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

July 6, 2012

Data Recorders

Specialist's Factual Report
By Michael Bauer

1. EVENT SUMMARY

Location: Reno, Nevada
Date: Sep 16, 2011
Aircraft: P-51D
Registration: N79111
Operator: Aero-Trans Corp.
NTSB Number: WPR11MA454

On September 16, 2011, about 1626 Pacific daylight time, an experimental single seat North America P-51D, N79111, collided with the airport ramp in the spectator box seat area following a loss of control while maneuvering during an unlimited class gold heat race at the National Championship Air Races (NCAR) at Reno Stead Airport (RTS), Reno, Nevada. The airplane was registered to Aero-Trans Corp, Ocala, Florida, and operated by the pilot as Race 177, the Galloping Ghost, under the provisions of 14 Code of Federal Regulations (CFR) Part 91. The commercial pilot and 10 people on the ground sustained fatal injuries; more than 60 people were treated for minor to serious injuries. The airplane fragmented upon impact with the ramp. Visual meteorological conditions prevailed, and no flight plan had been filed for the local air race flight, which departed RTS about 10 minutes before the accident.

2. DATA RECORDERS GROUP

A data recorders group was not convened.

3. DETAILS OF ENGINE DATA MONITOR INVESTIGATION

On September 20th, 2011, the Safety Board's Vehicle Recorder Division received the following devices capable of recording data:

Recorder Manufacturer/Model: **Dynon EFIS-10A**
Recorder Serial Number: **3870**

Recorder Manufacturer/Model: **RCATS Telemetry System**[1]
Recorder Serial Number: **N/A**

[1] System included 1-Data Collection Unit, 1-RF Transmitter, and 1-Sensor Adaptor Board

3.1. Dynon EFIS-10A Description

The Dynon Electronic Flight Information System (EFIS) D10A is a 4" wide screen display mounted in the cockpit of non type certificated aircraft. The instrument integrates multiple flight instruments including airspeed, altitude, gyro-stabilized magnetic compass, turn rate, slip/skid ball, bank angle, pitch angle and vertical speed. The unit also has other functions that include a clock/timer, g-meter, voltmeter and a density altitude/true airspeed calculator. The unit contains an Air Data, Attitude and Heading Reference System (ADAHRS) to provide air data, attitude and heading information to the display. Depending on the installation in the operators' aircraft certain parameters might not be displayed, for example angle-of-attack.

Depending on the firmware version on the unit, the ability to log data to internal memory exists. According to the manufacturer, firmware versions 5.0 and later contain the ability to log certain EFIS and GPS parameters. The data logging must be configured by the operator to enable logging and set the data log interval. The unit can also be configured to start logging data automatically at boot-up. The data logging interval can be set to store at 1,3,5,10,30 and 60 second intervals. The internal memory can store at least 2 hours of cumulative data at a 1 second recording interval or at least 120 hours at a 60 second data recording interval. When the recording limit in the internal memory is reached, the oldest record is dropped and a new record is added.

3.1.1. Recorder Condition

The recorder was substantially damaged in the event, see Figure 1 and Figure 2. Multiple components were identified as pieces of the EFIS-D10A. The components were inspected to locate the non-volatile memory component. On the EFIS-D10A, one surface mounted flash TSOP[2] memory chip contains the flight data log information. The memory chip is mounted on a circuit board behind the display. Due to the damage the device sustained in the accident, the memory chip was not attached to the circuit board and was not located. Without the memory chip, no data could be recovered from the EFIS-D10A.

Figure 1 - Dynon EFIS-10A recovered components

[2] Thin Small Outline Package – A type of surface mount design for integrated circuit devices

Figure 2 - Dynon EFIS-10A recovered display components

3.2. RCATS P-51 Telemetry System Description

The aircraft was equipped with a custom RCATS P-51 Telemetry System. The system consisted of three main components, a Data Collection Unit, a RF data link, and Virtual Instrument Panel software. The system was installed aft of the cockpit, see Figure 3 and Figure 4[3].

Figure 3 – Accident aircraft (N79111) with approx. location (red oval) of the RCATS telemetry system

[3] Figure 3 and Figure 4 photos courtesy of Scott Germain.

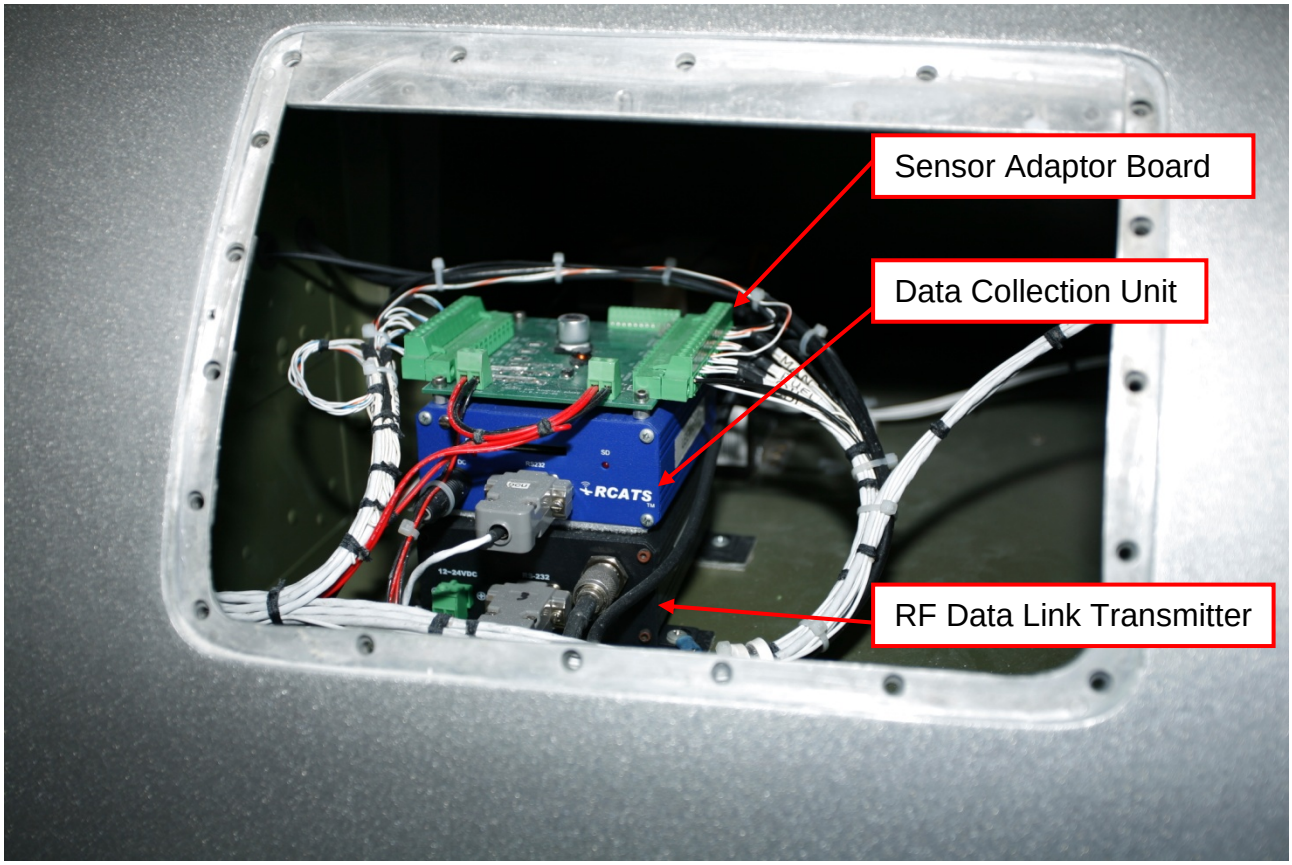


Figure 4 - Accident aircraft (N79111) RCATS telemetry system installation

The Data Collection Unit (DCU), collects the data from various onboard sensors, an internal GPS receiver and an internal accelerometer. The DCU also contains three pressure inputs and two thermocouples. A sensor adaptor board is mounted on top of the DCU which allows for additional inputs. The sensor board inputs are transmitted to the DCU. The DCU has a SD (secure digital) card slot in order to record data from the installed sensors. The sensor data is stored at an approximate rate of 2-3 Hz and GPS system parameters are stored at a 1 Hz rate.

Data from the DCU can also be output to the installed RF data link. The RF data link is a 1 Watt frequency hopping spread spectrum radio. The RF data link consists of a transmitter which is mounted on the aircraft and a receiver which part of a ground station. The DCU data is transmitted via the RF transmitter to the ground station, which allows an operator to monitor the various aircraft parameters in real-time, this is refered to as telemetry (TM) data. The RF data link has an approximate line of sight range of 15 miles, with 20 miles being possible with optimal conditions. The RF datalink is susceptible to data loss due to outside interference, loss of signal, antenna orientation. The system will attempt to send a data packet approximately 5 times, if the packet was not successfully sent, the unit will move onto the next data packet for transmission.

Once data has been transmitted to the ground station via the RF link, the ground station operator can review and store the data in real time using the Virtual Instrument panel software, see Figure 5. The software can be used to playback data recorded either on board the aircraft via the SD card or with data logged from the telemetry system.

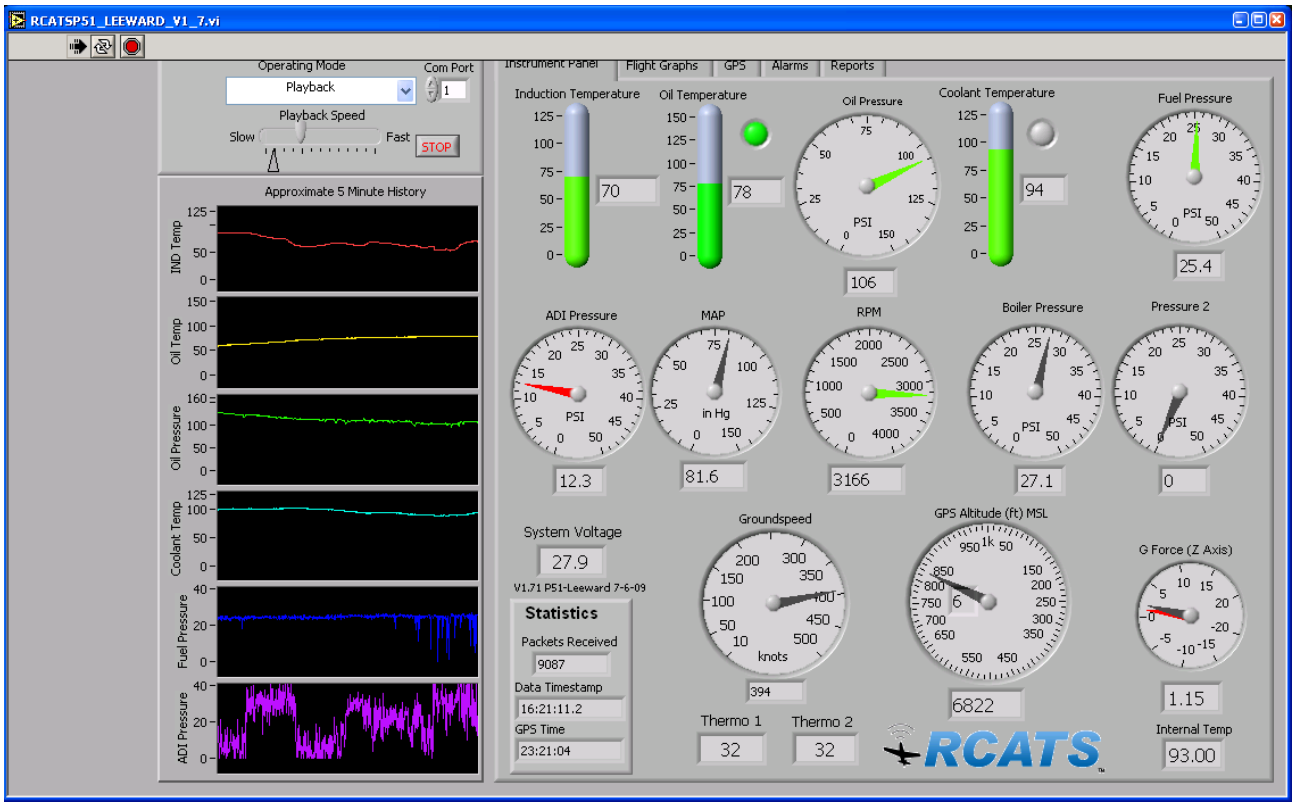


Figure 5 - Sample image of Virtual Instrument panel

3.2.1. Recorder Condition

The DCU, sensor adapter board and the RF transmitter were substantially damaged in the accident, see Figure 6. The DCU was disassembled to gain access to the SD card installed in the unit. One 2 GB SD card was removed from the DCU, see Figure 7. An external inspection of the SD card showed no signs of the external packaging being compromised but did show some surface scratches. The external packaging was removed and the SD card circuit board was visually inspected. No obvious signs of damage were noted. The unit was cleaned and an attempt was made to access the device using an SD card reader. The SD card would mount on the PC, however the drive size was substantially lower (30 Megabytes) than the card capacity.

The SD card was sent to the Federal Bureau of Investigations' Cryptologic and Electronic Analysis Unit in Quantico, VA, to attempt recovery of the data on the SD card. Attempts to recover the data were unsuccessful. During polishing of the device packaging in order to expose the internal die surface, severe cracks in the backside of the memory device were found. The cracks in the memory device make recovery of data from the device unfeasible. The FBI report is included as attachment 1 to this report.

Figure 6 - DCU, sensor adaptor and RF transmitter

Figure 7 - Top and bottom view of recovered SD card

Due the damage to the DCU and the SD card, data recorded onboard the aircraft was not recovered. Data from the ground station TM system was retained and provided to the Safety Board.

3.2.2. Recording Description

The TM recording contained approximately 60 minutes of data. The TM recording captured the data corresponding to the accident.

Additional data files from previous flights and ground runs for the accident aircraft were provided to Safety Board staff. The earliest data set received was a partial flight recorded on September 21, 2009. Section 3.7 contains information regarding data received and data plots for the additional flights that were reviewed and included in this report.

3.2.3. Engineering Units Conversions

The data from the RCATS system is recorded in engineering units.

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

3.2.4. DCU Acceleration Parameter

The DCU contains an accelerometer installed to the units' main circuit board. The datasheet for the accelerometer states a full scale range of ±11g. The design of the unit allows for a possible range of ±10g. The accelerometer readings are not subject to any filtering for airframe vibration and are output at a rate of 2-3 Hz.

3.2.5. GPS data

The DCU contains an internal GPS device and data is output at a rate of 1 Hz. The GPS device has certain dynamic operating limits. The unit will function normally within an acceleration range of +/- 4 g's, a jerk limit of 20 m/s^3 and a speed limit of 515 m/s (approx. 1,001 kts). The quality of the GPS signal can also be degraded during periods of rapid banking and at bank angles which obscure the antenna view of the sky.

The manufacturer/designer of the TM system has noted issues with GPS data when the g's exceed the operational limits.

During the verification of certain datasets, invalid GPS data was removed and not plotted.

3.2.6. GPS and IAS Velocity

In certain data sets, speed information (GPS Velocity or IAS Velocity) was recorded in miles per hour. The data recorded by the accident aircraft was in knots. For comparison purposes all speed data was converted to knots using the following conversion.

$$V_{knots} = V_{miles\ per\ hour} \times 0.868976$$

3.3. Additional Data

During the course of the investigation, additional sets of data[4] were provided by the crew of the accident aircraft. Data from two other race aircraft were provided to Safety Board staff by their respective crews. Aircraft 1 was a modified P-51D race aircraft named Voodoo. Aircraft 2 is a modified Hawker Sea Fury named September Fury[5].

Section 3.8 contains data plots for the additional aircraft and flights that were reviewed and included in this report

3.4. Data Timing

Each recorded data record contains a packet counter and if the data record include a GPS dataset a UTC timestamp. The data was reviewed for consistency in the packet counter and the UTC timestamp. In the event of a data dropout, discontinuities in the packet counter and/or the UTC timestamp are recorded in the data. For certain datasets,

[4] Only positional, speed and acceleration data was provided.
[5] Data from the Hawker Sea Fury included flights before and after the wings were clipped.

including the accident flight, the data timing was reviewed and during periods of data dropouts, the timing was realigned based on the packet counter and valid UTC timestamps.

3.5. Time Correlation

Correlation of the accident flight data to the event local time, Pacific Daylight Time (PDT), was established by using the recorded time in Coordinated Universal Time (UTC) and then applying an additional seven hours offset to change UTC to PDT. Therefore, for the rest of this report, all times are referenced as PDT, not recorded time for the accident flight.

Data from previous flights is referenced to the data record number (Data Point) and is not time based.

3.6. Data Plots and Corresponding Tabular Data for Accident Flight

The following 22 figures contain data recorded during the accident flight, previous flights by the accident aircraft and data received from two additional aircraft.

