

NATIONAL TRANSPORTATION SAFETY BOARD

Vehicle Recorder Division

Washington, D.C. 20594

July 30, 2021

Rotorcraft Condition Monitor – Recorded Flight Data

Specialist's Factual Report

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1. EVENT SUMMARY

Location: Eden, North Carolina
Date: April 28, 2021
Aircraft: Bell 429
Registration: N53DE
Operator: Duke Energy Business Service LLC
NTSB Number: ERA21FA195

2. RECORDED FLIGHT DATA GROUP

A recorded flight data group was not convened.

3. DETAILS OF INVESTIGATION

On May 5, 2021, the National Transportation Safety Board (NTSB) Vehicle Recorder Division received the following electronic device:

Device Manufacturer/Model: **GPMS Foresight MX**
Serial Number: **unknown**

3.1. Device Description

The Foresight MX, Health & Usage Monitoring System (HUMS), is a rotorcraft condition monitoring system developed and manufactured by GPMS. The system consists of an onboard control unit (OBCU), numerous sensors and cloud-based software. It is capable of exceedance monitoring, flight data monitoring, and engine and mechanical system monitoring. It provides the pilots with automated rotor track and balance solutions, and predictive estimates on component remaining useful life. The OBCU has 16 GB flash storage, which can more than 1,000 hours of flight data with sampling frequency of 2 Hz. Depending on the installation, recorded flight data can include altitude, speed, pitch, roll, accelerations, engine RPM, transmission torque and transmission outlet temperature etc. The OBCU carries a dual modem with WiFi and cellular capabilities, which allow the unit to automatically upload data to the manufacturer's network platform.

3.2. Device Data Recovery

Figure 1 shows the condition of the GPMS Foresight MX OBCU as received by the Vehicle Recorder Division. The unit had sustained severe post-crash fire damage. The flash memory module was removed from the unit, and corrosion was found on the memory module, as

shown in Figure 2. The memory module was cleaned, and data were read out using hardware provided by the manufacturer. The data were then sent to the manufacturer for decoding.



Figure 1: Undamaged OBCU vs. OBCU as received.

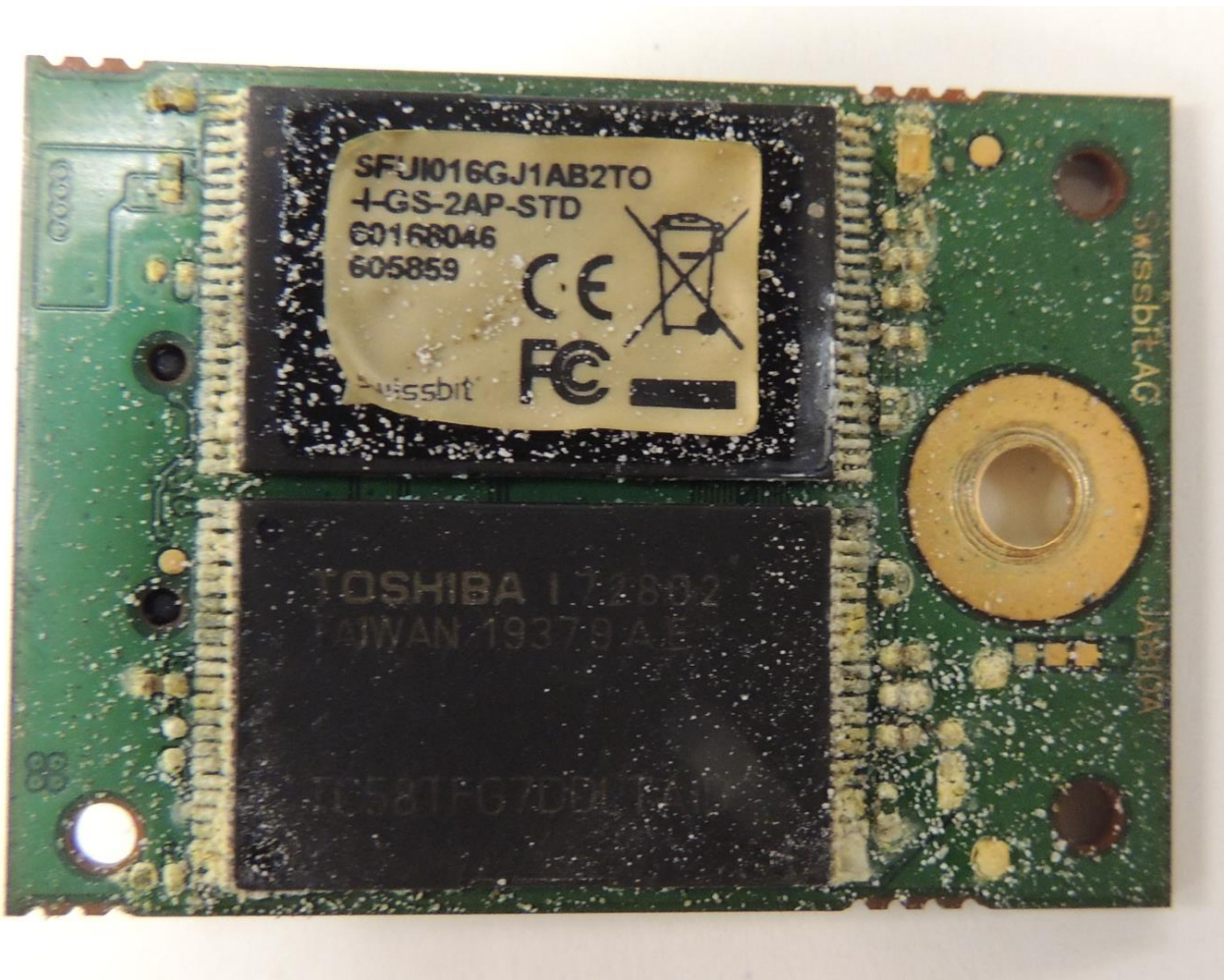


Figure 2: Flash memory module removed from the OBCU.

