

National Transportation Safety Board

Office of Research and Engineering

Washington, D.C. 20594

Performance Study

Specialist Report

Marie Moler

A. ACCIDENT

Location:	Bartow, Florida
Date:	February 13, 2020
Time:	11:25 Eastern standard time (EST)
Airplane:	Mooney M20J, N1149T
NTSB Number:	ERA20FA101

B. SUMMARY

On February 13, 2020, at 1125 eastern standard time, a Mooney M20J, N1149T, was substantially damaged when it impacted terrain while on approach to Bartow Executive Airport (BOW), Bartow, Florida. The private pilot and a passenger were fatally injured. The airplane operated under the provisions of Title 14 *Code of Federal Regulations* Part 91 as a personal, 4-airplane formation flight.

C. PERFORMANCE STUDY

This performance study is based on data from an onboard Stratus device which recorded the airplane's Global Positioning System (GPS) position and other data five times a second. The GPS position has an accuracy of approximately 20 meters (m) in both the horizontal and vertical dimensions. Other data recorded by the Stratus included pitch, roll, and accelerations, but these parameters were determined to be inaccurate and not consistent with the airplane's recorded flight path. Also on board was an engine monitor which recorded RPM, horsepower, fuel consumption, outside temperatures and engine temperatures.

The accident airplane was number 4 of 4 in a formation flight. Automatic Dependent Surveillance-Broadcast (ADS-B) data was provided by the Federal Aviation Administration (FAA) for the lead airplane in the flight and is also used in this study. ADS-B broadcasts an airplane's Global Positioning System (GPS) position and other data to the ground where it is recorded. The GPS position has an accuracy of approximately 20 meters (m) in both the horizontal and vertical dimensions. No data was recorded for the second or third airplane in the formation.

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Groundspeed and calibrated airspeed were calculated using the recorded flight path data and reported weather. A simplified airplane model consisting of lift curve data provided by Mooney International Corporation and airplane geometry was used to calculate airplane pitch, roll, and angle of attack (AoA).

The airplane took off on a south-southeasterly heading from Spruce Creek Airport (7FL6) at about 10:45 (Figure 1). It climbed to 1,300 ft then 1,700 ft msl (mean sea level) while maintaining an airspeed between 120 kts and 140 kts (Figure 2). The airplane began descending at 11:17.