Data used in figures 8 through 13 have had invalid data removed from the dataset and timing has been adjusted based on the UTC timestamp and the frame counter parameters. The data was recorded using the telemetry ground station.

Figure 8 and Figure 9 contain plots of basic and engine parameters from the accident aircraft during the accident flight. The time period covered is from 16:14:00 to 16:24:40 PDT.

Figure 10 and Figure 11 contain plots of basic and engine data parameters from the accident aircraft during the race portion of the accident flight. The time period covered is from 16:20:50 to 16:24:40 PDT.

Figure 12 and Figure 13 are Google Earth images with the flight path as recorded by the telemetry ground station. The images only cover the race portion of the flight which was three laps. The last recorded GPS position was at 16:24:29. Non GPS data continued recording for an additional 8 seconds. Pylon locations shown are for reference only.

3.7. Data Plots and Corresponding Tabular Data for Previous Flights

During the course of the investigation the Safety Board received a log containing a list of 29 flights from July 2010 to September 2011. The Safety Board also received multiple data sets[6] of telemetry based data from the race team and aircraft owner for previous flights dating back to September 21, 2009. When compared to the flight log and the data sets received, nine flights did not contain and corresponding data set. Of the 74 data files received, 52 files contained data recorded during ground operations and did not contain any flight operations or did not contain relevant flight data. The remaining 22 sets of flight data were reviewed the airworthiness and performance groups, 13 flights were not used. The data for the remaining 9 flights was reviewed. The maximum recorded GPS Velocity was 431 knots during a flight on September 14, 2010 and the maximum recorded G Force

[6] The data sets can contain flights, ground runs or instances when the unit was powered on and recorded although no relevant aircraft operations were being perfomed.

was 5.2 g during a flight on September 17, 2010. Flight information and data plots can be found in Appendix B.

3.8. Data Plots and Corresponding Tabular Data for Additional Aircraft

As stated in section 3.3, data was received from additional race aircraft. Data used in figures 14 through 17 was obtained from aircraft 1 as defined in section 3.3. Data used in figures 18 and 19 were obtained from aircraft 2 as defined in section 3.3.

Figure 14 contains a plot of basic information from a gold class race in 2006. The portion of the data plotted was recorded during maneuvering on the NCAR course. The maximum recorded velocity was 398 kts and the maximum recorded vertical acceleration was 6.2 g. The flight originated and terminated at RTS.

Figure 15 contains a plot of basic information from a gold class race in 2010. The portion of the data plotted was recorded during maneuvering on the NCAR course. The maximum recorded velocity was 401 kts and the maximum recorded vertical acceleration was 5.1 g. The flight originated and terminated at RTS.

Figure 16 contains a plot of basic information from a test flight in 2011. The portion of the data plotted was recorded during a dive, followed by a pull-up. During the dive the maximum recorded velocity was 409 kts and the maximum recorded vertical acceleration was 4.9 g. The flight originated and terminated at RTS

Figure 17 contains a plot of basic information from the same race in which the accident occurred on September 16, 2011. The portion of the data plotted was recorded during maneuvering on the NCAR course. The flight originated and terminated at RTS.

Figure 18 contains a plot of basic information from a gold class race in 2006. The aircraft wing was in its original manufactured configuration. The portion of the data plotted was recorded during maneuvering on the NCAR course. The maximum recorded velocity was 420 kts and the maximum recorded vertical acceleration was 4.8 g. The flight originated and terminated at RTS.

Figure 19 contains a plot of basic information from a gold class race in 2008. The aircraft wing was modified from its original manufactured configuration by reducing the overall wingspan. The portion of the data plotted was recorded during maneuvering on the NCAR course. The maximum recorded velocity was 401 kts and the maximum recorded vertical acceleration was 5.3 g. The flight originated and terminated at RTS.

The corresponding tabular data used to create all plots are provided in electronic (*.csv[7]) format as attachment 2 to this report.

[7] Comma Separated Value format.

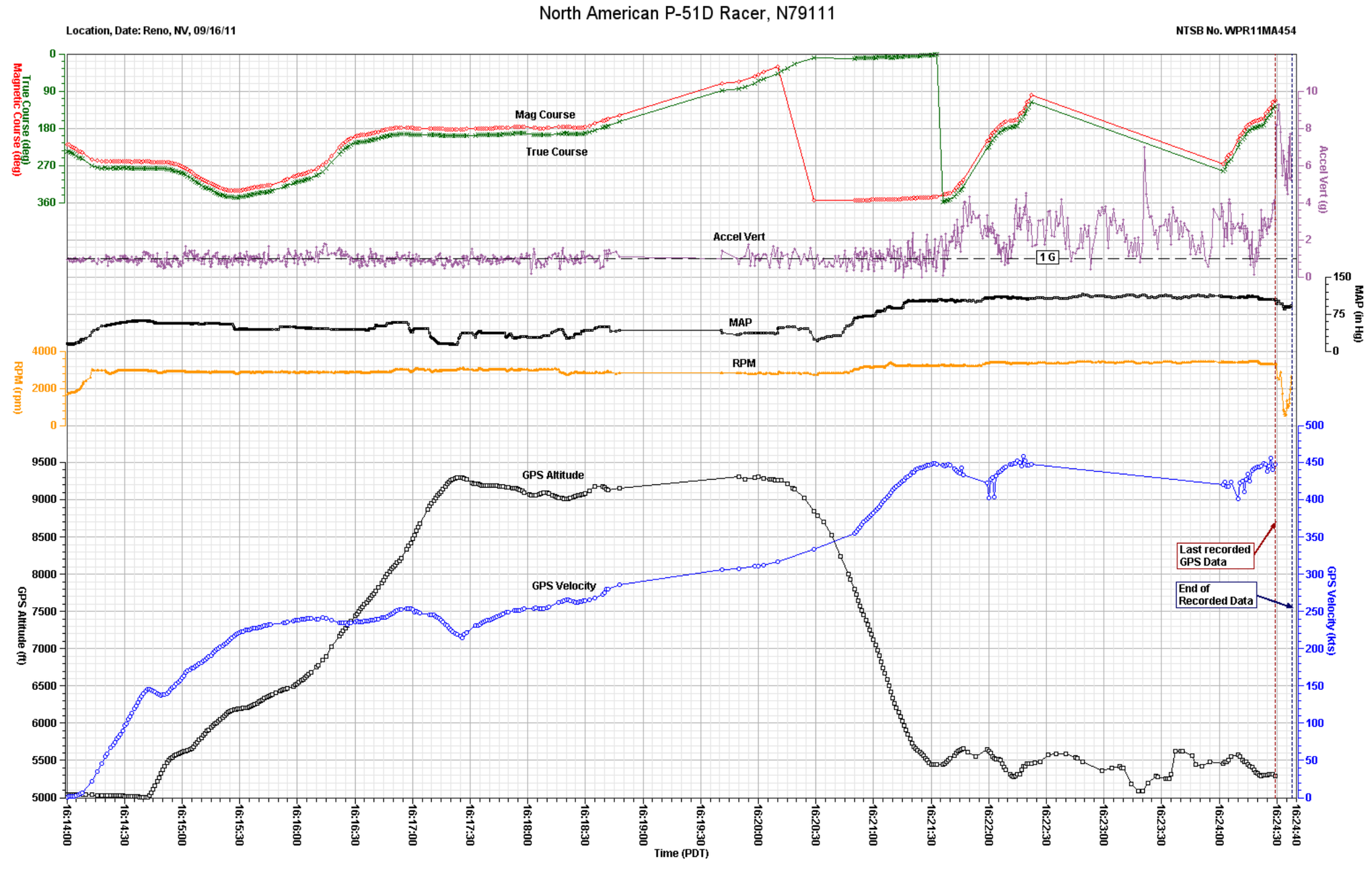
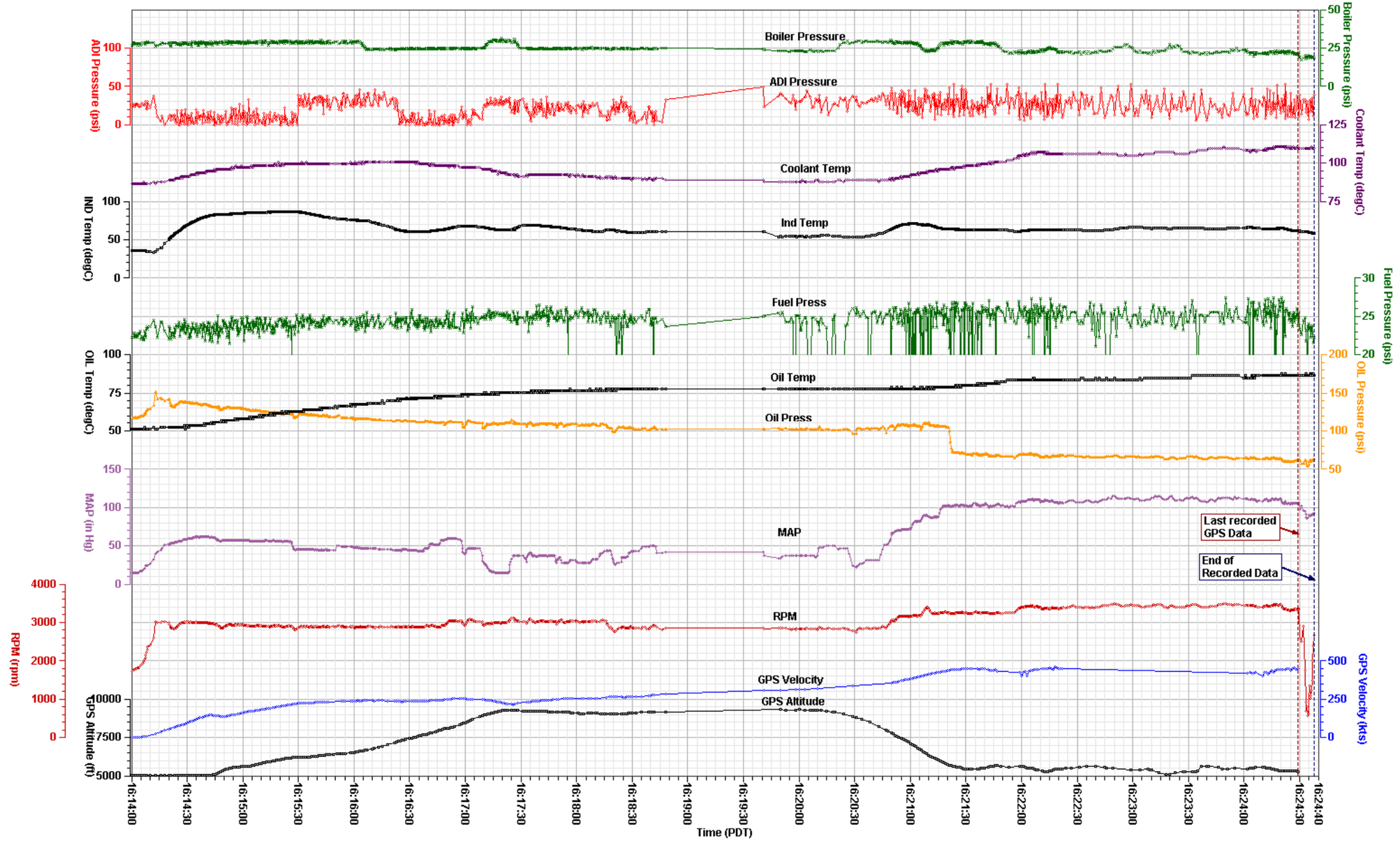


Figure 8 - Basic parameters for accident aircraft from TM system on accident flight

North American P-51D Racer, N79111

Location, Date: Reno, NV, 09/16/11

NTSB No. WPR11MA454



Revised: 14 June 2012

Engine Parameters-Galloping Ghost Accident Flight

National Transportation Safety Board

Figure 9 - Engine parameters for accident aircraft from TM system on accident flight

North American P-51D Racer, N79111

Location, Date: Reno, NV, 09/16/11

NTSB No. WPR11MA454

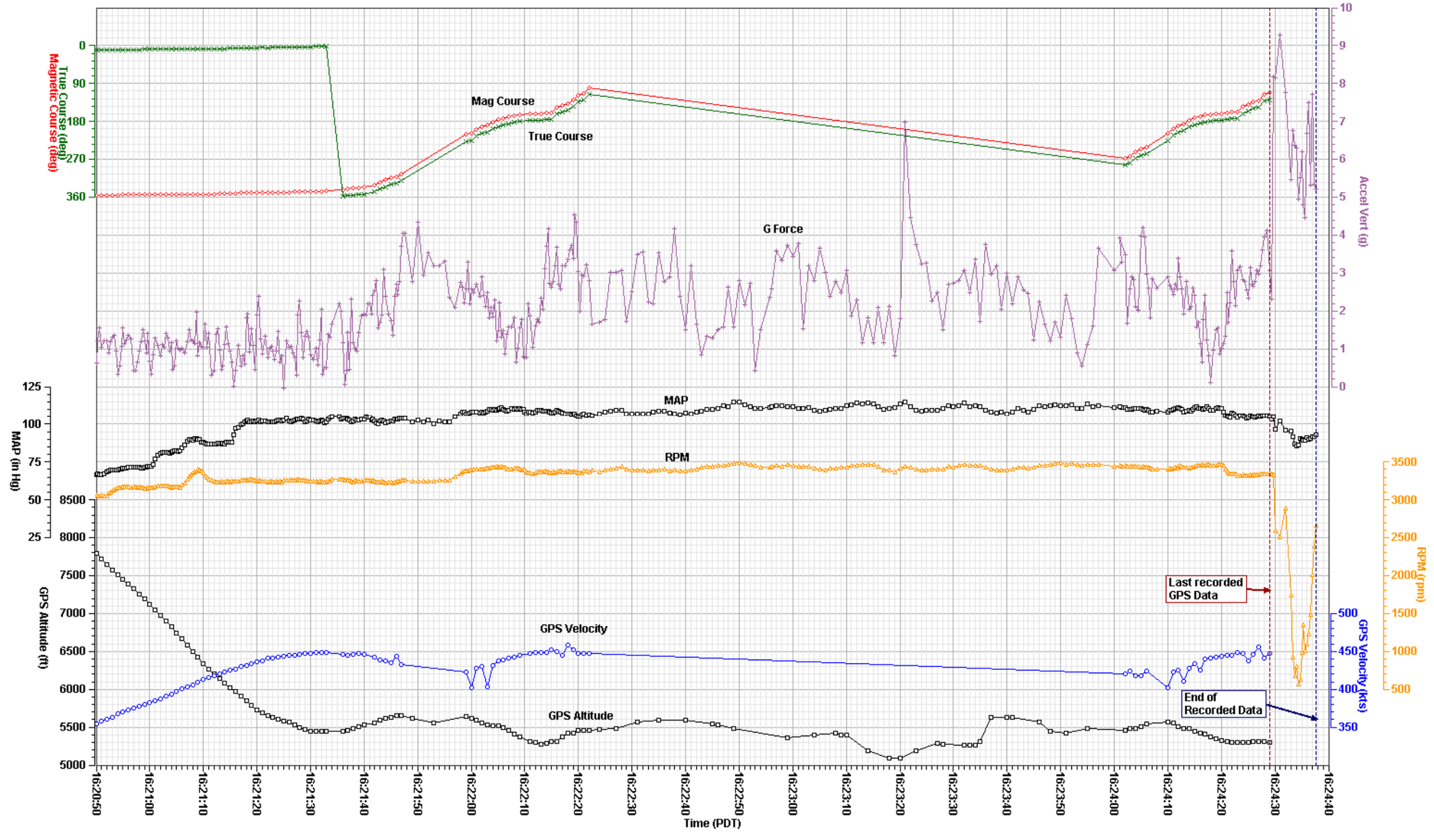


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Figure 10 - Basic parameters for accident aircraft from TM system on accident flight, approximately last four minutes