3.3. Device Data Description

The decoded data sent back from the manufacturer contained a flight recorded on April 28, 2021, and this flight was identified to be related to the accident event. The data were recorded in Universal Coordinated Time (UTC). All time were converted to eastern daylight time (EDT), the local time of the accident, for the rest of this report. The difference between UTC and EDT is 4 hours. The duration of the recording was 53 minutes and 16 seconds, from 12:33:37 to 13:26:53 EDT.

3.3.1. Parameters Provided

Table 1 shows the data parameters recovered from the device. There were abnormalities noticed on some of the parameter data, including pitch, roll, heading and accelerations. The parameter, pitch, started out with high negative values during the initial climb and showed large positive values at many different times later. The values of the X-axis and Y-axis accelerations were all negative and positive until the crash occurred and did not track the changes in ground speed and the roll parameter. The values for the heading were between 60 and 270 degrees when the accident aircraft completed numerous full turns during the accident flight. These abnormalities were reported to the manufacturer, and the inertial measurement unit (IMU) of the main circuit board was sent to the manufacturer for testing. The testing results concluded that the flash memory of the IMU had sustained damage due to the accident, that there were offsets within some of the parameter data, but the exact offsets could not be determined due to the damage of the IMU. The manufacturer further examined the same device installation on other Bell 429 and its recorded data, and no similar abnormalities noticed. After a meeting with the investigators including the investigator-in-charge (IIC), a vehicle performance engineer and a helicopters engineer, it was concluded that the parameters highlighted in yellow in Table 1 were invalid for this investigation.

Table 1: Data Parameters.

Parameter Name	Parameter Description
Lat (deg)	GPS position latitude in degrees
Lon (deg)	GPS position longitude in degrees
Alt (m)	GPS altitude in meters
Dens Alt (m)	Density altitude in meters
Radar Alt (m)	Radar altitude in feet
Ground Speed (kts)	Aircraft ground speed in knots
Ind Airspeed (kts)	Indicated airspeed in knots
Vert Speed (ft/s)	Vertical Speed in feet per second
Heading (deg)	Aircraft heading in degrees
Pitch (deg)	Pitch angle in degrees
Roll (deg)	Roll angle in degrees
Pitch Rate (deg/s)	Pitch angle change rate in degrees per second
Roll Rate (deg/s)	Roll angle change rate in degrees per second
Yaw Rate (deg/s)	Yaw angle change rate in degrees per second
Accel X (Gs)	Acceleration in X-axis in g
Accel Y (Gs)	Acceleration in Y-axis in g
Accel Z (Gs)	Acceleration in Z-axis in g

Parameter Name	Parameter Description
Norm Accel (Gs)	Normal acceleration in g
OAT (deg F)	Outside air temperature in degrees Fahrenheit
N1 L/R (%RPM)	Left/Right engine gas generator RPM in percentage
N2 L/R (%RPM)	Left/Right engine power turbine RPM in percentage
MR speed (%RPM)	Main rotor RPM in percentage
Torque L/R (%)	Left/Right engine Transmission torque in percentage
TOT L/R (deg F)	Left/Right engine Turbine outlet temperature in degrees Fahrenheit
Trans Oil Temp (deg F)	Transmission oil Temperature in degrees Fahrenheit
Wind Speed (kts)	Wind speed in knots
Wind Direction (deg)	Wind direction in degrees

3.3.2. Plots and Corresponding Tabular Data

The following ten figures contain data recorded on the GPMS Foresight MX on April 28, 2021. Figures 3 through 8 show parameters plots and figures 9 through 12 show Google Earth overlays of the accident flight.

Figure 3 is a plot of the engine parameters for the entire accident flight. The time interval displayed is 12:30:00 to 13:30:00 EDT.

Figures 4 and 5 show the plots of the engine parameters for the last 10 minutes and last 1 minute of the accident flight.

Figure 6 is a plot of the operational parameters for the entire accident flight. The time interval displayed is 12:30:00 to 13:30:00 EDT.

Figures 7 and 8 show the plots of the operational parameters for the last 10 minutes and last 1 minute of the accident flight.

Figure 9 is a Google Earth overlay of the entire accident flight recorded on April 28, 2021. The weather and lighting conditions in Google Earth are not necessarily the weather and lighting conditions present at the time of the recording.

Figure 10 is a Google Earth overlay of the beginning of the accident flight. It shows the aircraft took off at Danville Regional Airport around 12:34:46 EDT, then headed west.

Figures 11 and 12 are Google Earth overlays of the final portion of the accident flight. The reported wreckage location is shown with a red pin.

The corresponding tabular data used to create figures 3 through 12 are provided in electronic comma-delimited (.csv) format as Attachment 1 to this report. Not every additional parameter in the attachments have been validated by the specialist.