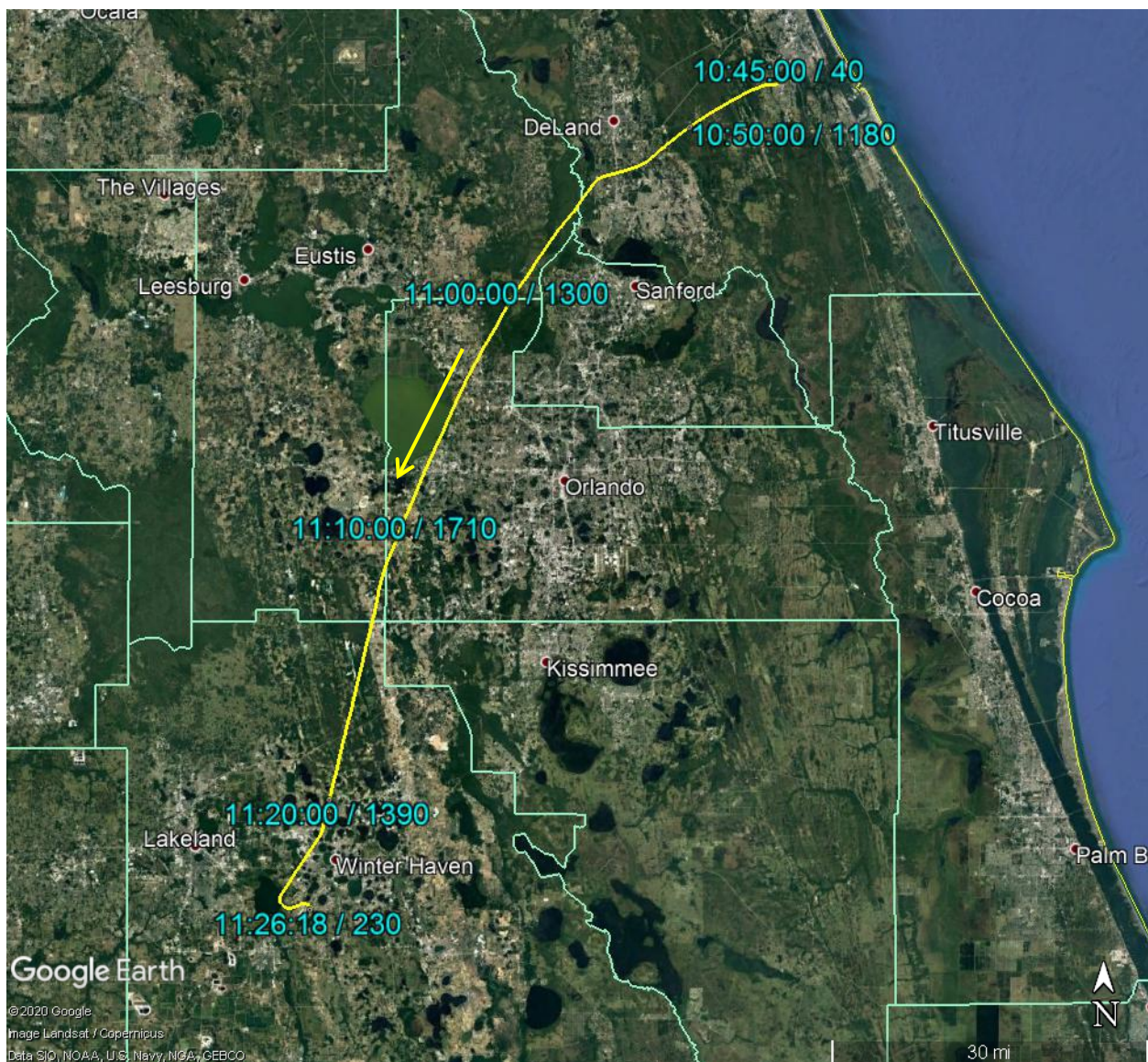


Figure 1. Accident flight in yellow with select times and altitudes (msl) annotated in blue.

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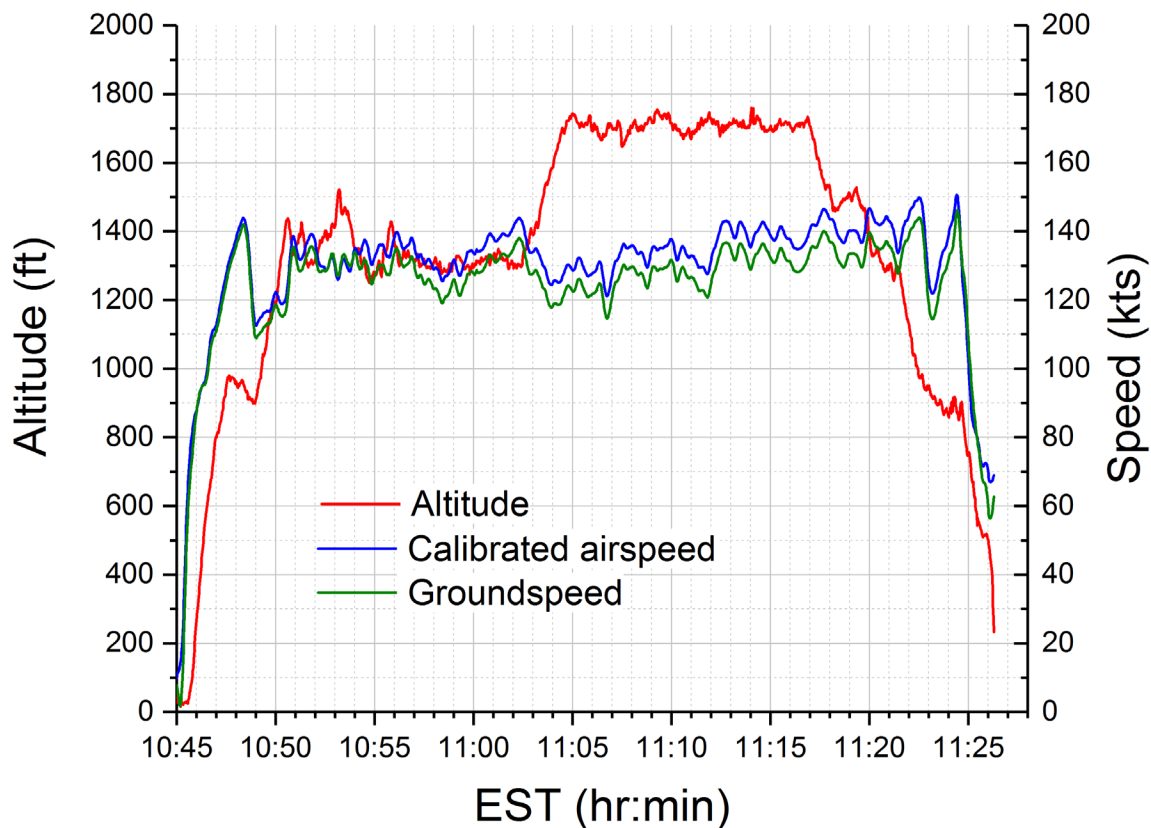


