

National Transportation Safety Board

Office of Research and Engineering

Washington, D.C. 20594

Performance Study

Specialist Report

Marie Moler

A. ACCIDENT

Location: Memphis, Indiana
Date: November 30, 2018
Time: 10:28 eastern standard time (EST)
Airplane: Cessna 525, N525EG
NTSB Number: CEN19FA036

B. SUMMARY

On November 30, 2018, about 10:28 EST, a Cessna 525A (Citation) airplane, N525EG, collided with trees and terrain near Memphis, Indiana. The airline transport certificated pilot and 2 passengers were fatally injured, and the airplane was destroyed. The airplane was owned and operated by EstoAir LLC under the provisions of 14 *Code of Federal Regulations* Part 91 as a business flight. Visual meteorological conditions prevailed for the flight which operated on an instrument flight rules flight plan. The cross-country flight departed Clark Regional Airport (JVY), Jeffersonville, Indiana, about 10:25, with Chicago Midway Airport (MDW), Chicago, Illinois, as the intended destination.

C. PERFORMANCE STUDY

The aircraft was equipped with automatic dependent surveillance – broadcast (ADS-B) which recorded latitude and longitude from GPS and pressure and geometric altitude every one second. Additionally, selected altitude and heading were recorded. The aircraft was also equipped with a cockpit voice recorder (CVR) which recorded annunciations from the ground proximity warning system (GPWS) [1].

Weather Observations

Weather recorded at 10:53 at Louisville International Airport (KLOU), 11 NM south of JVY, was wind from 50° at 4 kts, temperature 54°F (12°C), dew point 46°F (8°C), and altimeter 30.00 inHg. The cloud ceiling was variable between 500 and 1,100 ft AGL. Low-stratiform cloud tops were near 3,200 ft AGL and altostratus cloud tops near 10,000 ft AGL [2].

Flight Path

Figure 1 shows the accident flight path. The flight path was approximately 7.5 NM long and the flight lasted about 2 minutes and 30 seconds. Figure 2 shows the altitude profile, calculated groundspeed, airspeed, roll, and roll rate of the flight. The airplane took off from runway 36 (elevation 476 ft) and climbed to about 1,400 ft MSL¹ before turning left onto a track of 330° and continuing to climb. The airplane likely entered the clouds between about 1,000 and 1,500 ft MSL, per the cloud ceiling information in the Weather Observations section. The airplane's autopilot was turned on at approximately 10:25:26. Selected altitude, initially set to 3,000 ft, was changed to 10,000 ft at 10:25:50, consistent with ATC instructions [3]. Once passing 3,000 ft at 10:26, the airplane's airspeed leveled out between 230 and 240 kts and the airplane continued to climb steadily.

