

National Transportation Safety Board

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CEN23FA057

AIRCRAFT PERFORMANCE STUDY

Specialist's Study

February 1, 2024

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A ACCIDENT

Location: Cleburne, Texas
Date: December 4, 2022
Time: 20:56 central standard time
 02:56 UTC (December 5, 2022)
Airplane: Cessna 210-5 (205), N8149Z

B SUMMARY

On December 4, 2022, about 20:56 central standard time (CST), a Cessna 210-5 airplane, N8149Z, was destroyed when it was involved in an accident near Cleburne, Texas. The certificated instrument flight instructor and the airline transport pilot were fatally injured. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 91 personal flight.

The airplane departed from runway 15 at Cleburne Regional Airport (CPT) about 20:55 on an instrument flight rules flight plan to Granbury Regional Airport (GDJ), Granbury, Texas. The airplane was cleared to an assigned heading of 090 and a climb to 3,000 ft above mean sea level (msl).



Figure 1. The accident airplane, N8149Z, a Cessna 210-5 (205).

C PERFORMANCE STUDY

1.0 Airplane

The airplane was a Cessna 210-5, also known as a Cessna 205, a high-wing, single-engine airplane with fixed landing gear that seats six. Figure 1 is a photograph of the accident airplane, which was manufactured in 1962.

2.0 Weather

The weather was recorded at CPT at 20:55, a minute before the accident, as winds from 160° at 7 knots (kts), visibility 2.5 statute miles, overcast cloud ceiling at 300 ft above ground level (agl), temperature 10 °C (50 °F), dewpoint 10 °C (50 °F), barometric setting of 30.10 inches of mercury.

3.0 Data

The Federal Aviation Administration (FAA) provided Automatic Dependent Surveillance-Broadcast (ADS-B) data, which broadcasts an aircraft's Global Navigation Satellite System (GNSS) position and other data to ground stations, where it is recorded approximately once per second. The GNSS position data is expected to have an uncertainty of approximately 20 m (65 ft) in horizontal and vertical dimensions. The ADS-B data extended from 20:55:06 to 20:56:26. The GNSS-based altitude above the reference ellipsoid was corrected to the mean sea level altitude above the geoid by adding 93.7 ft.

The first ADS-B data point at 20:55:06 was located approximately halfway down runway 15 and the GNSS altitude data for that point was erroneously low (well below ground level). The ADS-B data also showed offsets on the order of 0.001° in both the latitude and longitude in the interval between 20:55:12 and 20:55:14, and again in the interval between 20:55:26 and 20:55:31. The airplane was still less than about 200 ft agl at these times.

Winds aloft and temperature and pressure as a function of altitude were taken from a High-Resolution Rapid Refresh (HRRR) model sounding from the National Oceanic and Atmospheric Administration¹. The data was downloaded for coordinates 32.32° North, 97.43° West, at 21:00 CST.

¹ [READY Archived Meteorology \(noaa.gov\)](https://www.noaa.gov/data/ready)

4.0 Flight Path

Figure 2 shows a Google Earth image of the flight path using the GNSS position data and the GNSS altitude corrected to msl. Points are annotated with the time, altitude msl and calculated calibrated airspeed in kts. The crash site was reported as 32.323764° North, 97.431479° West.

The first ADS-B data point was at 20:55:06. Based on the GNSS altitude corrected to msl and the reported overcast ceiling at 300 ft agl, the airplane entered the clouds at about 20:55:35. The airplane reached a maximum rate of climb of about 1,900 ft/min at 20:55:53, and reached a maximum altitude of about 1,870 ft msl at 20:56:13, after which it began to descend steeply, reaching a descent rate of over 11,000 ft/min. The airplane's ground track was generally aligned with the extended centerline of the runway until 20:56:00, when it began a right turn that averaged about 6°/s until the data ended.



Figure 2. Google Earth image of the flight path, with selected times, msl altitude and calibrated airspeeds indicated.

The ADS-B latitude and longitude were converted to east and north relative to the displaced threshold of runway 15 using the WGS84 model of the ellipsoid. A smooth flight path was created from the ADS-B data by integrating the recorded easting and northing groundspeeds. The smoothed east and north data were offset to minimize the summed difference between the ADS-B data and the smoothed data after 20:55:34 to avoid the observed offsets in the ADS-B latitude and longitude data before 20:55:32. Figure 3 shows the raw east and north data and the smoothed fits from the integrated groundspeeds as functions of time. Figure 4 shows the flight path as north versus east. The first ADS-B data point was at about the midpoint of runway 15.