Figure 2. Accident flight altitude, msl, and calculated calibrated airspeed and groundspeed.

Around 11:22:45, the airplane's speed decreased from 150 kts calibrated airspeed to 120 kts in about 30 seconds before returning to 150 kts by 11:24:30 (Figure 3). During this time the airplane was in a level left turn from a track of 210° to 70° (Figure 4). After 11:24:45, the airplane slowed and descended and at 11:25:15 began a right turn towards runway 23. During the right turn, the airplane's bank angle varied between 5° and 20° right wing down while descending and slowing. From 11:25:45 to 11:26, the airplane leveled off at an airspeed of about 70 kts and an altitude of 500 ft msl¹. Just after 11:26, its descent rate increased to -1,500 ft/min and the airplane began to pitch down. From 11:26:10 to 11:26:12, the airplane was briefly aligned with runway 23 before continuing to turn right and passing through the runway heading (Figure 5). At 11:26:15 the airplane turned left. The data ended at 11:26:19 when the airplane was about 230 ft msl, 110 ft above ground level, 0.6 NM short of the threshold for runway 23.

¹ The elevation around Bartow Executive Airport is between 110 and 130 ft above sea level.

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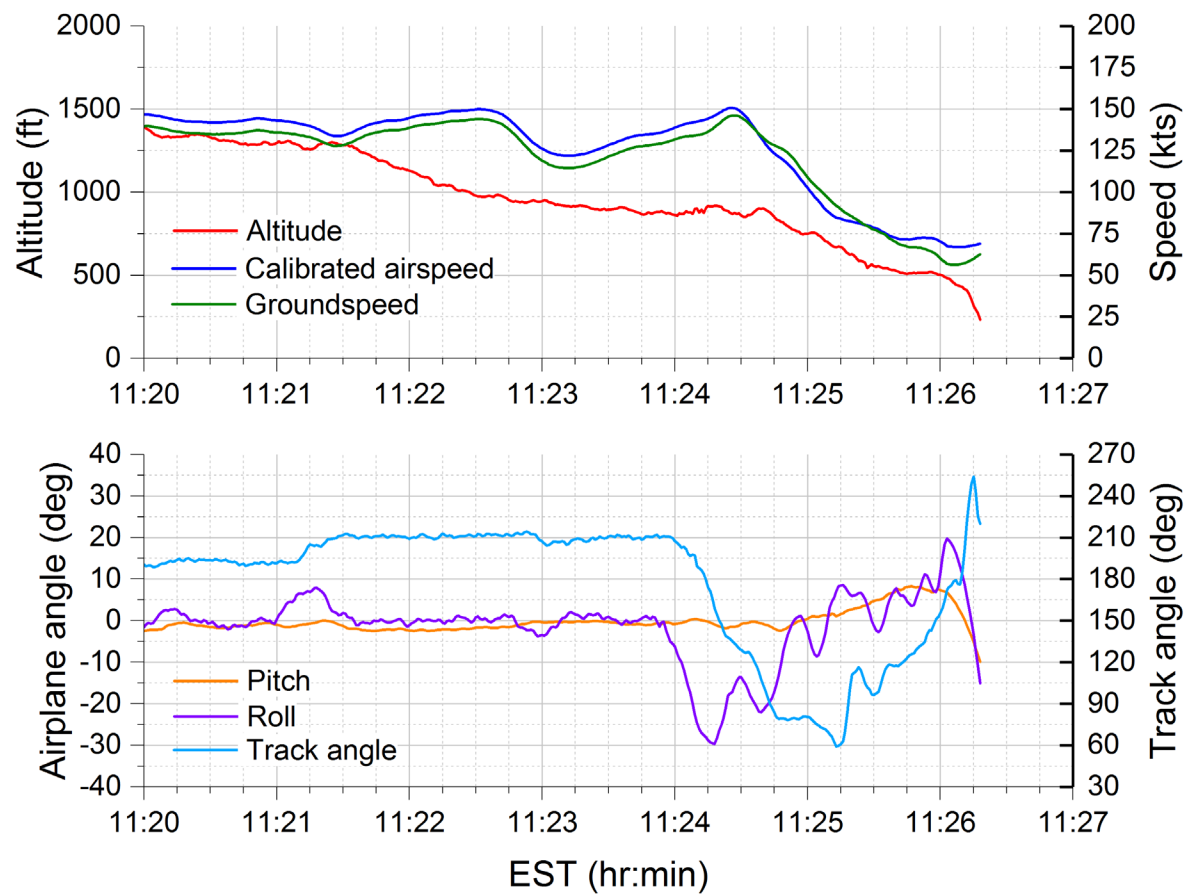


