

National Transportation Safety Board

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WPR24FA083

AIRPLANE PERFORMANCE STUDY

July 7, 2024
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A. ACCIDENT

Location: Westwater, Utah
Date: February 7, 2024
Time: 1048 MST
1748 GMT
Airplane: Hawker 900XP, N900VA

B. AIRPLANE PERFORMANCE GROUP

No airplane performance group was formed.

C. SUMMARY

On February 7, 2024, about 1048 mountain standard time (MST), a Hawker 900XP, N900VA, was destroyed when it was involved in an accident near Westwater, Utah. The captain and co-pilot were fatally injured. The airplane was operated as a Title 14 *Code of Federal Regulations* (CFR) Part 91 positioning flight.

The flight crew had planned to fly the airplane from Grand Junction Regional Airport (GJT), Grand Junction, Colorado, to Gig Harbor, Washington. During the flight the crew planned to perform a stall warning and systems check in accordance with the airframe manufacturer's requirements following routine maintenance inspections¹.

According to Automatic Dependent Surveillance - Broadcast (ADS-B) data, the airplane departed GJT at 1037 and entered a climb on a southeast heading. The flight crew asked air traffic control (ATC) for a block of altitudes from FL180 to FL200 and ATC approved the request. The airplane circled to the northwest as it continued to climb and subsequently leveled off at 1043:49, near the top of the altitude block. At 1046:47 the flight track data showed the airplane begin a rapid descent in a circular pattern that resembled the shape of a corkscrew. The airplane made multiple rotations before the track ceased at 1047:44. The airplane came to rest in flat, open terrain about 25 nautical miles (NM) northwest of GJT at an elevation of about 4,800 ft mean sea level (msl) and oriented on a west heading. The recorded ADS-B ground track for the eleven-minute flight is shown in Figure 1. A picture of the main wreckage site is shown in Figure 2.

¹ Multiple routine inspections had been completed on the airplane which included the removal of the wing leading edges and Tecalemit-Kilfroast-Sheepbridge Stokes (TKS) panels to inspect for cracks and signs of corrosion. The Hawker 900XP ice protection system consists of heated bleed air for the engines and a "weeping wing" or TKS system which dispenses an ethylene glycol-based fluid through porous titanium panels attached to the leading edges of the wings. Icing conditions must be anticipated with the TKS system in order that it be properly primed before entering ice.

Times in the study are quoted in MST. Greenwich Mean Time (GMT) = MST + 7 hr.

D. THE AIRPLANE

A picture of the accident airplane, a Hawker 900XP, is shown in Figure 3. It was manufactured by Hawker Beechcraft Corporation Aircraft (now Textron) in 2008 and is registered to Sil-Con Air, LLC. The airplane was equipped with two Honeywell (previously Garrett) TFE731 turbofan engines.

E. WEATHER SUMMARY

A routine weather observation for GJT about five minutes after the accident was reported as:

KGJT 071753Z 35008KT 10SM -RA BKN037 OVC055 07/02 A2959 RMK AO2

The automated surface weather observation for Grand Junction Regional Airport on February 7th at 1053 MST is wind from 350° at 8 knots (kt); 10 statute miles visibility with light rain; broken ceiling at 3,700 ft above ground level (agl), overcast at 5,500 ft agl; temperature 7° Celsius (C); dew point 2° C; altimeter 29.59" of mercury. The observation site is automated and has a precipitation sensor.

The NTSB Meteorology Group Chairman concluded that N900VA was in instrument meteorological conditions (IMC) during some or all of its ascent from 5,000 feet through 16,700 feet. In addition, the airplane may have accreted up to one millimeter of ice during that time. See the Meteorology Group Chairman's factual report for more details.

F. AIRPLANE PERFORMANCE STUDY

The airplane performance study is based on information provided by Textron, data recovered from the flight data recorder (FDR) and cockpit voice recorder (CVR) on-board the airplane, and Automatic Dependent Surveillance - Broadcast (ADS-B) data provided by the Federal Aviation Administration (FAA).

The FDR was a lightweight, crash-survivable Honeywell AR-FDR and configured to record and retain the most recent 25 hours of flight data at 256 words per second from an ARINC-717 data stream. While the air data² in the FDR data stream were unusable beyond 10:46:48, ADS-B data were used to estimate these parameters.

² Air data included airspeed, barometric altitude, and rate of climb (ROC).

The CVR was a Universal CVR-120 that records the last two hours of cockpit communication. However, only the last 30 minutes were recovered from the CVR on N900VA.

ADS-B broadcasts an airplane's Global Positioning System (GPS) position to the ground where it is displayed to ATC. The GPS position is also transmitted to other airplanes with ADS-B receivers, either directly or relayed through ground stations, to allow self-separation and to increase situational awareness.

GPS has an accuracy of approximately 20 meters in both the horizontal and vertical dimensions. GPS augmented with the Wide Area Augmentation System (WAAS) is accurate to approximately 1.5 - 2 meters.

Figure 4 includes the altitude, vertical speed, airspeed and ground speed from both the FDR and ADS-B data for the entire accident flight. Figure 5 shows the same parameters but highlights approximately the last two minutes of the flight³.

FDR pitch, bank, and heading Euler angles for the entire flight are shown in Figure 6, and the last two minutes are highlighted in Figure 7. The pitch was slowly increasing from about 10° airplane-nose-up (ANU) to 15° ANU as the airspeed decreased from 146 kt at 10:46:00 to 118 kt at 10:46:37. At 118 kt, the airplane banked right to 83° in two seconds, despite the flight crew's immediate input of full left-wing-down (LWD) control wheel. Figure 8 includes the elevator, aileron, and rudder deflections associated with the flight crew's input.

Figure 9 shows the recorded engine low pressure compressor fan speeds, n_1 , associated with the flight crew's inputs for the entire flight. Figure 10 includes only the last two minutes. The flight crew first added 89% maximum rpm at 10:46:37 when the airplane banked right to 83° and later reduced engine power to 58% before finally inputting 100% rpm at 10:47:00.

The vertical load factor recorded on the FDR is shown in Figures 9 and 10. About the same time the airplane pitched up to 15° and banked right to 83°, the vertical load factor went from 1g to about 0.6g. Similarly, the recorded angle-of-attack or AOA (as a percentage of maximum lift⁴) shown in Figure 11 went from approaching 90% to less than 80% and finally up to 100%.

³ Note: the point at which the airplane likely reached its critical AOA and stalled, about 10:46:37, is shown as a vertical red line in the figures. The dashed vertical line in the figures at approximately 10:46:50 is where the FDR air data is considered no longer usable.

⁴ At slow stall entry rates or less than 1 kt/sec in the case of the accident, the stick shaker activates at 23° vane AOA or about 15° body AOA. This is approximately 90% maximum lift as shown in Figure 11.