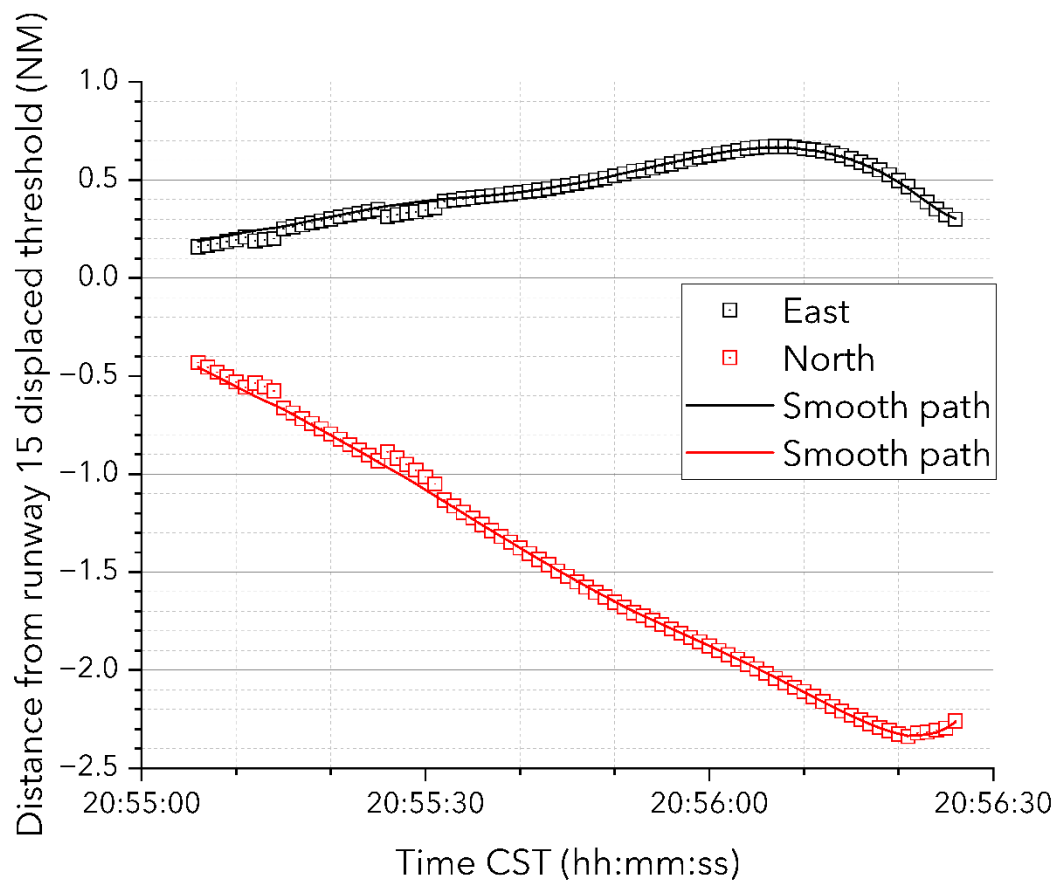


Figure 3. Distance east and north from the displaced threshold of runway 15, with the smooth paths calculated by integrating the ADS-B north and east velocities. Note offsets in the data between 20:55:12 and 20:55:14, and again between 20:55:26 and 20:55:31.

