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

August 8, 2016

Appareo Stratus 2 / JPI EDM-800 Time Alignment Study

by Michael Johnson and Bill Tuccio, Ph.D.

1. EVENT

Location:	Santa Rosa, California
Date:	January 28, 2016
Aircraft:	Piper PA-24-260C
Registration:	N9362P
Operator:	Tango Charlie Aviation LLC
NTSB Number:	WPR16FA059

2. GROUP - No Group

3. SUMMARY

On January 28, 2016, about 1900 Pacific standard time (PST), a Piper PA-24-260C, N9362P, was destroyed when it impacted terrain during an instrument landing system (ILS) approach into Charles M. Schulz Airport – Sonoma County Airport (STS), Santa Rosa, California. The commercial pilot and passenger were fatally injured. The airplane was registered to and operated by Tango Charlie Aviation LLC as a 14 *Code of Federal Regulations* Part 91 flight. Night instrument meteorological conditions prevailed about the time of the accident, and a visual flight rules (VFR) flight plan was filed for the cross country flight. The personal flight departed Palm Springs International Airport (PSP), Palm Springs, California at 1535.

4. DETAILS OF INVESTIGATION

The purpose of this study was to time align Appareo Stratus 2 ("Stratus") and JPI EDM-800 data ("JPI").[1]

Alignment Methodology

The alignment process for the Stratus and the JPI from this accident had a number of limitations, including:

(a) The JPI had a sample rate of once every 2 seconds, which increased the ambiguous time range when alignment events occurred;

[1] Factual reports of the Appareo Stratus 2 and JPI EDM-800 may be found in the public docket for this accident.

(b) The JPI and the Stratus did not record any equivalent parameters, which meant that parameters such as RPM or fuel flow rate from the JPI were aligned with ground speed from the Stratus. These parameters are not perfectly linked since changes in altitude, wind speed or direction, and aircraft attitude can also affect ground speed. This significantly limited the number of points that could be used for alignment purposes; and

(c) The Stratus recording stopped shortly before the aircraft reached the ground reducing the usefulness of the recording end time for alignment purposes.

Given these limitations, the following method was used to align the data:

1. Four events were chosen to align the data, constraining the correction time to a 0.995 second range.

2. The takeoff events were utilized to choose a correction time that fit within the constrained range.

3. The JPI data was shifted to match the Stratus data.

The limitations resulted in uncertainty in the overlay, as discussed in this study.

Status and JPI alignment

Four events were chosen to align the Stratus data with the JPI data:

(a) RPM/fuel flow rate increase coinciding with the start of the aircraft turning on to the runway;

(b) RPM/fuel flow rate increase coinciding with the start of a rapid increase in the aircraft's ground speed during takeoff;

(c) drop in ground speed coinciding with a RPM/fuel flow rate drop resembling a cruise flight power anomaly; and

(d) the return of the RPM/fuel flow rate to regular levels after the power anomaly coinciding with the ground speed reversing its decline.

Figure 1 shows the two takeoff events and figure 2 shows the two power anomaly events for the Stratus and JPI. Table 1 summarizes the time intervals for these events and the required low and high bound correction to align the JPI data to the Stratus data for each event.

Figure 1. JPI and Stratus takeoff data excerpt.