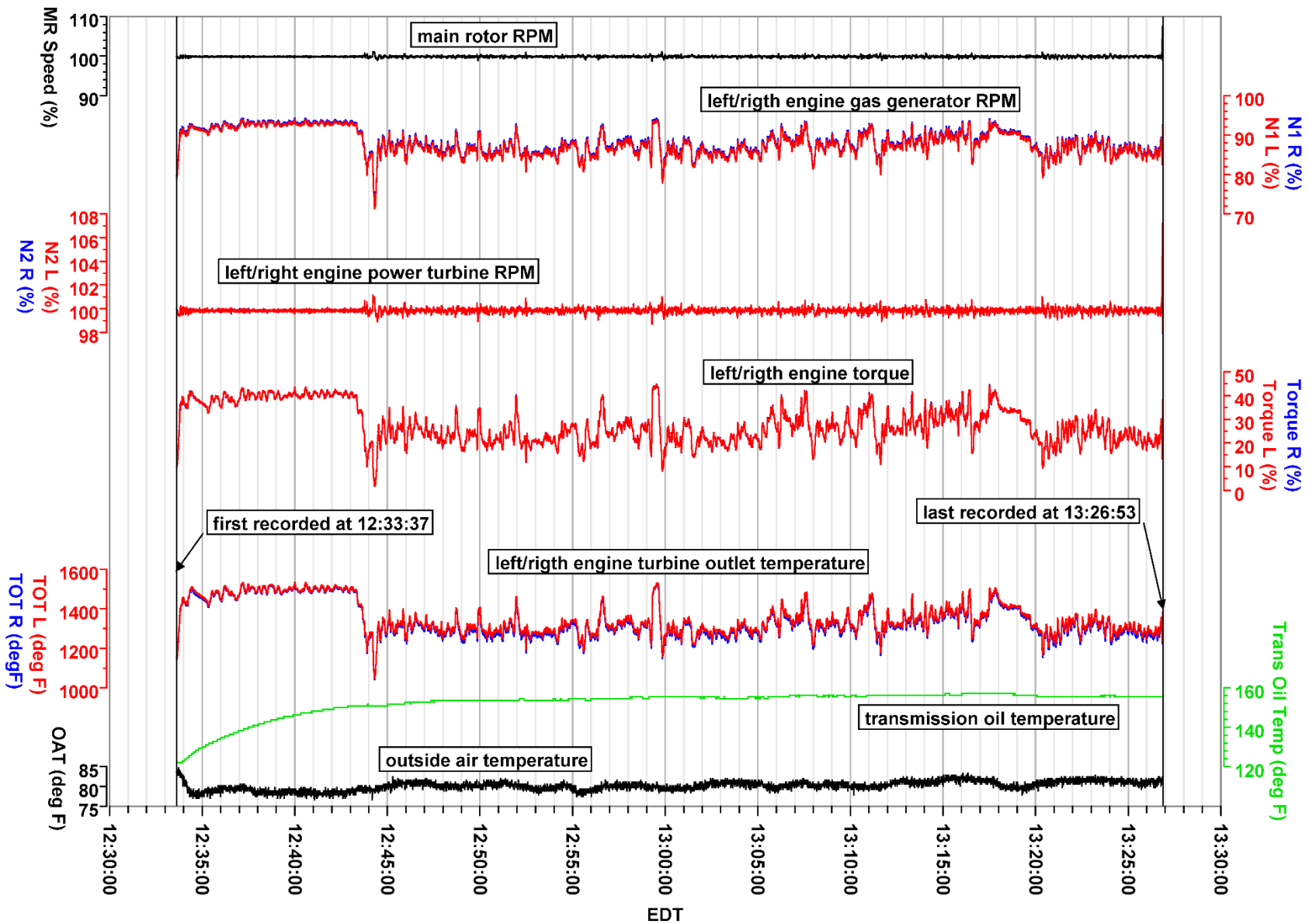


Figure 3: Plot of engine parameters for the entire accident flight recorded on April 28, 2021.