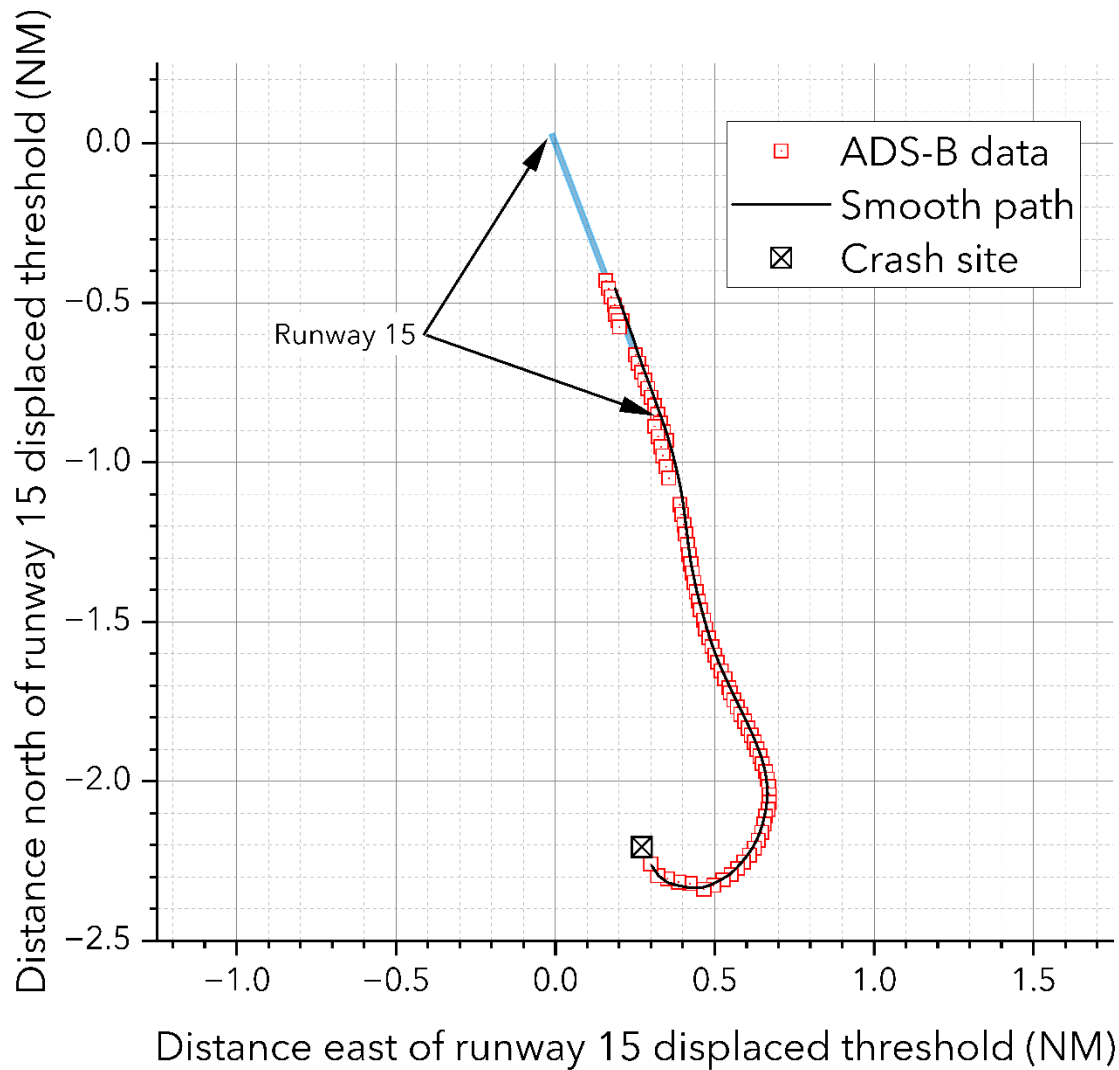


Figure 4. Flight path relative to runway 15, with a smooth path calculated from the ADS-B north and east velocities.

The ADS-B pressure altitude was reported to the nearest 100 ft, and the GNSS altitude data was reported to the nearest 25 ft. A smoothed altitude trace was created by integrating the ADS-B pressure altitude rate of climb data, and minimizing the summed difference between the ADS-B pressure altitude and the smoothed trace after 20:55:33. Figure 5 shows the GNSS altitude converted to msl, the recorded pressure altitude and the calculated smooth pressure altitude. The airport elevation is 854 ft, and the first valid GNSS-based altitude is 869 ft. Based on the atmospheric conditions, the pressure altitude should be 100 to 200 ft less than the GNSS-based msl altitude, but the pressure altitude seems to nearly coincide with the GNSS-based msl altitude until about 20:56:00, when the difference between the two sets of data is more in line with expectations.

