

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



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ELECTRONIC DEVICES

Specialist's Factual Report

December 19, 2024

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A. ACCIDENT

Location: Logan, West Virginia
Date: March 15, 2024
Time: 1627 eastern daylight time (EDT)
2027 coordinated universal time (UTC)
Airplane: Cirrus SR20, private operator, N312DD

B. ELECTRONIC DEVICES SPECIALIST

Specialist: Steven Smith
Mechanical Engineer (Recorder Specialist)
National Transportation Safety Board (NTSB)

C. DETAILS OF THE INVESTIGATION

A group was not convened. The NTSB Vehicle Recorder Division received the following electronic devices:

Recorder Manufacturer/Model: Heads-Up Recoverable Data Module (RDM)
Part Number: RDM100-002
Recorder Serial Number: 18299

Recorder Manufacturer/Model: 3 SD Cards from Garmin G1000
Part Number: Unknown
Recorder Serial Number: Unknown

1.0 Heads-Up Technologies RDM Description

The Heads-Up Technologies RDM is designed to record flight data in a crash and fire-resistant housing. The unit records flight, engine, and autopilot parameters, including parameters provided by the Garmin G1000. Data is logged once per second and stored internally on four thin small outline package (TSOP) memory chips inside the crash-hardened enclosure. When the storage limit of the memory device is reached, the oldest recording is overwritten.

1.1 Heads-Up Technologies RDM Data Recovery

The Heads-Up Technologies RDM was in good condition, as shown in figure 1 and the data were downloaded using the manufacturer's procedure.



Figure 1. Heads-Up RDM as received by the NTSB Vehicle Recorder Laboratory.

1.2 Heads-Up Technologies RDM Recording Description

The decoded data contained 15 flights recorded from February 29, 2024, to March 15, 2024. The last flight, recorded from 14:55:00 EDT to 16:27:29 EDT on March 15, 2024, was determined to be the accident flight. The data were sampled at 1 Hertz (Hz). The last recorded position sample does not align with the approximate wreckage location. The last recorded position at 16:27:29 EDT, is approximately 201 feet from the approximate wreckage location.

1.3 Heads-Up Technologies RDM Parameters Provided

Table 1 lists the Heads-Up Technologies RDM parameters verified and provided in this report. This aircraft engine is configured with 6 cylinders. In table 1, '#' represents the number of cylinders. In the data plots, the '#' is replaced with the appropriate cylinder ID.

Table 1. Heads-Up Technologies RDM verified and provided parameters.

Parameter Name (unit)	Parameter Description (unit)
% Pwr (%)	Engine Power (percentage)
Accel Lat (g)	Lateral Acceleration (unit of gravitational acceleration)
Accel Long (g)	Longitudinal Acceleration (unit of gravitational acceleration)
Accel Norm (g)	Normal Acceleration (unit of gravitational acceleration)
Alt Press (ft)	Pressure Altitude (feet)
CHT# (degF)	Cylinder Head Temperature (degrees Fahrenheit)
EGT# (degF)	Exhaust Gas Temperature (degrees Fahrenheit)
Flap Mode (%)	Flap Mode (percentage)
Fuel Flow (gph)	Fuel Flow (gallons per hour)
Gnd Spd (kts)	Ground Speed (knots)
GPS Alt (ft)	Global Positioning System Altitude (feet)
IAS (kts)	Indicated Airspeed (knots)
Lat (deg)	Latitude (degrees)
Long (deg)	Longitude (degrees)
Mag Hdg (deg)	Magnetic Heading (degrees)
MAP (inHg)	Manifold Pressure (inches of Mercury)
OilP (psi)	Oil Pressure (pounds per square inch)
OilT (degF)	Oil Temperature (degrees Fahrenheit)
Pitch (deg)	Pitch Attitude (degrees)
Roll (deg)	Roll Attitude (degrees)
RPM (rpm)	Engine Speed (revolutions per minute)
Stall Warn (discrete)	Stall Warning (WARNING/NO WARNING)
Track (deg)	Magnetic Ground Track (deg)
Vert Spd (fpm)	Vertical Speed (feet per minute)

1.4 Heads-Up Technologies RDM Time Correlation

The time recorded by the Heads-Up Technologies RDM was in UTC. The difference between UTC and the local time, EDT, is 4 hours, or 14,400 seconds. The accident flight data has been offset from the recorded RDM time to EDT by subtracting 14,400 seconds.

2.0 Garmin G1000 Description

The Garmin G1000 Integrated Flight Deck is a collection of multiple avionics units which include flight displays, air data computers, Attitude/Heading Reference

System (AHRS), communications and other systems. A typical installation includes a Primary Flight Display (PFD) and a Multi-Function Display (MFD). Each display includes two Secure Digital (SD) card slots, an upper and a lower slot. The lower SD card slot is used by the system for software updates and various databases.¹

Depending on the display unit software, the aircraft can include a data logging feature. The data logging feature must be enabled by the aircraft operator. If the data logging feature is available and enabled, a SD card has to be installed in the upper slot of the MFD. Depending on the airframe and engine combination as many as 64 parameters can be stored at a rate of one sample per second (1Hz). According to the manufacturer of the display unit, one flight hour can be stored in approximately 2 megabytes (MB). The SD card typically used is 2 gigabytes (GB) in size and can store over 1,000 flight hours.

2.1 Garmin G1000 SD Cards Data Recovery

The SD cards were in good condition and the data were downloaded using the manufacturer's procedure. Figure 2 shows the SD cards as received by the NTSB Vehicle Recorder Laboratory.



Figure 2. Garmin G1000 SD cards as received by the NTSB Vehicle Recorder Laboratory.

¹ Databases can include terrain data, obstacle data, SafeTaxi charts, flight charts and airport terrain databases.

2.2 Garmin G1000 SD Cards Recording Description

The data extracted included 86 sessions from October 7, 2021, through March 15, 2024. The last flight, recorded from 14:45:32 EDT to 16:27:28 EDT on March 15, 2024, was determined to be related to the accident flight. The data were sampled at 1 Hz. The last recorded position sample does not align with the approximate wreckage location. The last recorded position at 16:27:28 EDT, is approximately 347 feet from the approximate wreckage location. After a review of the accident flight recording, it was determined that a significant portion of the data recorded on the Garmin G1000 was redundant to the parameters recorded on the RDM. A select subset of parameters from the Garmin G1000 data that were not recorded to the RDM were used to generate a series of automation and deviation plots, as well as the positional data to generate the Google Earth overlay of the event.

2.3 Garmin G1000 SD Cards Parameters Provided

Table 2 lists the Garmin G1000 SD cards parameters verified and provided in this report.