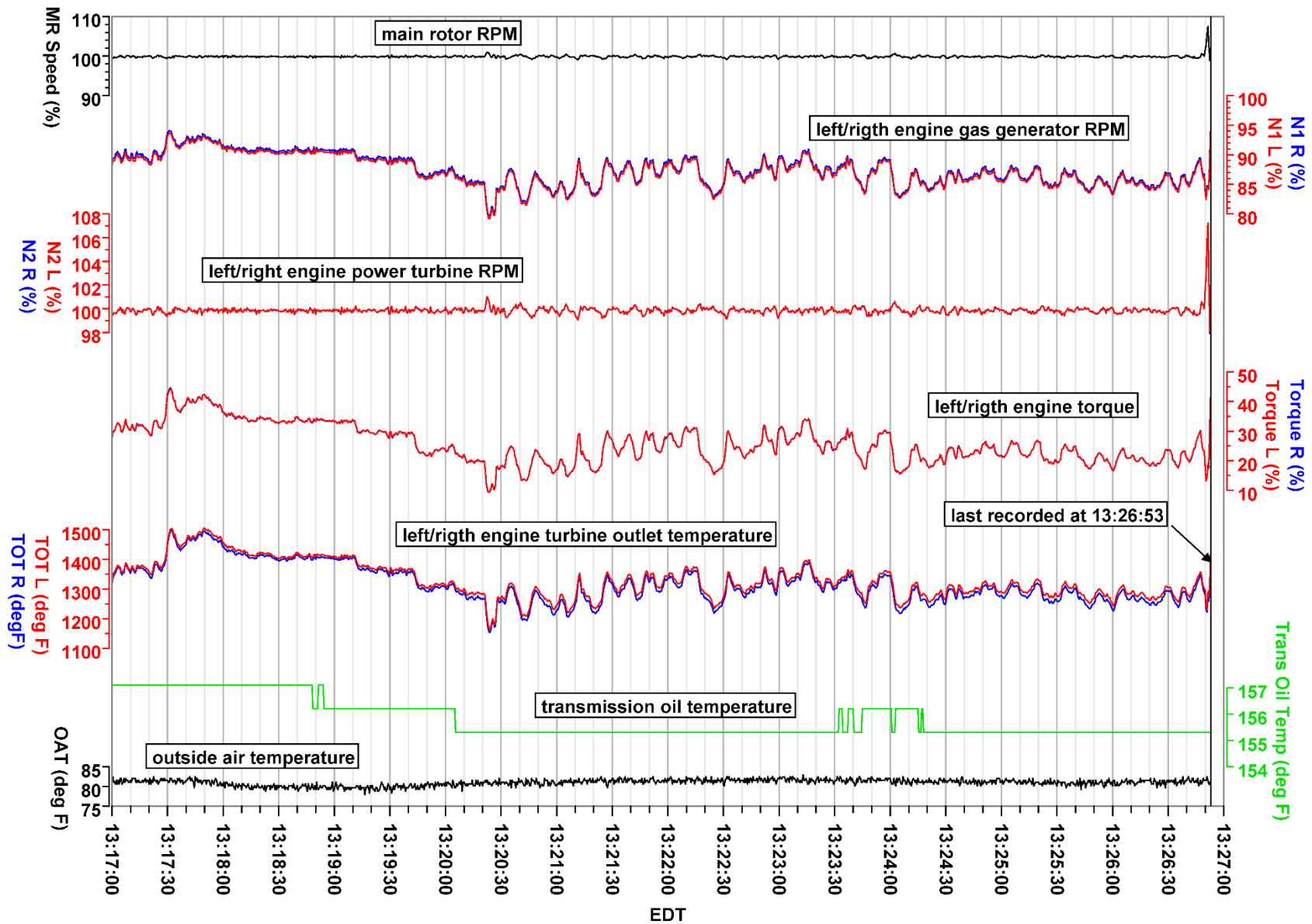


Figure 4: Plot of engine parameters for the last 10 minutes portion of the accident flight.