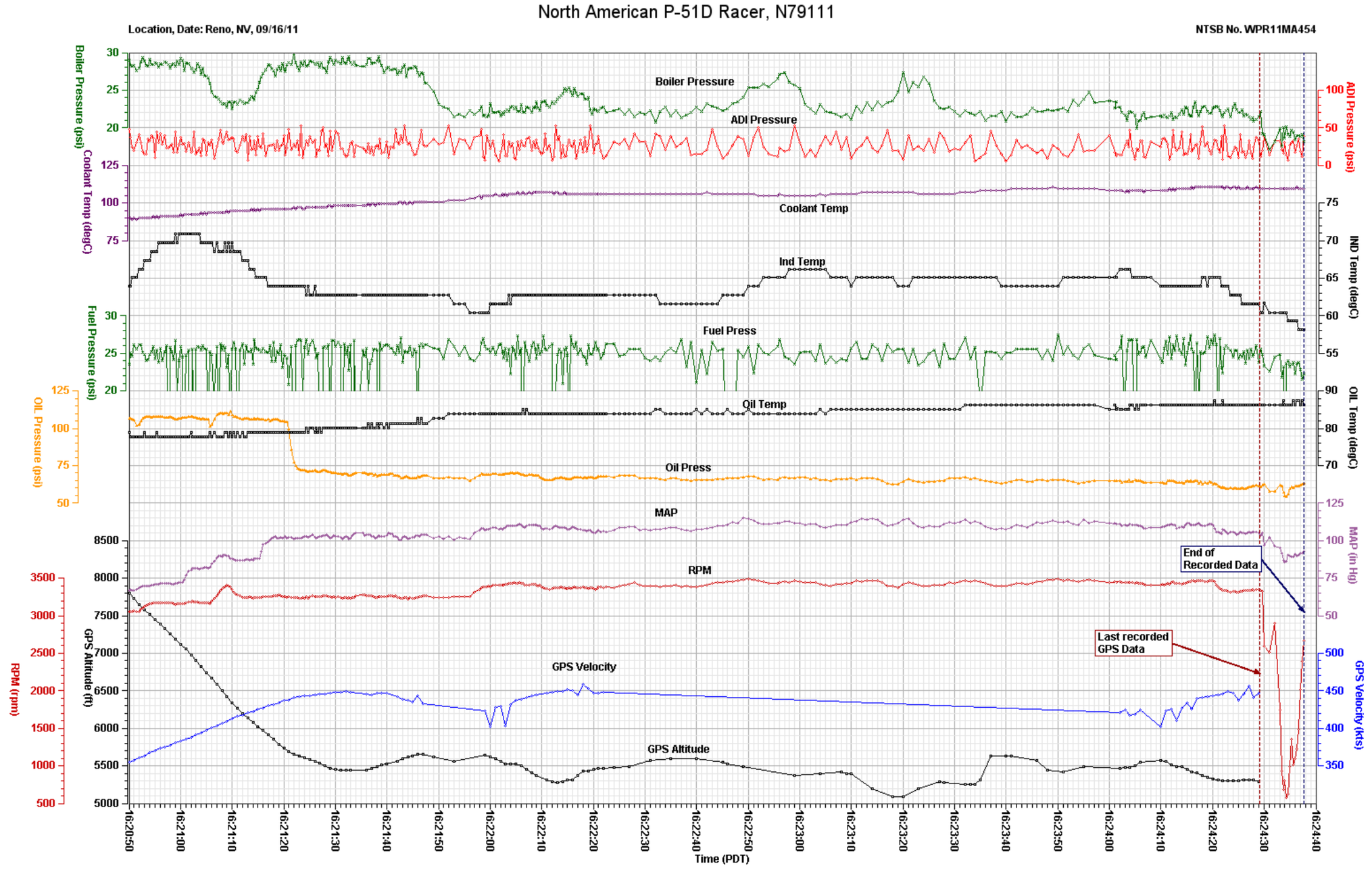


Figure 11 - Engine parameters for accident aircraft from TM system on accident flight, approximately last four minutes

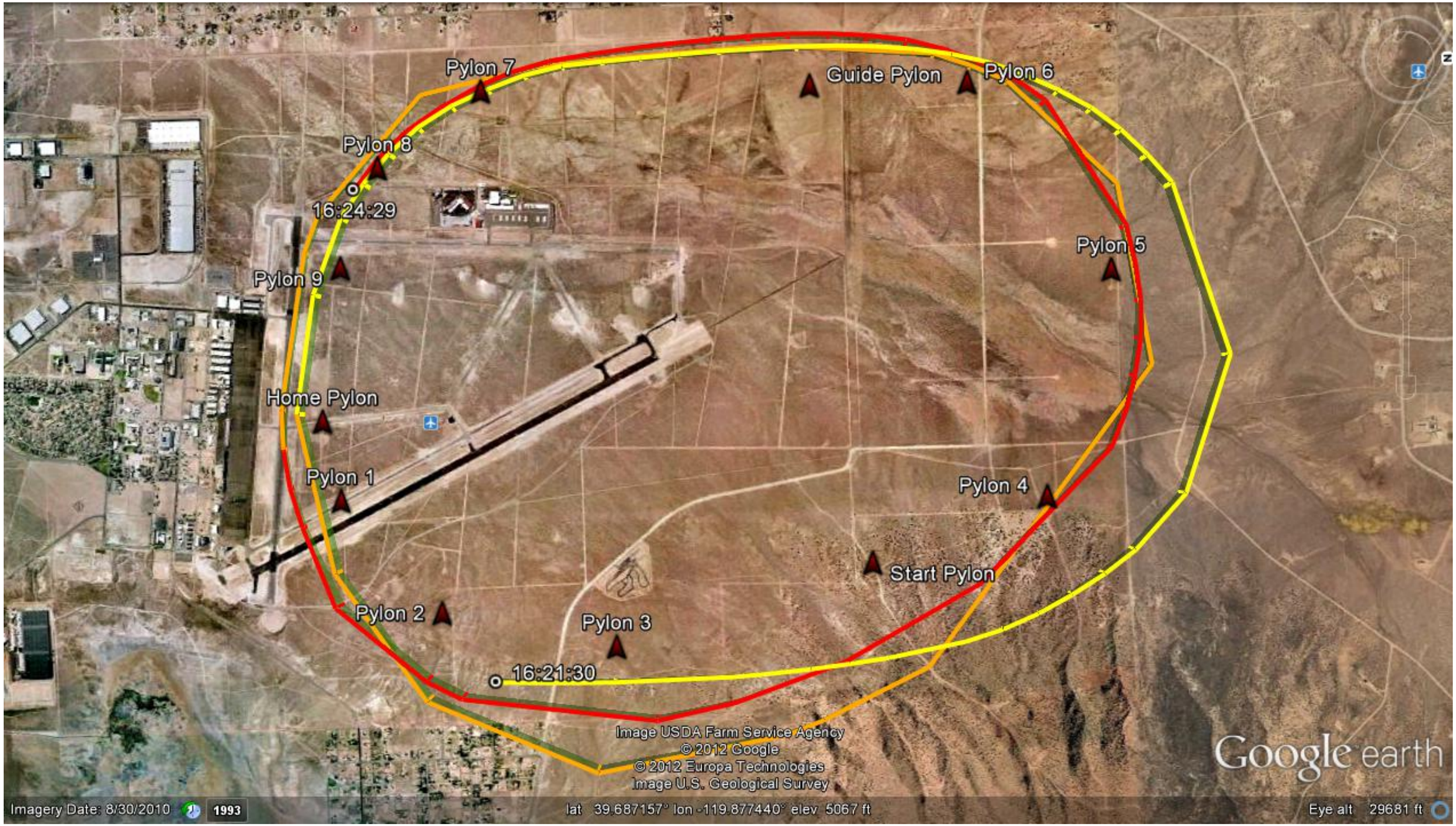


Figure 12 - Accident aircraft flight path, lap 1 (Yellow), lap 2 (Orange), and lap 3 (Red)

Figure 13 - Flight path showing start of lap 3 and the final recorded GPS position

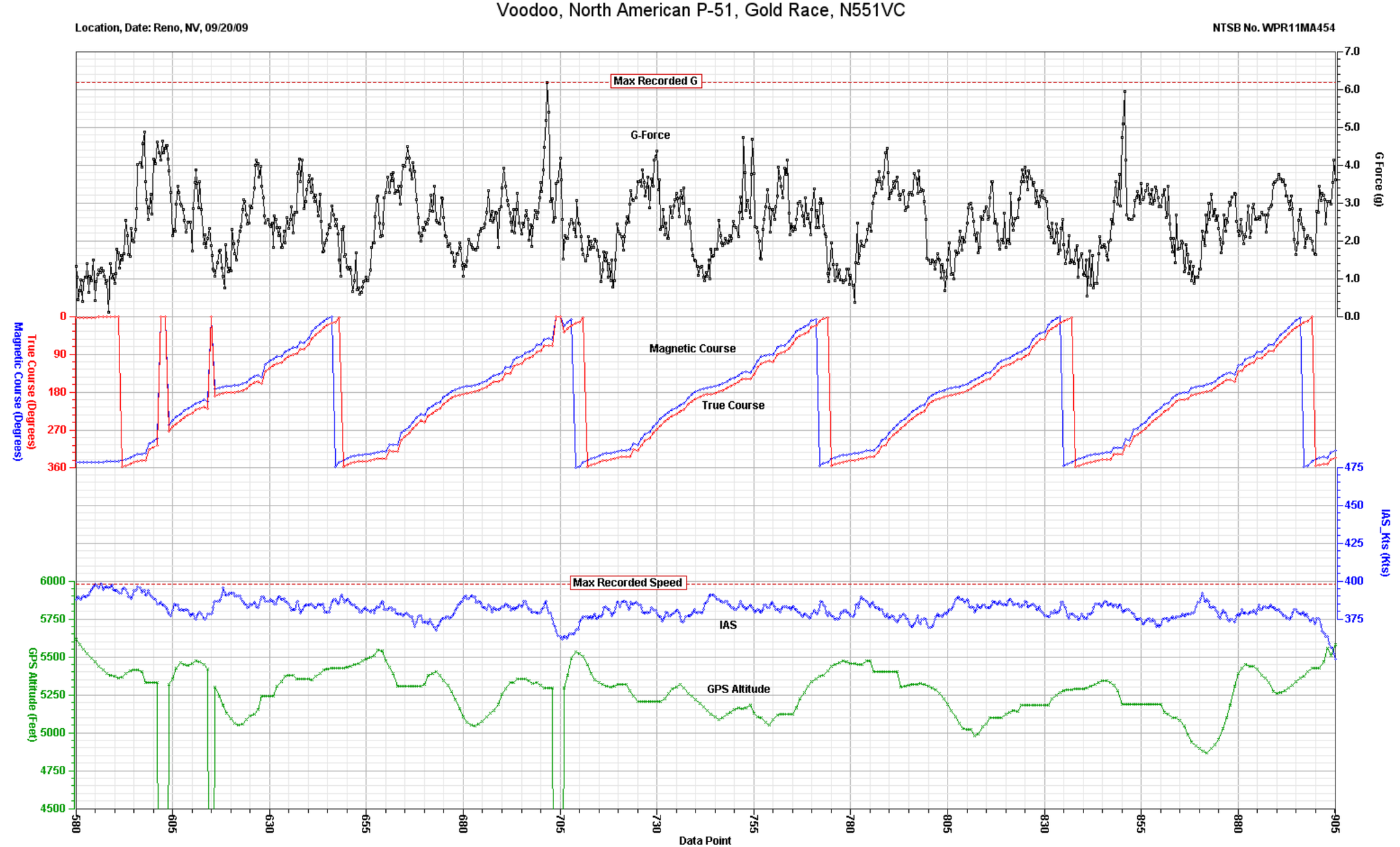
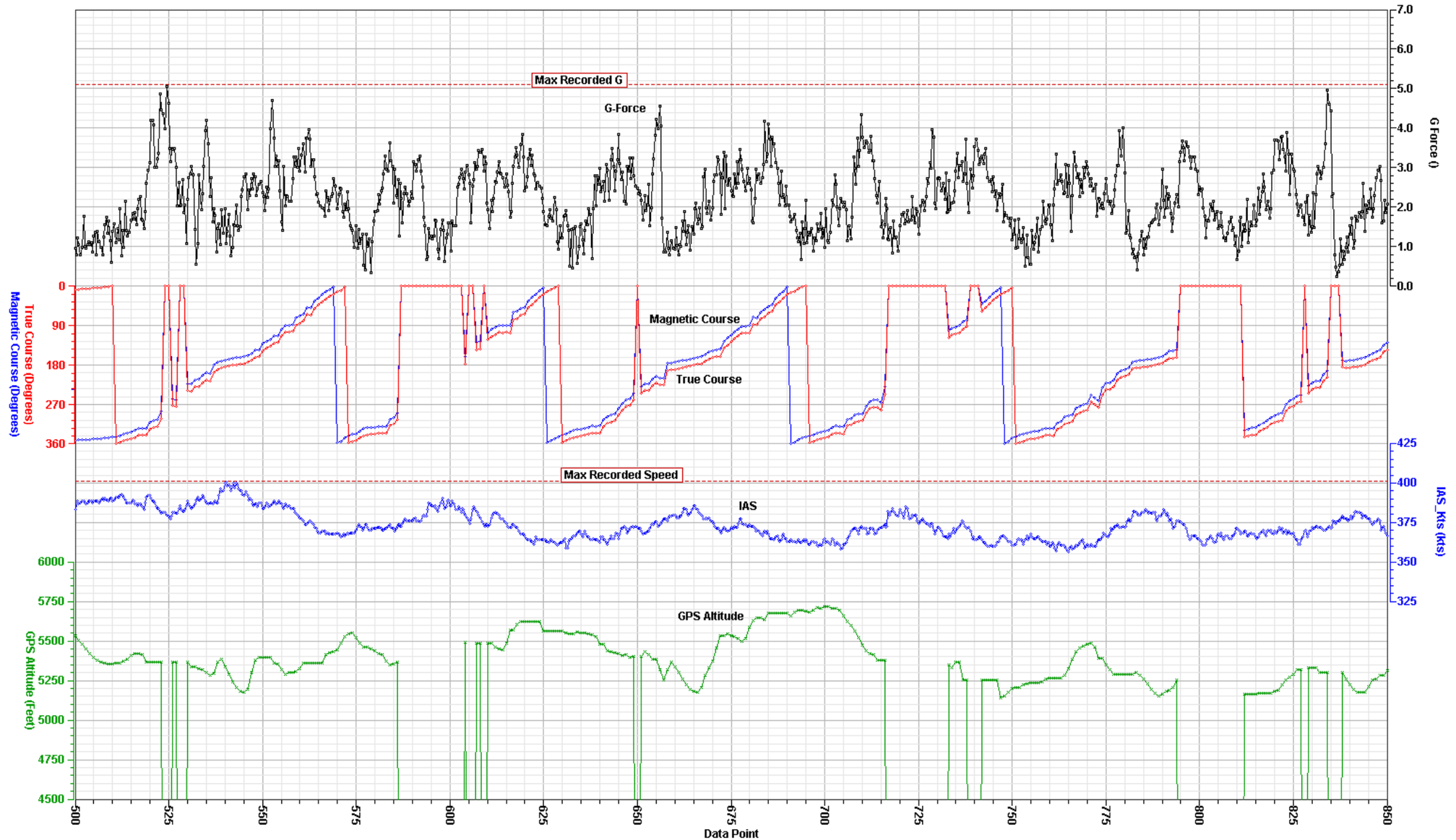


Figure 14 - Basic information for additional aircraft 1 (Voodoo) recorded during a gold class race in 2009

Voodoo, North American P-51, Gold Race, N551VC

Location, Date: Reno, NV, 09/17/10

NTSB No. WPR11MA454



Revised: 15 June 2012

National Transportation Safety Board

Figure 15 - Basic information for additional aircraft 1 (Voodoo) recorded during a gold class race in 2010