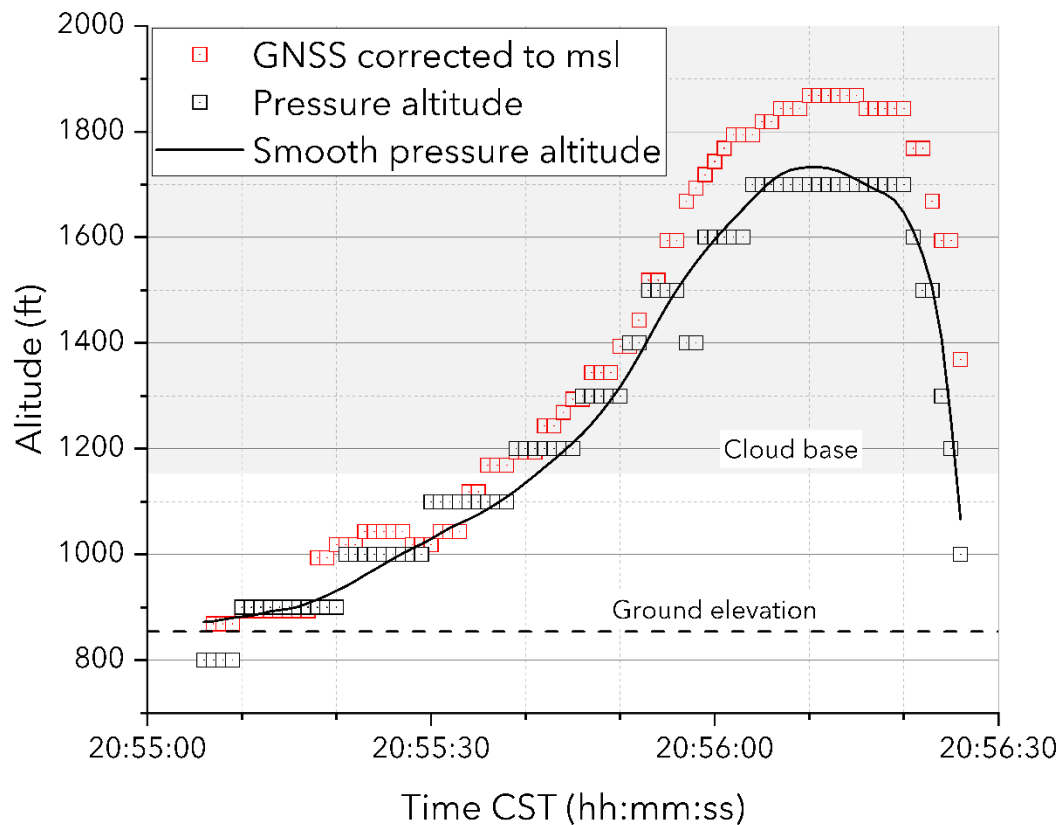


Figure 5. Recorded pressure altitude and GNSS altitude converted to msl along with a smooth pressure altitude from integrating the ADS-B rate of climb, relative to the airport elevation and the reported overcast cloud layer at 300 ft agl.

Winds aloft and the atmospheric conditions from the HRRR sounding were used to calculate true airspeed and calibrated airspeed from the recorded groundspeed. A simplified aerodynamic model of the airplane was used to estimate pitch and roll angles, along with the normal and longitudinal load factors. The model uses an assumption that sideslip is zero, so the lateral load factor is also zero.