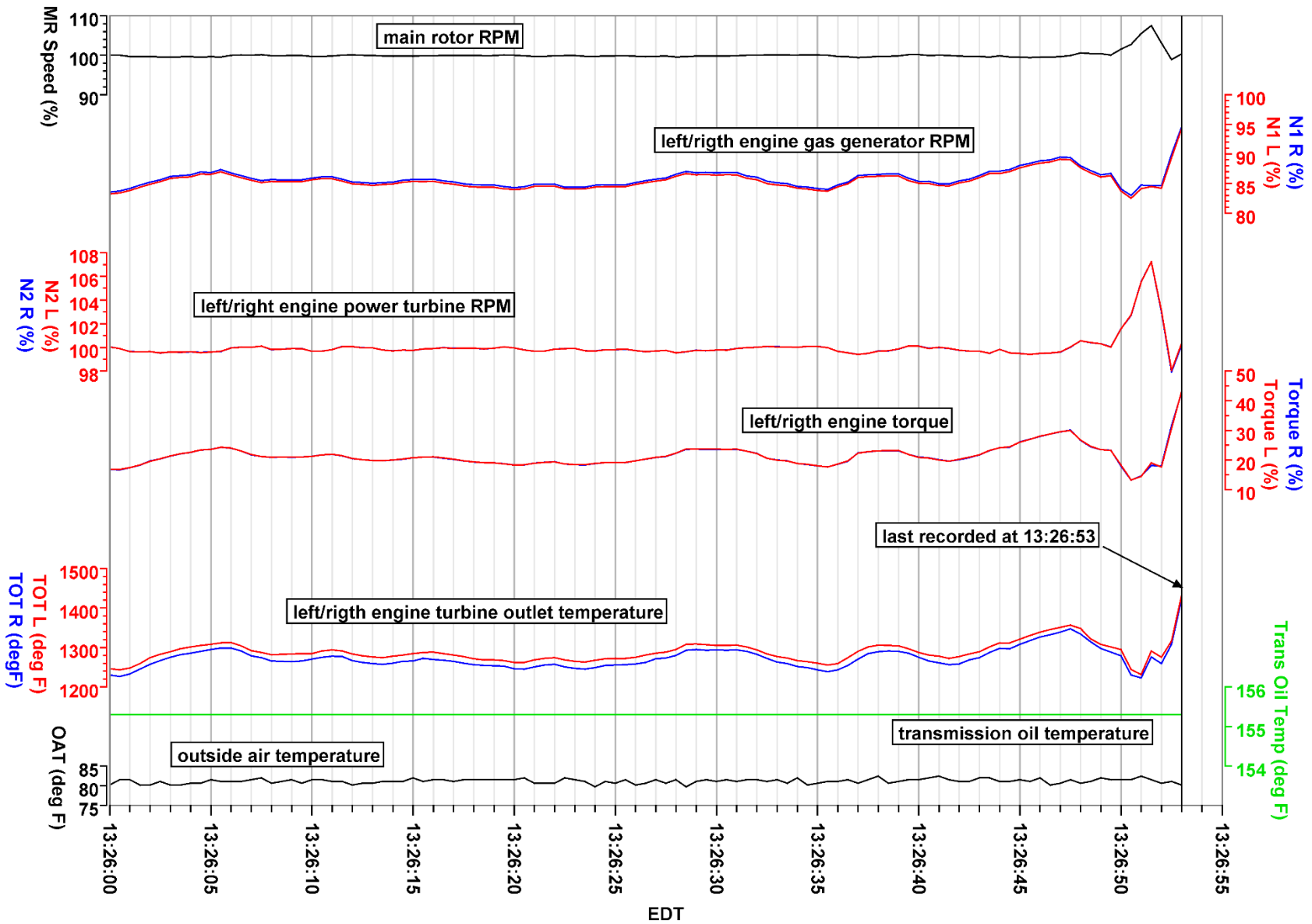


Figure 5: Plot of engine parameters for the last 1 minute portion of the accident flight.

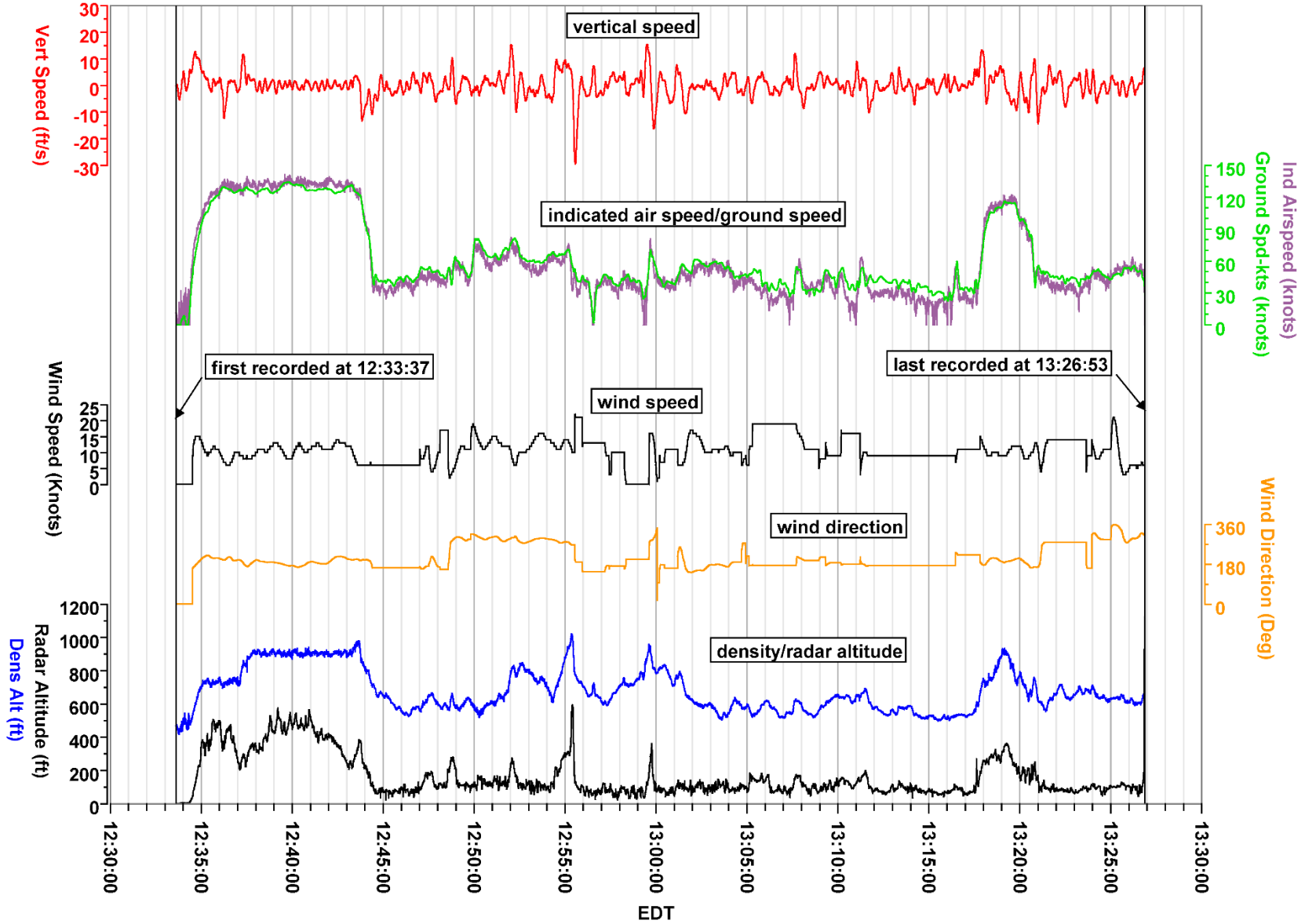


Figure 6: Plot of operational parameters for the entire accident flight recorded on April 28, 2021.

