

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



ERA25MA106

HUMAN PERFORMANCE

Factual Report

July 7, 2026

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A. ACCIDENT

Location: Philadelphia, Pennsylvania
Date: January 31, 2025
Time: 1807 EST
2307 UTC
Airplane: Learjet 55, XA-UCI

B. HUMAN PERFORMANCE

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C. SUMMARY

On January 31, 2025, at 1807 eastern standard time, a Learjet 55 airplane, Mexican registration XA-UCI (call sign MTS056) was destroyed when it was involved in an accident in Philadelphia, Pennsylvania. The two pilots, two medical crew members, and two passengers were fatally injured. One person on the ground was fatally injured, 4 people were seriously injured, and 20 people incurred minor injuries. The airplane was operated as a Title 14 Code of Federal Regulations Part 129 air ambulance flight.

D. DETAILS OF THE INVESTIGATION

The human performance investigator assigned to this accident did not launch on the accident or participate in field activities due to workload. This report compiles information collected by other groups to facilitate human performance analysis.

1.0 History of Flight

The airplane lacked a flight data recorder (FDR). It was equipped with a cockpit voice recorder (CVR), however the CVR was not operating. Aside from radio communications, there was no direct evidence of pilot actions or communications in the cockpit. The airplane was broadcasting ADS-B data, including position, altitude, and groundspeed. These data made it possible for an NTSB vehicle performance specialist to recreate the airplane's flight path after takeoff.¹ This information, in combination with recorded radio transmissions, were used to identify the following key events in the history of flight.

¹ Vehicle Performance Specialist's Study. ERA25MA106.

The airplane was cleared for takeoff on runway 24. The tower instructed the crew to turn right heading 290 degrees after takeoff. The first officer (FO) correctly read back that clearance and completed his transmission at 1804:47. The first Federal Aviation Administration (FAA) Automatic Dependent Surveillance - Broadcast (ADS-B) data point from the flight was recorded at 1806:25. At that time the airplane was 0.45 nm beyond the departure end of the runway and still aligned with the extended runway centerline. Its altitude was about 400 ft agl, its speed 191 kts cas.

From 1806:34 to 1806:38, PNE local control instructed the crew to change to a departure frequency. From 1806:39 to 1806:44 the FO provide a correct readback. Air traffic control received no further communications from the flight crew.

The airplane's track showed a right turn after the first ADS-B data point. About 1806:38, its track briefly stabilized on a heading of 254 degrees magnetic. At 1806:42, the track began a gradual left turn. The final ADS-B data point, recorded at 1807:03, showed a continuation of that left turn up to that data point. The last two data points indicated a track heading of about 190 deg magnetic. A bearing from the final data point to the initial ground impact was approximately 173 deg magnetic. This indicates that the left turn likely continued after the final data point to the point of impact.

The vehicle performance specialist's study calculated roll angle throughout the flight. This analysis indicated that the airplane's roll angle was +22 degrees (right) at 1806:26 (right after the first ADS-B data point was received). It decreased to +12 degrees by 1806:28. Roll angle decreased thereafter in linear fashion at a rate of approximately 1.7 degrees per second with very little roll acceleration (average -0.3 degrees per second squared) until 1806:50. At that time, roll angle was -23 degrees (left). After that, roll angle began to rapidly decrease. By 18:07:00, roll angle was less than -100 degrees. The last two data points indicated a rapid increase in the roll angle, but the airplane remained in a steep left bank by the final data point (figure 1).

Altitude peaked at 1,320 ft agl at 1806:56. About 18:06:57, pitch dropped below zero degrees and continued decreasing as roll decreased through -65 degrees. By 18:06:59, altitude was also decreasing. By the final ADS-B data point, pitch was less than -20 degrees, and the airplane was in a rapid descent (figure 2).