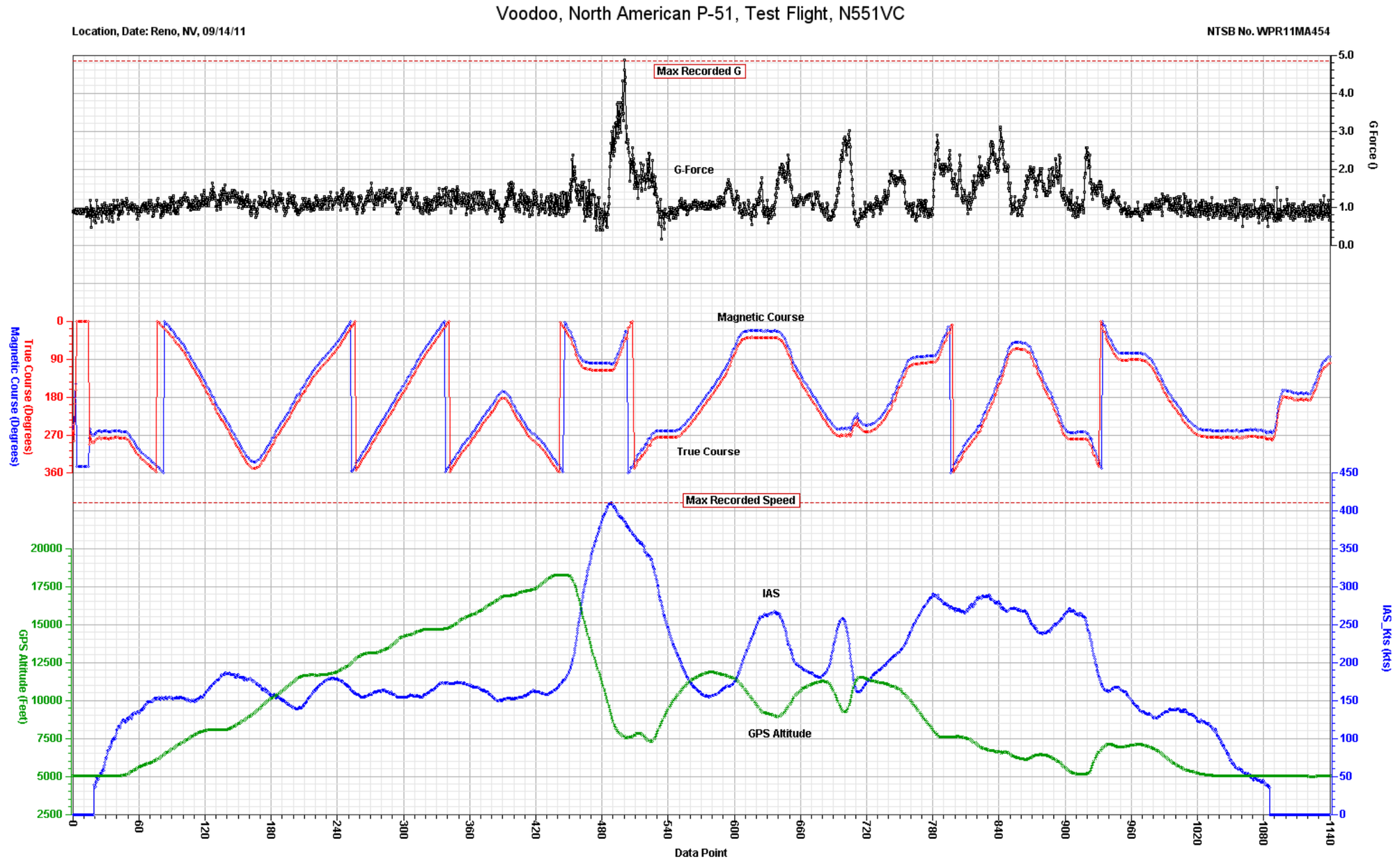
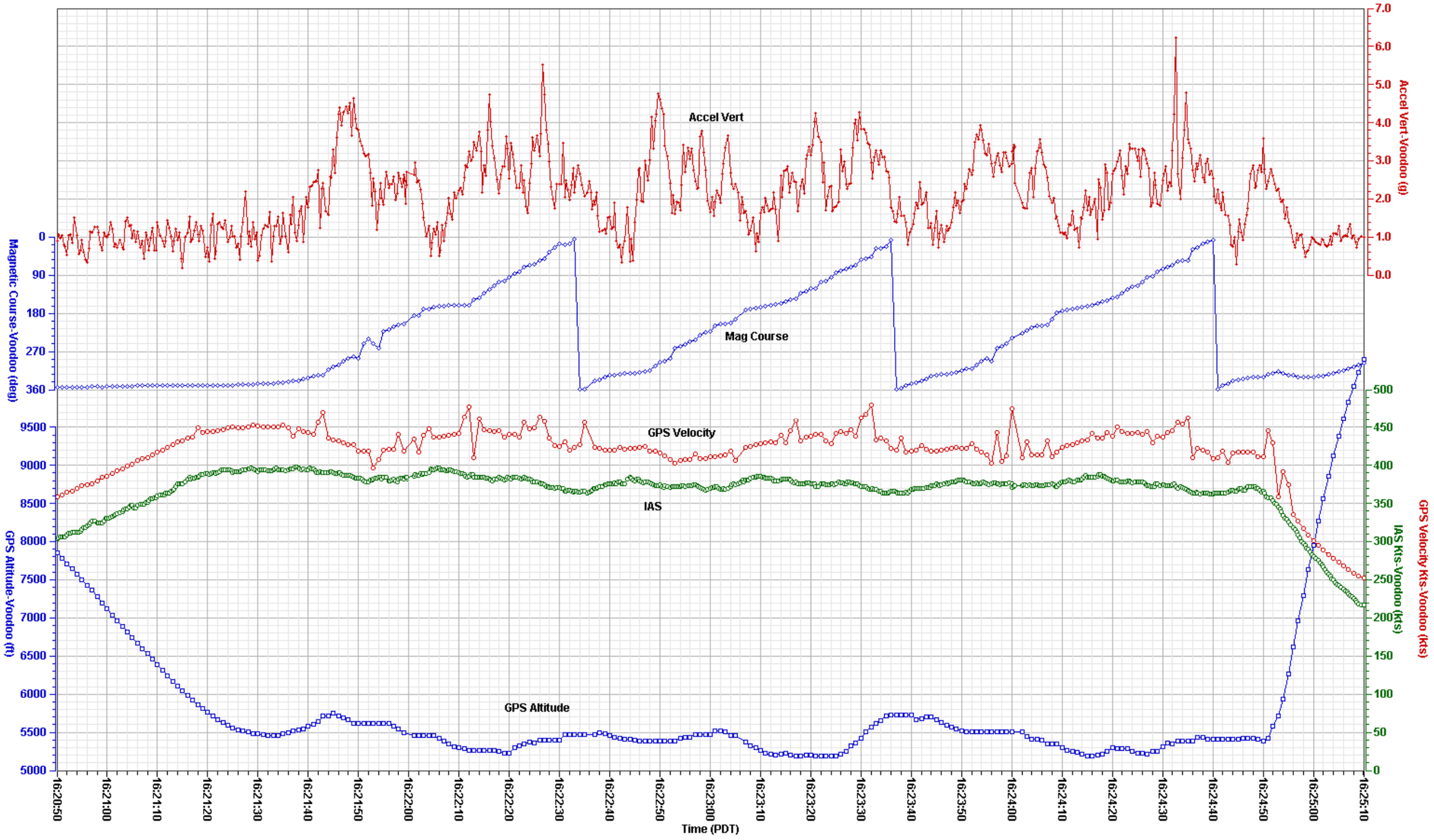


Figure 16 - Basic information for additional aircraft 1 (Voodoo) recorded during a test flight in 2011

Voodoo, North American P-51, N551VC

Location, Date: Reno, NV, 09/16/11

NTSB No. WPR11MA454



Revised: 19 October 2011

National Transportation Safety Board

Figure 17 - Basic information for additional aircraft 1 (Voodoo) recorded in 2011 (same race as accident flight)

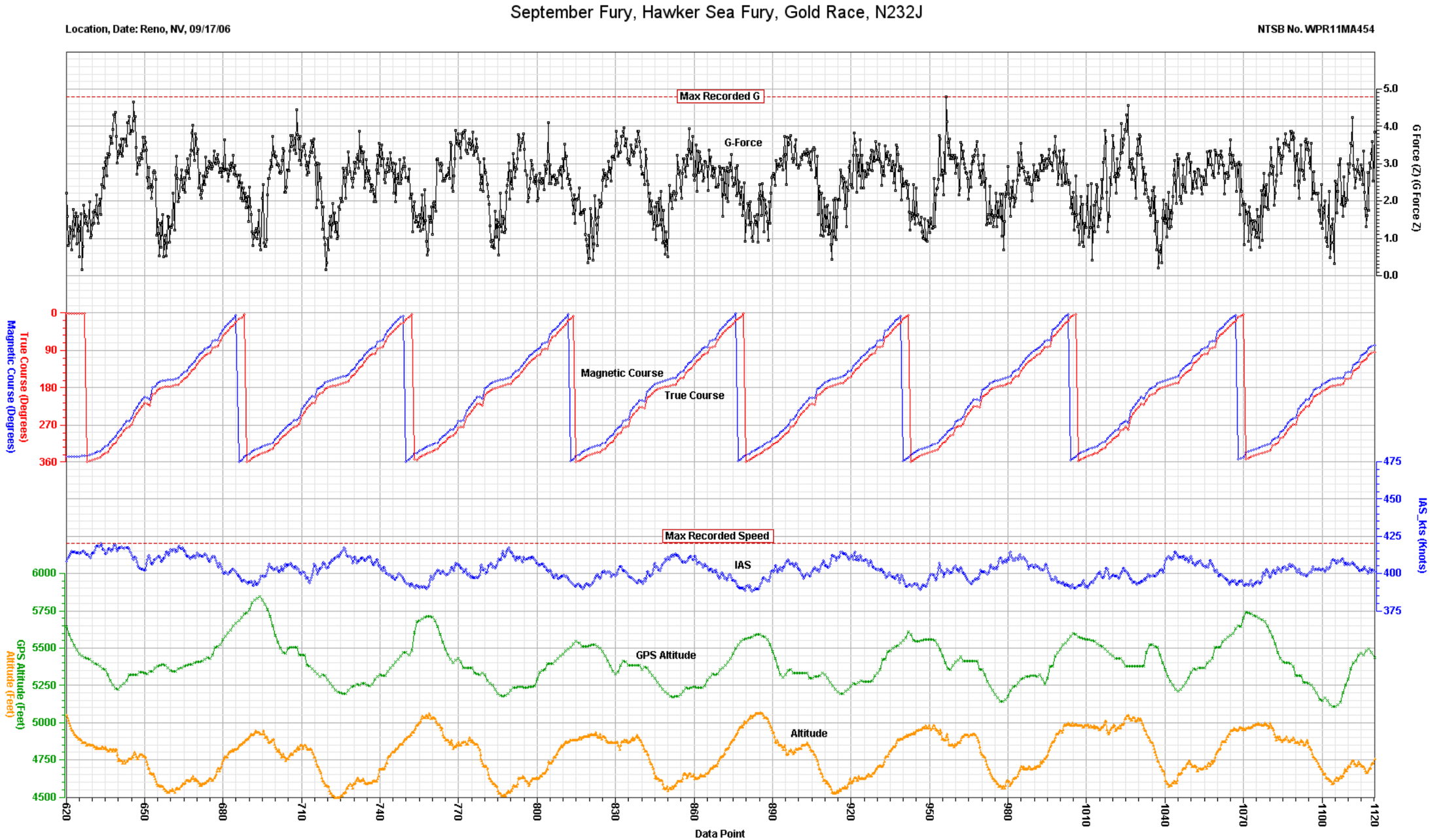


Figure 18 - Basic information for additional aircraft 2 (September Fury) recorded during a gold class race in 2006 (original wings)

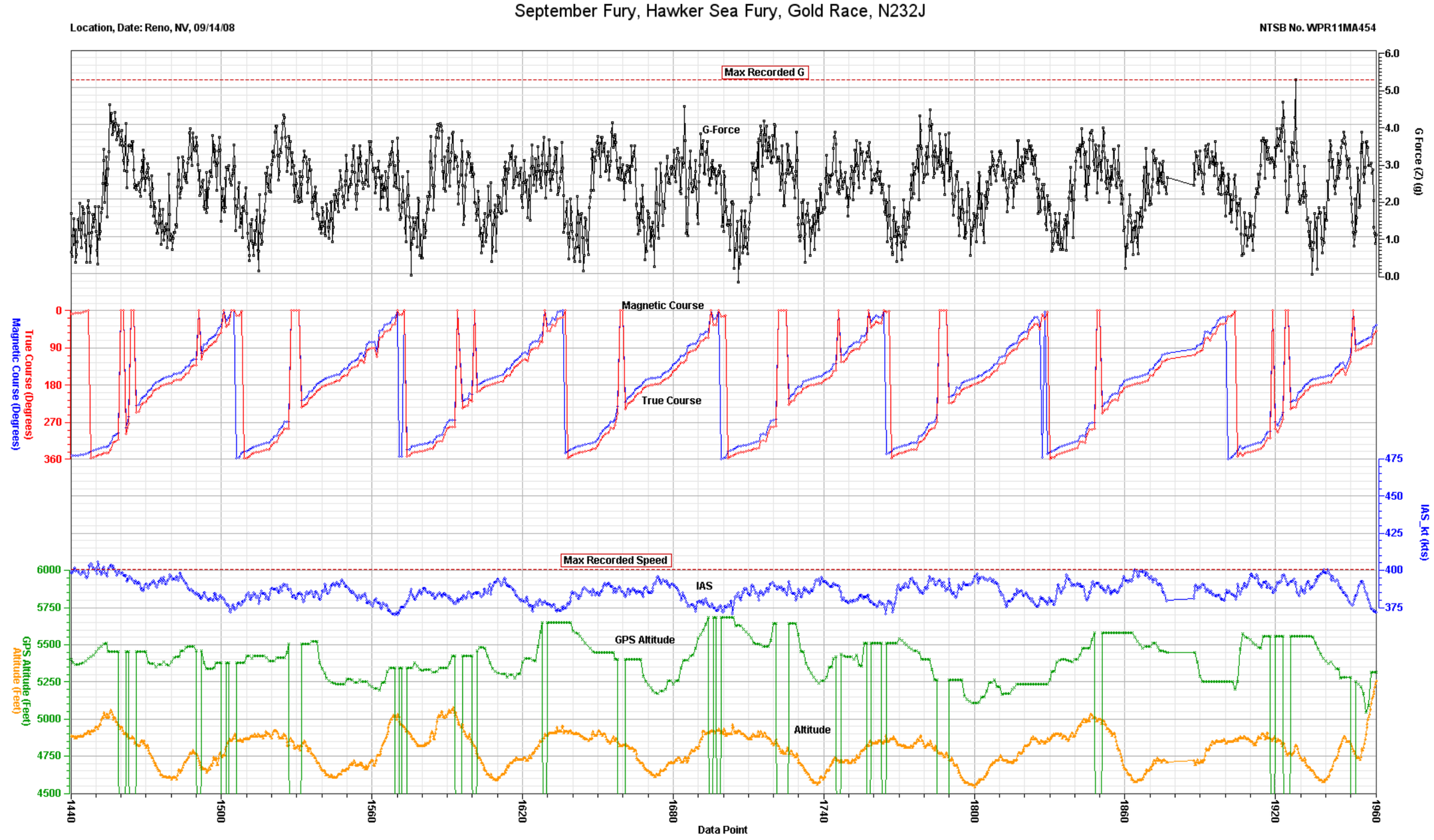


Figure 19 - Basic information for additional aircraft 2 (September Fury) recorded during a gold class race in 2008 (clipped wings)

APPENDIX A

This appendix describes the parameters provided and verified in this report. Table A-1 lists the parameters and table A-2 describes the unit abbreviations used in this report. Depending on the aircraft dataset, not every parameter listed in Table A-1 is available.

Table A-1. Verified and provided parameters.

Parameter Name	Parameter Description
1. Accel Vert (g)	Vertical Acceleration
2. ADI Pressure (psi)	Anti-Detonation Injection Fluid Pressure
3. Boiler Pressure (psi)	Boiler Pressure
4. Coolant Temp (degC)	Coolant Temperature
5. Fuel Press (psi)	Fuel Pressure
6. GPS Altitude (ft)	GPS Altitude
7. GPS Velocity (kts)	GPS Velocity
8. IAS Velocity (kts)	Indicated Air Speed
9. Ind Temp (degC)	Induction Temperature
10. Latitude (deg)	Latitude
11. Longitude (deg)	Longitude
12. Mag Course (deg)	Magnetic Course
13. MAP (in Hg)	Manifold Pressure
14. Oil Press (psi)	Oil Pressure
15. Oil Temp (degC)	Oil Temperature
16. Packet #	Packet Number
17. RPM (rpm)	Revolutions Per Minute
18. True Course (deg)	True Course

Table A-2. Unit abbreviations.

Units Abbreviation	Description
deg	degrees
degC	degrees Celsius
ft	feet
g	gravity
kts	knots
psi	pounds per square inch
rpm	revolutions per minute

NOTE: For parameters with a unit description of discrete, a discrete is typically a 1-bit parameter that is either a 0 state or a 1 state where each state is uniquely defined for each parameter.