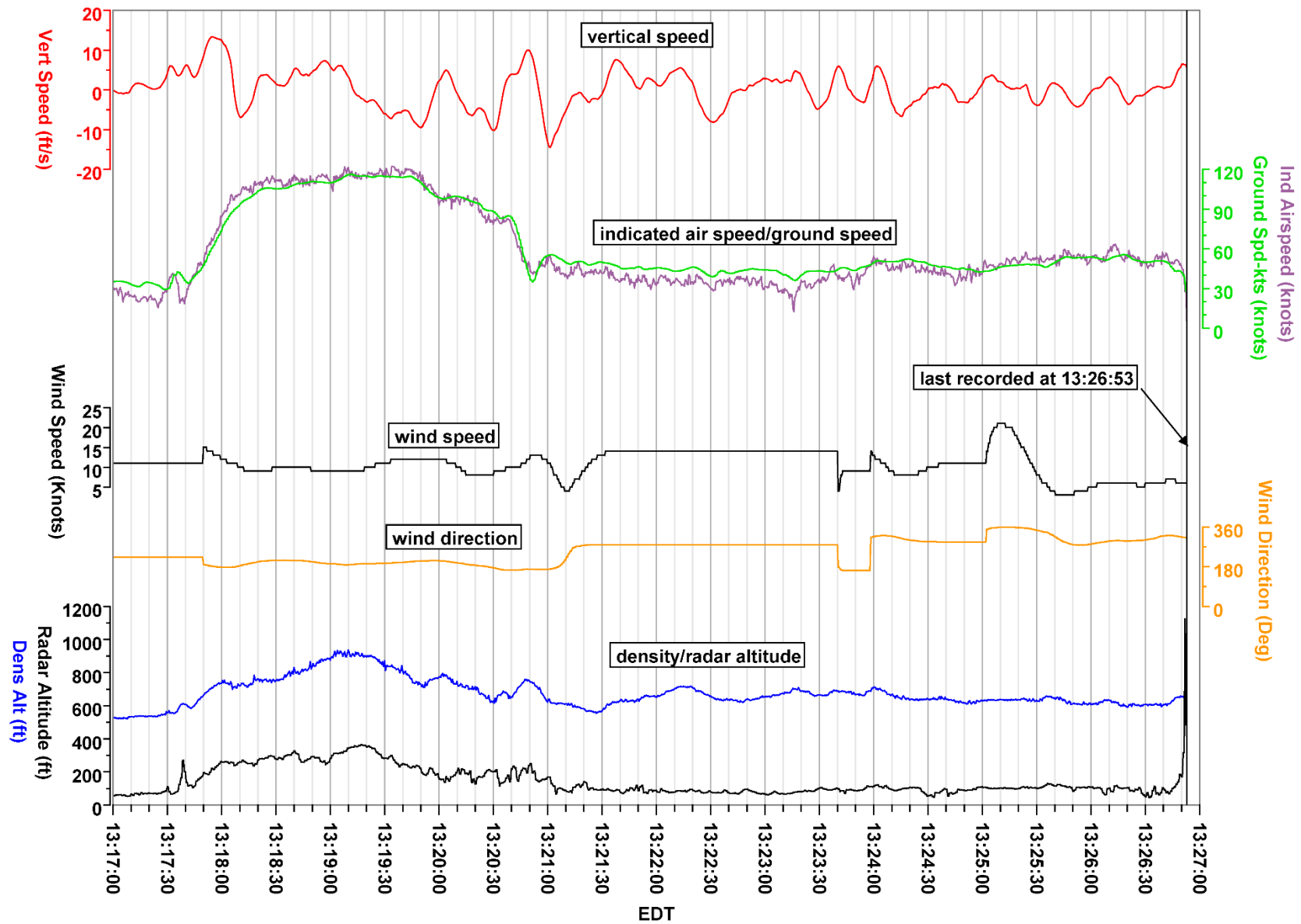


Figure 7: Plot of operational parameters for the last 10 minutes portion of the accident flight.