Table 2. Garmin G1000 SD Cards verified and provided parameters.

Parameter Name (unit)	Parameter Description (unit)
AFCS (discrete)	Automatic Flight Control System (ON/OFF)
Alt MSL (ft)	Altitude Mean Sea Level (feet)
AtvWpt (ident)	Active Waypoint (identification)
IAS (kts)	Indicated Airspeed (knots)
HCDI (%fsd) ²	Horizontal Course Deviation Indicator (percent full scale deflection)
Lat (deg)	Latitude (degrees)
Long (deg)	Longitude (degrees)
Mag Hdg (deg)	Magnetic Heading (degrees)
PitchM (discrete) ³	AFCS Pitch Mode (NONE, ALT, GP)
RollM (discrete) ⁴	AFCS Roll Mode (NONE, GPSa)
Time (HH:MM:SS)	Universal Coordinated Time (Hours:Minutes:Seconds)
VCDI (%fsd) ⁵	Vertical Course Deviation Indicator (percent full scale deflection)
WptDst (NM)	Waypoint Distance (nautical miles)

² Positive HCDI is defined as left of the runway (fly right).

³ The AFCS Pitch Modes that were active during the approach and landing were: NONE = Off, ALT = Altitude Hold, and GP = Glidepath.

⁴ The AFCS Roll Modes that were active during the approach and landing were: NONE = Off and GPSa = Approach, GPS Arm/Capture/Track (Glidepath Mode Automatically Armed, if available).

⁵ Positive VCDI is defined as above the glidepath (fly down).

2.4 Garmin G1000 SD Cards Time Correlation

The time recorded by the Garmin G1000 SD cards was in UTC. The difference between UTC and the local time, EDT, is 4 hours, or 14,400 seconds. The accident flight data has been offset from the recorded recorder time to EDT by subtracting 14,400 seconds.

D. FIGURES AND TABULAR DATA

Figures 3 to 8 contain Heads-Up Technologies RDM and Garmin G1000 data recorded during the event on March 15, 2024. All the parameters listed in tables 1 and 2 are plotted.

Figure 3 and 4 are time history plots of basic parameters and engine parameters on approach and landing at Logan County Airport (6L4), Logan West Virginia from 16:22:00 EDT to 16:27:30 EDT, respectively.

Figures 5 and 6 are time history plots of basic parameters and engine parameters for landing at 6L4 from 16:26:30 EDT to 16:27:30 EDT, respectively.

Figures 7 and 8 are time history plots of aircraft automation and deviation indicators for approach and landing at 6L4 from 16:21:40 EDT to 16:27:30 EDT and 16:26:30 EDT to 16:27:30 EDT, respectively.

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 Heads-Up Technologies RDM and Garmin G1000 SD card data indicated the following sequence of events:

- **16:21:48 EDT:** The aircraft crossed waypoint MYNAS.⁶ The AFCS was on. The aircraft AFCS pitch and roll modes were altitude hold (ALT) and GPS approach (GPSa), respectively.
- **16:22:00 EDT:** The aircraft GPS altitude was 5,062 ft at an airspeed of 119 kts. Magnetic heading was 52 deg. The aircraft was climbing.
- **16:22:01 EDT:** The AFCS pitch mode changed from ALT to glidepath (GP). The AFCS roll mode remained in GPSa.
- **16:22:08 EDT:** The aircraft began to descend from 5,128 ft.
- **16:22:16 EDT:** Vertical speed was -1440 fpm.

⁶ The aircraft followed the correct sequence of waypoints for the GPS approach for runway 6 at 6L4.

- **16:22:40 EDT:** HCDI and VCDI was -1.2 %fsd and 0.3 %fsd, respectively.
- **16:23:46 EDT:** The aircraft passed through 3,800 ft at 102 kts. The magnetic heading was 59 deg.
- **16:24:56 EDT:** The aircraft crossed waypoint LOWAK. HCDI and VCDI was 2.8 %fsd and -1.1 %fsd, respectively.
- **16:24:57 EDT:** The aircraft passed through 3,000 ft at 108 kts. The magnetic heading was 58 deg.
- **16:25:48 EDT:** The aircraft crossed waypoint VARNY. HCDI and VCDI was 2.8 %fsd and -1.1 %fsd, respectively.
- **16:24:34 EDT:** The AFCS was turned off. The AFCS pitch and roll modes both changed to NONE.
- **16:26:39 EDT:** The aircraft was at 1,959 ft at 117 kts. The magnetic heading was 66 deg. The engine power began to reduce from 49%.
- **16:26:47 EDT:** Engine power was reduced to 0%. Engine RPM began to reduce. HCDI and VCDI were -32.0 %fsd and 174.70 %fsd, respectively.
- **16:26:59 EDT:** The aircraft crossed runway 6 threshold (RW06 waypoint).
- **16:27:04 EDT:** The aircraft was at 1,690 ft (25 ft above ground level) at 89 kts. The magnetic heading was 58 deg.
- **16:27:09 EDT:** GPS altitude was 1,670 ft.⁷ The aircraft speed was 83 kts. Magnetic heading was 65 deg.
- **16:27:23 EDT:** Engine power and RPM increased to 33% and 1507 rpm, respectively.
- **16:27:24 EDT:** Normal acceleration reduced from 1.15 g to 0.61 g, consistent with the aircraft departing the paved runway surface. The Garmin G1000 data positioned the aircraft at the end of runway 6 (start of runway 24 threshold).
- **16:27:28 EDT:** End of recorded Garmin G1000 data. The aircraft positional data showed the aircraft was no longer on the runway. The stall warning was active for the remainder of the RDM recording.
- **16:27:29 EDT:** End of recorded Heads-Up Technologies RDM data. Engine power and RPM were 88% and 2644 RPM, respectively.

⁷ 6L4 runway 6 Touchdown Zone Elevation (TDZE) is 1,665 ft.

Figures 9 through 11 are graphical overlays generated using Google Earth for the approach and landing, a perspective view looking down runway 24 at 6L4, and a perspective view of short final down to landing, respectively. The weather and lighting conditions in Google Earth are not necessarily the weather and lighting conditions present at the time of the recording. The data used to create these overlays was obtained from the Garmin G1000 SD cards. Figure 12 is the Jeppesen approach plate for an area navigation (RNAV)/GPS approach for runway 6 at 6L4.

The corresponding Heads-Up Technologies tabular data used to create figures 3 to 8 are provided in electronic comma-separated value (CSV) format as attachment 1 to this report. The corresponding Garmin G1000 SD card tabular data used to create figures 7 and 11 are provided in electronic CSV format as attachment 2 to this report.