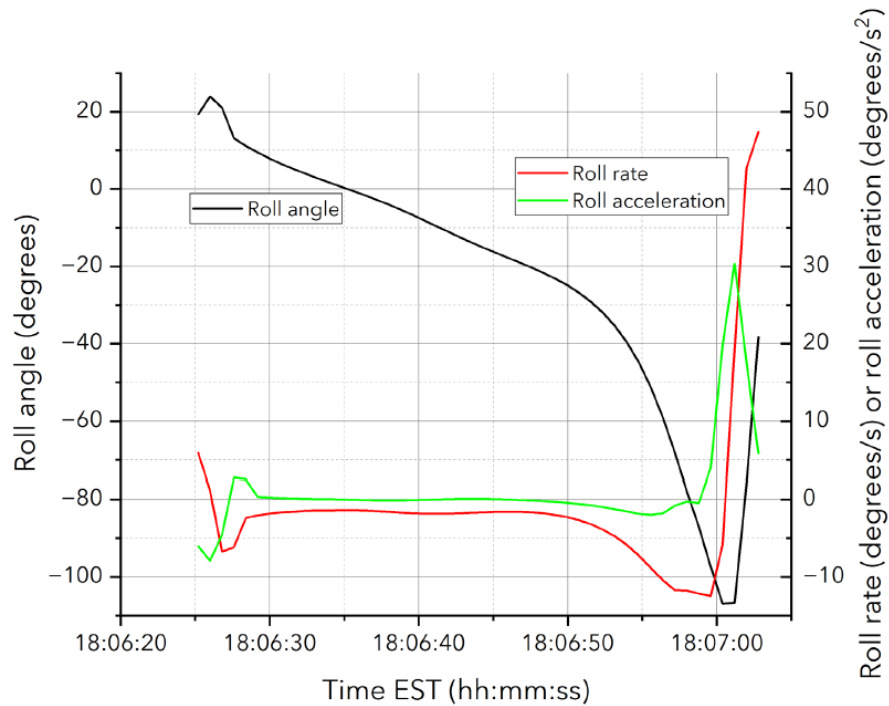


Figure 1. Calculated roll angle, roll rate and roll acceleration (figure 10 in the vehicle performance specialist's study).

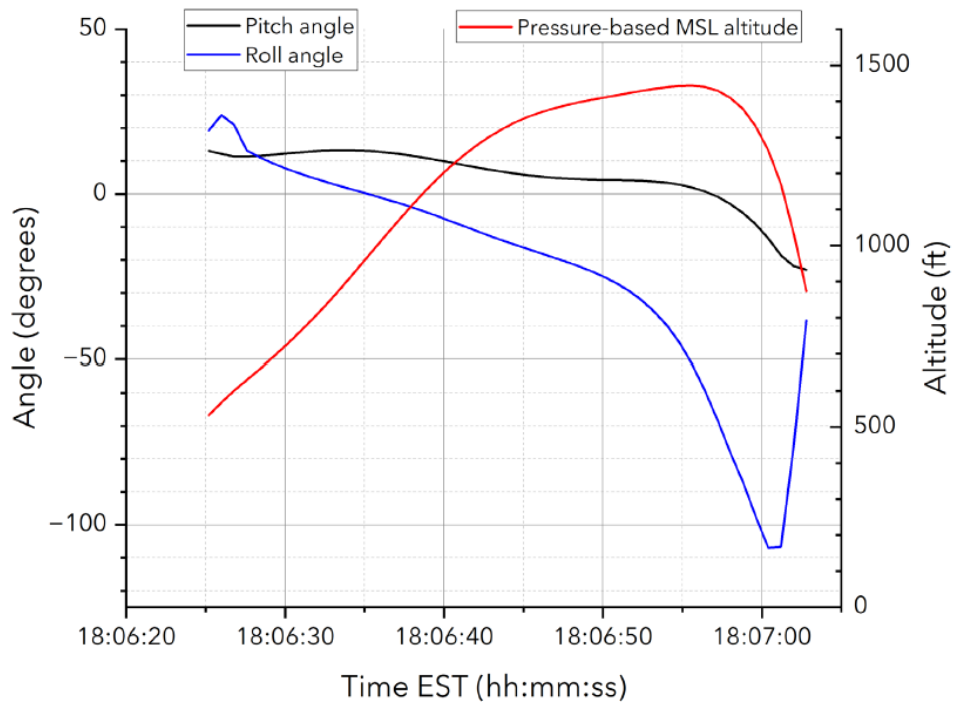


Figure 2. Pitch angle, roll angle, and curve fit to the GNSS-based MSL altitude (Figure 8 in the vehicle performance specialist's study).

A timeline of communications, roll, and climb events is shown in figure 3.