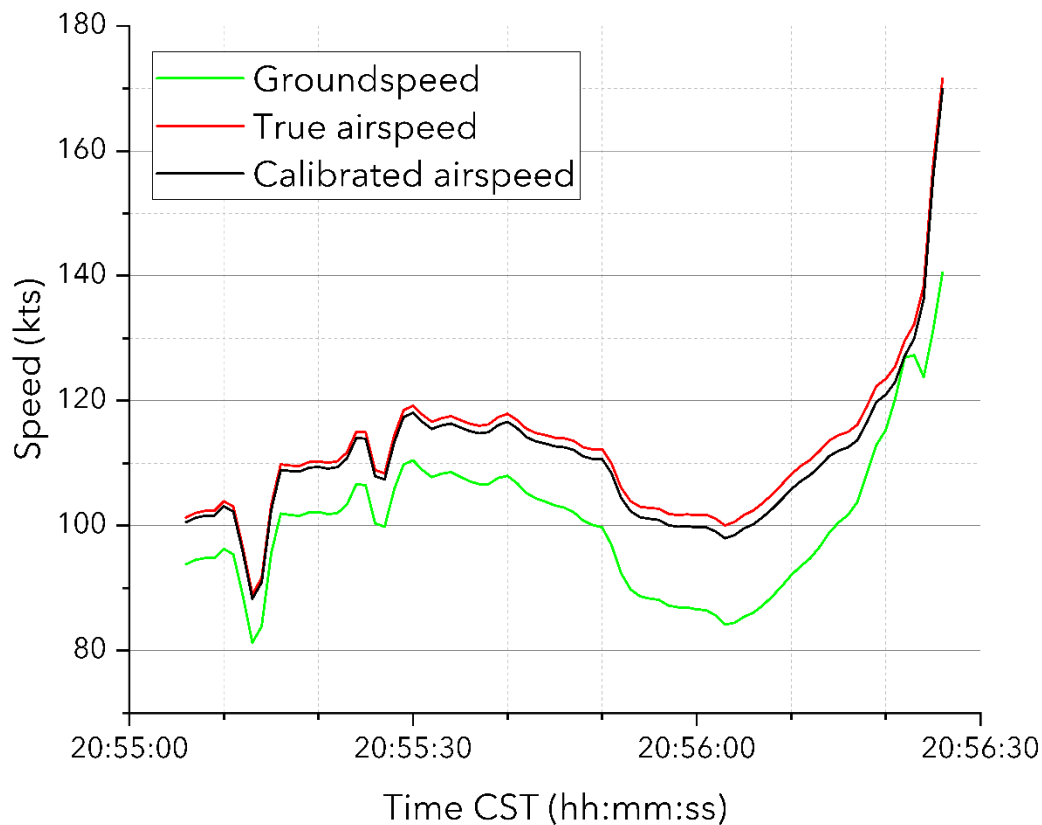


Figure 6. Calculated groundspeed, true airspeed and calibrated airspeed for the flight.

Figure 6 shows the groundspeed along with the calculated true airspeed and calibrated airspeed. The calibrated airspeed was generally between 100 and 120 kts until after 20:56:20, when the airplane was beginning its steep descent. (There are some deviations in the speeds that appear to be related to the offsets in the latitude and longitude data the interval between 20:55:12 and 20:55:14, and again in the interval between 20:55:26 and 20:55:31.) The Cessna 205 Owner's Manual reports the flaps-up, wings-level, power-off stall speed at 3,300 lbs gross weight is 67 mph (58 kts), rising to 95 mph (83 kts) at a bank angle of 60° in a level turn.