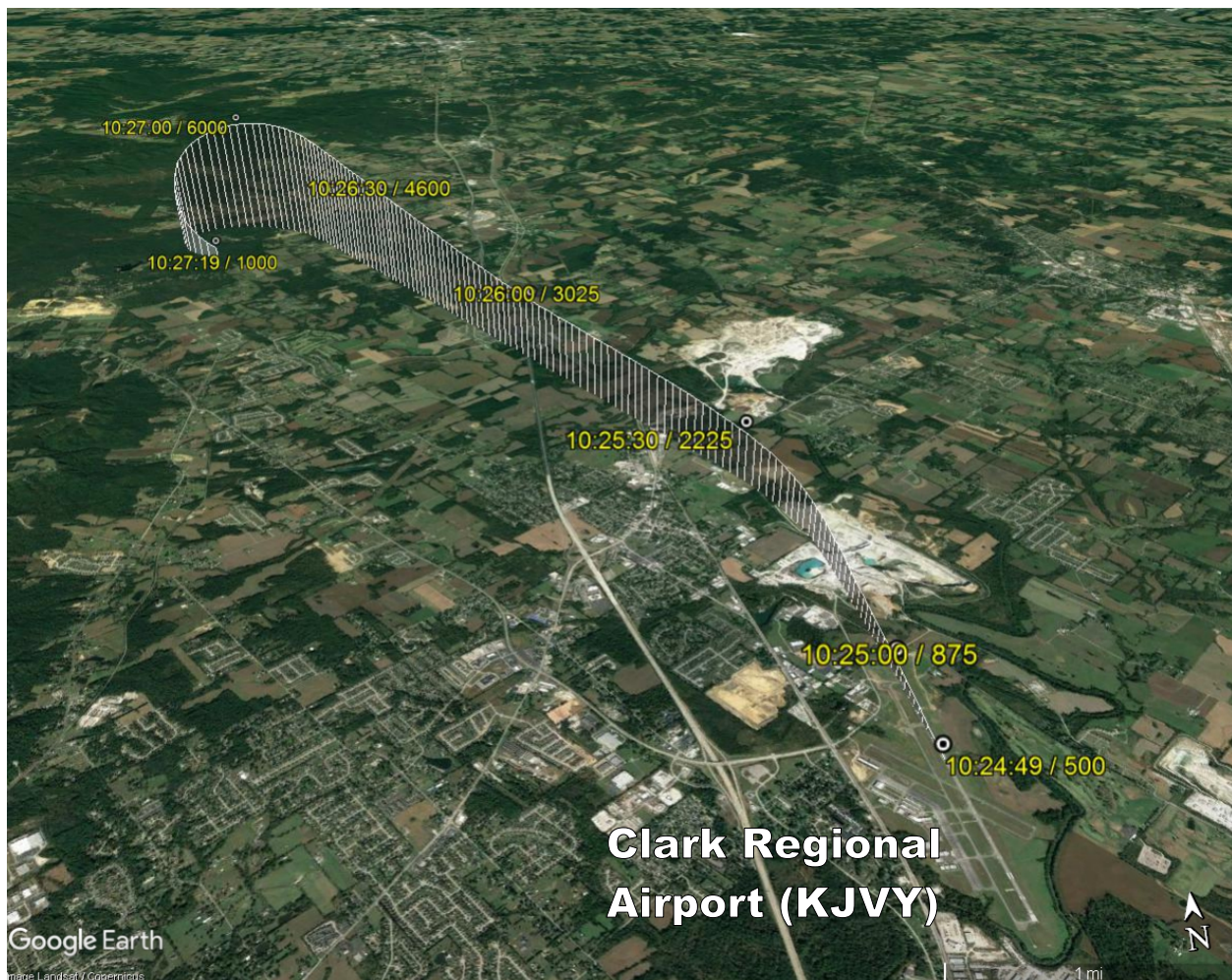


Figure 1. Accident flight with select times and altitudes annotated in yellow.

¹ Airplane altitude is reported in mean sea level, MSL, throughout the report.