Submitted by:

Steven Smith
Mechanical Engineer (Recorder Specialist)

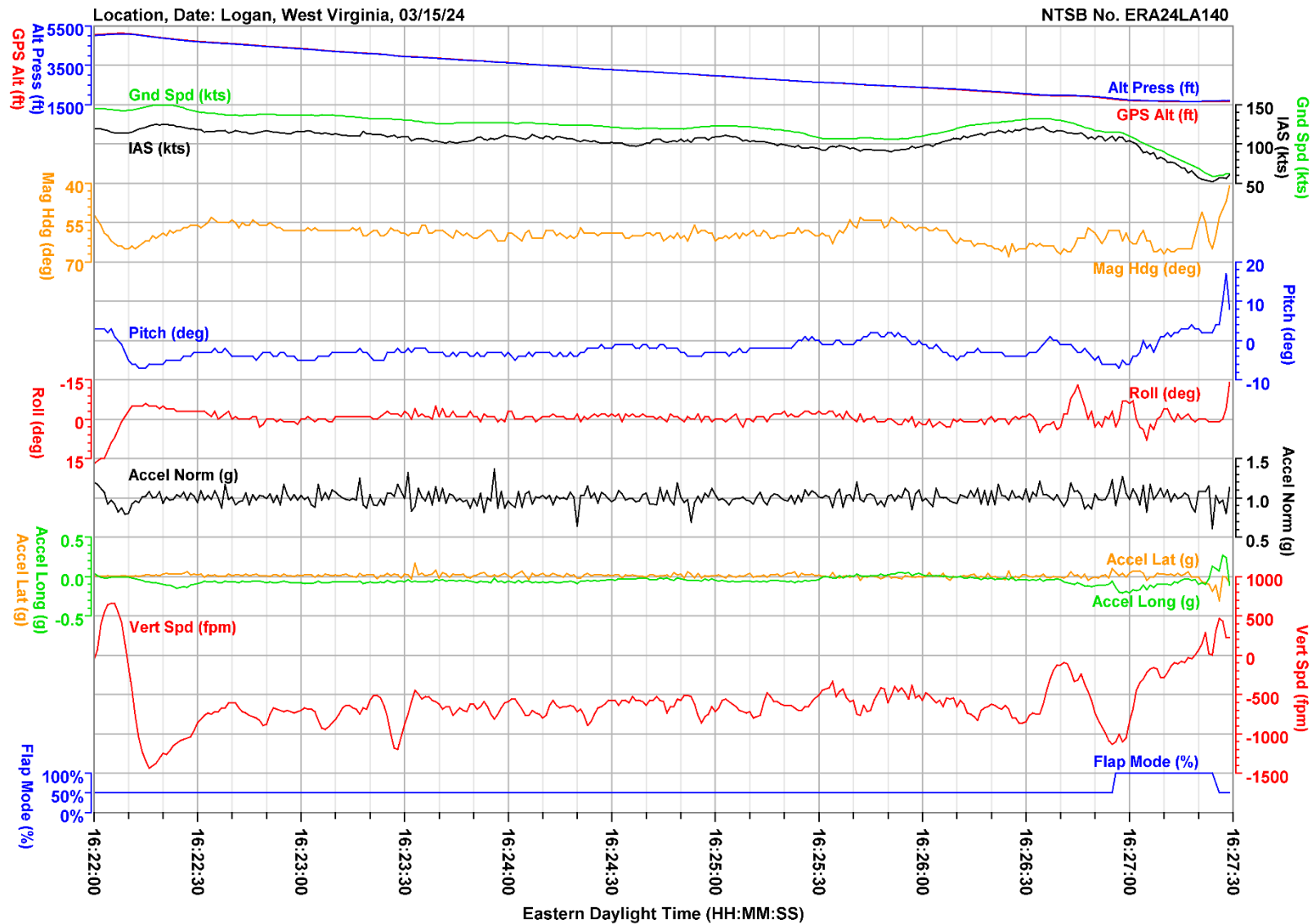


Figure 3. Time history plot of basic parameters for the approach and landing from 16:22:00 EDT to 16:27:30 EDT.