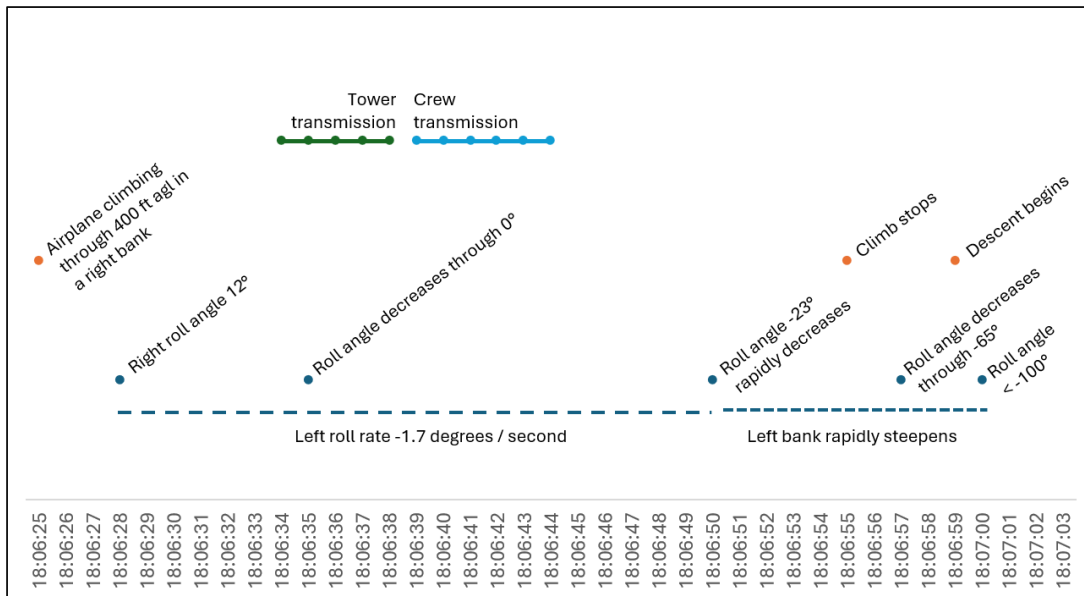


Figure 3. Timeline of communication, climb, and roll events.

The vehicle performance specialist calculated gravitoinertial force (GIF) vector (the sum of gravity and inertial forces) throughout the flight. The result was used to compute the gravitoinertial force angle in pitch (the angle between the GIF vector and the true gravity vector). GIF angle in pitch was positive for the entire portion of the flight for which ADS-B data were available (figure 4).

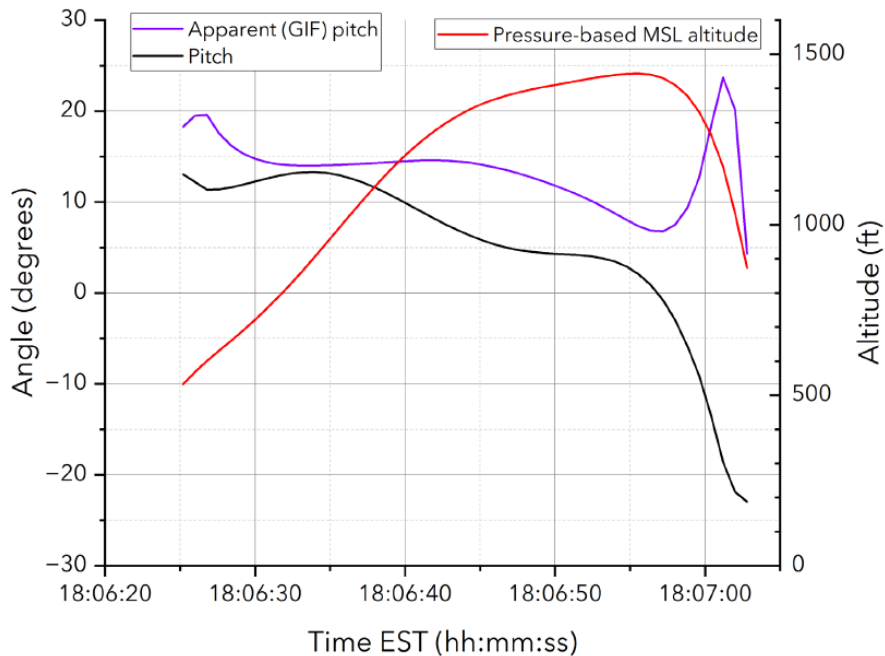


Figure 4. GIF angle in pitch, pitch angle, and pressure-based MSL altitude (Figure 13 in the vehicle performance specialist's study).