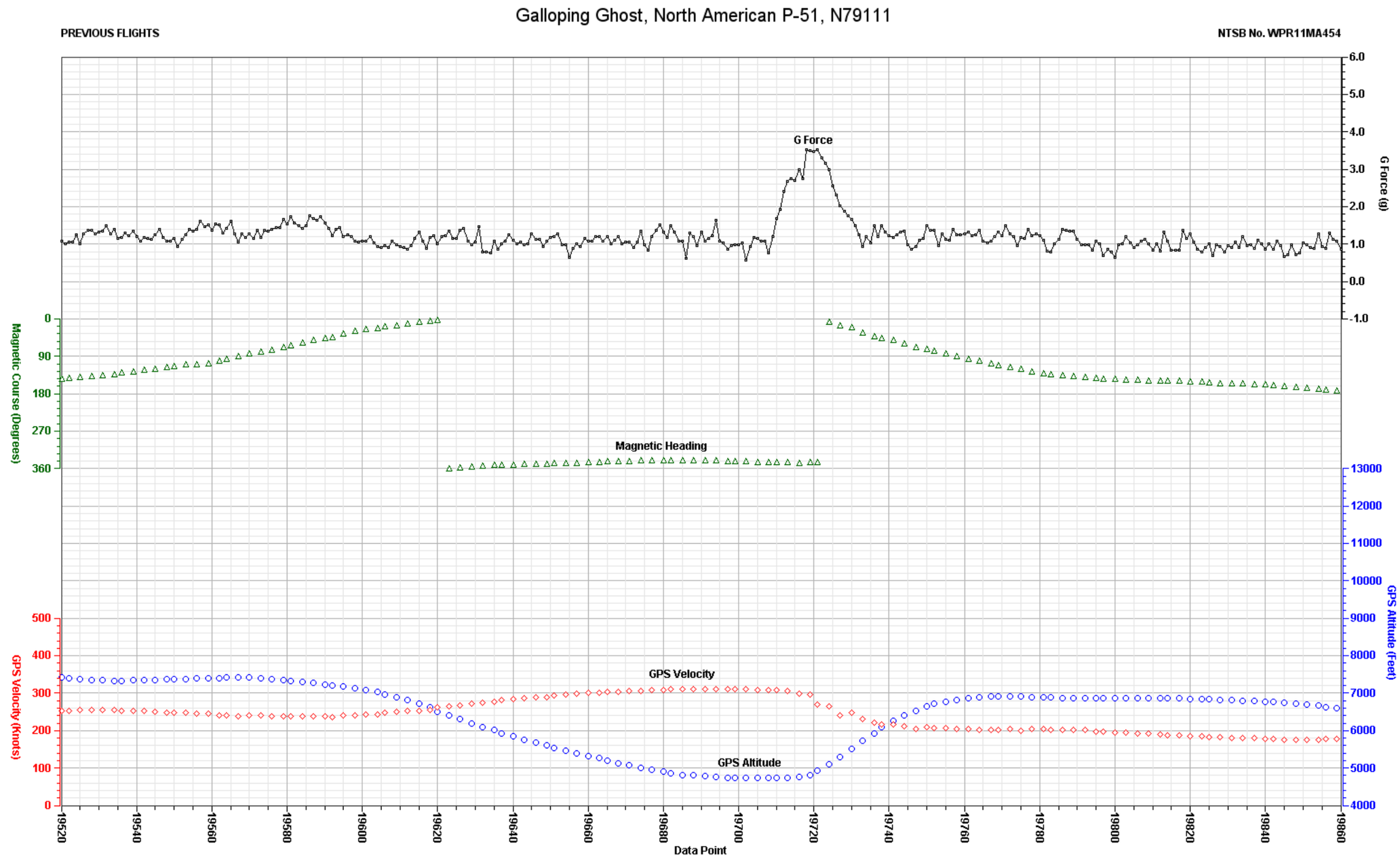
APPENDIX B

Table B-1 - Flight and Data Log

Number	Date of Log File	Timestamp of Log File or from Flight Log (HH:MM)	Flight Log Number (If applicable)	Max Recorded GPS Velocity (Kt)	Max Recorded G Force (g)	Flight Origin/ Destination	Corresponding Data Figure(s)	Comments
2009								
1	9/21/2009	12:03	-	-	-	MEV	-	Approximately 19 minutes of data. Data recording ends approximately 4 minutes into the aircraft flight
2	9/21/2009	18:46	-	-	-	-	-	File Length Too Short – No Relevant Data
3	9/22/2009	14:53	-	-	-	-	-	Approximately 4 Minutes of data recorded, does not contain a flight
4	9/22/2009	15:01	-	-	-	-	-	File Length Too Short – No Relevant Data
5	9/22/2006	15:03	-	-	-	-	-	File Length Too Short – No Relevant Data
2010								
6	3/24/10	16:36	-	-	-	-	-	File Length Too Short – No Relevant Data
7	3/24/10	16:37	-	-	-	-	-	File Length Too Short – No Relevant Data
8	3/24/10	16:43	-	-	-	-	-	File Length Too Short – No Relevant Data
9	3/24/10	16:48	-	-	-	-	-	File Length Too Short – No Relevant Data
10	3/24/10	16:49	-	-	-	-	-	File Length Too Short – No Relevant Data
11	3/24/10	16:55	-	-	-	-	-	File Length Too Short – No Relevant Data
12	3/24/10	16:57	-	-	-	-	-	File Length Too Short – No Relevant Data
13	3/24/10	16:58	-	-	-	-	-	File Length Too Short – No Relevant Data
14	3/24/10	17:01	-	-	-	-	-	File Length Too Short – No Relevant Data
15	3/24/10	17:05	-	-	-	-	-	File Length Too Short – No Relevant Data
16	3/24/10	17:15	-	-	-	-	-	File Length Too Short – No Relevant Data
17	3/24/10	17:20	-	-	-	-	-	File Length Too Short – No Relevant Data
18	3/24/10	17:21	-	-	-	-	-	File Length Too Short – No Relevant Data
19	3/24/10	17:24	-	-	-	MEV/MEV	-	Approximately 42 minutes of ground data only
20	7/9/10	14:54	-	-	-	-	-	File Length Too Short – No Relevant Data
21	7/9/10	16:29	-	-	-	-	-	File did not contain any GPS information, time or flight information
22	7/10/10	09:35	-	-	-	-	-	File did not contain any GPS information, time or flight information
23	7/10/10	14:20	-	-	-	-	-	File did not contain any GPS information, time or flight information
24	7/11/10	20:49	-	-	-	-	-	File did not contain any GPS information, time or flight information
25	7/13/10	09:34	1	-	-	-	-	No corresponding Telemetry Data File
26	7/13/10	11:14	2	-	-	-	-	No corresponding Telemetry Data File
27	7/13/10	19:31	3	-	-	-	-	No corresponding Telemetry Data File
28	7/14/10	15:54	4	-	-	-	-	Data File Incomplete and did not contain the flight when compared to the flight log
29	7/17/10	UNK	-	-	-	MEV/MEV	-	File contained approximately 20 minutes of flight data.
30	7/18/10	11:53	5	-	-	-	-	No corresponding Telemetry Data File
31	7/18/10	18:55	6	-	-	-	-	No corresponding Telemetry Data File
32	7/18/10	19:40	7	-	-	-	-	No corresponding Telemetry Data File
33	8/16/10	11:18	-	-	-	-	-	File Length Too Short – No Relevant Data
34	8/16/10	11:29	8	307	3.5	MEV/MEV	Figure B-1	Plot contains information during a dive maneuver.

Number	Date of Log File	Timestamp of Log File or from Flight Log (HH:MM)	Flight Log Number (If applicable)	Max Recorded GPS Velocity (Kt)	Max Recorded G Force (g)	Flight Origin/ Destination	Corresponding Data Figure(s)	Comments
35	8/16/10	16:49	9	-	-	MEV/MEV	-	File contained approximately 18 minutes of flight data.
36	8/17/10	11:13	10	-	-	-	-	No corresponding Telemetry Data File
37	8/17/10	19:26	11	-	-	MEV/MEV	-	File contained approximately 20 minutes of flight data.
38	8/18/10	12:22	12	-	-	MEV/MEV	-	File contained approximately 16 minutes of flight data.
39	8/18/10	12:57	-	-	-	-	-	File Length Too Short – No Relevant Data
40	8/19/10	8:08	-	-	-	MEV/MEV	-	File contained approximately 22 minutes of flight data.
41	9/11/10	00:00	13	-	-	-	-	Not enough information to correlate to data file
42	9/11/10	09:40	-	-	-	-	-	File Length Too Short – No Relevant Data
43	9/11/10	14:53	-	-	-	-	-	File did not contain any GPS information, time or flight information
44	9/11/10	16:53	-	-	-	-	-	File did not contain any GPS information, time or flight information
45	9/12/10	00:00	14	-	-	-	-	Not enough information to correlate to data file (Log states flight from MEV to RTS)
46	9/13/10	11:18	-	-	-	-	-	File Length Too Short – No Relevant Data
47	9/14/10	15:29	15	431	4.5	RTS/RTS	Figure B-2 Figure B-3	Plot contains information during a turning maneuver (Engine data included)
48	9/16/10	08:28	16	377	3.9	RTS/RTS	Figure B-4	Plot contains information during a turn and pull-up maneuver
49	9/17/10	08:33	-	-	-	-	-	Approximately 30 minutes of ground data only
50	9/17/10	09:48	17	357	4.1	RTS/RTS	Figure B-5	Max velocity recorded at beginning of on course flight, max G Force at end of work on course
51	9/17/10	18:26	18	310	5.2	RTS/RTS	Figure B-6	First of two dive/pull-ups performed during flight
				278	4.3		Figure B-7	Second of two dive/pull-ups performed during flight
52	9/18/10	09:14	-	-	-	-	-	Approximately 60 minutes of ground data only
53	9/18/10	10:59	-	-	-	-	-	Approximately 11 minutes of ground data only
54	9/18/10	11:57	19	412	4.3	RTS/RTS	Figure B-8 Figure B-9	Plot contains information during flight on course (Engine data included)
				334	3.8		Figure B-10	Plot contains information during a dive maneuver.
55	9/18/10	18:51	-	-	-	-	-	Approximately 34 minutes of ground data only (Timing information was incomplete)
56	9/19/10	06:59	20	-	-	RTS/RTS	-	File contained approximately 16 minutes of flight data.
57	9/19/10	10:52	-	-	-	-	-	File Length Too Short – No Relevant Data
58	9/19/10	15:05	-	-	-	-	-	Approximately 38 minutes of ground data only
59	9/20/10	UNK	-	-	-	-	-	No corresponding Telemetry Data File (Log states flight from RTS to MEV)
2011								
60	8/23/11	17:00	-	-	-	-	-	File did not contain any GPS information, time or flight information
61	8/24/11	09:27	-	-	-	-	-	File did not contain any GPS information, time or flight information
62	8/24/11	14:30	-	-	-	-	-	File Length Too Short – No Relevant Data
63	8/24/11	17:10	-	-	-	-	-	File did not contain any GPS information, time or flight information
64	9/4/11	15:32	-	-	-	-	-	Approximately 122 minutes of ground data only
65	9/5/11	09:27	-	-	-	-	-	File did not contain any GPS information, time or flight information
66	9/5/11	11:63	21	-	-	-	-	No corresponding Telemetry Data File
67	9/5/11	14:44	-	-	-	MEV/MEV	-	File contained approximately 18 minutes of flight data.
68	9/5/11	18:56	22	-	-	MEV/MEV	-	File contained approximately 22 minutes of flight data.

Number	Date of Log File	Timestamp of Log File or from Flight Log (HH:MM)	Flight Log Number (If applicable)	Max Recorded GPS Velocity (Kt)	Max Recorded G Force (g)	Flight Origin/ Destination	Corresponding Data Figure(s)	Comments
69	9/8/11	18:33	-	-	-	-	-	File Length Too Short – No Relevant Data
70	9/8/11	20:01	-	-	-	-	-	Approximately 74 minutes of ground data only
71	9/9/11	09:21	-	-	-	-	-	File did not contain any GPS information, time or flight information
72	9/9/11	12:27	-	-	-	-	-	File did not contain any GPS information, time or flight information
73	9/9/11	15:16	-	-	-	-	-	Approximately 22 minutes of ground data only
74	9/9/11	17:25	-	-	-	-	-	Approximately 15 minutes of ground data only
75	9/9/11	17:52	23	309	2.8	MEV/MEV	Figure B-11	Plot contains information during a dive maneuver.
76	9/10/11	13:45	24	-	-	MEV/MEV	-	File contained approximately 26 minutes of flight data.
77	9/10/11	15:58	-	-	-	-	-	File Length Too Short – No Relevant Data
78	9/10/11	16:00	25	-	-	MEV/MEV	-	File contained approximately 15 minutes of flight data.
79	9/11/11	18:18	26	-	-	MEV/MEV	-	File contained approximately 16 minutes of flight data.
80	9/12/11	17:19	27	-	-	-	-	No corresponding Telemetry Data File
81	9/13/11	12:01	28	411	4.8	RTS/RTS	Figure B-12 Figure B-13	Plot contains information during flight on course (Engine data included)
82	9/13/11	15:42	29	389	2.8	RTS/RTS	Figure B-14 Figure B-15	Plot contains information during flight on course (Engine data included)
83	9/14/11	11:56	-	-	-	-	-	Approximately 50 minutes of ground data only



Revised: 14 June 2012

Flight 08/16/10

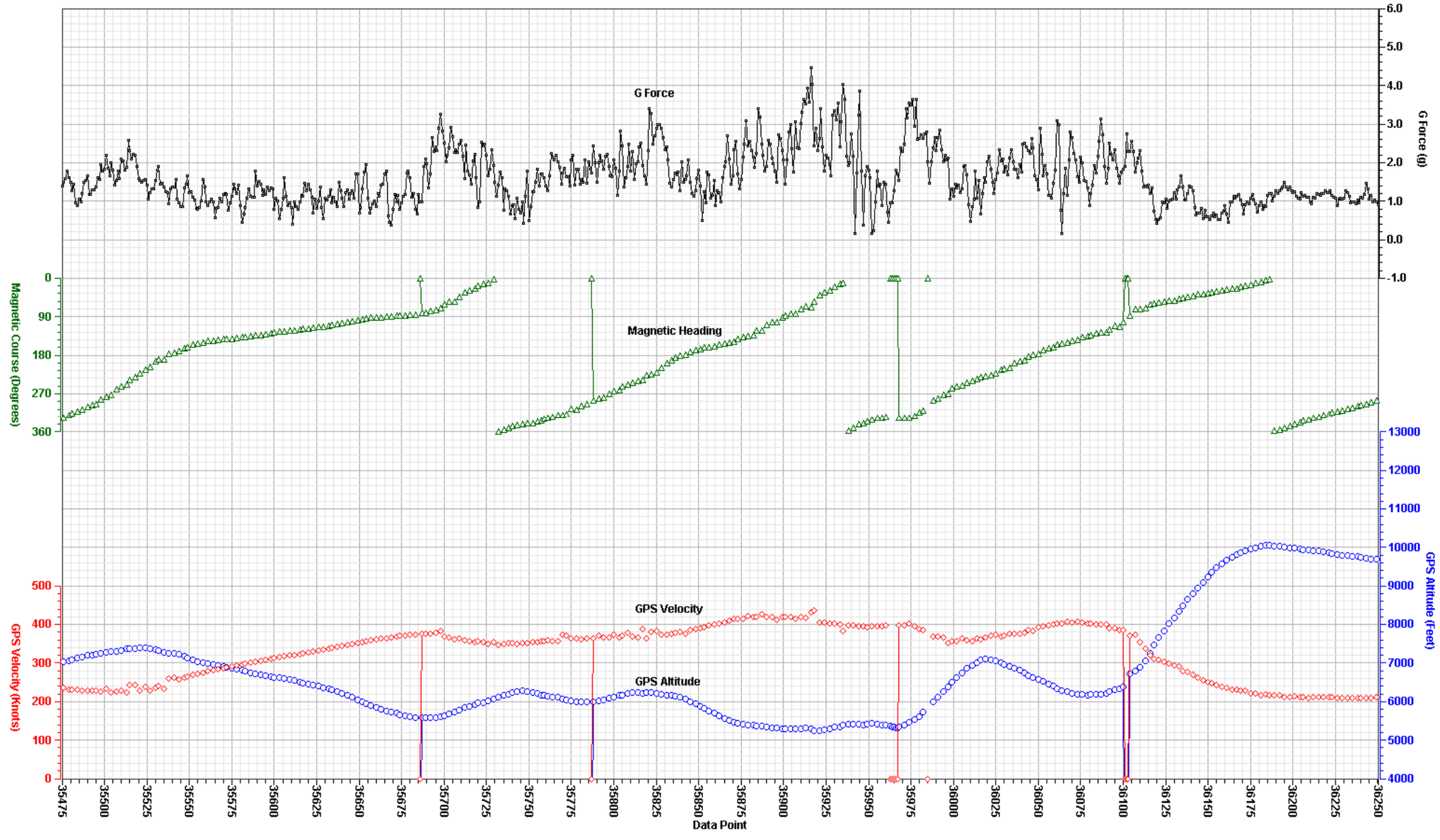
National Transportation Safety Board

Figure B-1 - Basic information for accident aircraft recorded during a portion of a flight on 08/16/10

Galloping Ghost, North American P-51, N79111

PREVIOUS FLIGHTS

NTSB No. WPR11MA454



Revised: 14 June 2012

Flight 09/14/10

National Transportation Safety Board

Figure B-2 - Basic information for accident aircraft recorded during a portion of a flight on 09/14/10

