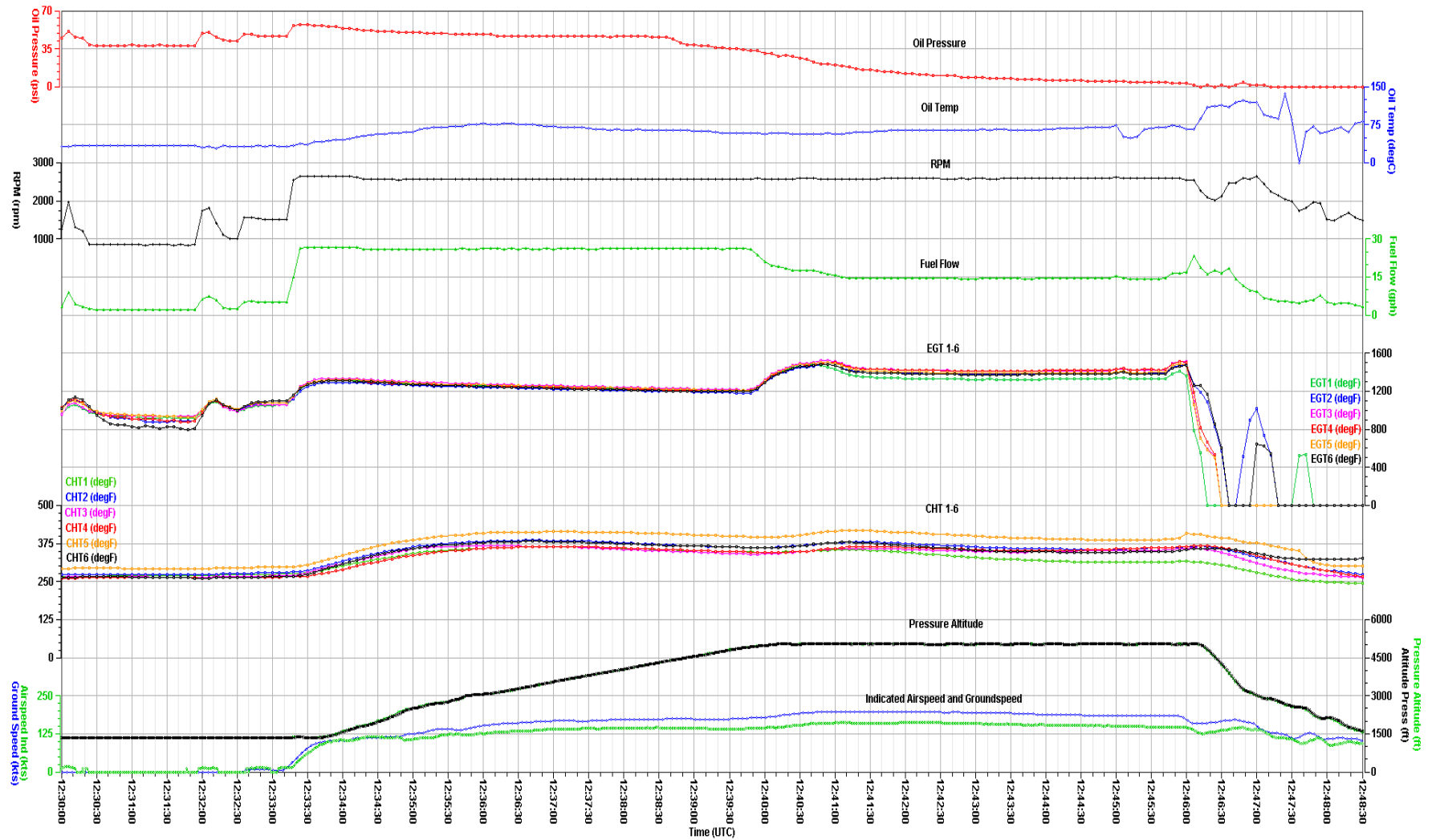


Figure 6. Plot of engine parameters from accident day.