Performance Study
CEN19FA036, Cessna 525, N525EG

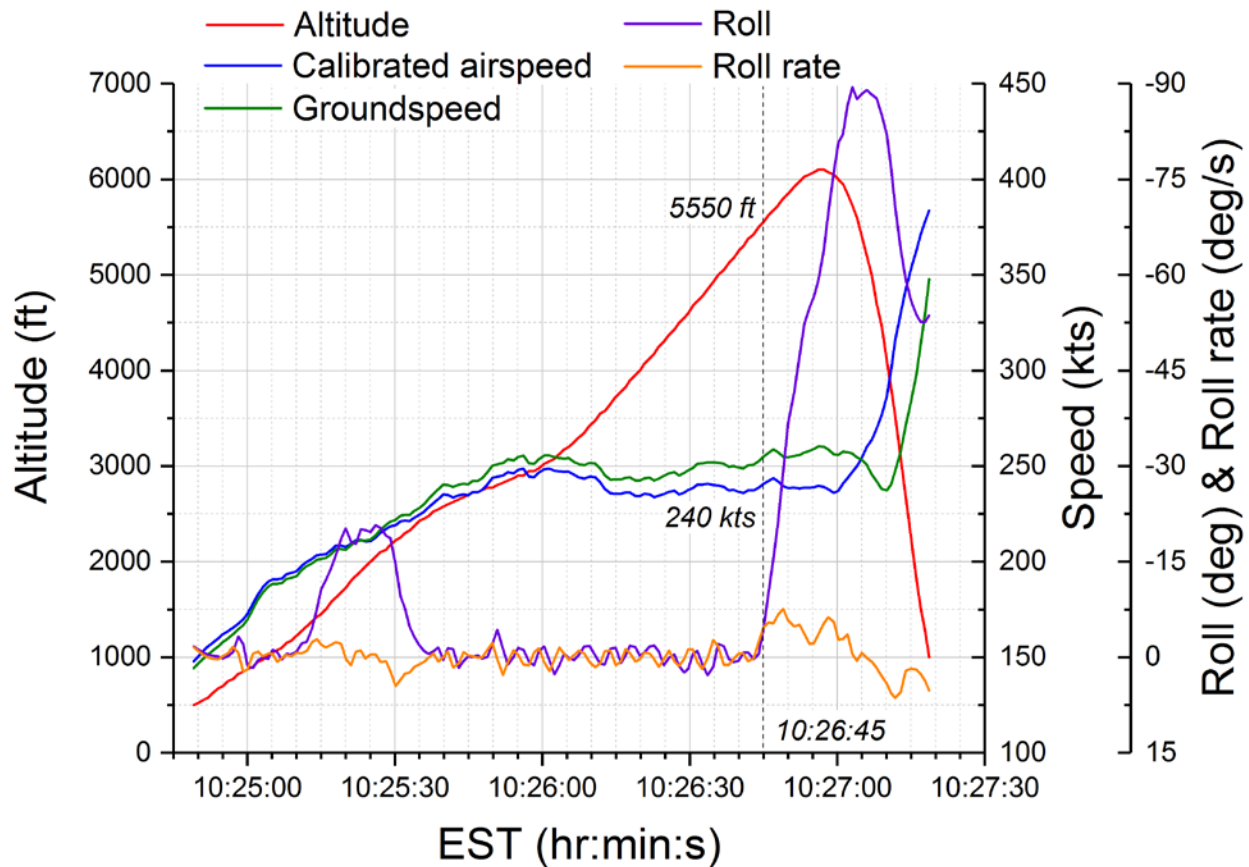


Figure 2. Accident flight altitude, calculated ground and airspeeds, and roll and roll rate.

Then, at 10:26:45 the airplane began to bank to the left at a rate of about $5^\circ/\text{s}$ so that by 10:27:05 the airplane was near 90° left wing down. After the onset of the roll, the airplane maintained airspeed while continuing to climb for 12 seconds, indicating that engine power was not reduced in response to the roll onset. At 10:26:57, the airplane reached its maximum altitude of 6,100 ft and began to descend rapidly, reaching a final recorded altitude of 1,000 ft by 10:27:18.7.

Figure 3 shows the flight altitude, speeds, cockpit annunciations, ATC communications, calculated normal load factor, roll, and roll rates. About six seconds after the start of the left bank, as the bank angle reached about -45° left wing down, the autopilot disconnected. At 10:26:58, when the bank angle was calculated to be about -70° left wing down and the airplane was beginning to descend, the GPWS began to annunciate “Bank Angle”. The GPWS annunciated “Bank Angle” six times until at 10:27:08 it said “Overspeed Warning” as the airplane passed 270 kts of calibrated airspeed and an altitude of 4,700 ft. The GPWS annunciated “Bank Angle” two more times. The final “Bank Angle” warning was at 10:27:12, after which the airplane’s bank angle was less than -60° . ADS-B data ended at 10:27:18. The final recorded altitude was 1,000 ft and the airplane’s calculated airspeed was 380 kts and final bank angle was -53° left wing down. At 10:27:20, the CVR recorded the GPWS annunciating “Terrain Terrain” and the approximate time of impact was 10:27:24. The impact point was 800 ft of ground distance from the last ADS-B point and at an

Performance Study
CEN19FA036, Cessna 525, N525EG

elevation of about 550 ft. Total time from beginning of left roll to the sound of impact was about 39 seconds.