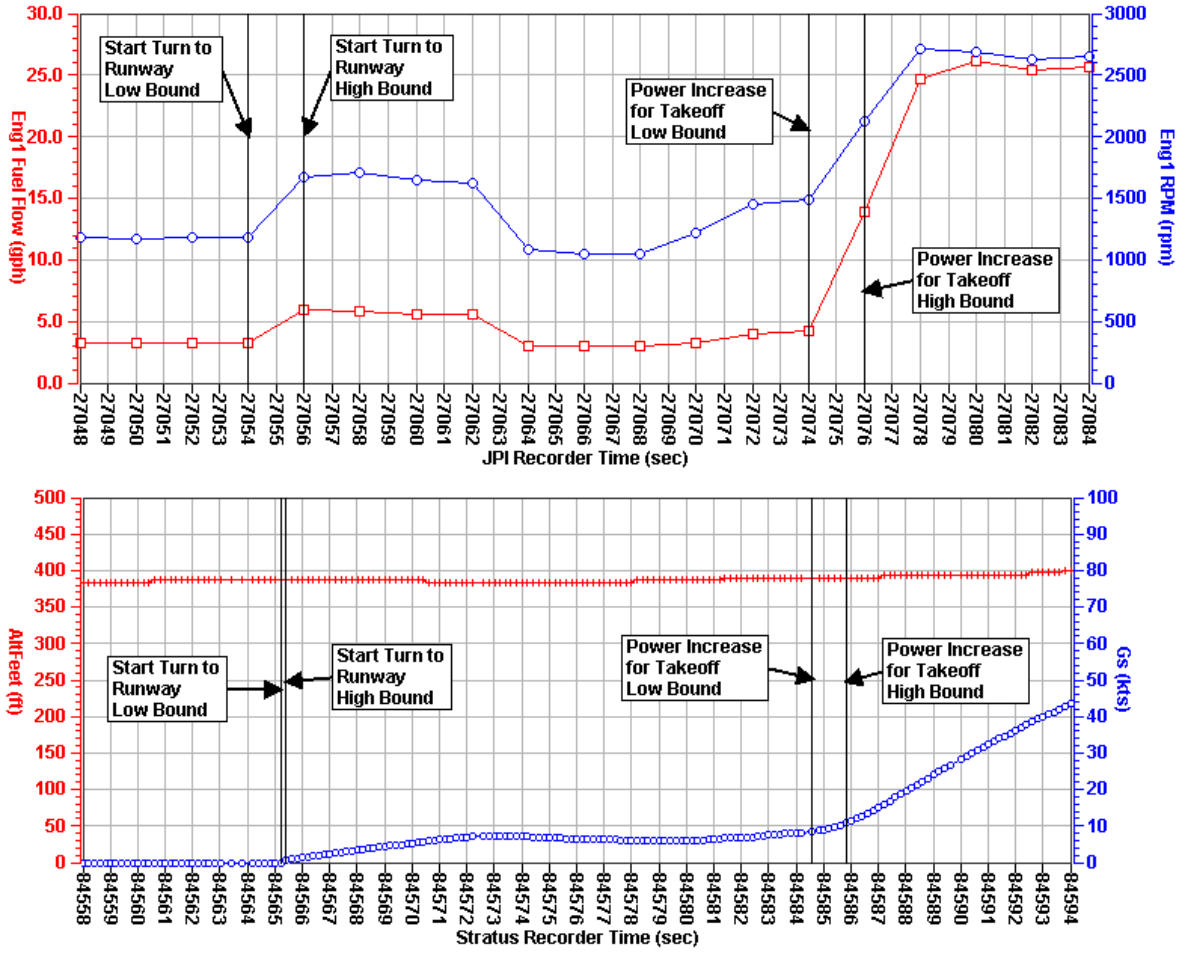


Figure 2. JPI and Stratus power anomaly data excerpt.