G. SUMMARY AND CONCLUSIONS

Approximately three minutes after leveling off at 19,600 ft on a positioning flight to Gig Harbor, Washington, recorded FDR and FAA ADS-B data show the airplane airspeed slowing and the pitch attitude increasing, consistent with the flight crew of N900VA performing planned, post-maintenance, stall warning and systems checks⁵.

Figure 10 shows an abrupt change or “break” in vertical load factor at 10:46:37 as the airspeed slowed to about 117.5 kt during the first system check. Such a break in load factor is often the result of a stall when one or both wings reach the critical AOA, and the air flow over the wing becomes separated⁶. As a result of the separation, the stalled wing can no longer generate necessary lift and the airplane descends, often rapidly. If the airplane is uncoordinated⁷ at stall, a spin may result. N900VA’s final descent was in a circular pattern that resembled a spin or “corkscrew”. See Figure 12.

A generic recovery technique⁸ for a spin is to reduce the power, neutralize the aileron input, apply full opposite rudder to arrest the yaw rate, and input forward control column to reduce the AOA with elevator. However, the flight crew of N900VA immediately input full LWD aileron when the airplane abruptly banked right and ultimately applied full power and full aft control column, likely aggravating a stall/spin⁹.

Figure 13 lists the stick shaker and stick pusher speeds at the accident conditions where the stall warning system¹⁰ is designed to activate to prevent a stall: first the stick shaker and then, if necessary, the stick pusher. The stick shaker is electrically activated and set to operate at an indicated airspeed of 7% to 9% above the stall speed. The stick shaker activation is not directly recorded on the FDR but can be computed.

⁵ The Hawker 900XP Pilot’s Operating Manual (POM) warns that pilots conducting stall checks should have prior experience in performing stalls in the Hawker and must be prepared for unacceptable stall behavior at any point leading up to and throughout the maneuver. Unacceptable behavior includes a roll angle beyond 20°.

The stall characteristics section of the POM also states that “aileron snatch” may occur at or prior to stall and is not acceptable. The aileron snatch may be strong enough to affect recovery using aileron input, in which case the elevator control must be moved forward to decrease the AOA and allow the return of normal aileron control. In such an event, the pilot must be prepared to recover from an unusual attitude.

Depending on the severity of the flow separation, the control force necessary to overcome the un-commanded deflection of the ailerons can be beyond the pilot’s physical capability.

⁶ While the stick pusher may have contributed to the break in vertical load factor, the abrupt right roll is also indicative of a wing stall.

⁷ “Uncoordinated” flight refers to a non-zero sideslip angle, cross-control, and/or “top rudder”

⁸ All airplanes are different in their spin characteristics, and the airplane manufacturer should be consulted for the proper technique for recovering from an inadvertent spin.

⁹ The Hawker 900XP POM does not include an emergency procedure for an inadvertent spin.

¹⁰ The Hawker 900XP POM states that there is “no natural warning or aerodynamic buffet prior to stall”. Instead, the airplane employs a stick shaker and a stick pusher to avoid stalls.

The FDR is configured to record stick pusher activation through discrete parameters "Stall Valve A" and "Stall Valve B". Stick pusher is active when both valves A and B are engaged.

FDR data from the accident and lift coefficient data provided by Textron indicate that the stick shaker activated at approximately 117.5 kt, a knot below the design activation speed for stick shaker with flaps zero or 118.5 kt as shown in Figure 13. Stick pusher activated at about 113.5 kt, 3 kt above the stick pusher speed as shown in Figure 13 or 110.5 kt with zero flaps. Given the airplane weight and load factor (e.g., because of the pilot's inputs in response to the stall), the stick shaker and stick pusher triggered at the appropriate speeds. However, the airplane stalled at approximately the same time the stick shaker activated¹¹ providing no warning to the accident flight crew. Subsequently, N900VA abruptly rolled right and entered an unusual attitude from which the flight crew never recovered.

The stall/stall warning sequence should be stick shaker, stick pusher, and finally stall (given the pilot does not initiate a stall recovery and the AOA continues to increase). In the accident, the sequence was stick shaker and stall at the same time followed by stick pusher (while in the stall). The incorrect stall warning sequence in the accident was likely due to a degradation in the relationship between lift and angle-of-attack on N900VA and, specifically, a degradation in the maximum lift coefficient, C_{Lmax} , and the stall AOA.

One possible explanation for the degraded lift is ice¹². The NTSB Meteorology Group Chairman concluded that N900VA was in IMC during most of the climb and may have accreted up to a millimeter of ice. Even small amounts of ice on a wing can lower the critical AOA at which stall occurs¹³.

A second explanation for the degradation could be the routine maintenance that had just been completed on N900VA. This included removing the wing leading edges and TKS panels to inspect for cracks and signs of corrosion. The proper re-installation of the leading edges and panels is critical to wing performance and the reason the manufacturer requires post maintenance flight tests.

¹¹ The stick shaker activation was heard on the CVR by the CVR Group about the time the stall occurred and at the time calculations show the stick shaker would activate.

¹² The Hawker 900XP utilizes a rotary-cutter ice detector that triggers a light in the cockpit to warn the flight crew when ice is present. However, the system is not connected to either the ice protection system, to automatically remove the ice if the flight crew misses the cockpit light, or to the stall warning system, to ensure that adequate stall margin exists, even with the presence of ice.

¹³ Stalls with ice accretions typically occur at a lower-than-published AOA and a higher airspeed.