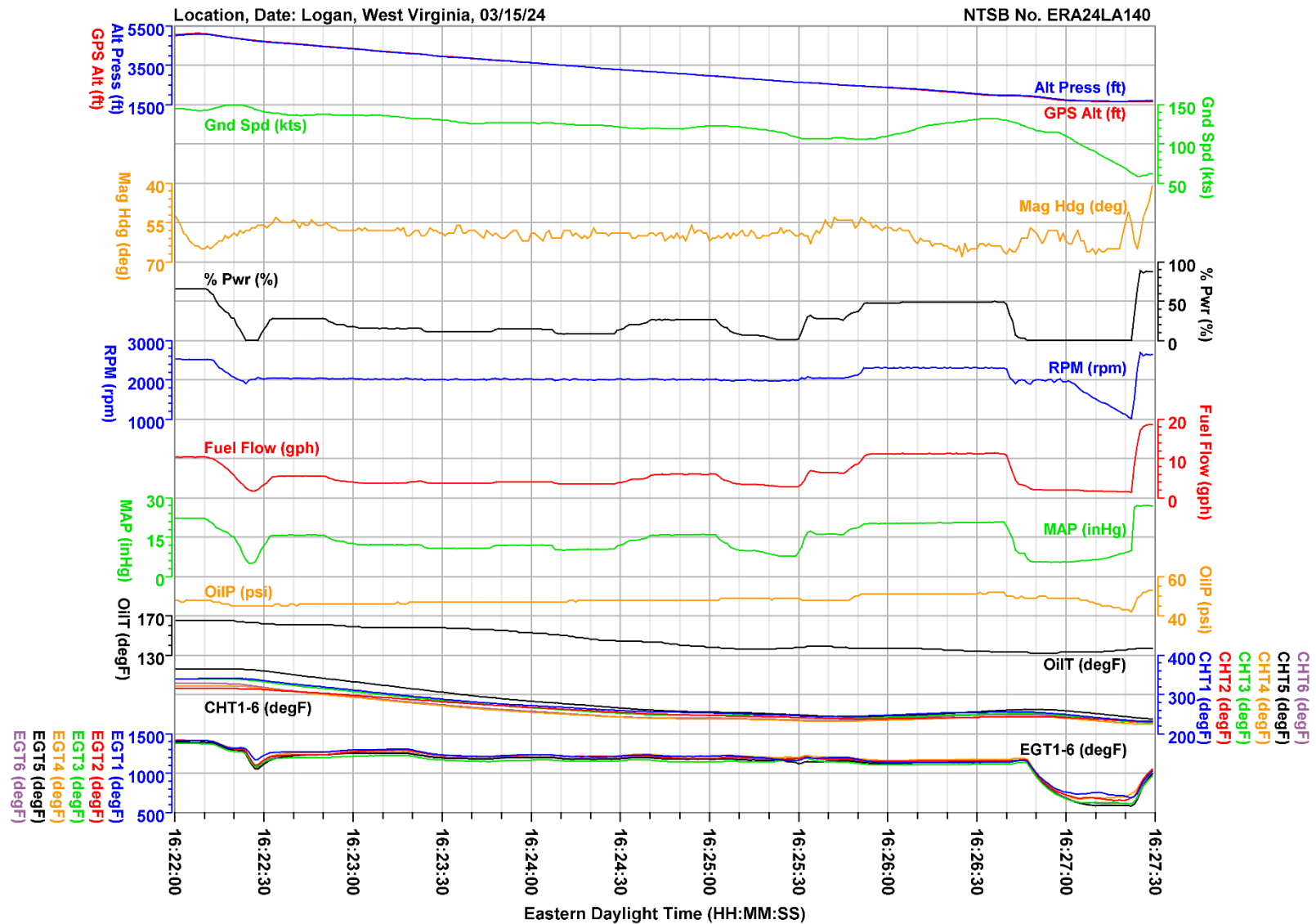


Figure 4. Time history plot of engine parameters for the approach and landing from 16:22:00 EDT to 16:27:30 EDT.

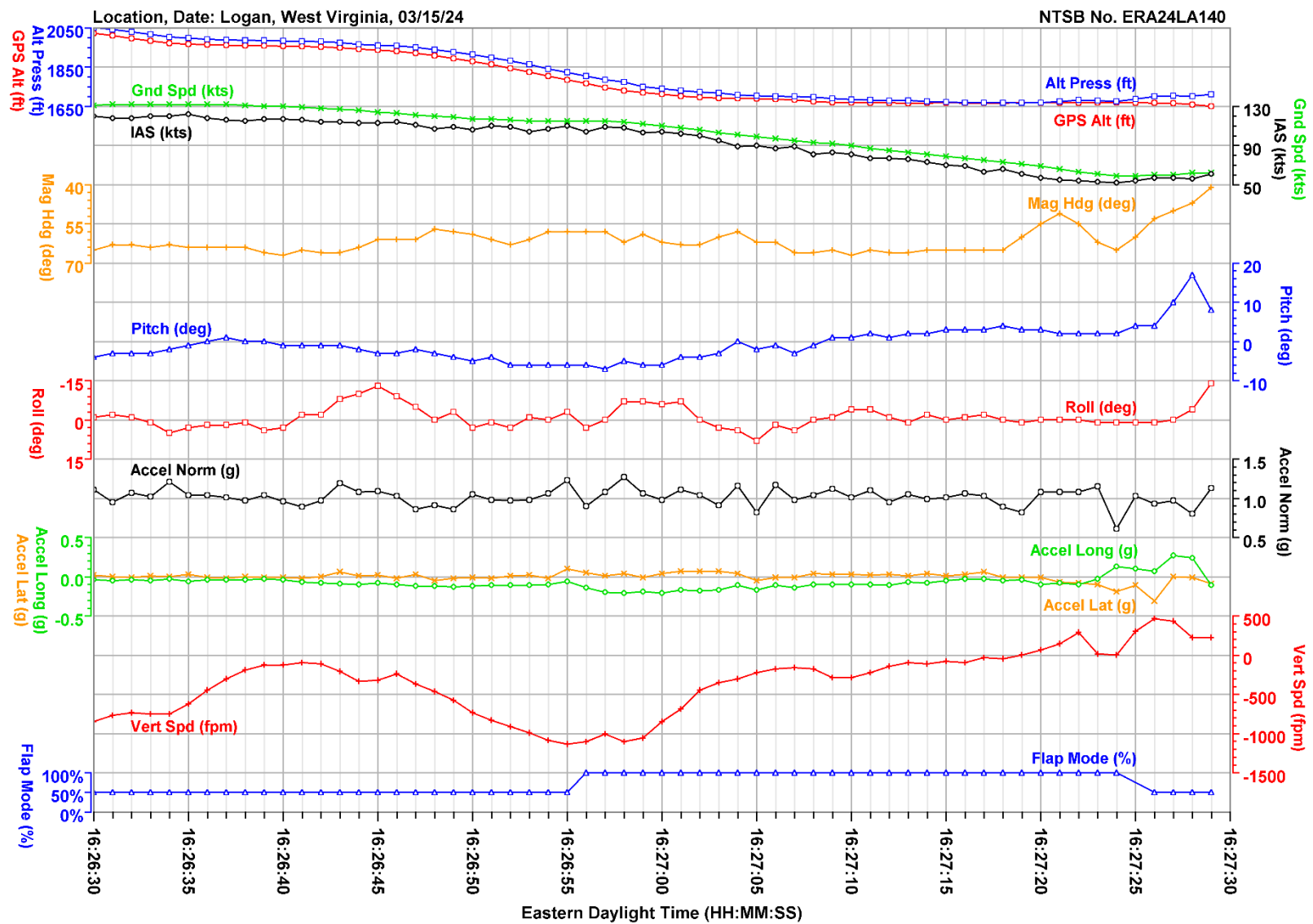


Figure 5. Time history plot of basic parameters for the landing from 16:26:30 EDT to 16:27:30 EDT.