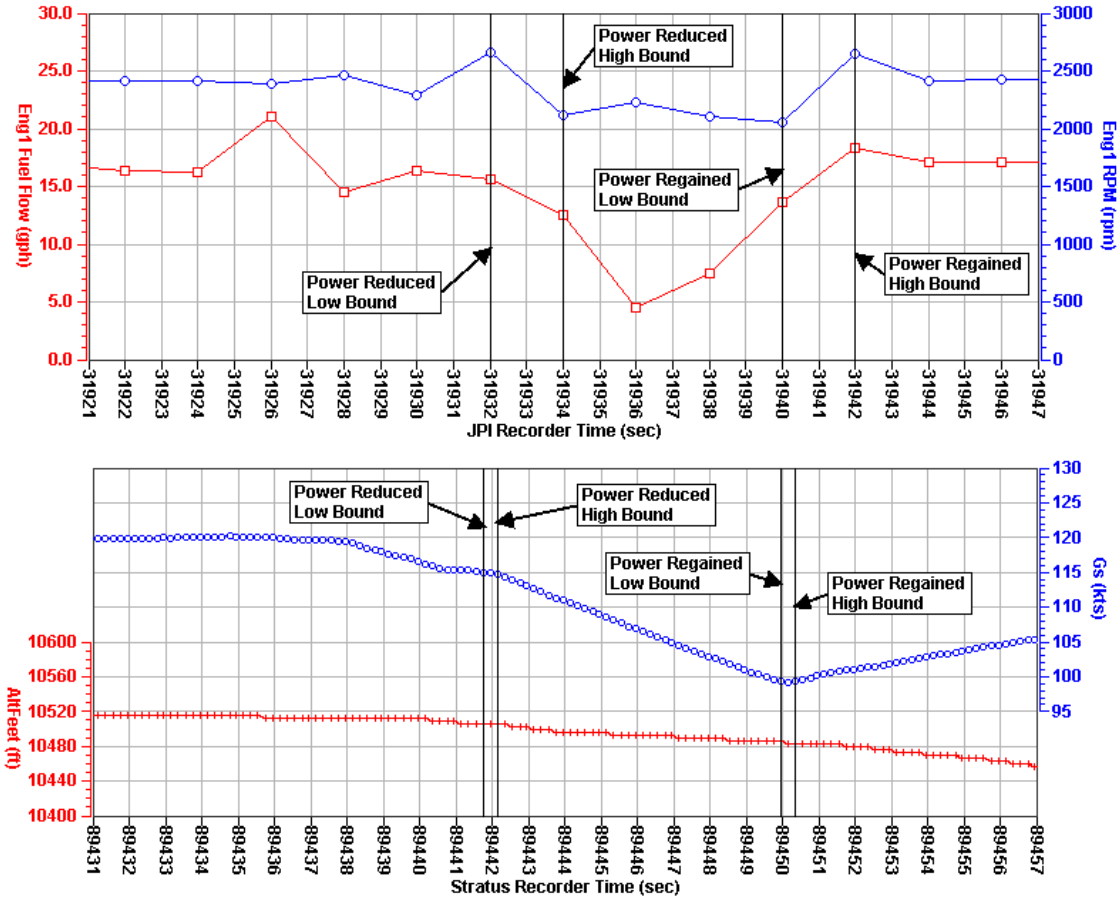


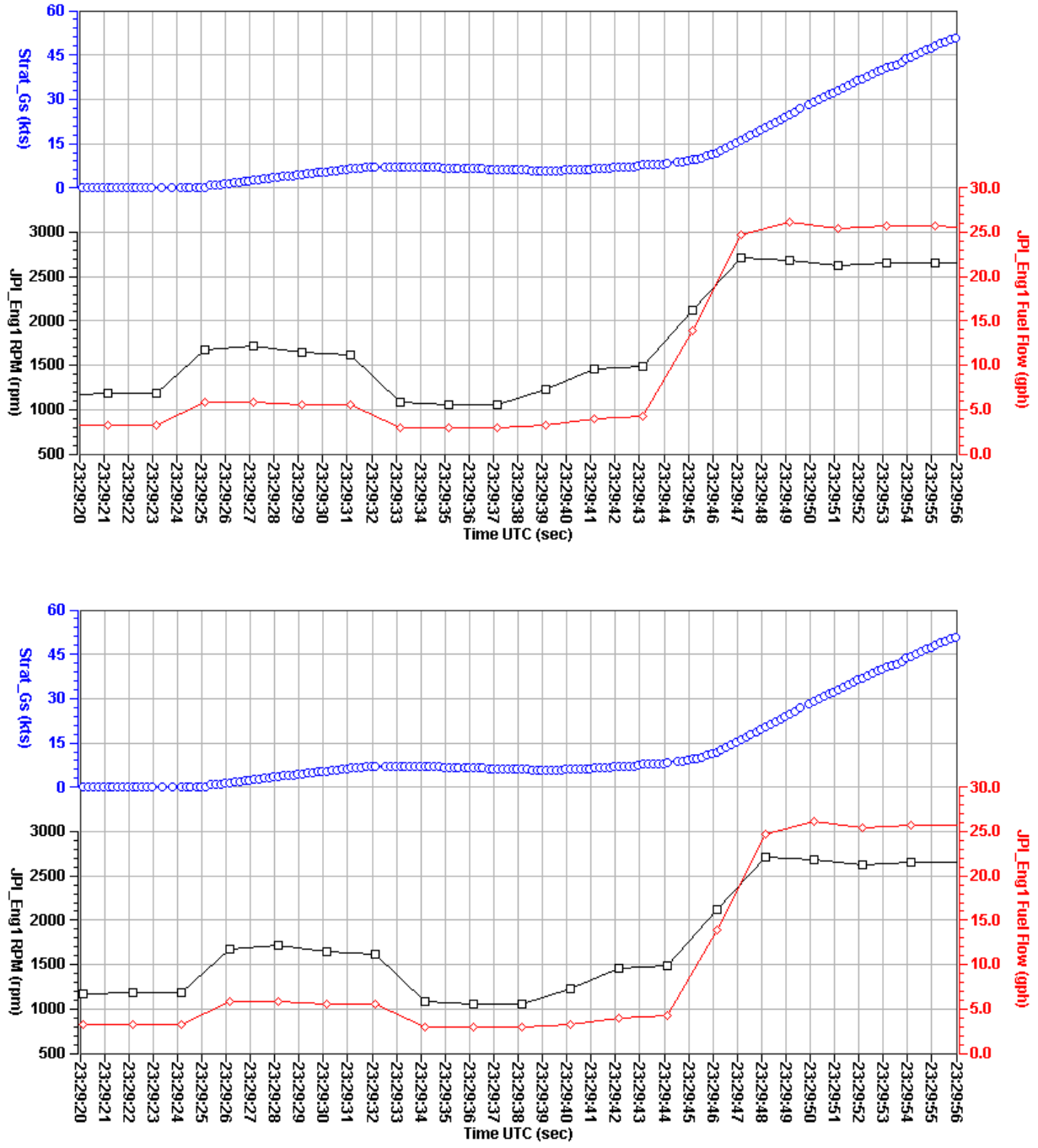
Table 1. JPI/Stratus alignment range summary.