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H. FIGURES

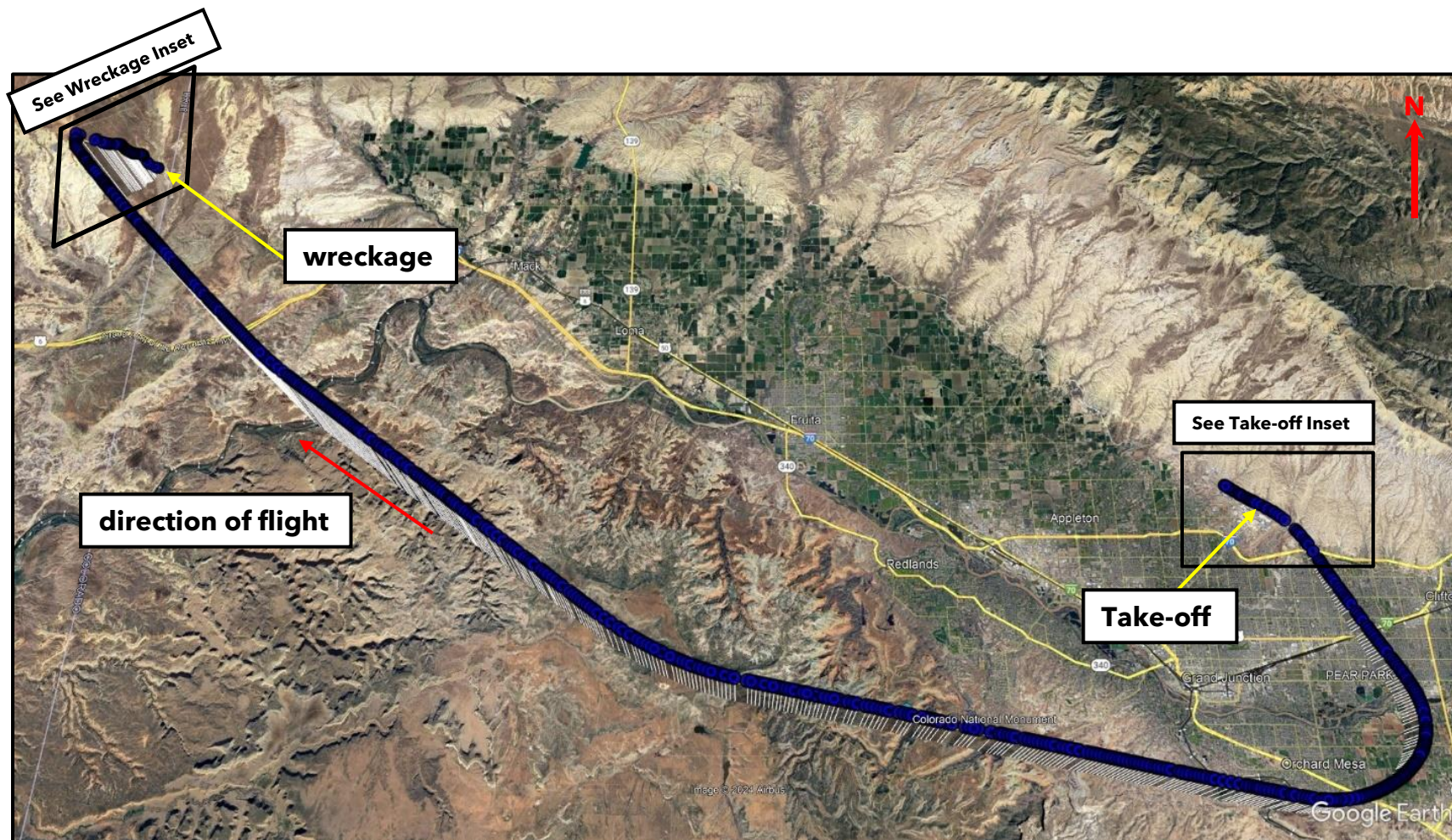
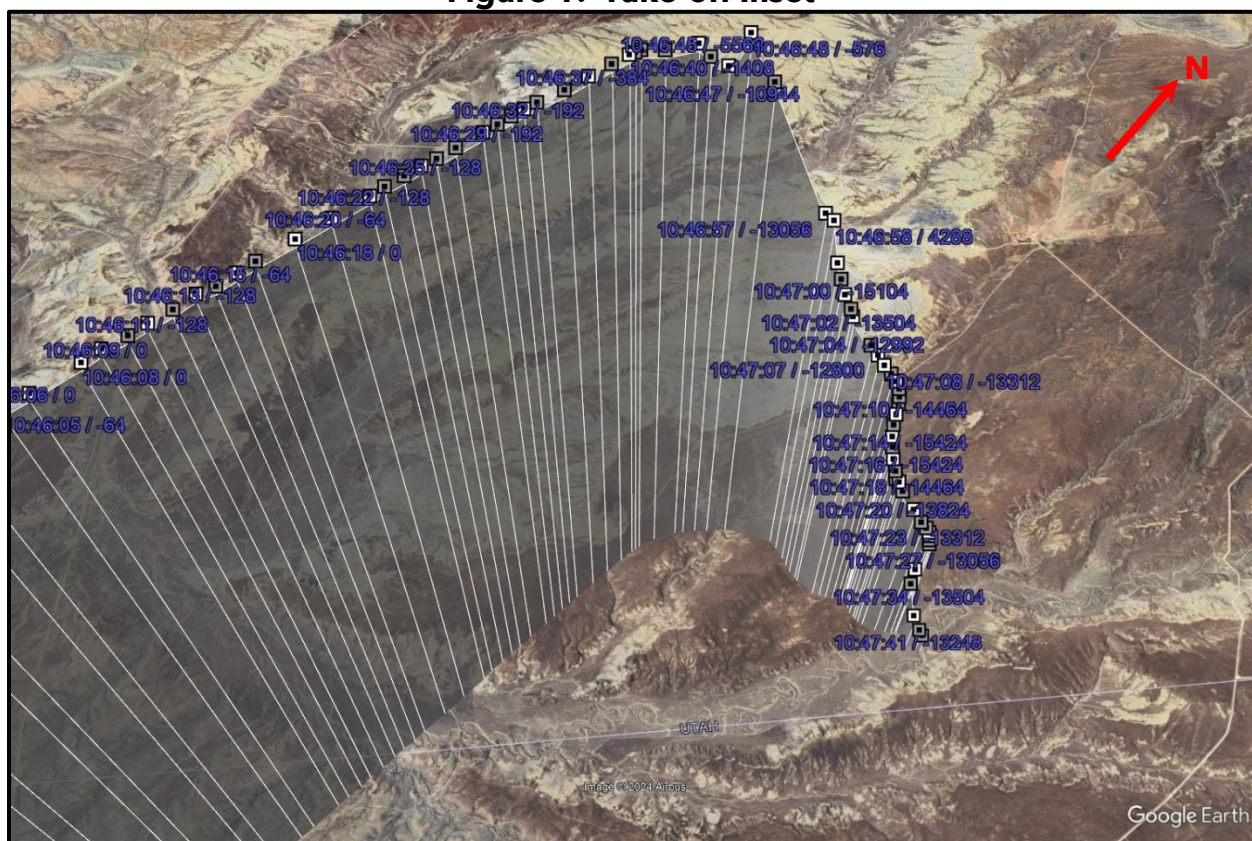


Figure 1: ADS-B Ground Track for the Eleven Minute Accident Flight



(Note: MST and ROC are shown in Blue.)