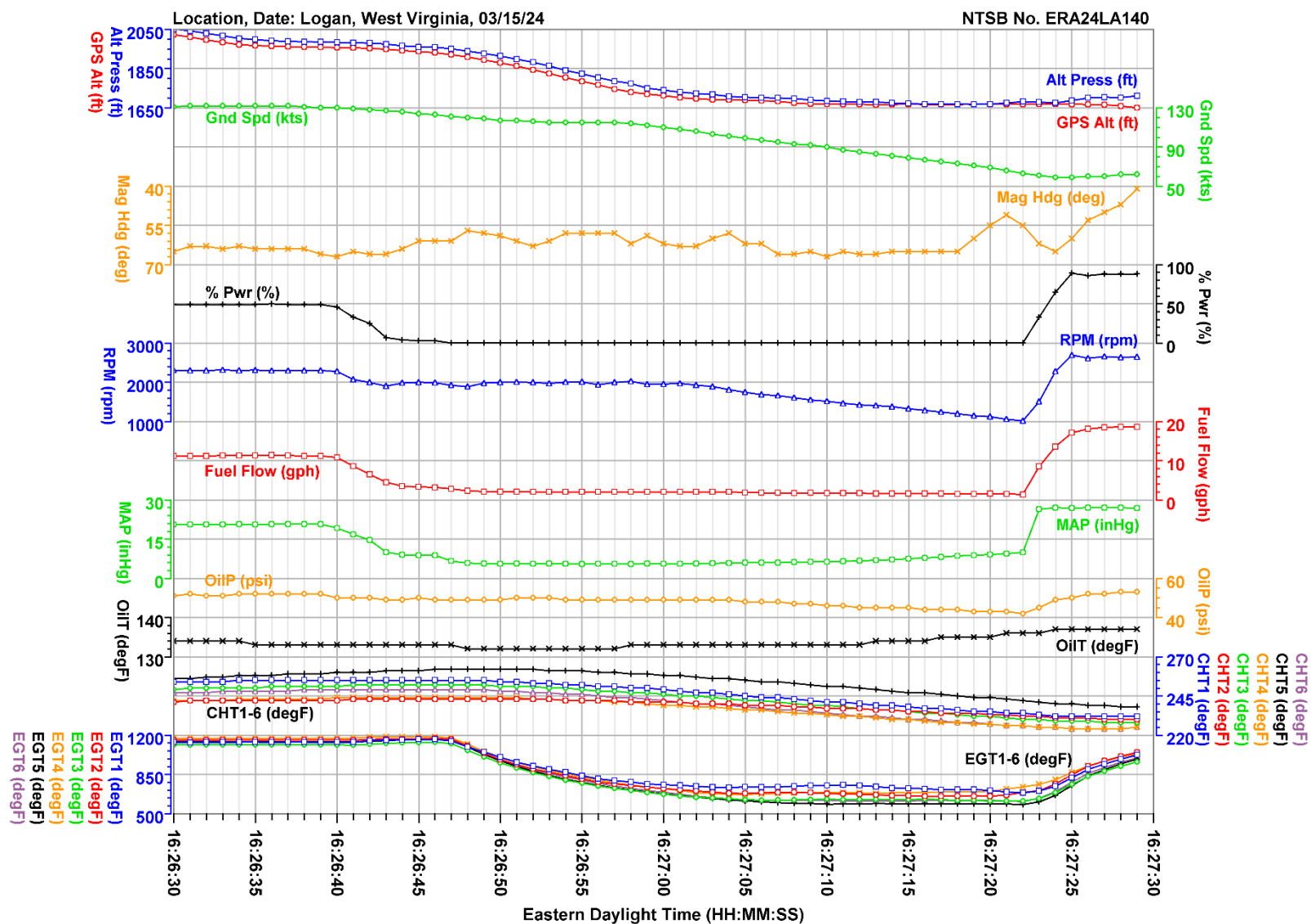


Figure 6. Time history plot of engine parameters for the landing from 16:26:30 EDT to 16:27:30 EDT.

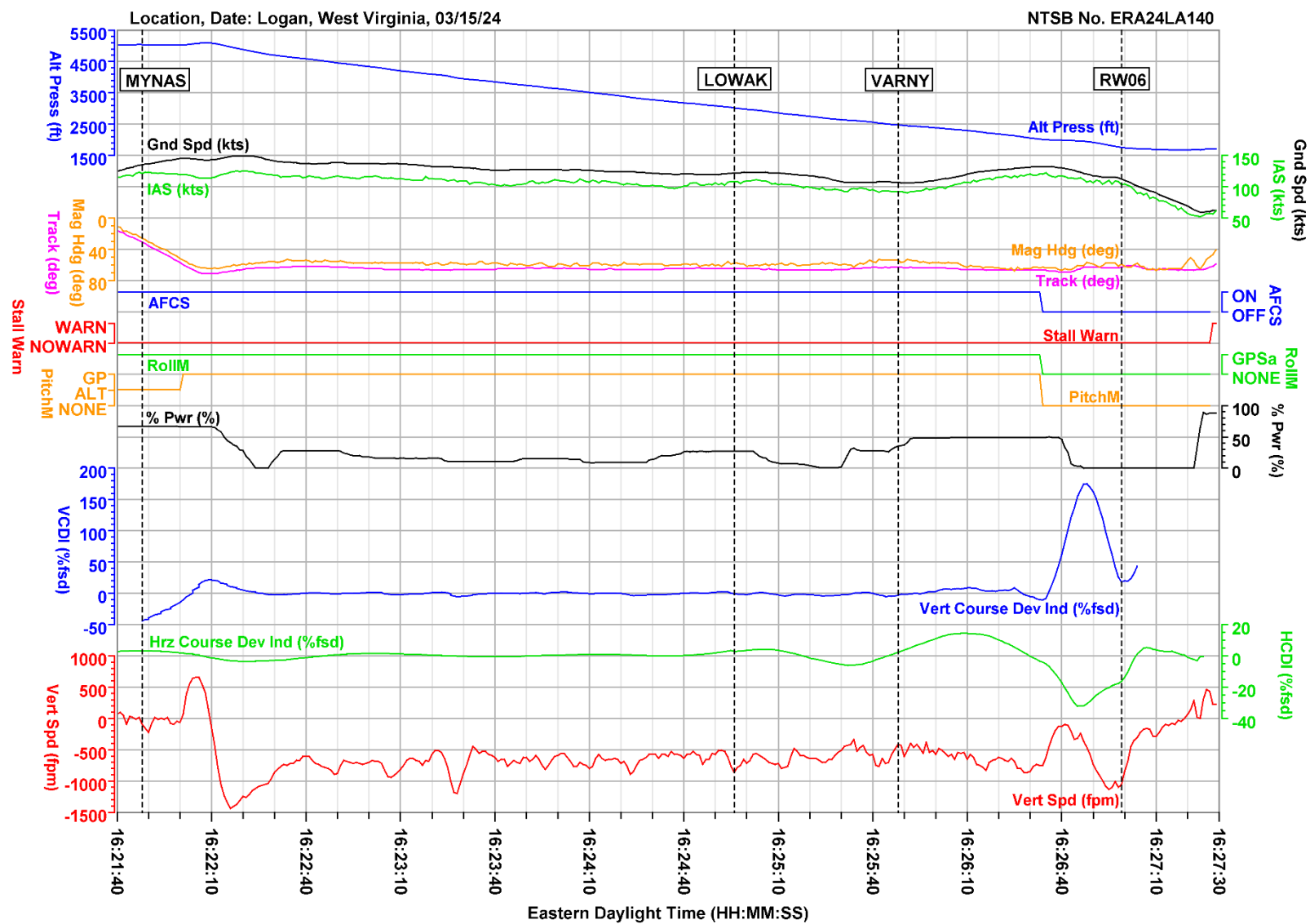


Figure 7. Time history plot of automation and deviation parameters on the approach to runway 6 at 6L4 from 16:21:40 EDT to 16:27:30 EDT.