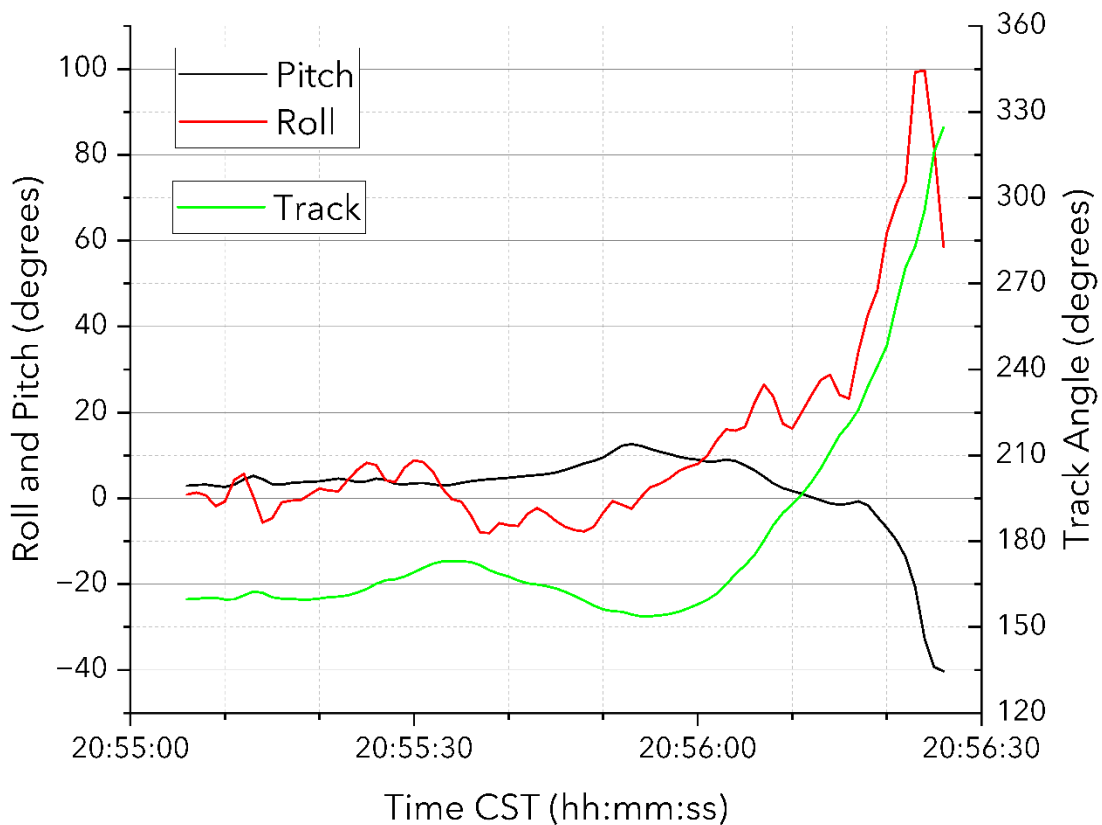


Figure 7. Calculated roll, pitch and track angles for the flight.

Figure 7 shows the calculated roll, pitch and track angles. Beginning about 20:56:00, the roll angle began a steady increase, and the pitch angle began a steady decrease; both rates increased sharply after about 20:56:15. The calculated roll angle reached 100° about 20:56:23. The airplane's ground track was generally aligned with the extended centerline of the runway at 159° true until 20:56:00, when it began a right turn that averaged about 6°/s until the data ended.

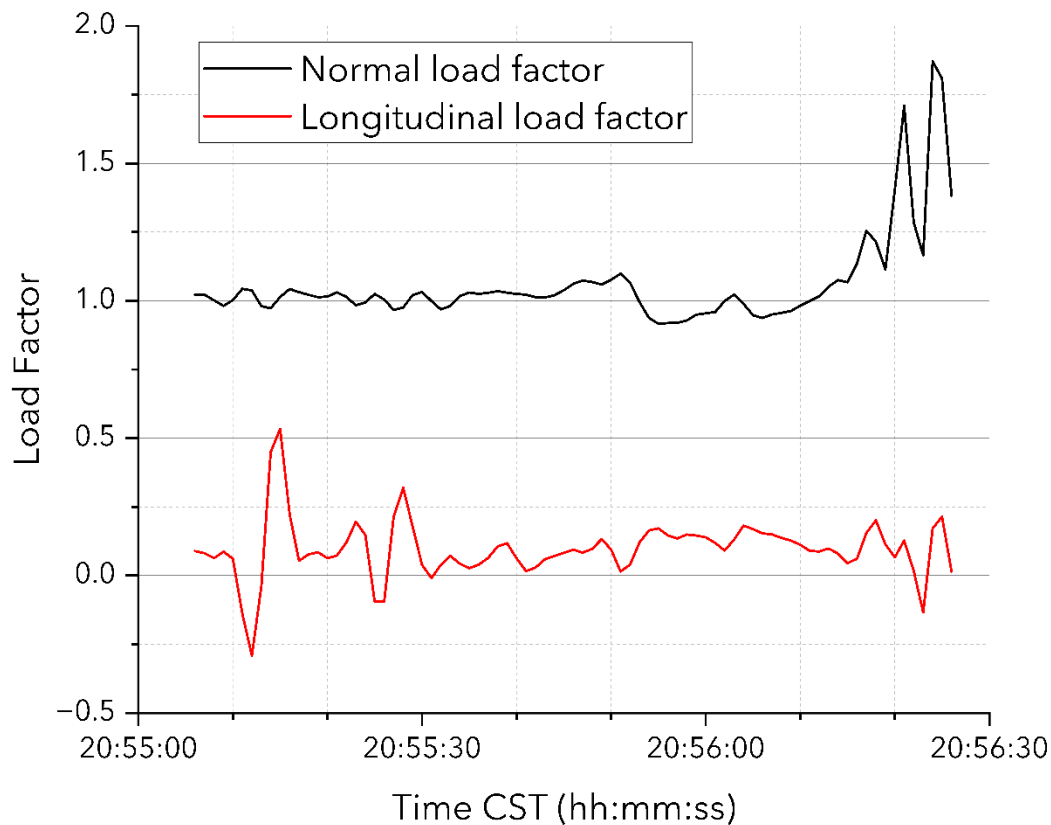


Figure 8. Calculated normal and longitudinal load factors for the flight.