Figure 2: Main Wreckage Site



Figure 3: Accident Airplane, a 2008 Hawker 900XP

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Westwater, UT
2/7/2024

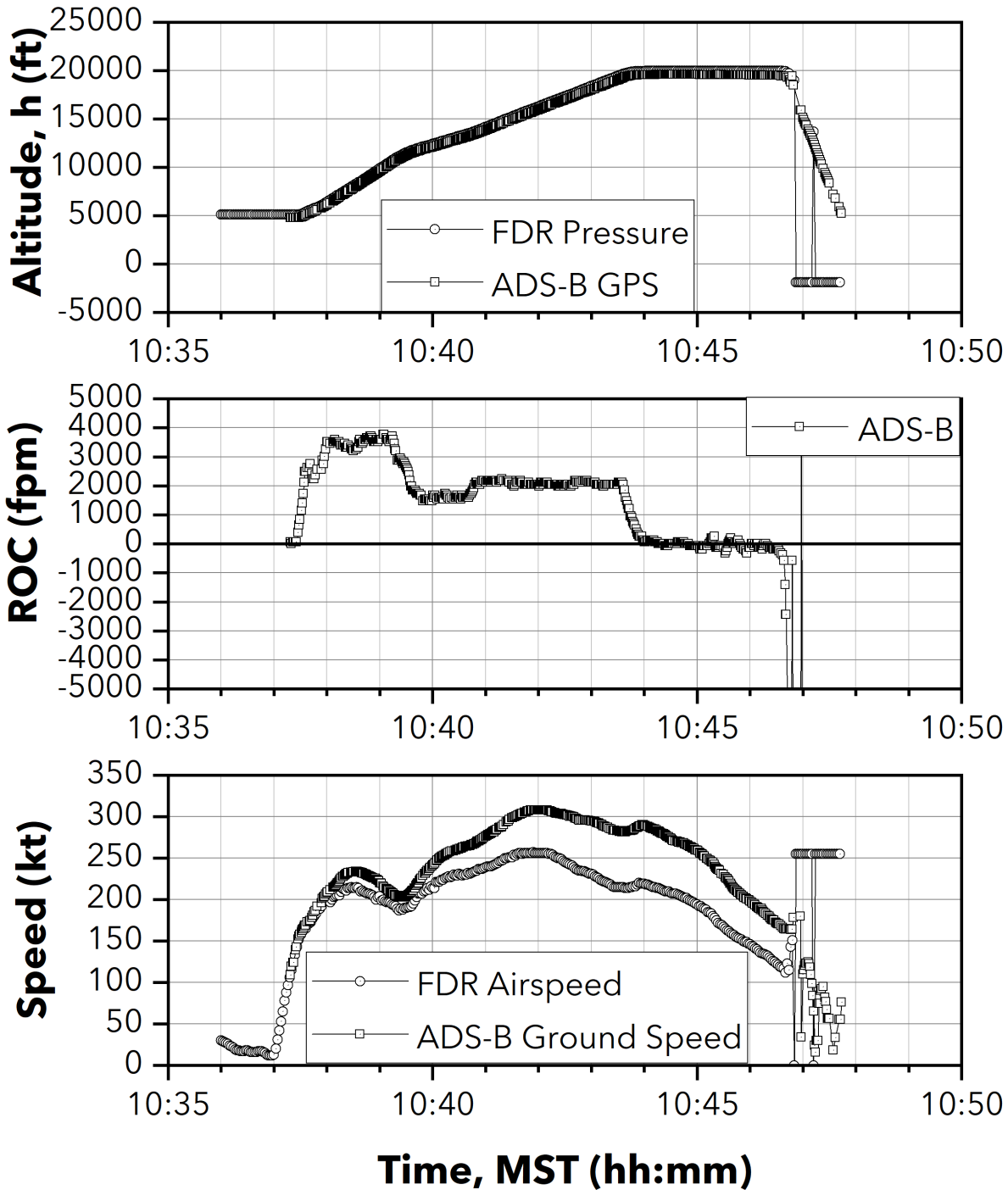


Figure 4: Altitude, Rate of Climb (ROC), and Speed for Entire Flight