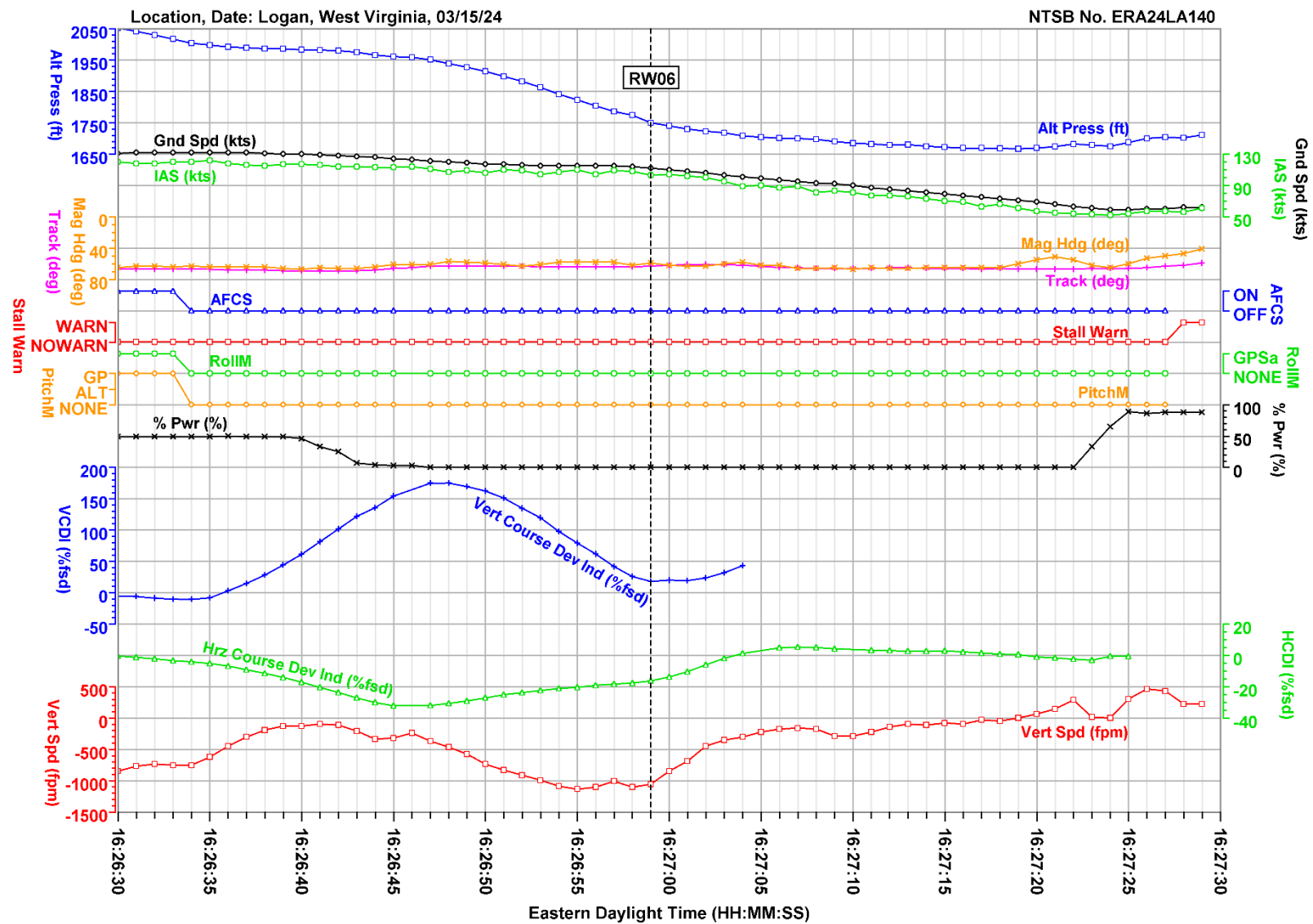


Figure 8. Time history plot of automation and deviation parameters on the approach to runway 6 at 6L4 from 16:26:30 EDT to 16:27:30 EDT.