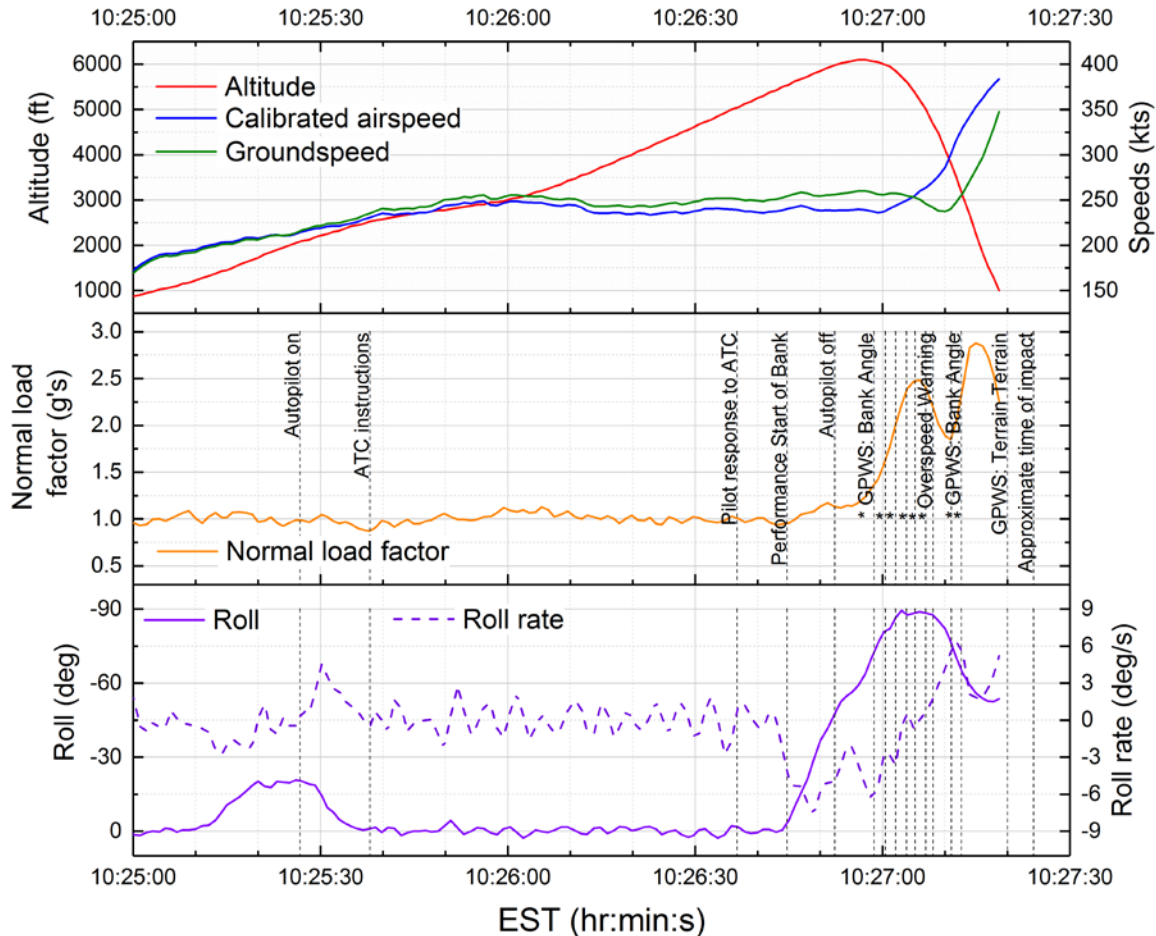


Figure 3. Accident flight including annunciations and ATC conversation. The multiple GPWS Bank Angle annunciations are indicated by the asterisks.

Of interest was comparing the roll rate seen in the accident, to roll rates related to a possible malfunction of the Active Technology Load Alleviation System (ATLAS) developed by Tamarack Aerospace Group, Inc. ATLAS is composed of wingtip extensions and winglets along with the Tamarack Active Camber Surfaces (TACS), which are active load-alleviation trailing edge flaps mounted on the wingtip extensions. Fuselage mounted accelerometers detect the airplane's vertical load factor and the TACS respond to alleviate wing bending moments due to gust and maneuver loads. ATLAS is independent of all other systems on the airplane. In case of malfunction, the TACS travel is limited to -18° (trailing edge up) and 8° (trailing edge down) by its electronic control unit. Certification failure assessment flight tests for the system found that at speeds of 240 kts, an initial bank angle of 30° , and a maximum unfavorable fuel imbalance (critical failure condition), a near full asymmetric deflection of the TACS resulted in a roll rate of greater than $20^{\circ}/s$, but it was recoverable.

Performance Study
CEN19FA036, Cessna 525, N525EG

At the start of the left roll, the airplane's airspeed was calculated to be 240 kts and wings approximately level. The accident roll rate of 5°/s was significantly less than the flight test data provided for a fully asymmetric TACS deflection at a critical failure initial condition. It is possible that the system was not experiencing a full asymmetric failure, or that the full possible roll rate could not be induced because the airplane was not initially in the critical failure condition. The roll rate did change from negative to positive, and the roll angle did recover from -90° left wing down to -60° left wing down before impact. If an asymmetric TACS deflection caused the left roll, it is possible the pilot was able to roll the airplane back to the right but not enough to fully recover and arrest the descent. However, since the airplane was not equipped with a flight recorder, control surface deflections and pilot input were unknown.

D. CONCLUSIONS

The airplane took off and climbed steadily, achieving an airspeed of 240 kts by 3,000 ft. At 5,550 ft of altitude, the airplane began to bank to the left at a rate of 5°/s. After the onset of the roll, the airplane maintained airspeed while continuing to climb for 12 seconds, indicating that engine power was not reduced in response to the roll onset. During the descent, the airplane reached a maximum bank of near -90° left wing down. The last calculated bank angle was -53° left wing down. The airplane's final speed was 380 kts at an altitude at 1,000 ft. Total time from beginning of left roll to impact was about 39 seconds.

The accident roll rate of 5°/s was significantly less than the measured roll rate induced by full asymmetric deflection of the ATLAS TACS as tested in the critical failure condition. It is possible the pilot was able to roll the airplane back to the right but not enough to fully recover and arrest the descent. However, since the airplane was not equipped with a flight recorder and control surface deflections and pilot input were unknown, there was not enough information to determine what initiated the left roll.

Marie Moler
Specialist – Airplane Performance
National Transportation Safety Board

E. REFERENCES

1. Cockpit Voice Recorder Factual Report, CEN19FA036, National Transportation Safety Board, 2019.
2. Meteorological Factual Report, CEN19FA036, National Transportation Safety Board, 2019.
3. Air Traffic Control Transcript, CEN19FA036, Federal Aviation Administration and National Transportation Safety Board, 2019.