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Westwater, UT
2/7/2024

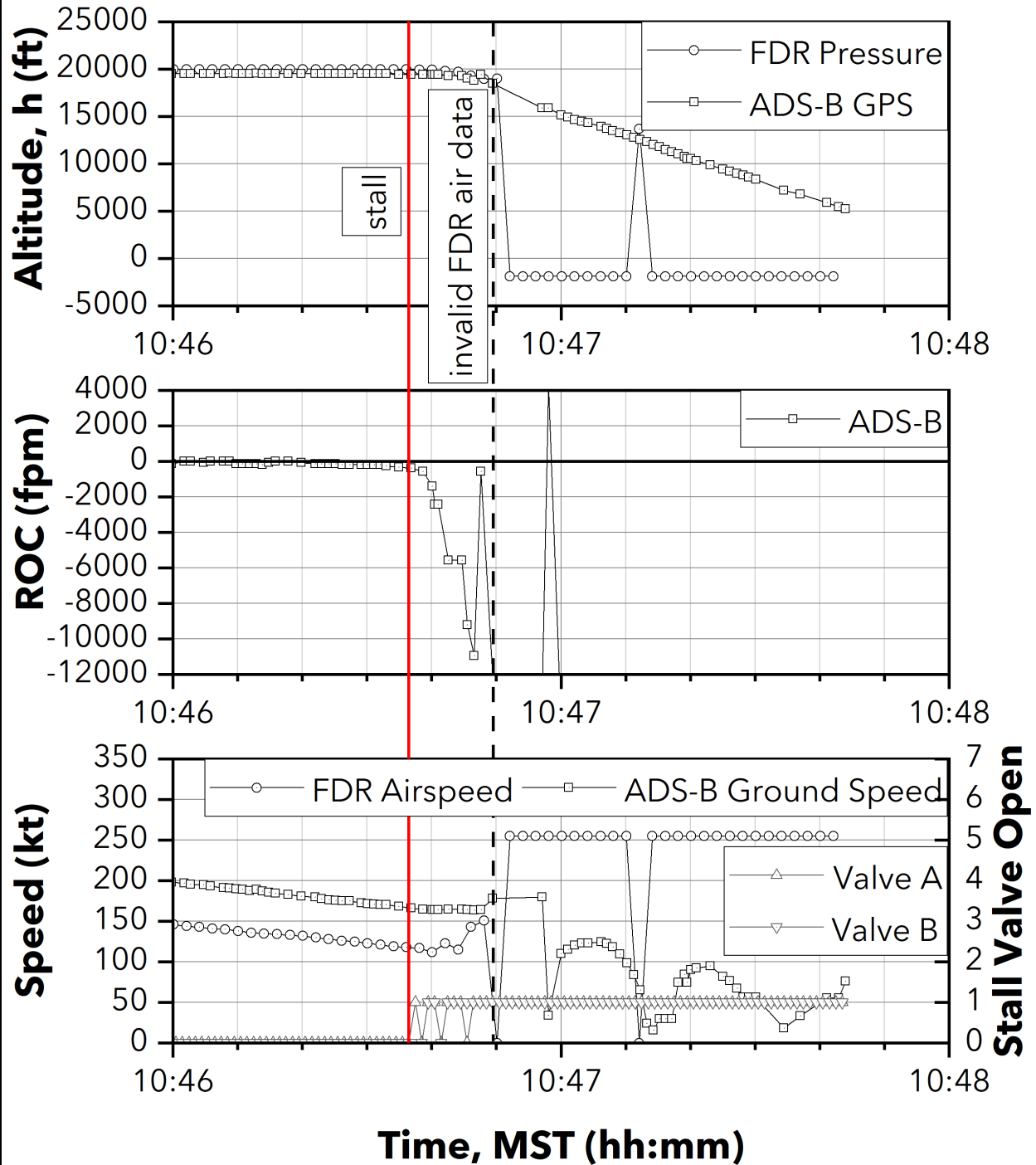


Figure 5: Altitude, ROC, and Speed for Final Minutes of Flight

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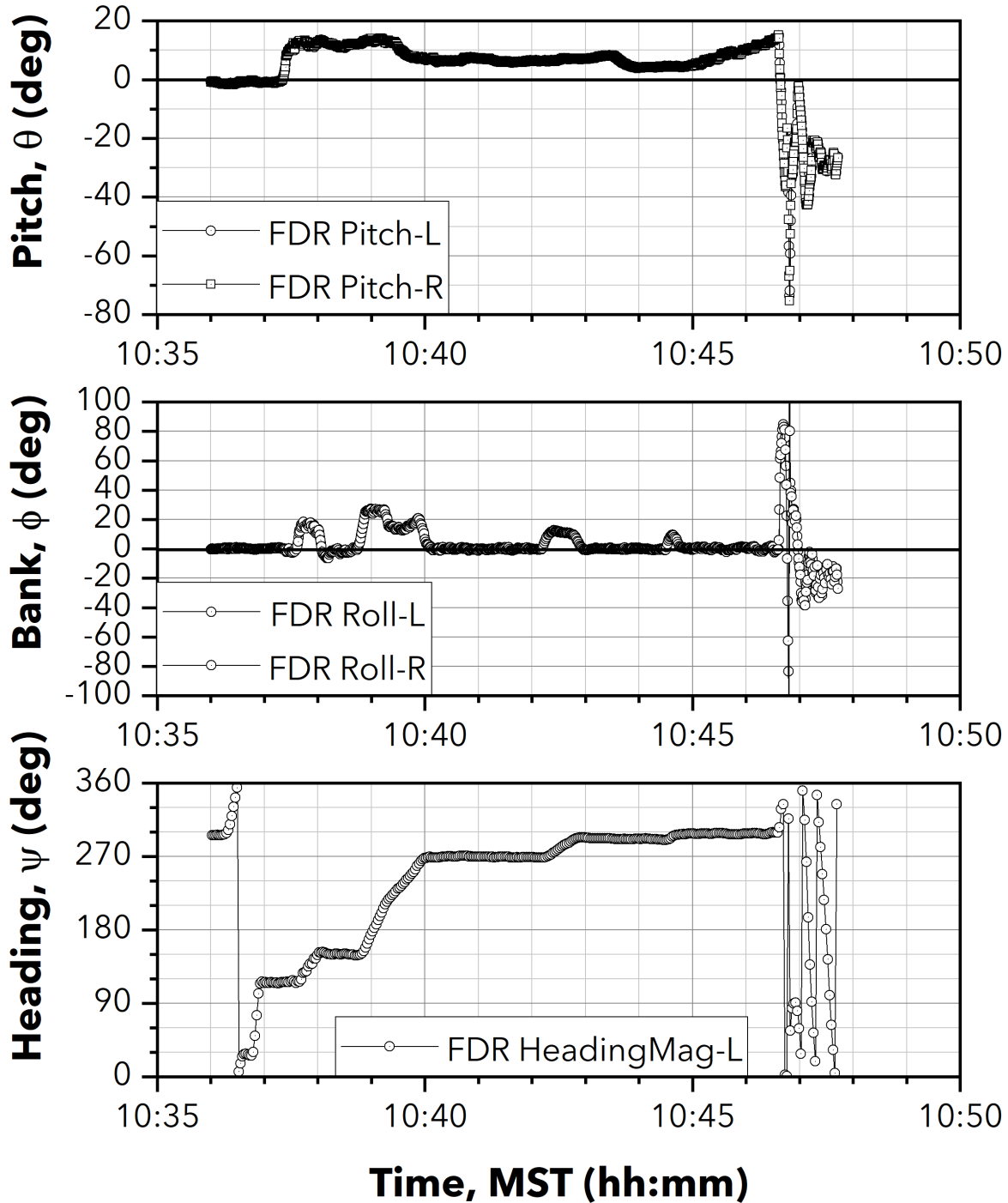