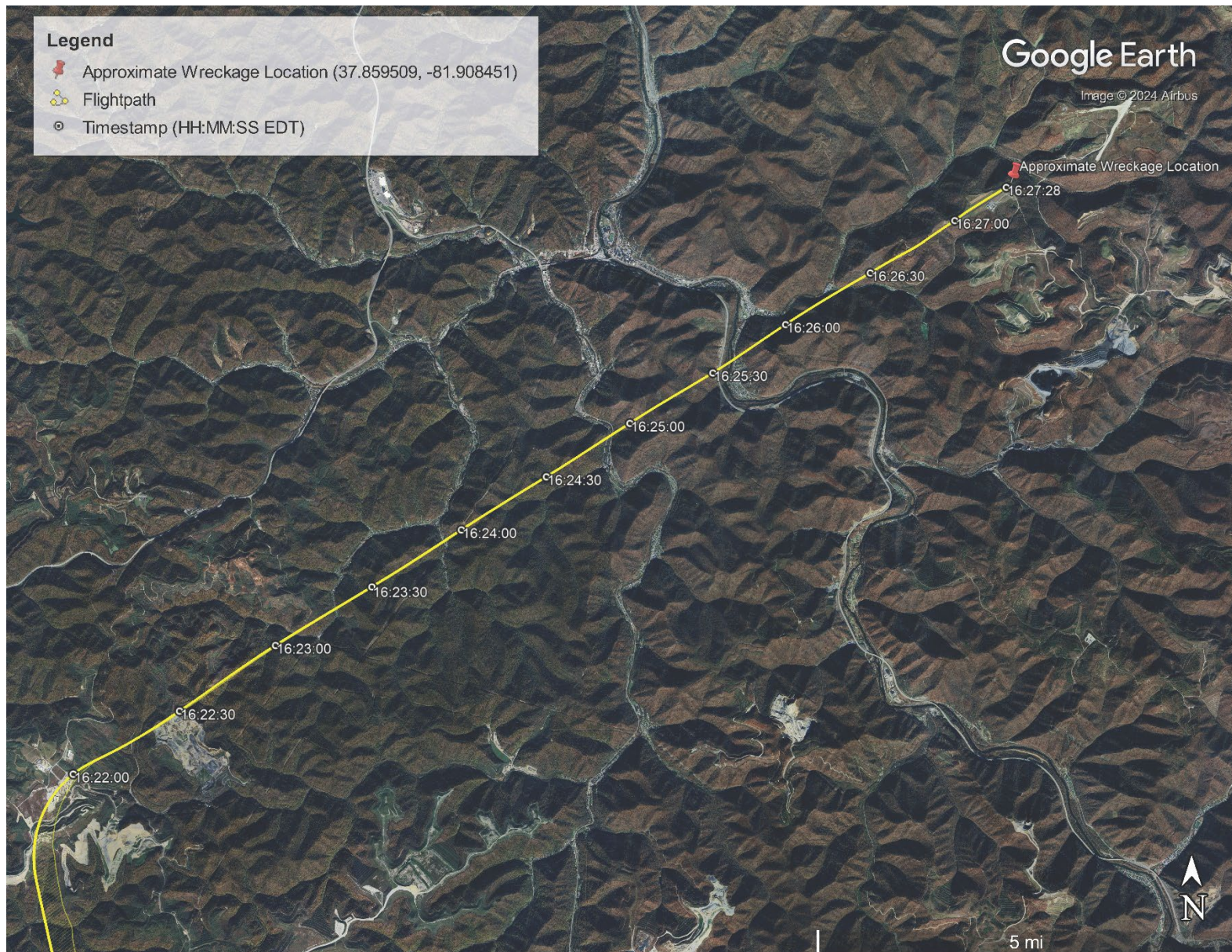


Figure 9. Google Earth overlay of the approach and landing from 16:22:00 EDT to 16:27:28 EDT.

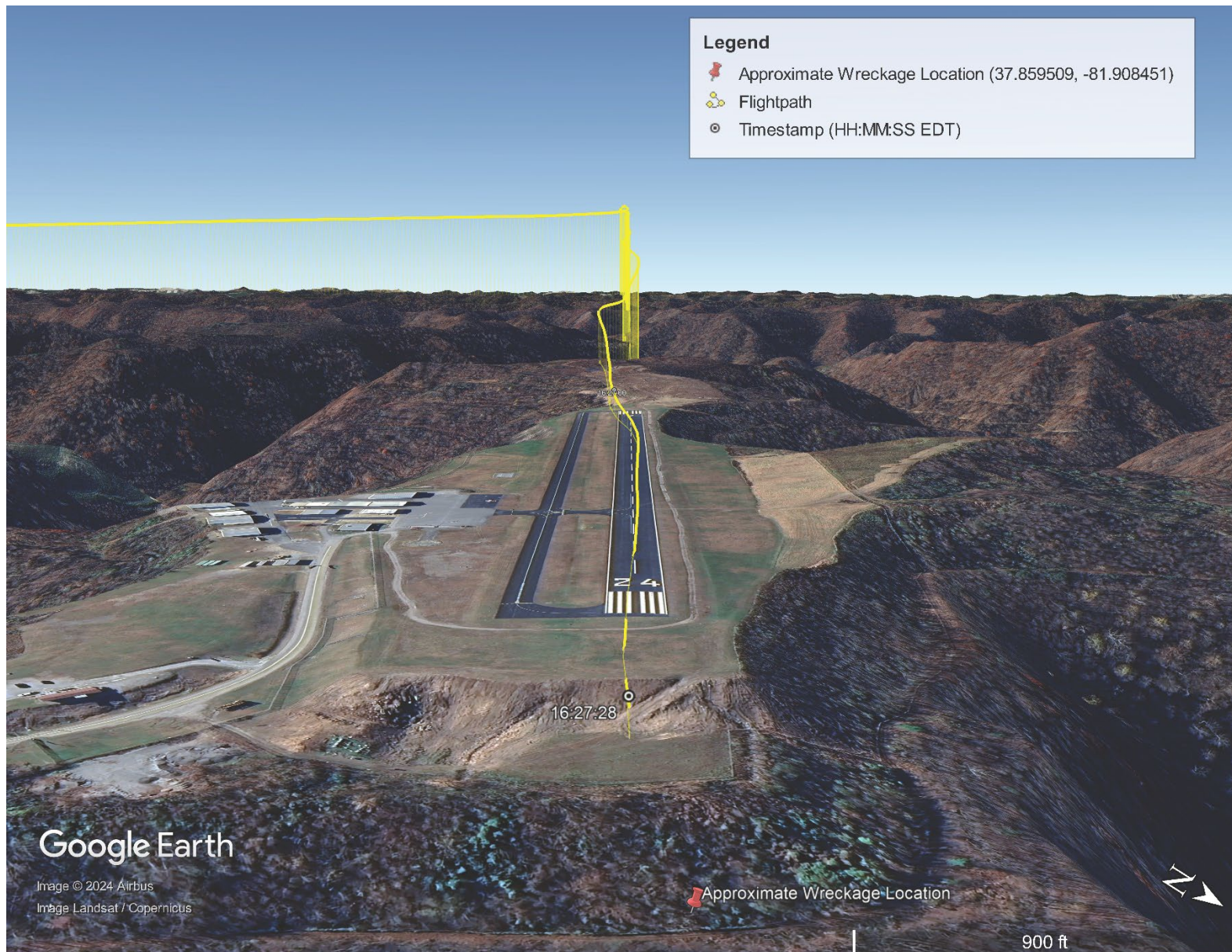


Figure 10. Google Earth overlay of the approach and landing with displayed times of 16:27:00 EDT to 16:27:28 EDT.