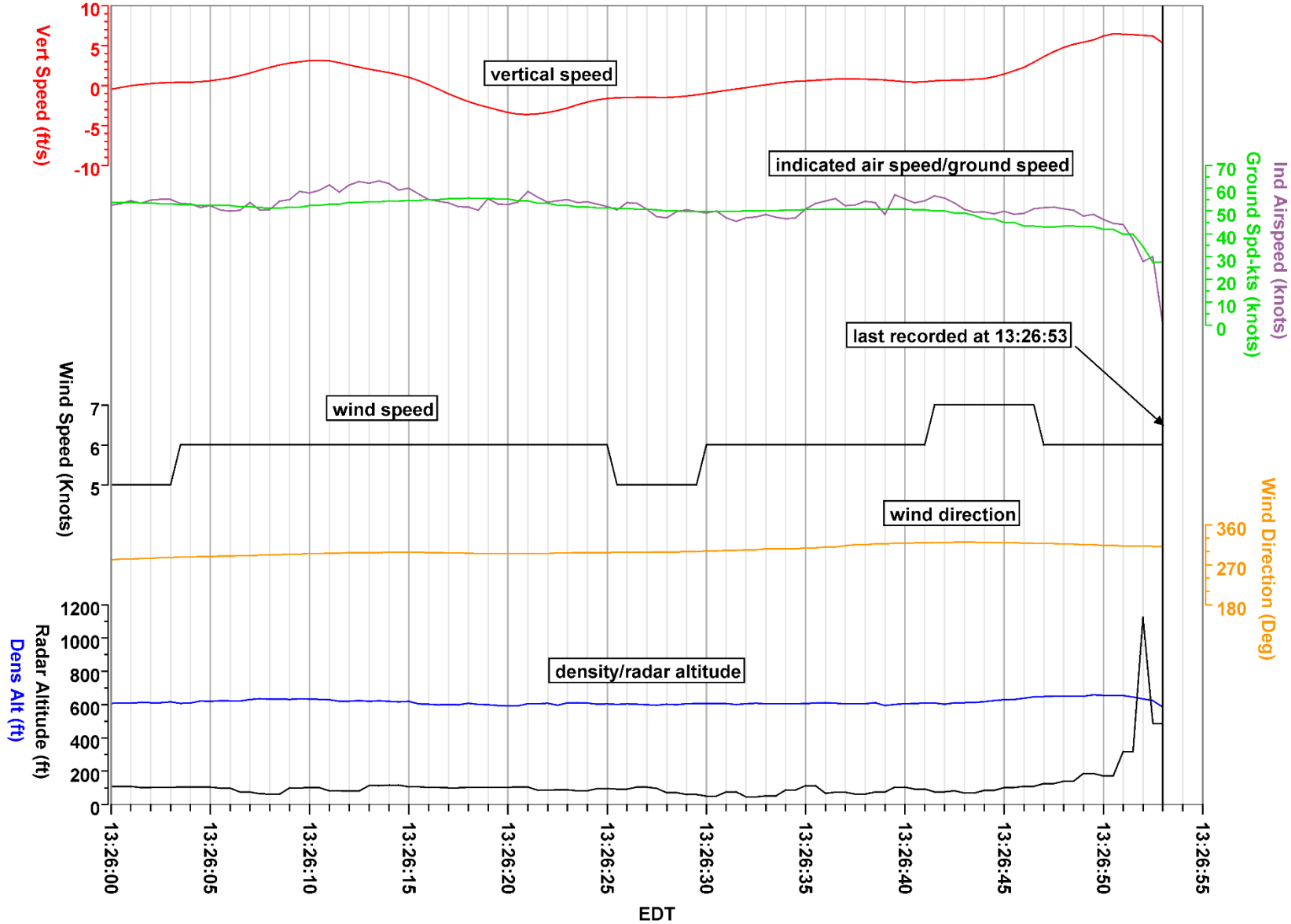


Figure 8: Plot of operational parameters for the last 1 minute portion of the accident flight.