Figure 6: FDR Pitch, Bank, and Heading Angles for Entire Flight

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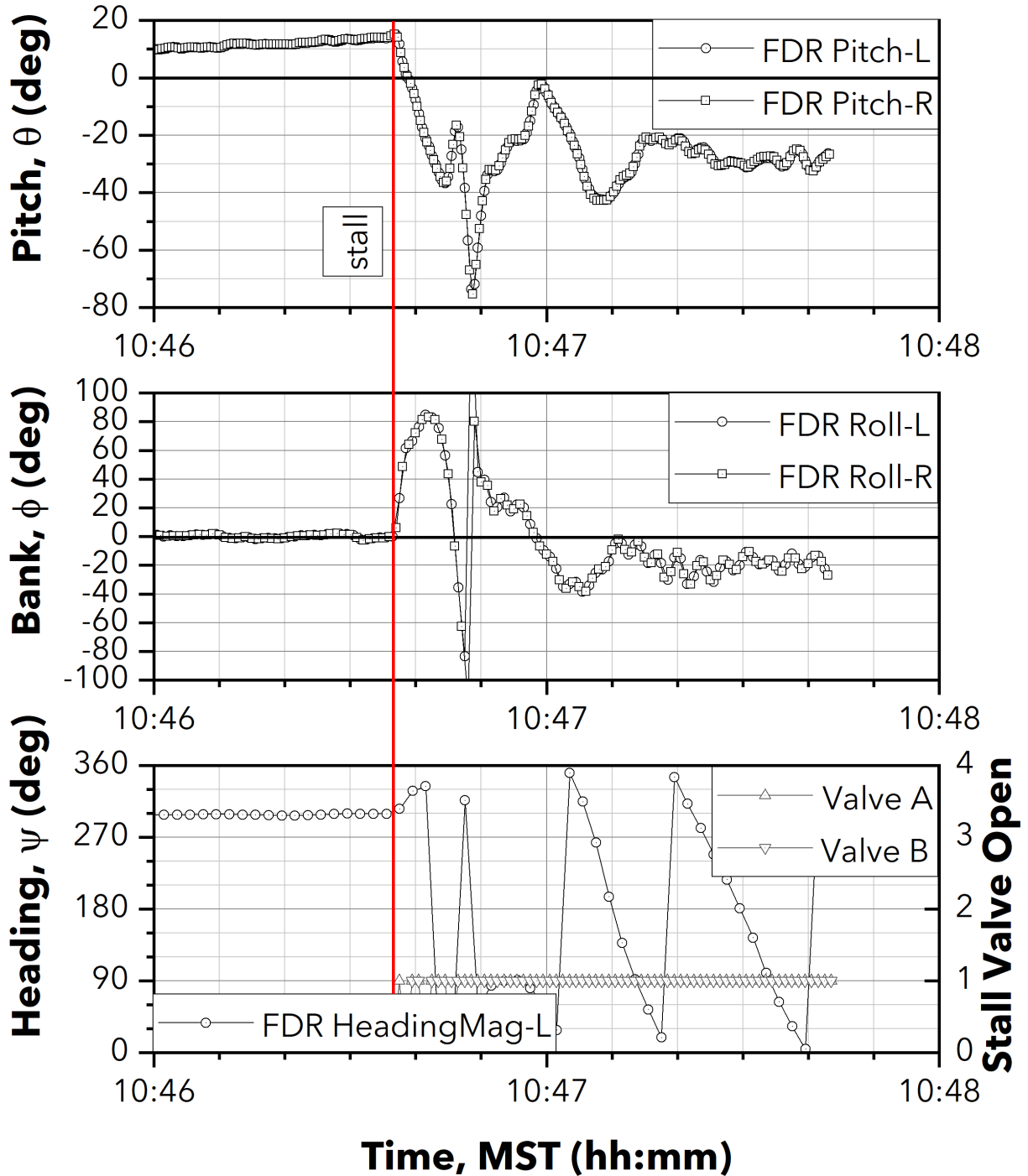


Figure 7: FDR Pitch, Bank, and Heading Angles for Final Minutes of Flight

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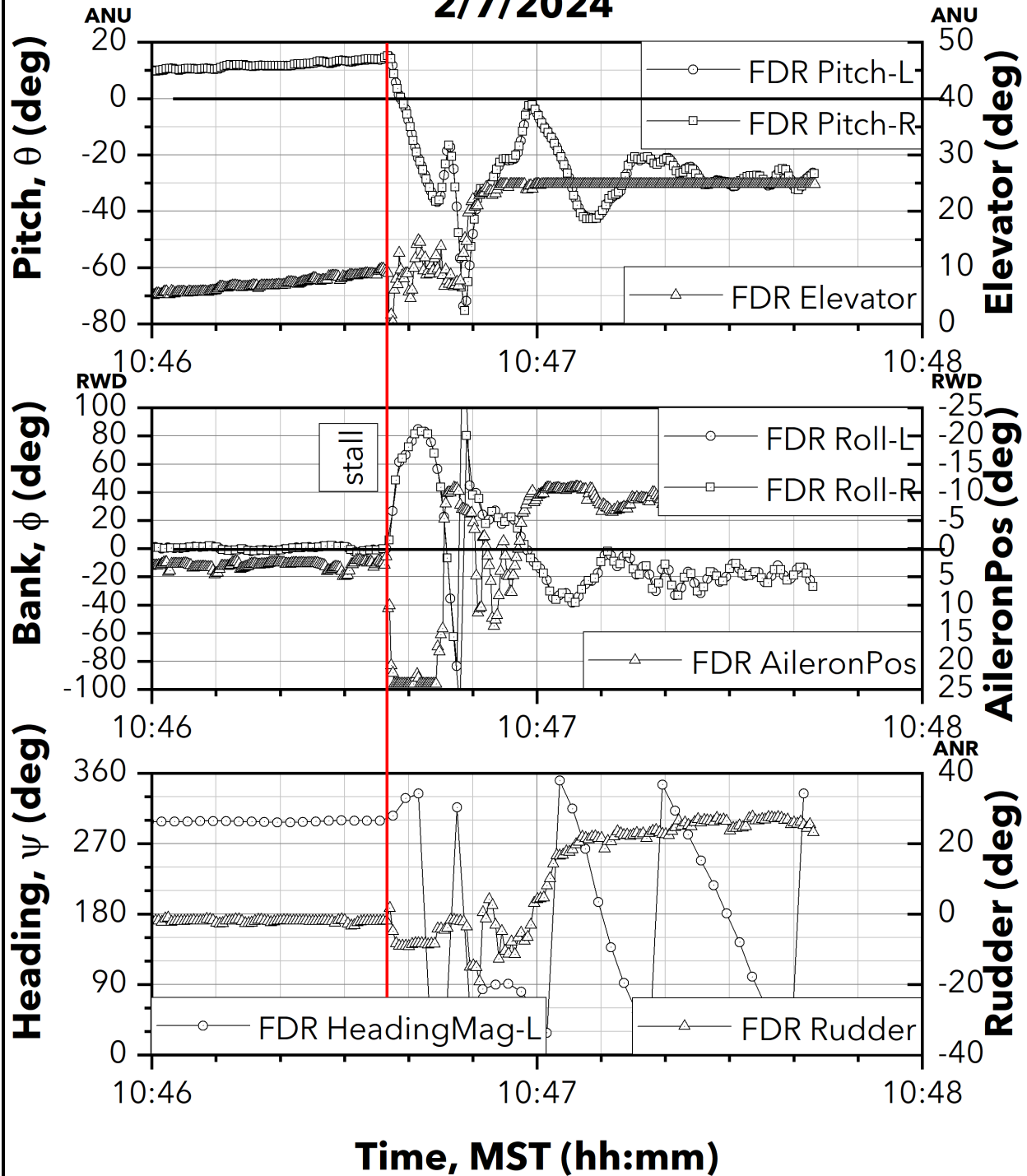