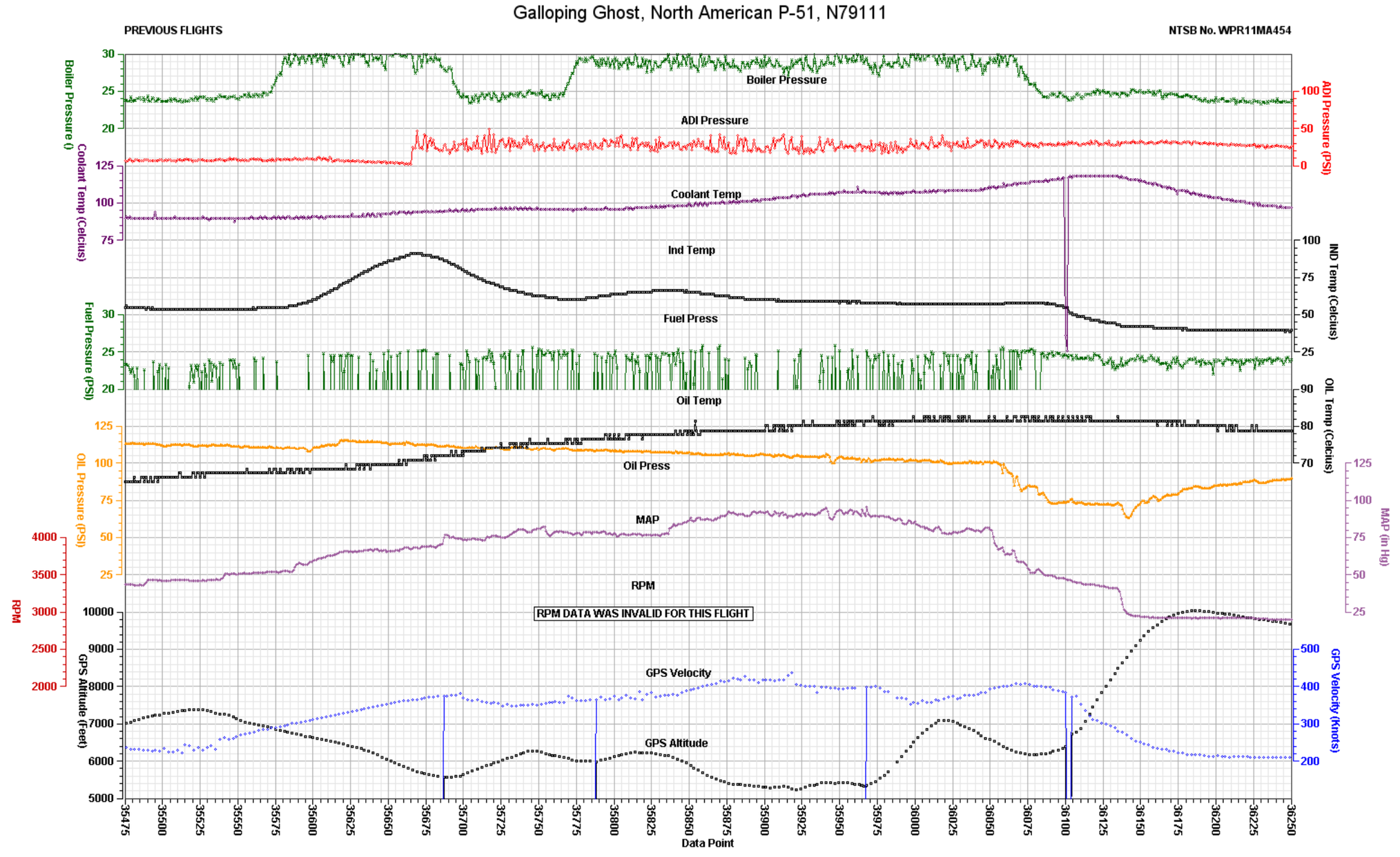
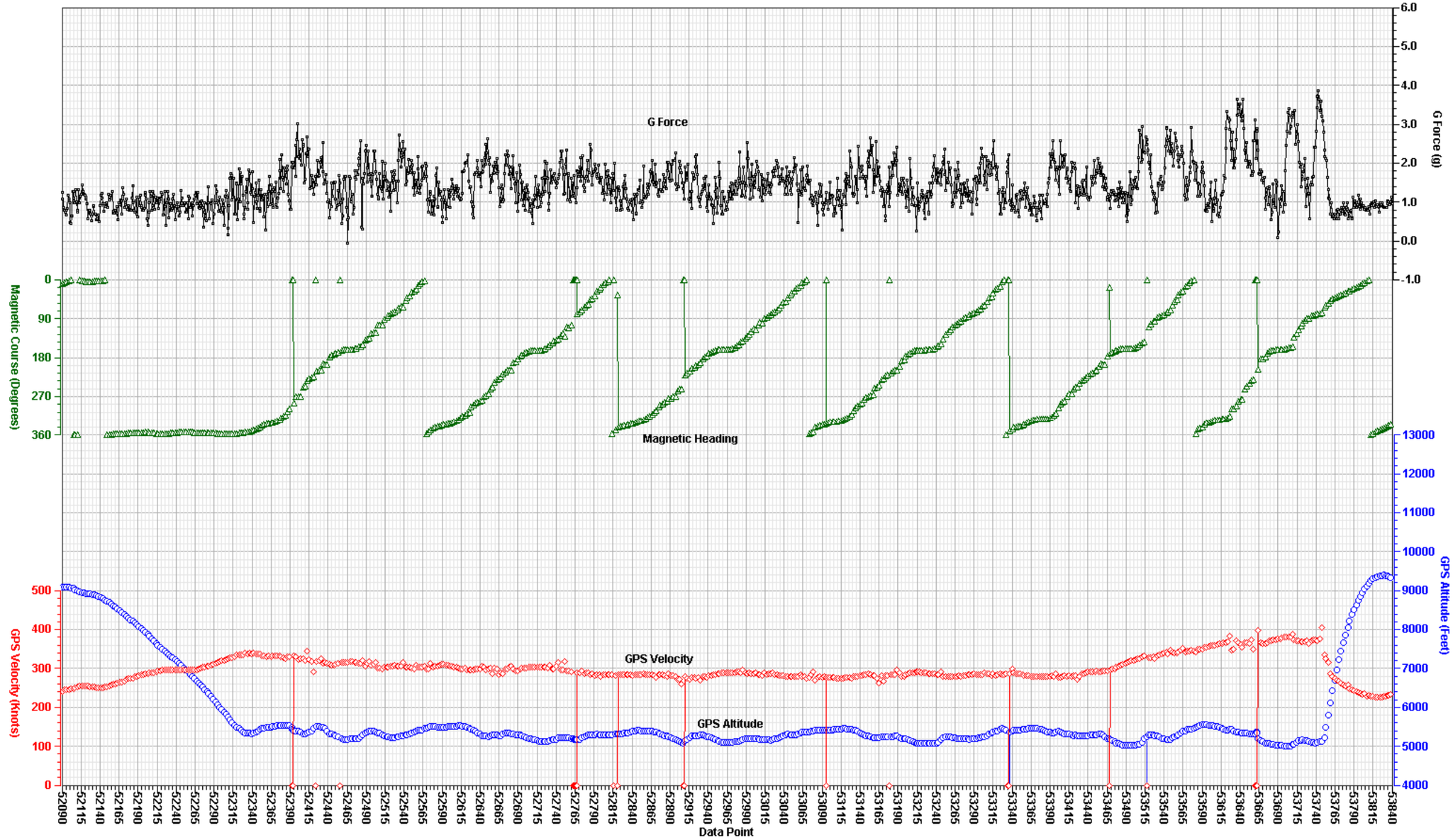


Figure B-3 - Engine information for accident aircraft recorded during a portion of a flight on 09/14/10

Galloping Ghost, North American P-51, N79111

PREVIOUS FLIGHTS

NTSB No. WPR11MA454



Revised: 14 June 2012

Test Flight 09/16/10

National Transportation Safety Board

Figure B-4 - Basic information for accident aircraft recorded during a portion of a flight on 09/16/10

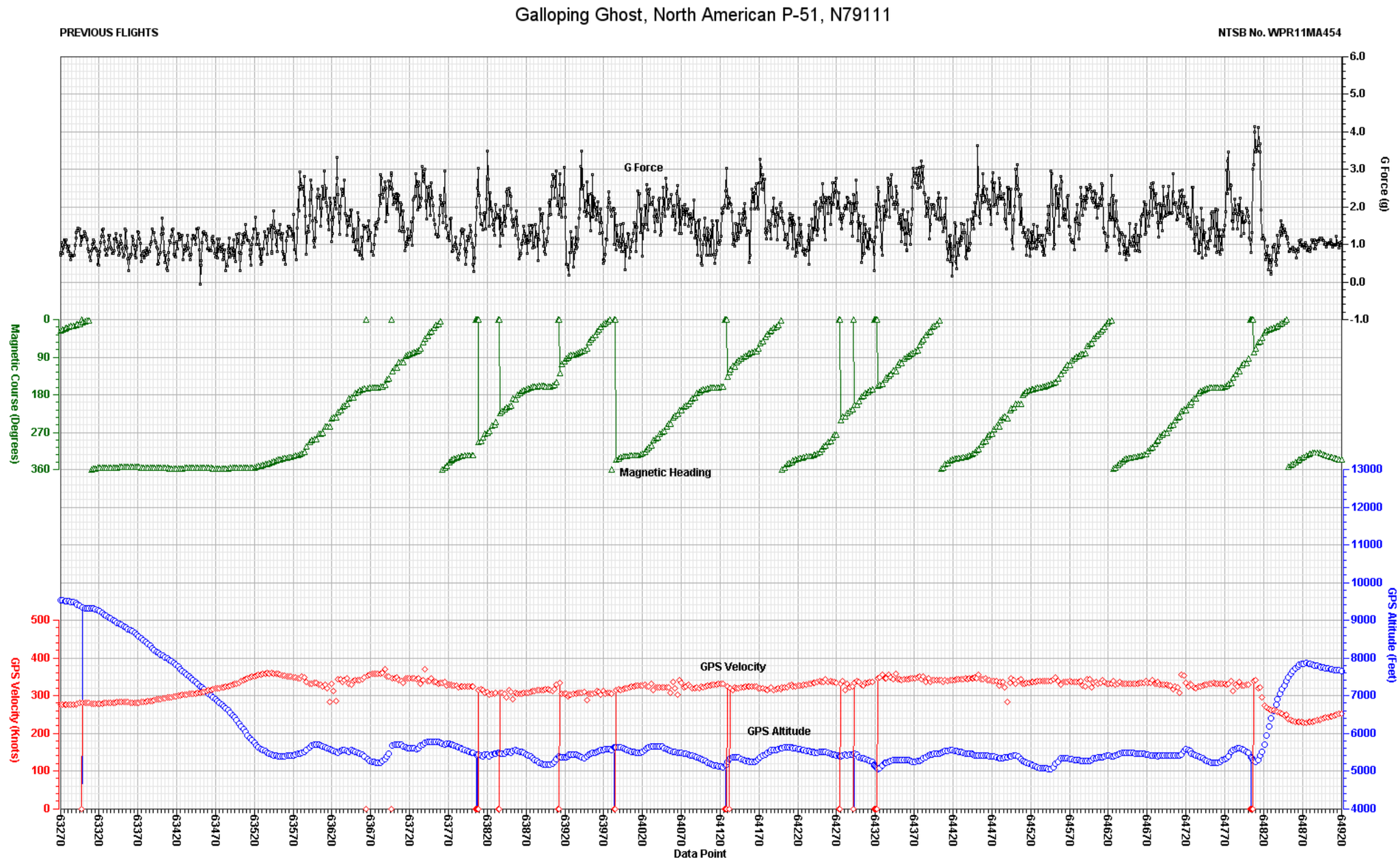


Figure B-5 - Basic information for accident aircraft recorded during a portion of a flight on 09/17/10 (Flight 1)

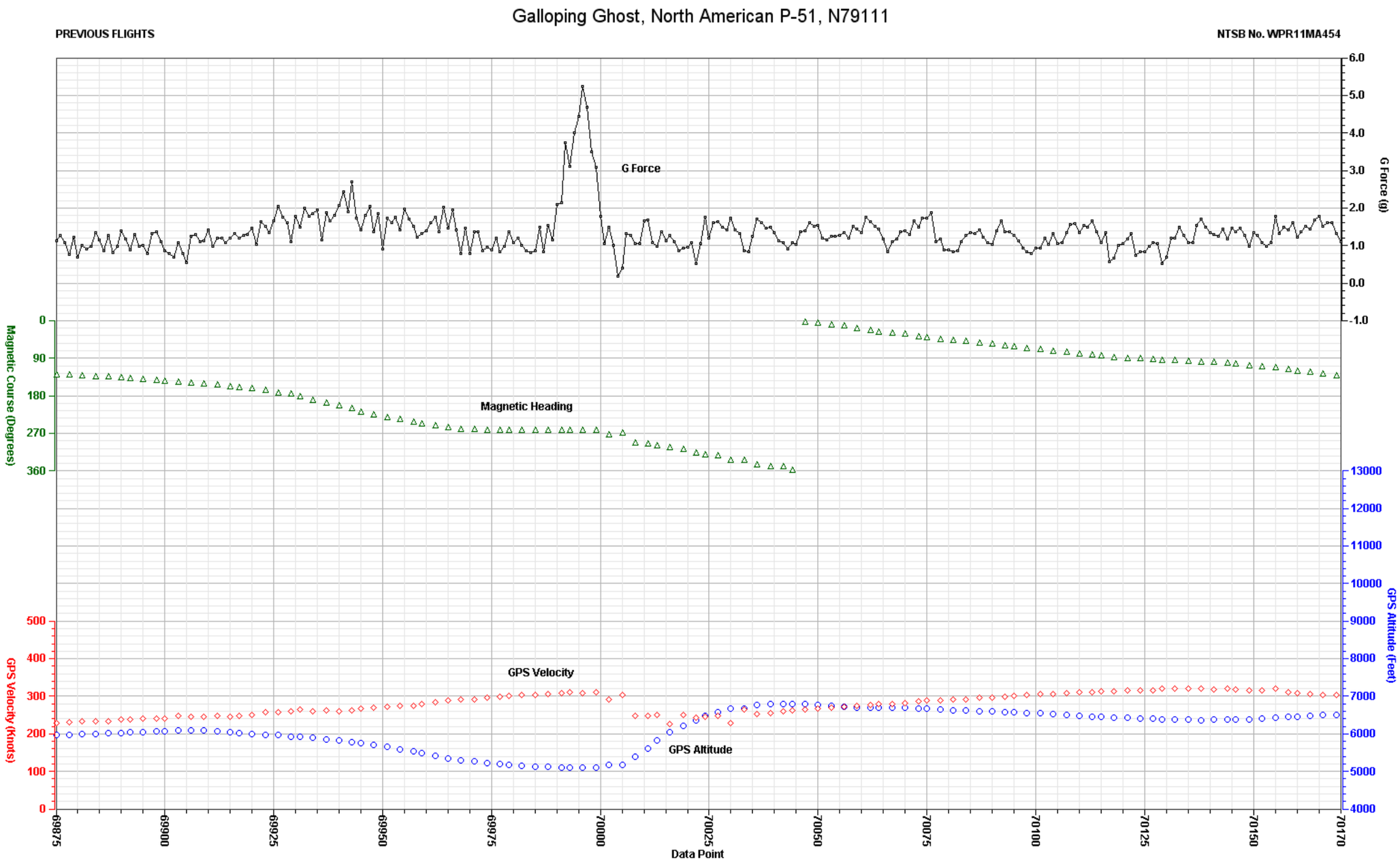
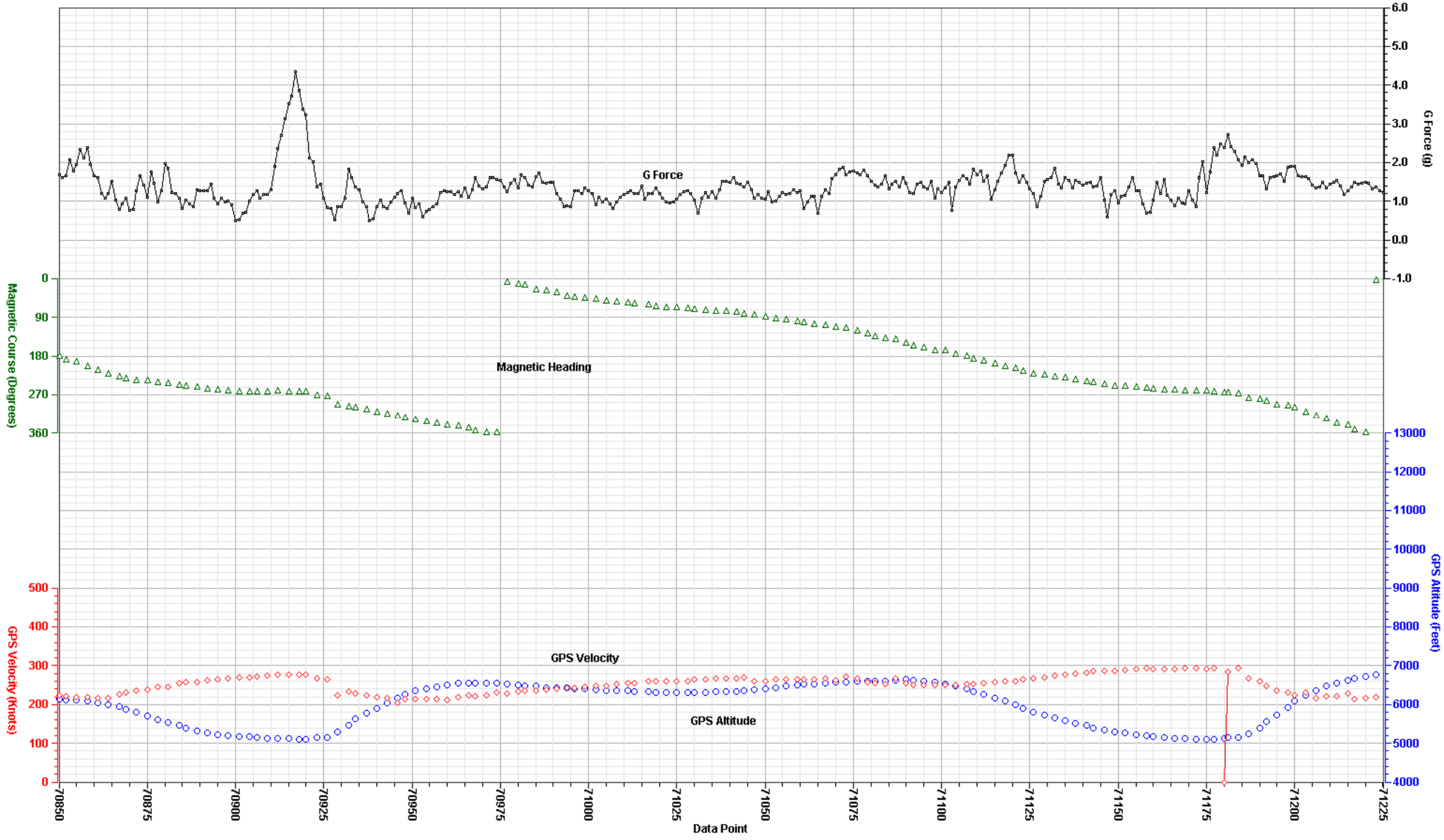