Event	Device	Low Bound (sec)	High Bound (sec)
Start of Turn to Runway	JPI	27054	27056
	Stratus	84565.155	84565.35
	Correction[2]	**57509.155**	**57511.35**
Power Increase for Takeoff	JPI	27074	27076
	Stratus	84584.55	84585.78
	Correction	**57508.55**	**57511.78**
Power Anomaly, Power Reduced	JPI	31932	31934
	Stratus	89441.77	89442.15
	Correction	**57507.77**	**57510.15**
Power Anomaly, Power Regained	JPI	31940	31942
	Stratus	89449.95	89450.35
	Correction	**57510.35**	**57507.95**

[2] The correction is calculated such that adding the correction value to the JPI time scale converts it to the Stratus time scale. The low bound correction is calculated by subtracting the high bound Stratus time from the low bound JPI time and the high bound correction is calculated by subtracting the low bound Stratus time from the high bound JPI time.

Taking the maximum low bound correction and the minimum high bound correction from Table 1 gives the possible correction range of 57509.155 seconds to 57510.15 seconds with an error bound of 0.995 seconds. The two extreme correction bounds are compared in figure 3. The time scale is in Coordinated Universal Time (UTC) for both plots.

Figure 3. Takeoff: Left (top plot) and right (bottom plot) most alignment.



From these figures it was decided that roughly splitting the range provided the best fit; therefore, the final correction used in the remainder of this report is 57509.7 seconds with an uncertainty of +0.45/-0.545. Figure 4 shows the entire flight with the JPI data aligned to the Stratus data and figure 5 shows the final approach. The time scale is in UTC for both plots.

Using Latitude/Longitude data from the Stratus, the aircraft's position during final approach was overlaid with the Santa Rosa instrument approach procedure chart in Google Earth. This overlay is shown in figure 6 with several reference points showing Stratus and JPI basic parameters.

Conclusions and Limitations

The alignment of the Stratus and JPI data was subject to limitations detailed in this report, including: JPI sampling frequency, the lack of equivalent recorded parameters between the JPI and Stratus, and the limited number of events that could be used for alignment purposes.

Four events were used to reduce the JPI/Stratus alignment to a range rounded to a +/- 0.5 second plausible range. The parsimonious alignment was used to align JPI and Stratus data in figures 4 through 6.

With these uncertainties in mind, the following observations can be made from the aligned data:

- For the majority of the approach, from 02:40:58 UTC to 02:54:16 UTC, the fuel flow remains between approximately 10 and 15 Gallons Per Hour (GPH) and the RPM remains near 2400 RPM.