Figure 8: FDR Euler Angles and Control Surfaces for Final Minutes of Flight

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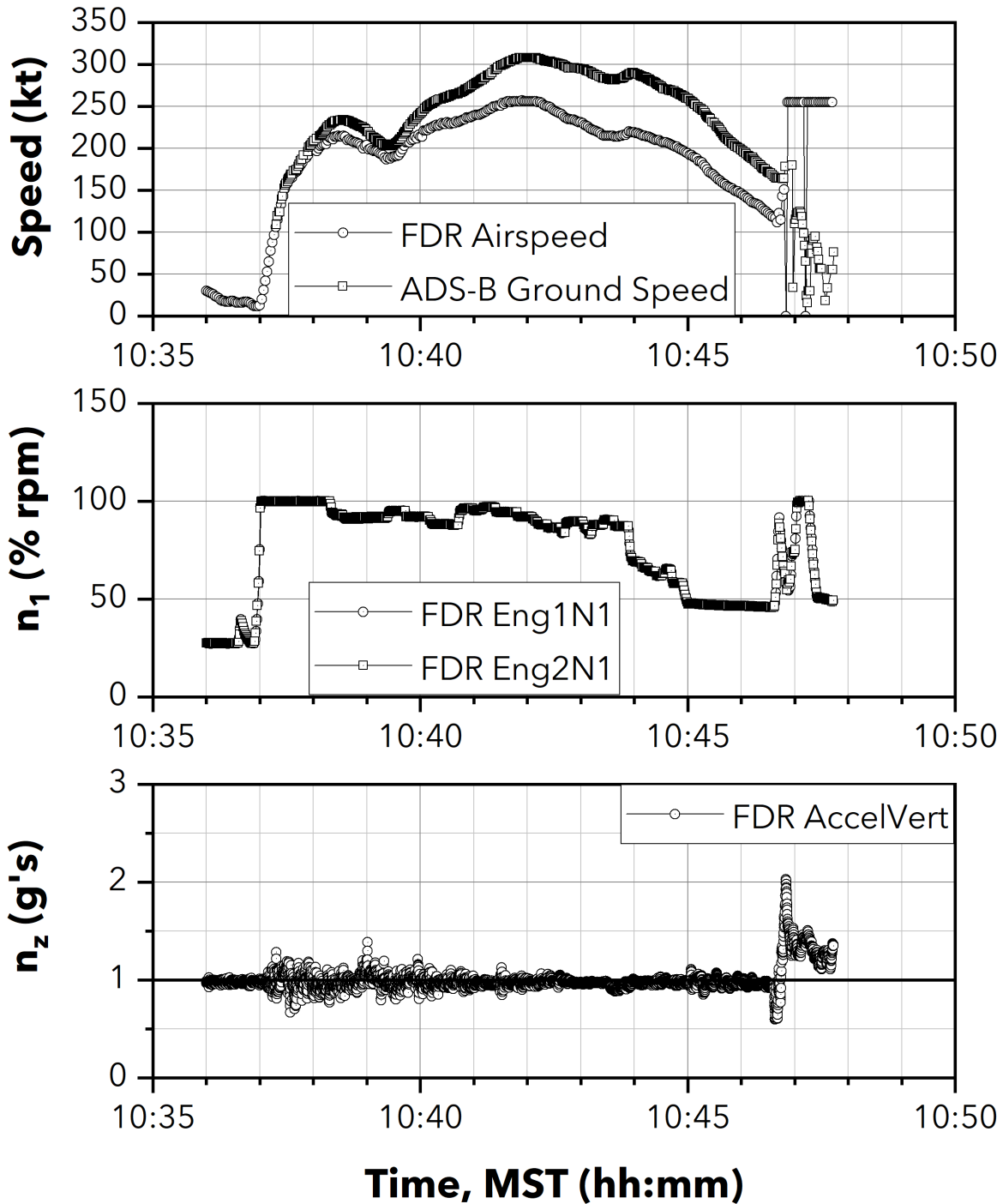


Figure 9: FDR Engine Fan Speed and Vertical Load Factor for Entire Flight

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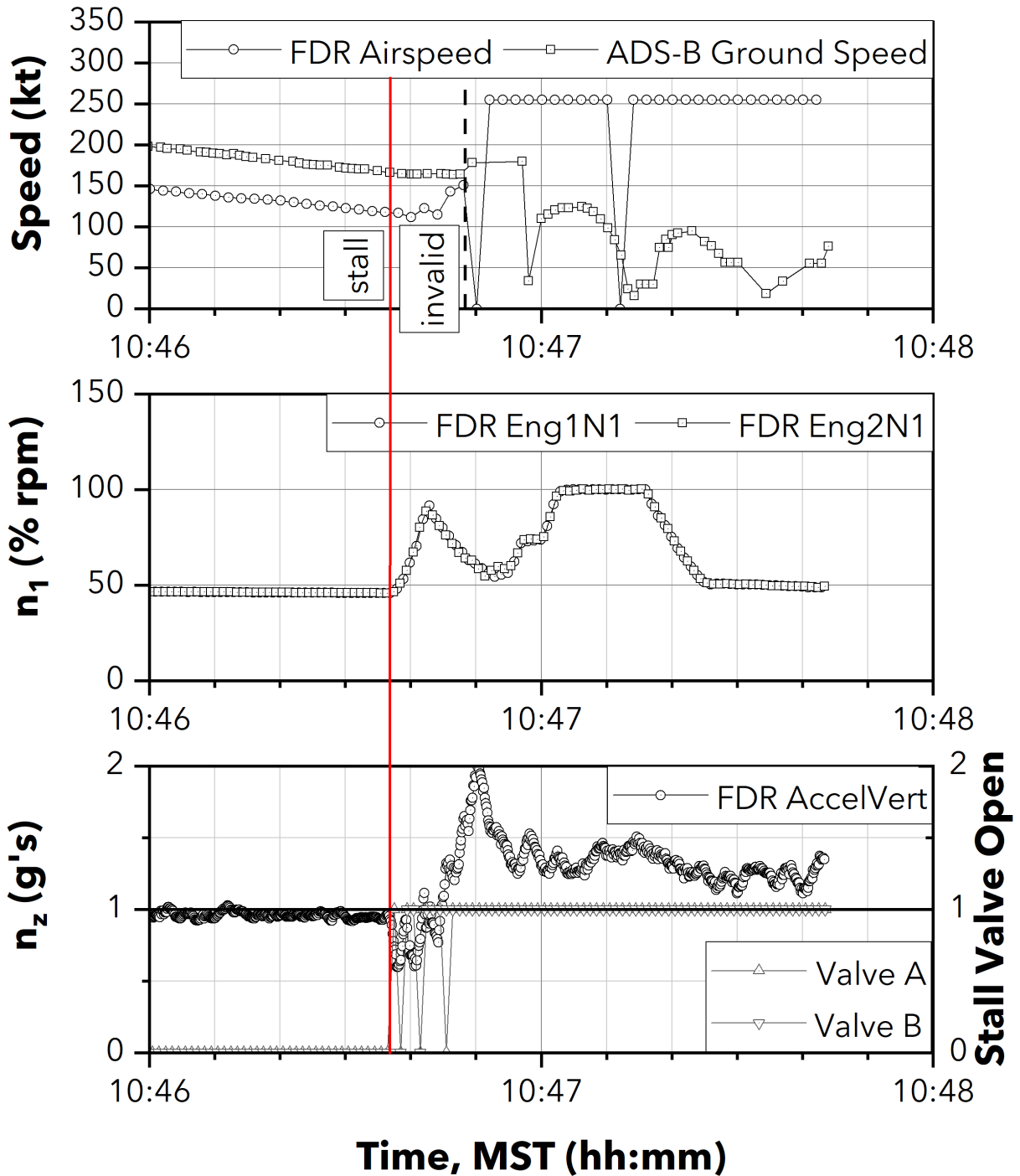