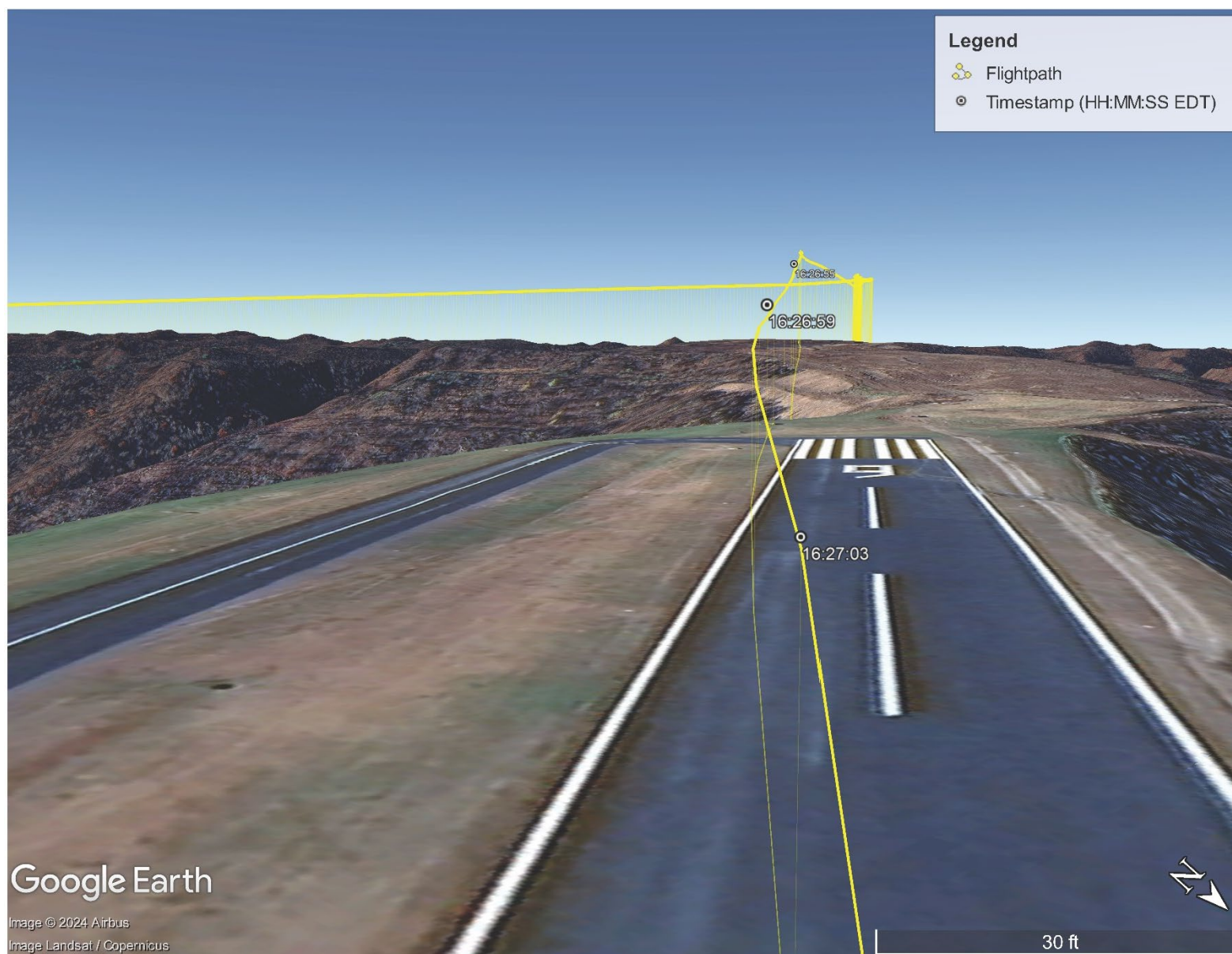


Figure 11. Google Earth overlay of short final down to landing with displayed times of 16:26:55 EDT to 16:27:03 EDT.

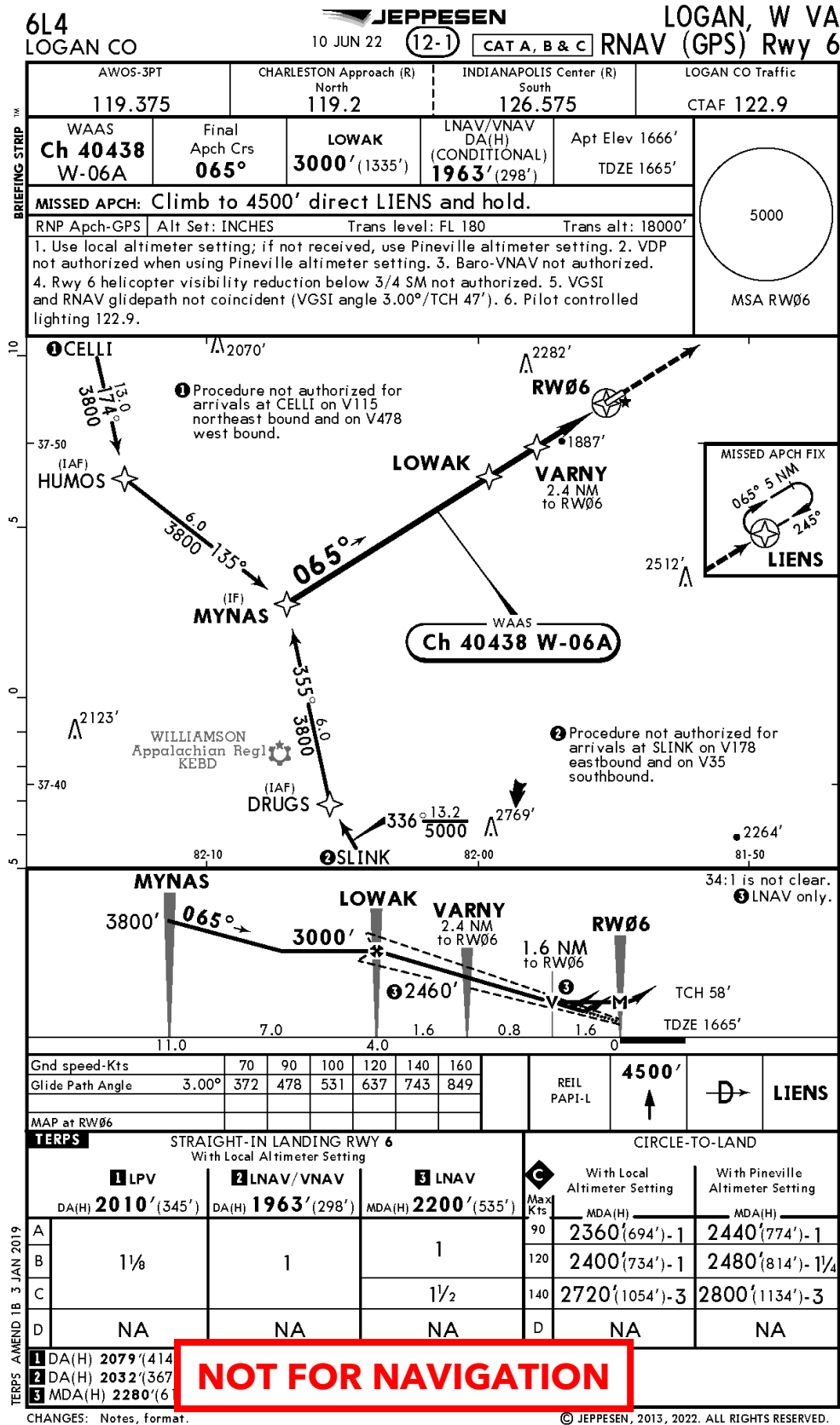


Figure 12. 6L4 approach plate for RNAV (GPS) runway 6 (Source: Jeppesen).