Figure 8 shows the calculated normal and longitudinal load factors. The longitudinal load factor was near zero for the entire flight. The normal load factor was near 1 until it began increasing about 20:56:10, as the airplane began to descend, the roll angle increased above 20°, and the airspeed increased above 110 kts.

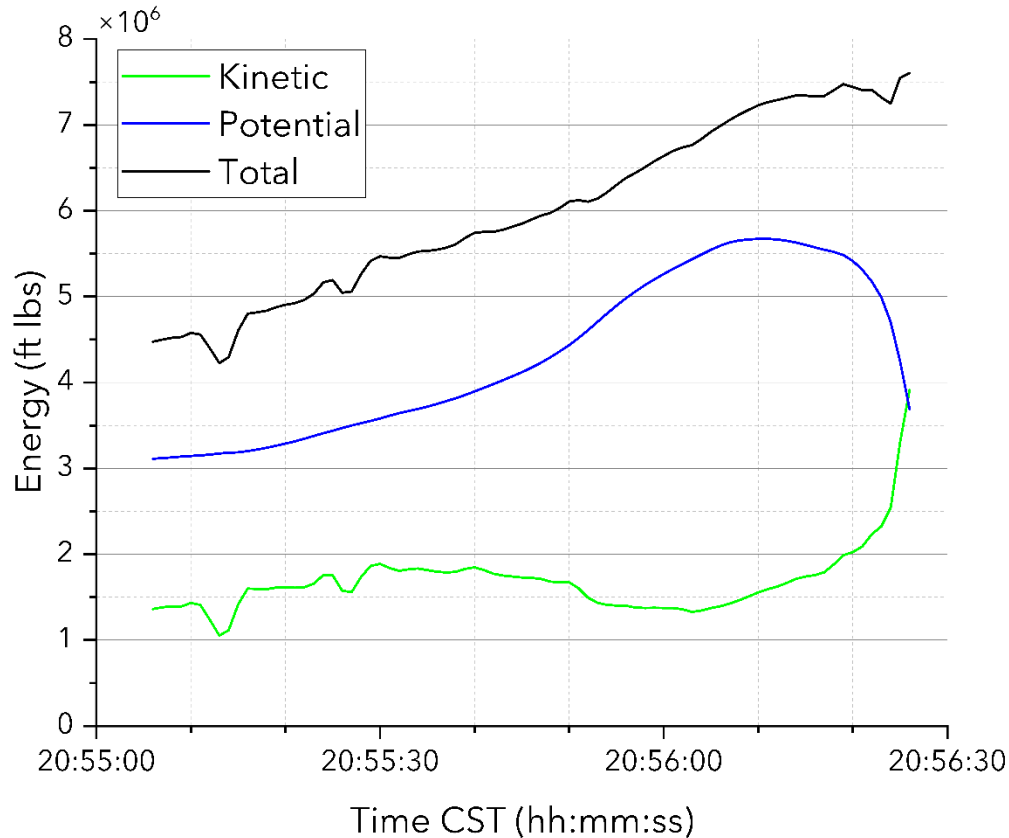


Figure 9. Kinetic, potential and total energy calculated for the flight.

Figure 9 shows the calculated kinetic and potential energies for the flight, along with the total energy, which is the sum of the kinetic and potential energies. The total energy shows a steady increase associated with the work done by the engine, and the decrease in potential energy as the airplane descends is more than offset by the increase in the airplane's kinetic energy. The steadily increasing total energy is not consistent with a loss of engine power.

D DISCUSSION

The first ADS-B data point was recorded at 20:55:06, with the airplane about at the midpoint of runway 15. The airplane climbed through the overcast ceiling about 20:55:35, and it reached a maximum altitude of about 1,870 ft msl at 20:56:13. The airplane tracked the extended centerline of the runway until 20:56:00, when it began a right turn. By 20:56:20, the airplane was descending rapidly, the airspeed was increasing through 140 kts, the pitch angle was decreasing past -10° , and the roll angle was increasing past 60° . The calculated normal load factor increased, but did

not exceed 2, and the longitudinal load factor remained near zero. The descent rate exceeded 11,000 ft/min, and the final ADS-B data point was recorded at 20:56:26.

There were offsets in the ADS-B position data before 20:55:31, and the recorded pressure altitude was somewhat less than expected before 20:56:00. The data from the rest of the flight appears consistent.

The total calculated energy shows a steady increase over the course of the flight, which is not consistent with a loss of engine power.

Submitted by:

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