- At 02:54:16 UTC, a drop in fuel flow corresponds with an increase in descent rate.

- At 02:56:44 UTC, about 20 seconds before the end of the recording, the fuel flow and RPM increase 6 seconds before the aircraft enters the final 60^{o} roll to the left.

Figure 4. Entire flight final alignment.

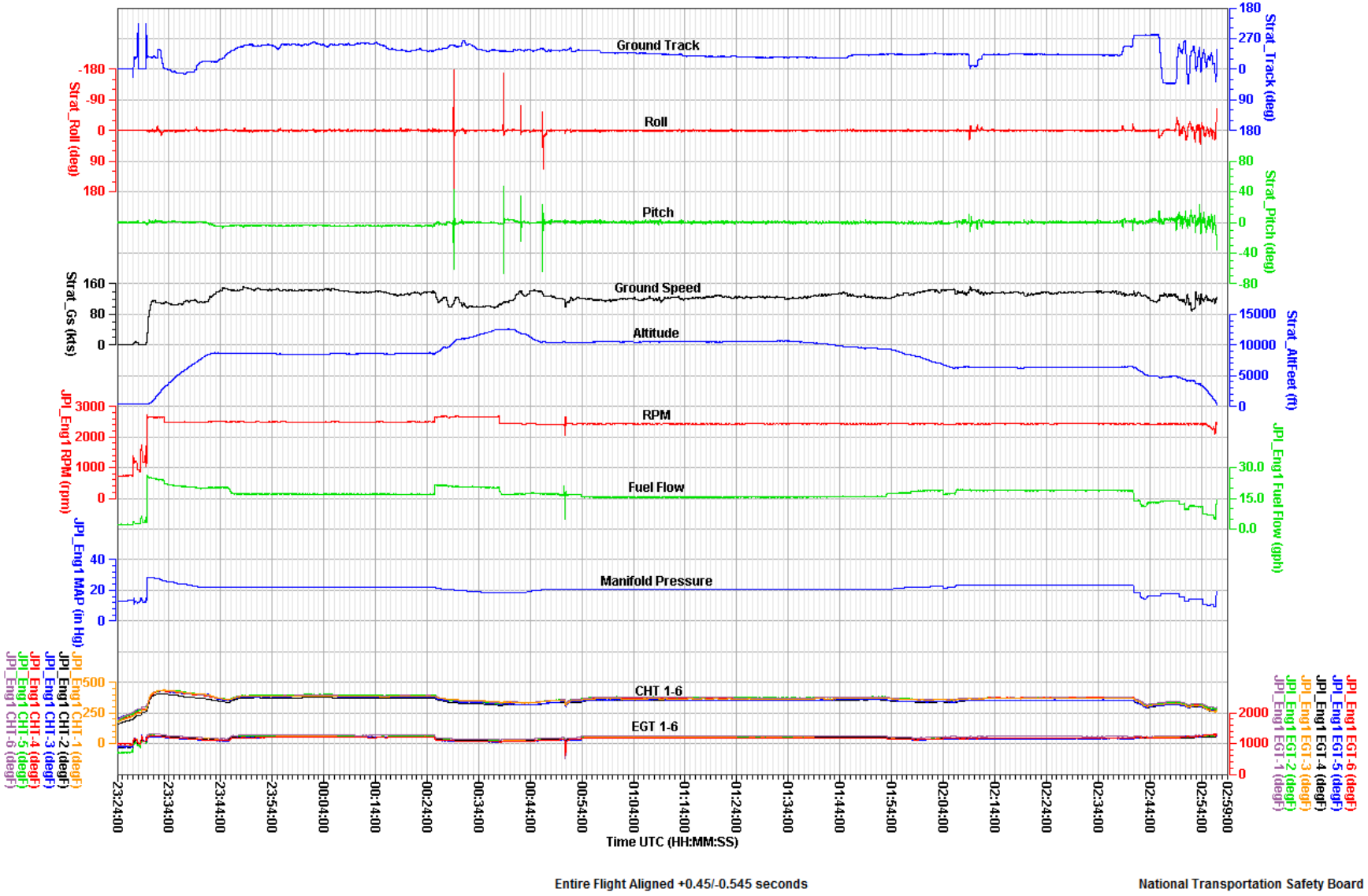


Figure 5. Final approach final alignment.