Figure 10: FDR Fan Speed and Vertical Load Factor for Final Minutes of Flight

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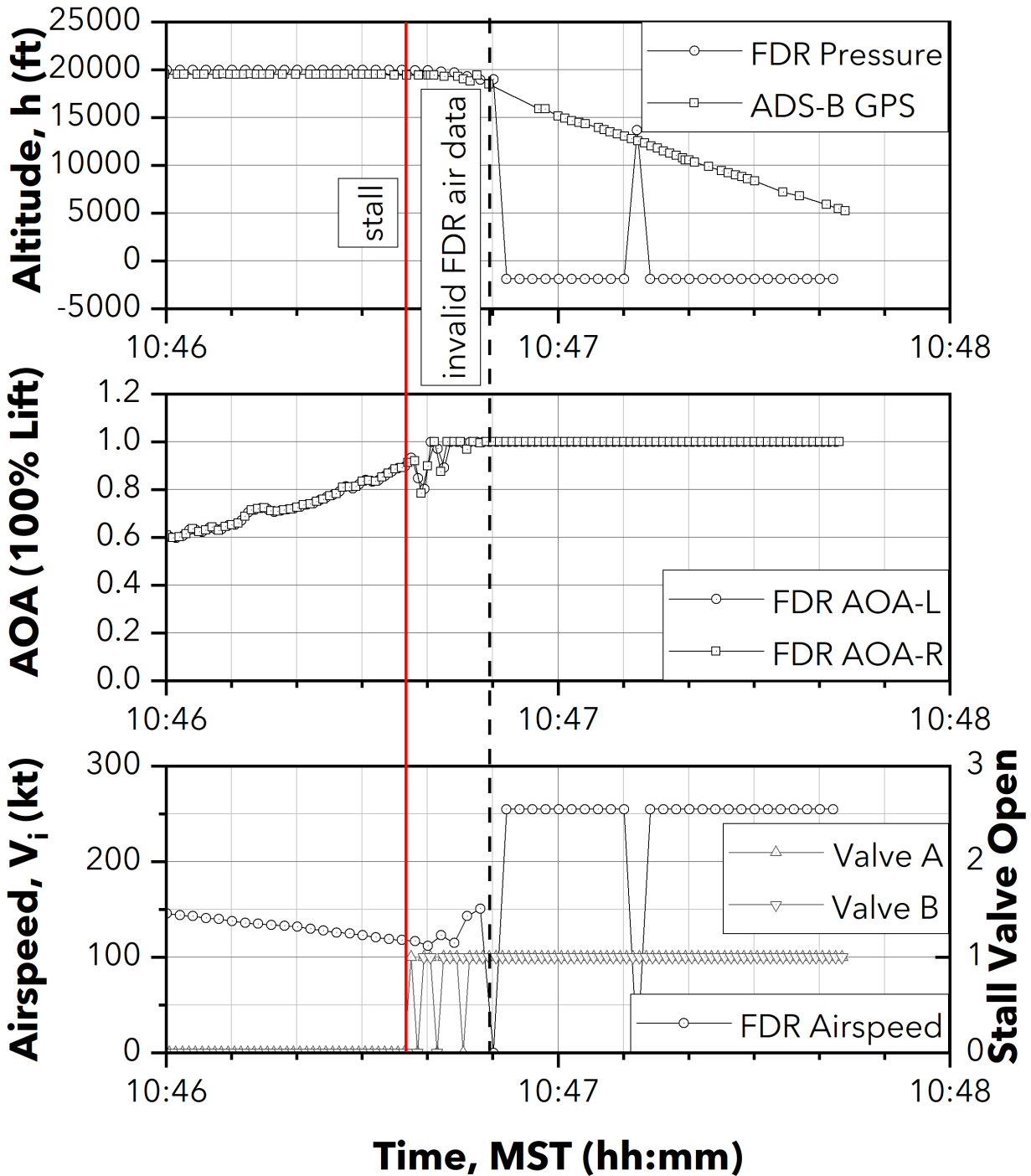


Figure 11: FDR Angle-of-Attack for Final Minutes of Flight

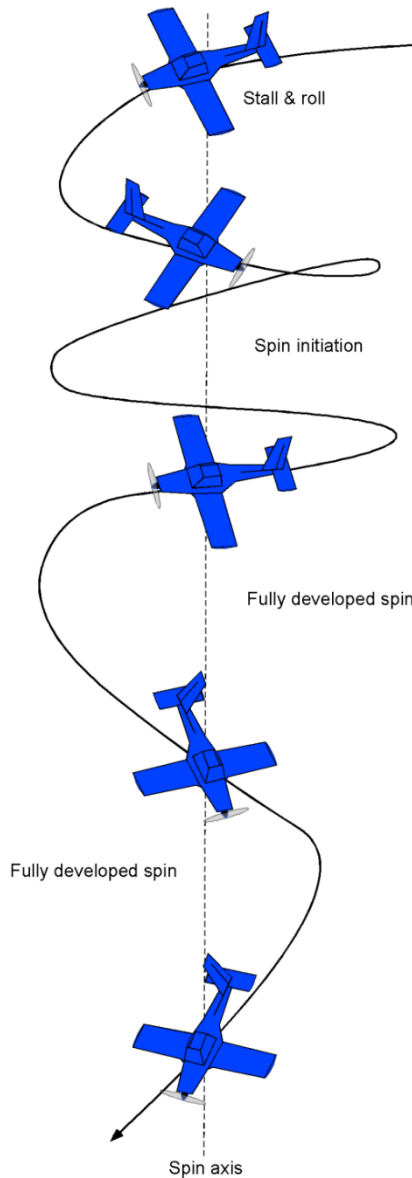


Figure 12: A Spin can result During an Uncoordinated Stall and Cause the Airplane to Develop into a Steep, Spiraling Downward Path that Resembles a Corkscrew

Weight ~ lbs	Flaps 0°			Flaps 15°			Flaps 25°/LG Down			Flaps 45°/LG Down		
	Trim	Shake	Push	Trim	Shake	Push	Trim	Shake	Push	Trim	Shake	Push
22,000	157	118.5	110.5	146	110	102.5	144	107.5	101	138	105	97.5

Figure 13: Stick Shaker and Stick Pusher Indicated Airspeeds from the Production Flight Test Procedure Quality Assurance Instructions (PFTP QAI)