Figure B-6 - Basic information for accident aircraft recorded during a portion of a flight on 09/17/10, first of two dives during flight 2

Galloping Ghost, North American P-51, N79111

PREVIOUS FLIGHTS

NTSB No. WPR11MA454



Revised: 14 June 2012

Flight 09/17/10-Flight 2-Dive 2

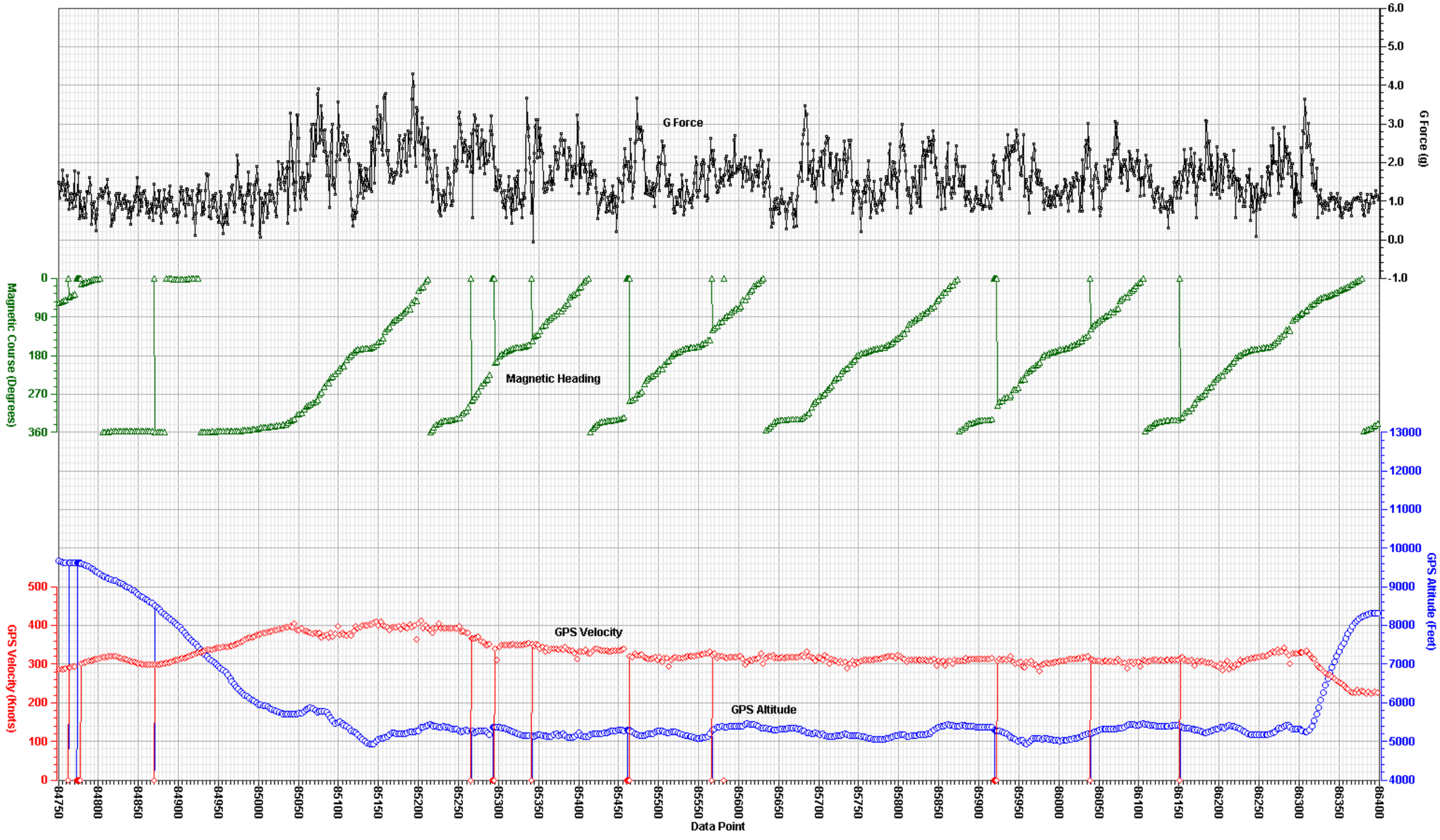
National Transportation Safety Board

Figure B-7 - Basic information for accident aircraft recorded during a portion of a flight on 09/17/10, second of two dives during flight 2

Galloping Ghost, North American P-51, N79111

PREVIOUS FLIGHTS

NTSB No. WPR11MA454



Revised: 14 June 2012

Flight 09/18/10-On Race Course

National Transportation Safety Board

Figure B-8 - Basic information for accident aircraft recorded during a portion of a flight on 09/18/10

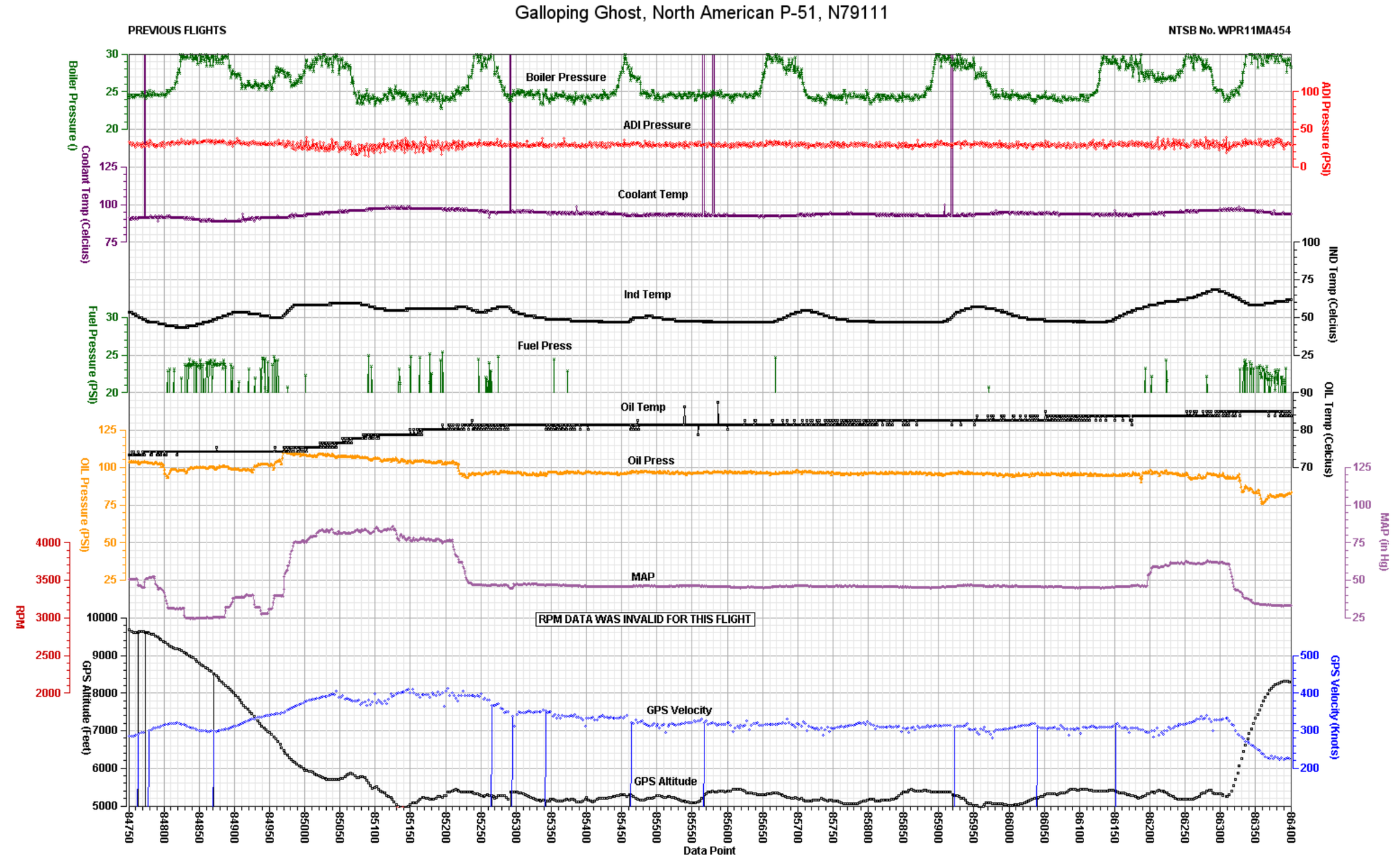


Figure B-9 - Engine information for accident aircraft recorded during a portion of a flight on 09/18/10

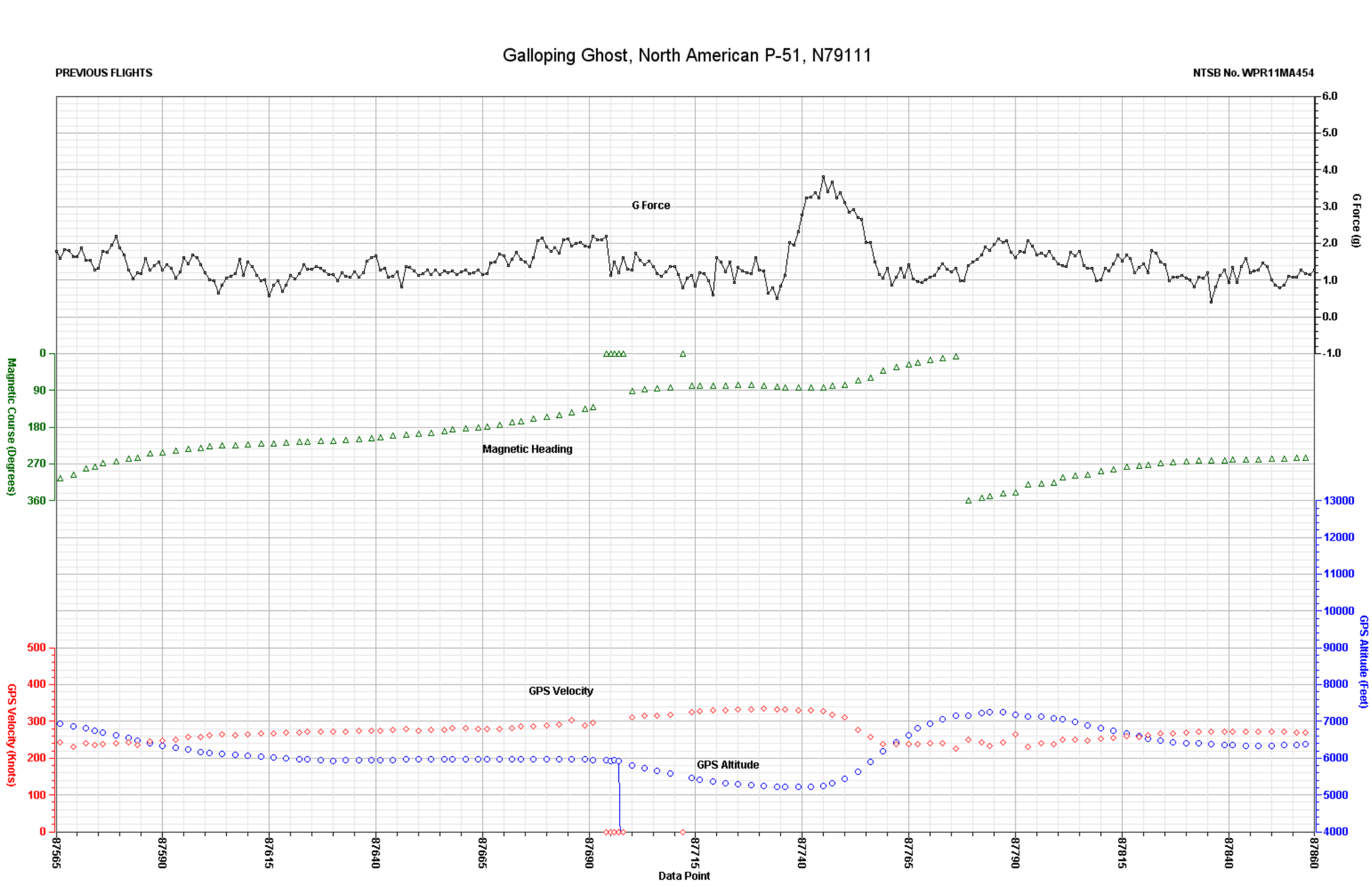


Figure B-10 - Basic information for accident aircraft recorded during a dive recorded during a flight on 09/18/10