2.0 Additional Information

Spatial orientation is a cognitive understanding of one's attitude and trajectory relative to the surface of the earth. Spatial orientation depends on sensory input to maintain a continuous representation of these variables. Spatial disorientation is a mismatch between one's actual and perceived attitude and motion.²

Vision is the primary sense used to maintain spatial orientation.³ The vestibular, kinesthetic, and proprioceptive senses, also support spatial orientation.⁴ These latter senses provide useful information during self-locomotion on the ground, but misleading information when subjected to the forces of flight.⁵

When visual references are obscured in flight, continuous monitoring of the flight instruments by the flying pilot is required to avoid spatial disorientation. Pilots who are properly trained and current in instrument flying can normally use instrument information to overcome misleading sensations, however, even well-trained pilots experience sensory illusions from time to time.⁶

Pilots often perform concurrent tasks in the cockpit. These concurrent tasks sometimes lead to the interruption of continuous monitoring of flight instruments that is required for the maintenance of an accurate cognitive representation of spatial orientation. When such gaps in monitoring occur, the risk of sensory illusions is elevated.⁷

Flight experiments show that varying amounts of time are required for spatial orientation to be regained after it has been lost. This can range from a few seconds in some situations, to tens of seconds or more in others.⁸ When there is a delay in

² Previc, F.H. (2004). Spatial disorientation in aviation: Historical background, concepts, and terminology. In F.H. Previc & W.R. Ercoline (Eds) Spatial disorientation in aviation. American Institute of Aeronautics and Astronautics, Reston, Virginia.

³ Previc, F.H. (2004). Visual orientation mechanisms. In F.H. Previc & W.R. Ercoline (Eds) Spatial disorientation in aviation. American Institute of Aeronautics and Astronautics, Reston, Virginia.

⁴ Cheung, B. (2004). Nonvisual spatial orientation mechanisms. In F.H. Previc & W.R. Ercoline (Eds) Spatial disorientation in aviation. American Institute of Aeronautics and Astronautics, Reston, Virginia.

⁵ Cheung, B. (2004). Nonvisual illusions in flight. In F.H. Previc & W.R. Ercoline (Eds) Spatial disorientation in aviation. American Institute of Aeronautics and Astronautics, Reston, Virginia.

⁶ Matthews, R. S. J., Previc, F. H., and Bunting, A. (2002). USAF spatial disorientation survey. Symposium on "Spatial Disorientation in Military Vehicles: Causes, Consequences and Cures", La Coruna, Spain, 15-17 April 2002, published in North Atlantic Treaty Organization, Research and Technology Organization, RTO-MP-086.

⁷ Matthews, R.S.J., et al. (2002).

⁸ Kraus, R. N. (1959). Disorientation: An evaluation of the etiologic factors. Aerospace Medicine 30(9): 664-673.

regaining spatial orientation, a pilot may make inappropriate control inputs that place an airplane in an unrecoverable trajectory.

Somatogyral illusions are a category of illusions implicated in spatial disorientation accidents. One pattern of motions preceding such illusions involves an increase in bank that occurs so slowly that the angular roll accelerations are below the threshold for detection by the semi-circular canals, organs of the inner ear. When in coordinated flight, such sub-threshold rolls can cause a pilot to feel as if the airplane is straight and level when, in fact, its angle of bank is changing.⁹

Subsequently noticing that the attitude indicator shows the airplane in a bank can, in some cases, lead to pilot confusion because of the difference between the pilot's internal representation of attitude and what is being displayed on the flight instruments. In some cases, pilots may experience a misperception of the attitude indicator that psychologists describe as a "roll-reversal" error.¹⁰ This involves a reversal in the perceived field-ground relationship between the airplane symbol and the moving horizon, such that the movement of the horizon becomes incorrectly interpreted as being the same as the direction of movement of the airplane, instead of the normally opposite relationship. In such instances, the pilot may make inputs that further increase the unwanted bank angle. In other cases, a pilot may make correct inputs that promptly eliminate the unwanted bank, but then experience vestibular sensations suggesting that the airplane is banking in the opposite direction. This misperception, known as "the leans", may prompt pilots to make incorrect control inputs that cause the airplane to resume the unwanted bank angle.¹¹

Submitted by:

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⁹ Cheung, B. (2004). Nonvisual illusions in flight. In F.H. Previc & W.R. Ercoline (Eds) Spatial disorientation in aviation. American Institute of Aeronautics and Astronautics, Reston, Virginia.

¹⁰ Previc, F. H. and W. R. Ercoline (1999). "The "outside-in" attitude display concept revisited. International Journal of Aviation Psychology 9(4): 377-401.

¹¹ Cheung, B. (2004). Nonvisual illusions in flight. In F.H. Previc & W.R. Ercoline (Eds) Spatial disorientation in aviation. American Institute of Aeronautics and Astronautics, Reston, Virginia.