Figure 3. Accident flight altitude, msl, calculated calibrated airspeed and groundspeed, track angle, and calculated pitch and roll for the end of flight.

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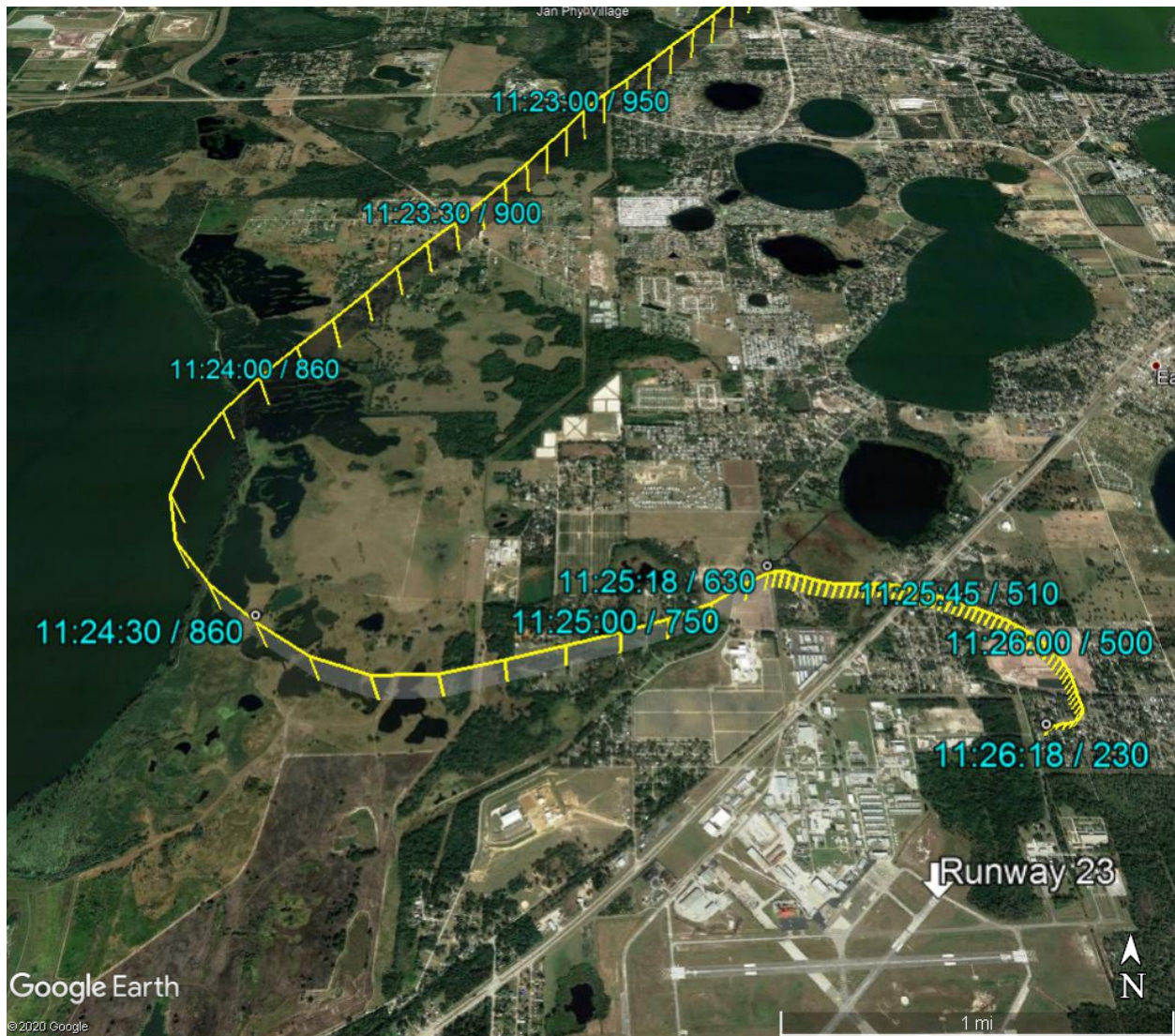