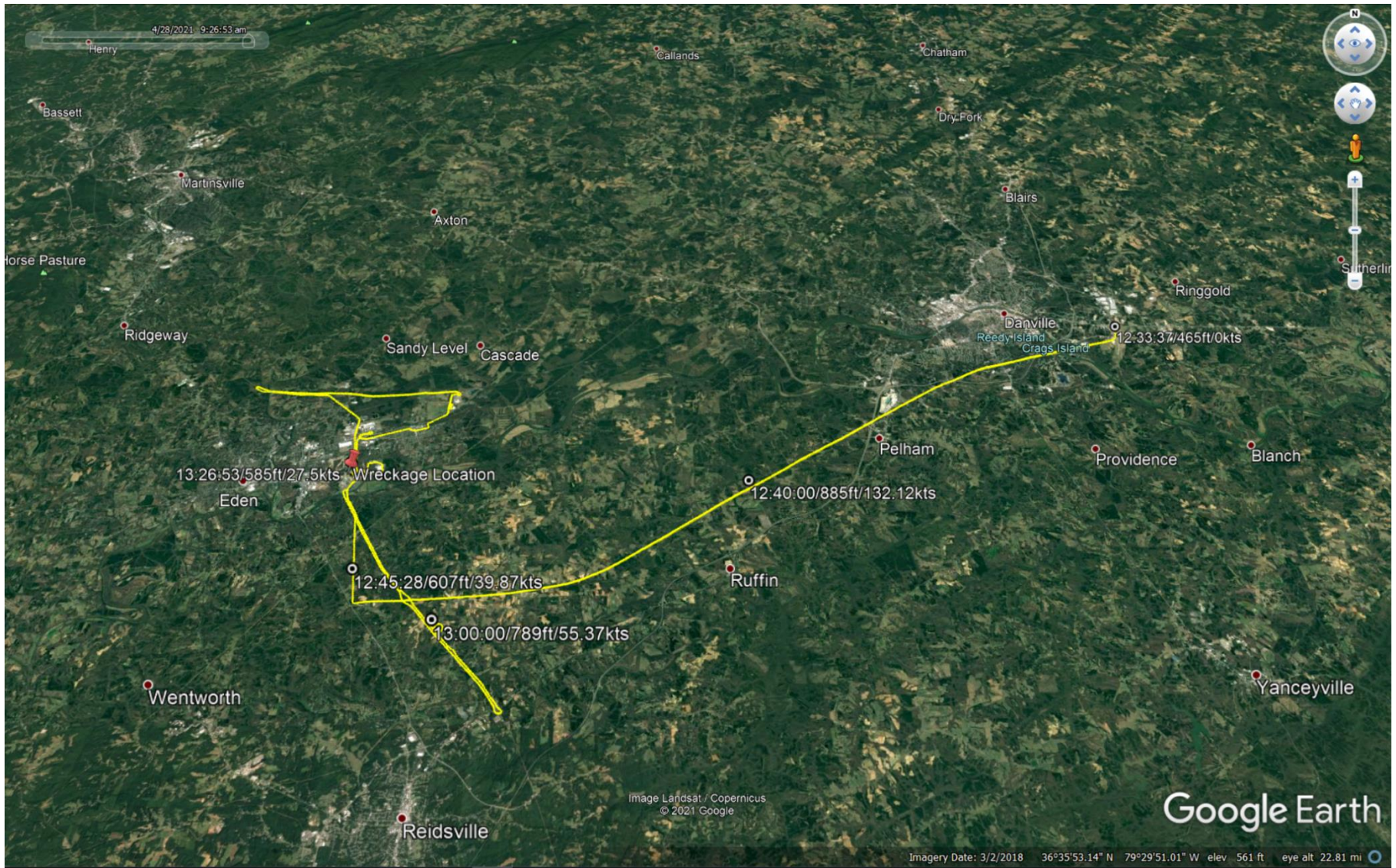


Figure 9: Google Earth overlay of the entire accident flight.



Figure 10: Google Earth overlay of the beginning of the accident flight.



Figure 11: Google Earth overlay of the final portion of the accident flight.

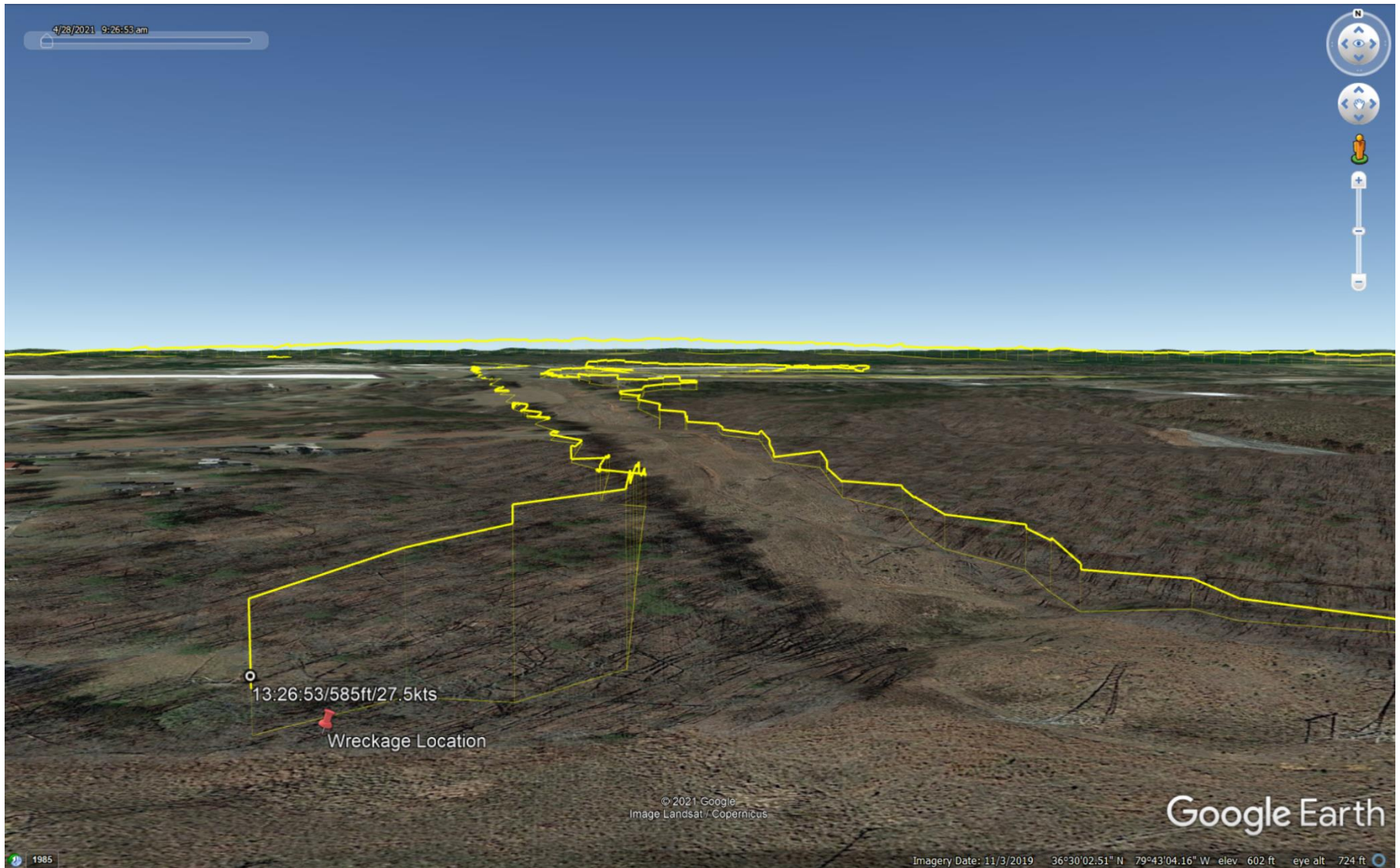


Figure 12: Google Earth overlay of the end of the accident flight with north up view.