Private, Lancair LC-42, N6506L

Location, Date: Winston-Salem NC, 03/31/13

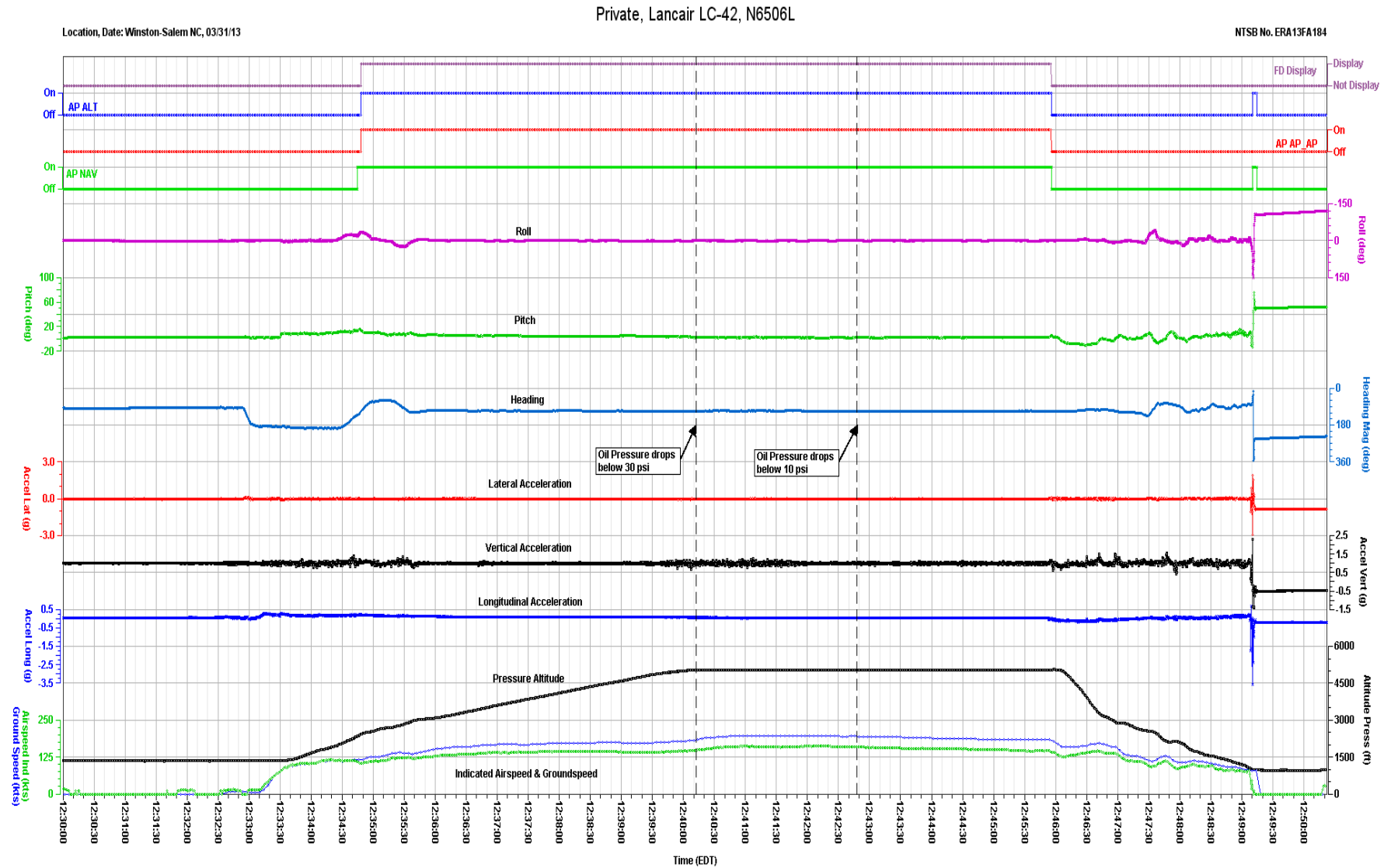
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Figure 7. Plot of basic aircraft parameters from accident flight.



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APPENDIX A

This appendix describes the parameters provided and verified in this report. Table A-1a and A-1b lists the parameters and Table A-2 describes the unit abbreviations used in this report.

Table A-1a. Verified and provided RDM parameters from the PFD.

Parameter Name	Parameter Description
1. Accel Long (g)	Longitudinal Acceleration
2. Accel Vert ^a (g)	Vertical Acceleration
3. Accel Lat (g)	Lateral Acceleration
4. Heading Mag (deg)	Magnetic Heading
5. Pitch (deg)	Aircraft Pitch
6. Roll (deg)	Aircraft Roll
7. Altitude Press (ft)	Altitude Press
8. Airspeed Ind (kts)	Indicated Airspeed
9. Ground Speed (kts)	Ground speed
10. AP NAV (discrete)	Auto Pilot Navigation
11. AP AP_AP (discrete)	Auto Pilot Activated
12. AP ALT (discrete)	Auto Pilot Altitude Mode
13. FD Display (discrete)	Flight Director Display
14. Latitude (deg)	Latitude
15. Longitude (deg)	Longitude

Table A-1b. Verified and provided RDM parameters from the MFD.

Parameter Name	Parameter Description
1. CHT # ^b (degF)	Cylinder Head Temperature #
2. EGT # ^b (degF)	Exhaust Gas Temperature #
3. Fuel Flow (gph)	Engine Fuel Flow
4. RPM (rpm)	Engine RPM
5. Oil Temp (degC)	Engine Oil Temperature
6. Oil Pressure (psi)	Engine Oil Pressure

Table A-3. Unit abbreviations.

Units Abbreviation	Description
degF	degrees Fahrenheit
kts	knots
deg	pounds per square inch
rpm	revolutions per minute
V	volts
ft	feet
gph	gallons per hour

NOTE: ^a The datum for Vertical Acceleration is 1g.

^b # denotes Cylinder numbers 1 through 6.