Figure 4. End of accident flight path in yellow, selected times and altitudes, msl, in blue.



Figure 5. End of accident flight path in yellow, selected times and altitudes, msl, in blue. The heading for runway 23 is shown in green.

The wreckage examination found that the airplane had 10° of flaps at impact. The airplane was equipped with an electric actuator that would change the flap position for as long as the pilot held down the switch and could put the flaps in any position between 0° and 33°². Mooney International provided lift data for no flaps, 15° of flaps, and 33° of flaps and respective stall angles of attack of approximately 14.5°, 13°, and 12.5°.

Figure 6 shows the calculated angle of attack of the airplane using the no flaps lift data and the flaps 15° lift data. Also shown is an estimated angle of attack for 10° of flaps assuming a linear relationship between the other flap lift curves. As the airplane slowed and maneuvered on descent, the angle of attack increased. The airplane's maximum angle of attack occurred at 11:26:10 after

² Later models of the airplane use a flap pre-select system where the pilot had a three-position switch with settings for flaps up (0°), take-off flaps (15°), and flaps down (33°).

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which it abruptly dropped, coinciding with the airplane's brief alignment with the runway. The airplane's descent also accelerated from about 500 fpm between 11:26 and 11:26:12 to more than 1,500 fpm after 11:26:12. The maximum angle of attack for the no flaps configuration just exceeds its stall angle at this point and the airplane's final flight path was consistent with aerodynamic stall. The maximum angle of attack for 15° of flaps was not exceeded in the calculations for that configuration and the stall angle for 10° is not known for certain. Nine more seconds of flight data were recorded before impact. While the flaps were documented as 10° in the wreckage, it is not known when flaps were deployed or if they were in transit at the time of impact.