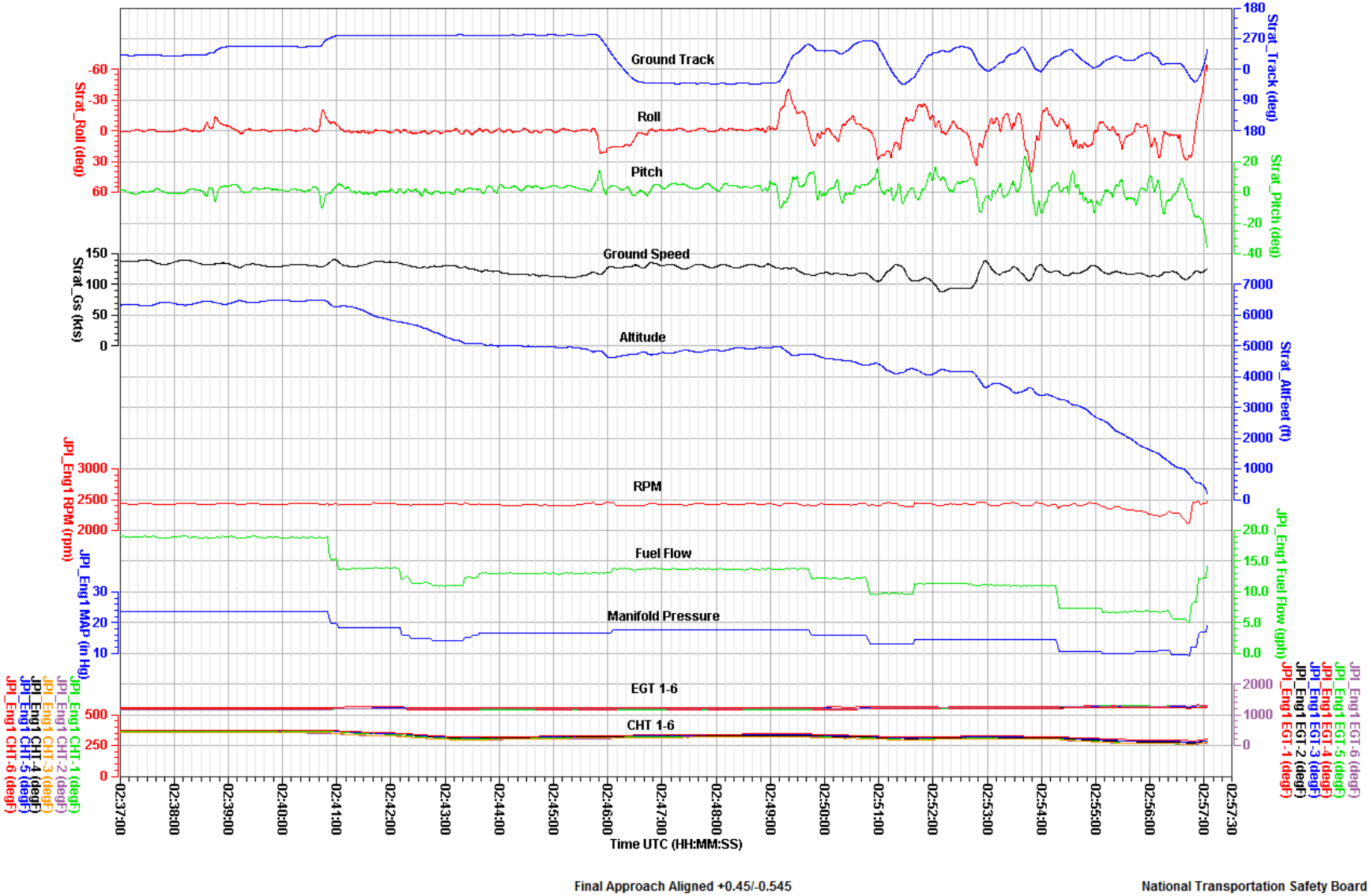


Figure 6. Final Approach Flight Path.