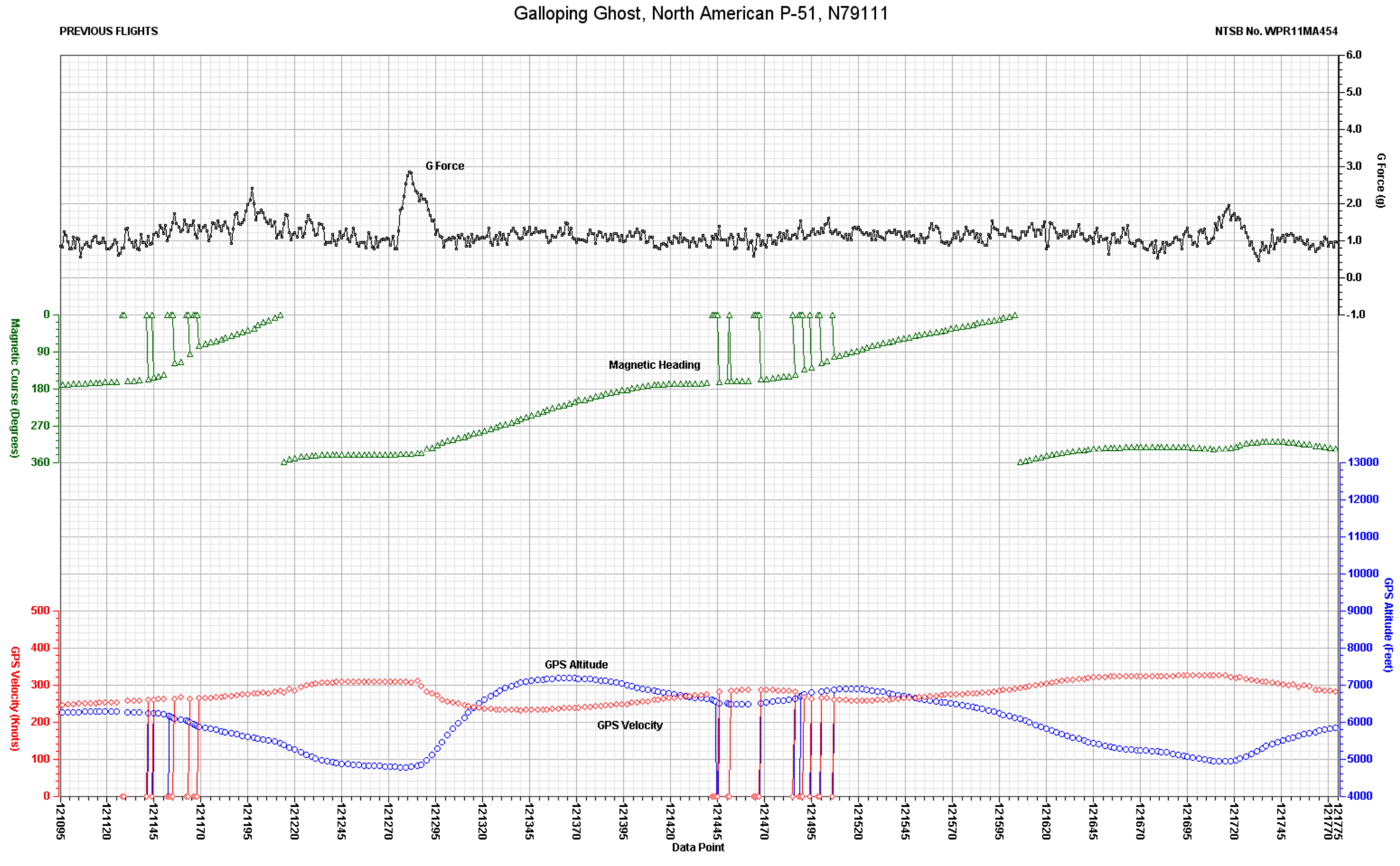
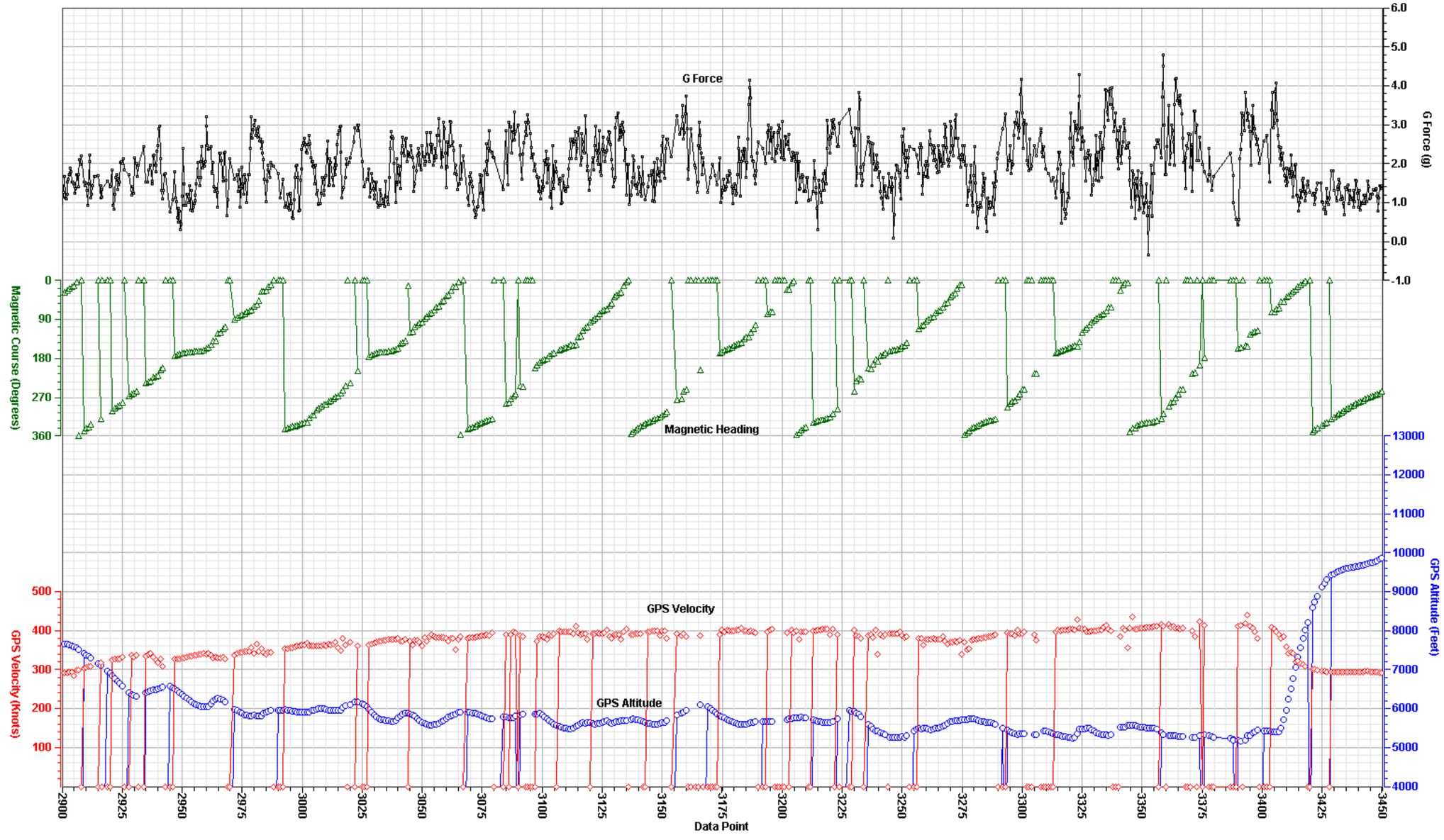


Figure B-11 - Basic information for accident aircraft recorded during a portion of a flight on 09/09/11

Galloping Ghost, North American P-51, N79111

PREVIOUS FLIGHTS

NTSB No. WPR11MA454



Revised: 14 June 2012

Flight 09/13/11-Flight 1

National Transportation Safety Board

Figure B-12 - Basic information for accident aircraft recorded during a portion of the first flight on 09/13/11

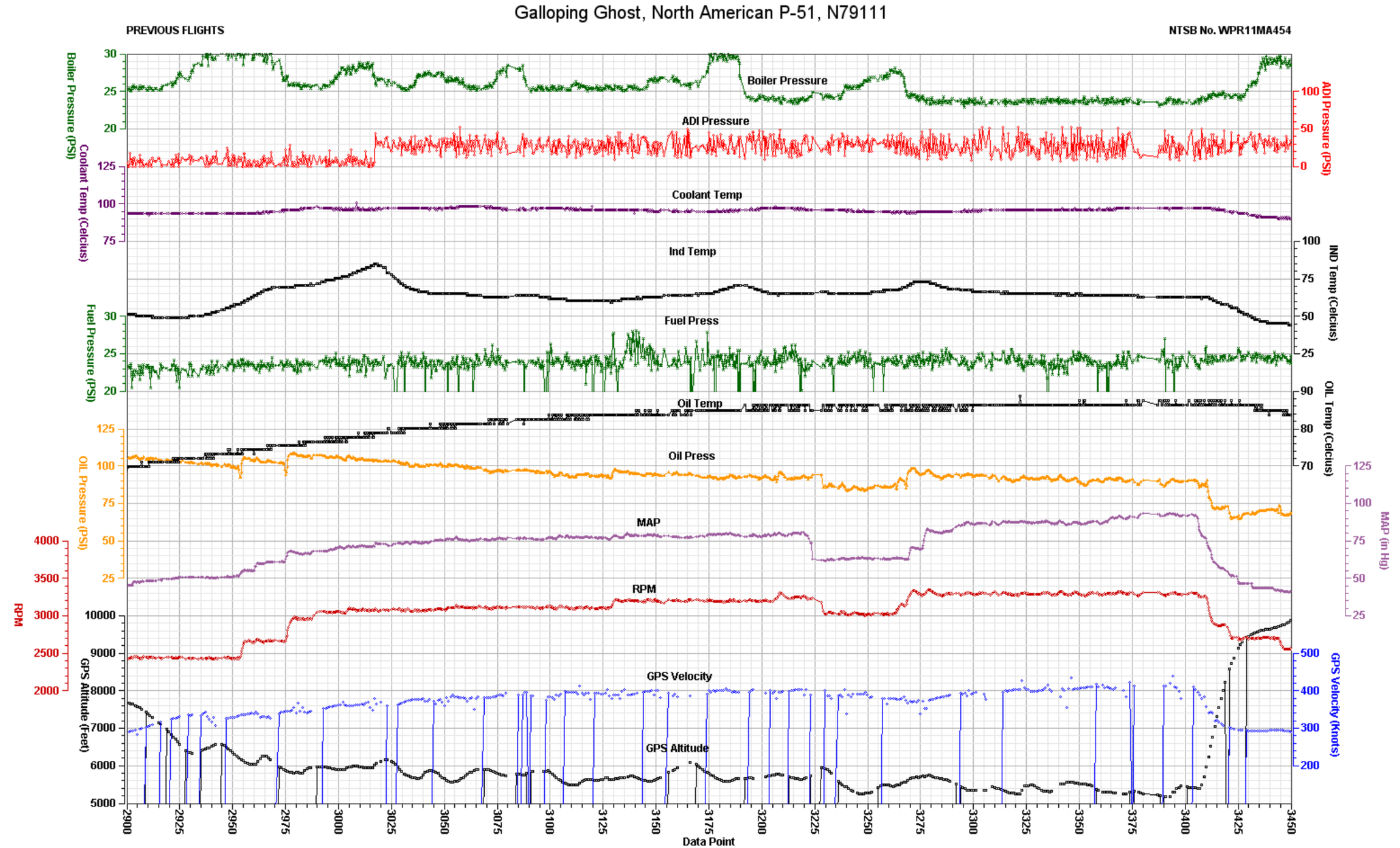
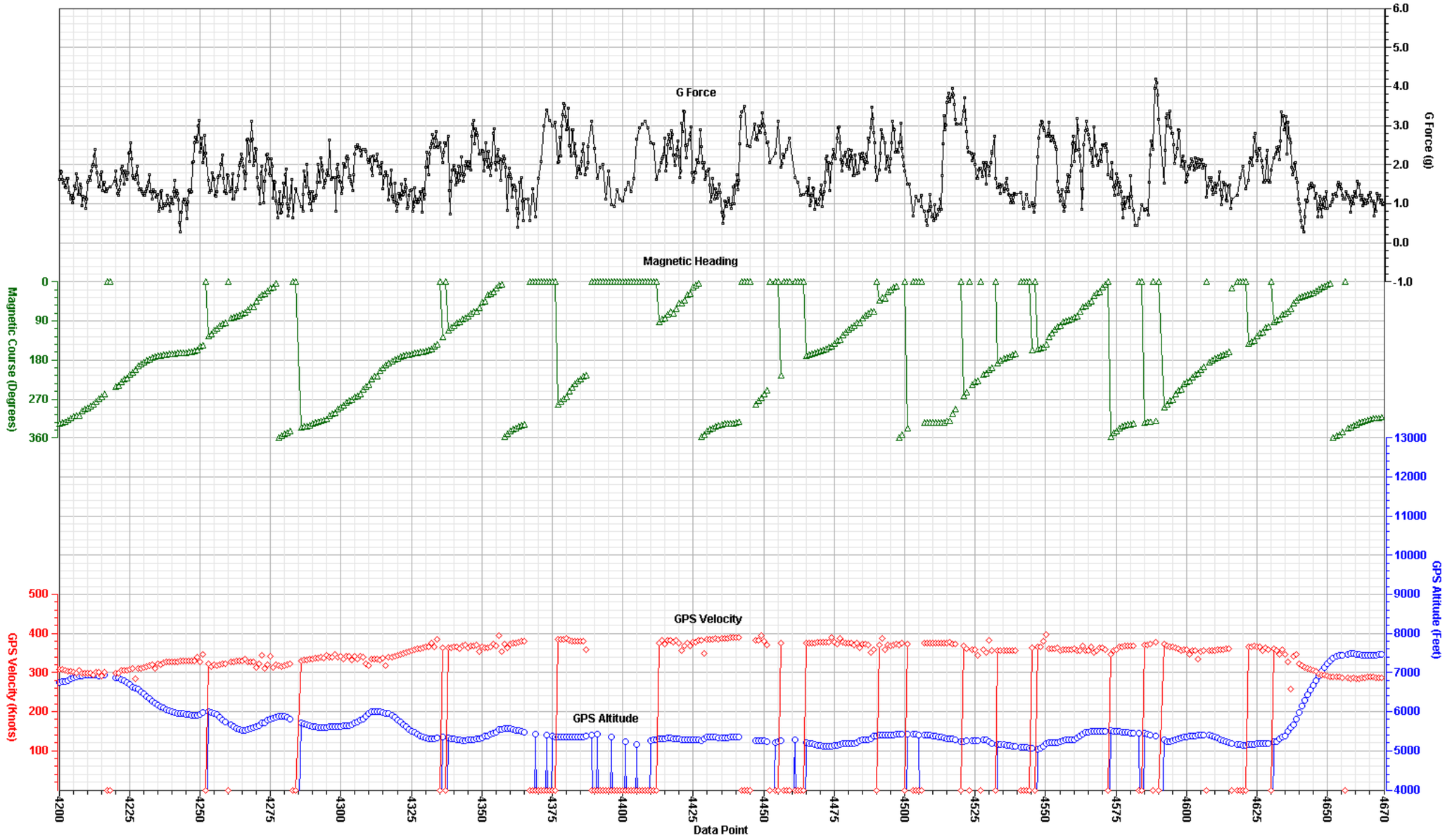


Figure B-13 - Engine information for accident aircraft recorded during a portion of the first flight on 09/13/11

Galloping Ghost, North American P-51, N79111

PREVIOUS FLIGHTS

NTSB No. WPR11MA454



Revised: 14 June 2012

Flight 09/13/11-Flight 2

National Transportation Safety Board

Figure B-14 - Basic information for accident aircraft recorded during a portion the second flight on 09/13/11

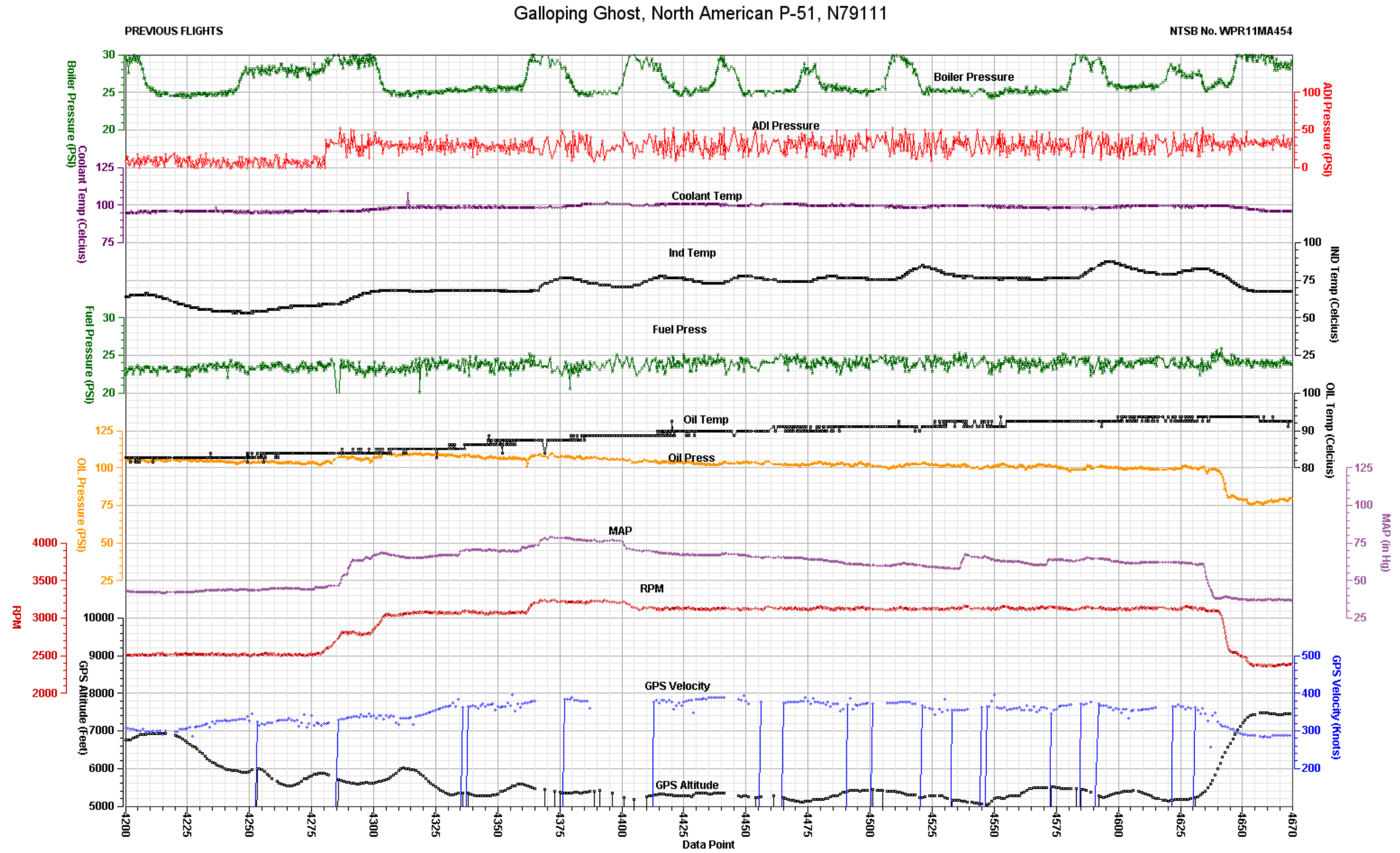


Figure B-15 - Engine information for accident aircraft recorded during a portion of the second flight on 09/13/11