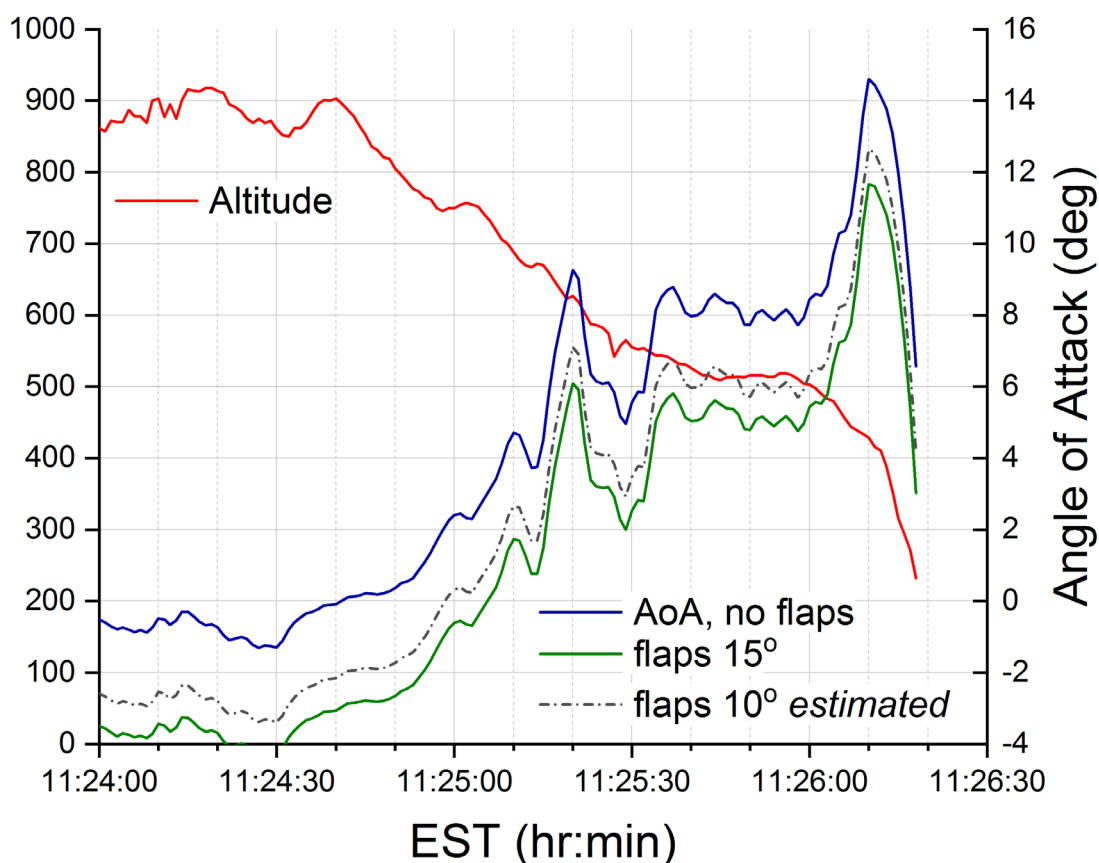


Figure 6. Accident flight altitude, msl, and calculated angle of attack (AoA).

Engine Data

The recorded engine data were time correlated with the position data by matching the increase in horsepower with the take-off roll at the beginning of flight. This engine data ended 13 seconds after the Stratus data. This time correlation shows good agreement between the two data sources. Figure 7 shows the relationship among horsepower, RPM (engine rotations per minute), altitude, and speed at the end of flight. The cylinder and exhaust temperature data from the engine were consistent with each other.

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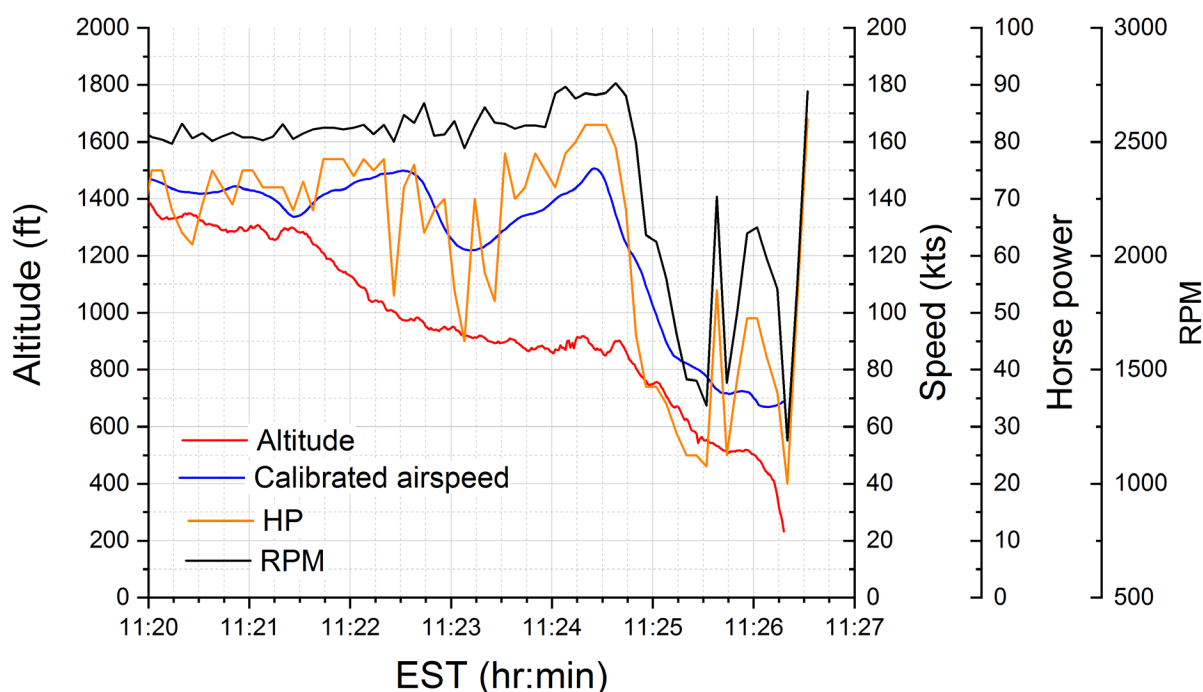


Figure 7. End of accident altitude, msl, and airspeed with time-correlated horsepower (hp) and RPM.

Lead Airplane

The accident airplane was number 4 in a formation of 4, but only the lead airplane and accident airplane recorded position data. Throughout the flight, the accident airplane's path, altitude, and speed closely followed the lead airplane. However, the accident airplane's speed diverged markedly from the lead airplane (Figure 8) from 11:22:45 to 11:24:30 when it slowed and then sped up rapidly, as discussed in detail earlier in this report.

According to the pilot of the lead airplane, each subsequent pilot was to extend their downwind leg from the previous airplane to allow sufficient spacing during landing. While the flight paths of the second and third airplanes are not known, the accident airplane's downwind was only extended an additional 1,500 ft compared to that of the lead airplane. Additionally, the turn onto final was not the expected rectangle shape with rounded corners demonstrated by the lead airplane's flight path (Figure 9). Comparison of the accident and lead airplanes' turns onto final emphasizes the irregular nature of the accident airplane's flight path after 11:25:15. Figure 10 shows the lead and accident airplane's approach to runway 23 and the 3.5° glide slope³. The accident airplane briefly captured the glide slope, coincident with lining up with the runway heading, before losing altitude.

³ The four-light PAPI is located on the left side of the runway, 980 ft from the threshold.

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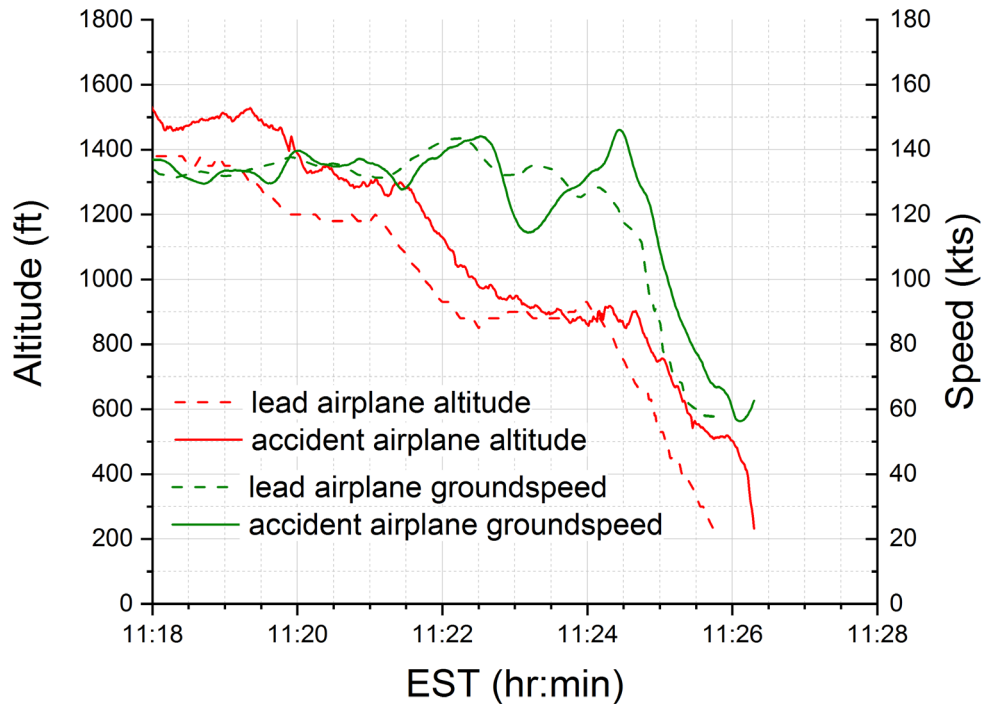


Figure 8. Accident airplane and lead airplane altitude, msl, and speeds.



Figure 9. Lead airplane and accident airplane flight paths, with selected times and altitudes, msl.

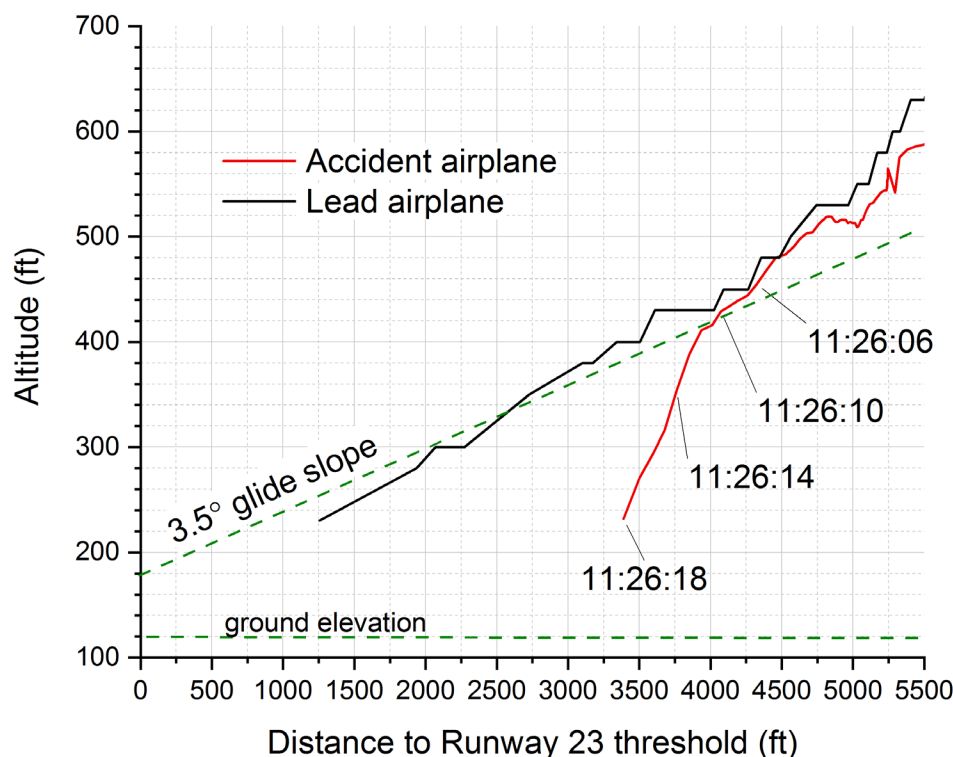


Figure 10. Lead airplane and accident airplane altitude, msl, while on approach. Ground elevation is shown at 120 ft above mean sea level.

D. CONCLUSIONS

The accident airplane's flight path, altitude, and speed closely followed that of the lead airplane from shortly after take-off until 11:22:45 when a 30 kts decrease and then increase in airspeed was observed. The accident airplane executed a steady left turn from a track of 210° to 70° following the lead airplane. The accident airplane slowed and descended and at 11:25:15 began a right turn during which its bank angle varied from 5° to 20° right wing down. The airplane briefly aligned with runway 23 and its glide slope from 11:26:10 to 11:26:12 before continuing to descend and turn away from the runway heading.

The airplane's calculated angle of attack increased to a maximum at 11:26:10. Mooney lift data, the airplane's departure from the runway heading, and increased rate of descent are consistent with the airplane experiencing aerodynamic stall.

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