

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



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AIRCRAFT PERFORMANCE

Specialist's Study

February 2, 2026

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A ACCIDENT

Location: Mandan, North Dakota
Date: September 1, 2024
Time: 15:20 central daylight time (CDT)
20:20 UTC
Airplane: Diamond DA42 NG, N705JP

B AIRCRAFT PERFORMANCE SPECIALIST

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C SUMMARY

On September 1, 2024, about 1520 central daylight time, a Diamond DA42 airplane, N705JP, sustained substantial damage when it was involved in an accident near Mandan, North Dakota. The pilot and passenger were not injured. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 91 personal flight.

The pilot reported that his approach to Mandan Regional Airport – Lawler Field (Y19) was uneventful and estimated that he touched down about 100 ft past the numbers for runway 31. The pilot stated that the brakes were not working until he approached the end of the runway at which point the brakes “slowly got responsive.”

According to the pilot-rated passenger, the landing at Y19 was so smooth that he did not notice the airplane had touched down until the nose wheel shimmied. The passenger stated that the airplane appeared to touchdown within the first third of the 4399 ft runway. He stated that the landing roll seemed normal, but he did not feel as much deceleration as he would have expected.

According to the airport manager, who examined the runway surface after the accident, there were visible tire skid marks leading off the end of the runway.

D DETAILS OF THE INVESTIGATION

1.0 AIRPLANE

The Diamond DA 42 NG is a low-wing, T-tail airplane that seats four. It is powered by two Austro Engine AE 300 turbocharged diesel engines.

The pilot reported that the weight at landing was 4007 lb; the maximum gross weight for the airplane is 4407 lb.

2.0 AIRPORT

Mandan Regional Airport - Lawler Field (Y19) is at an elevation of 1944 ft and has a magnetic variation of 6° east. The airport has two runways; runway 04/22 is a turf runway that is 2921 ft long and 140 ft wide, and runway 13/31 is a concrete runway that is 4399 ft long by 75 ft wide. The airplane was landing on runway 31, which is aligned at 325° true. Runway 31 has a 2-light precision approach path indicator (PAPI) located about 435 ft from the threshold, with a 3° glide path angle.

3.0 WEATHER

Weather was reported at 15:15 CDT at Y19 as winds from 170° at 7 kt, clear skies, visibility of 10 statute miles, temperature 24 °C (75 °F), dew point 9 °C (48 °F), and the barometric setting was 30.28 inHg.

Additional atmospheric parameters including temperature and pressure as functions of altitude above mean sea level (MSL) were taken from a High-Resolution Rapid Refresh (HRRR) model sounding from the National Oceanic and Atmospheric Administration¹. The data were downloaded for coordinates 46.76° North, 100.89° West, at 15:00 CDT.

4.0 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, pressure altitude 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 other data in the broadcast includes avionics-derived north and east velocities and the rate of climb based on the pressure altitude. The ADS-B data extended from 15:09:10 CDT to 15:20:18 CDT. The GNSS-based altitude above the reference ellipsoid was corrected to the MSL altitude above the geoid by adding 69.2 ft.

The DA 42 NG is equipped with a Garmin G1000 Integrated Avionics System, but the G1000 system in N705JP did not have any recording functions enabled.

¹ [READY Archived Meteorology](#)

Each AE 300 engine has an electronic control unit (ECU) that records data once per second. For this investigation, the data of interest were the time (s), propeller RPM, power lever position (%), weight on wheels or WOW (OnGround or InFlight), torque (%), and pressure altitude (ft). Time is measured from the application of electrical power in each flight and is measured independently by each ECU. Diamond's technical specifications indicate that a single lever controls both engines², so the power lever position was used to synchronize the time between datalogs A and B, which required 1 s to be subtracted from the time in datalog B. Time CDT was established by synchronizing the pressure altitude data from the ECU's and the ADS-B data. See Figures 5 and 6.

5.0 FLIGHT PATH

The flight departed from runway 13 at Bismarck Airport (BIS), Bismarck, North Dakota about 15:09. BIS is about 6.5 mi east of Y19. The first ADS-B data point was recorded at 15:09:10, and the flight lasted about 11 min. An overhead view of the flight path on a Google Earth background is shown in Figure 1 with annotations of time CDT, altitude MSL (ft) and groundspeed (kt). An oblique view of the flight path is shown in Figure 2. An overhead view of the airplane track along the runway is shown in Figure 3.

Figure 4 shows the pressure altitude, geometric altitude and a corrected smoothed altitude for the entire flight. The smoothed altitude was calculated by integrating the recorded rate of climb and correcting for the local atmospheric conditions. Figure 5 compares the ADS-B pressure altitude with the pressure altitudes recorded in datalogs A and B from the AE 300 engine ECU's. Each ECU has a different offset from the ADS-B pressure altitude. The two ECU data sets were synchronized using the power lever position, with 1 s being subtracted from the time in datalog B, and the pressure altitude data from datalog B was then shifted upward to match the data from datalog A. Time CDT for the datalogs was calculated by fitting a bilinear model to the last 1800 ft of the descent and the level-off for the ADS-B data and the ECU data, and identifying the time where the linear descent intersects the horizontal level data for each dataset; that time was used to synchronize the clocks at time 15:19:50.35, as shown in Figure 6. The resulting time origin for datalog A was 14:50:57.29, and the time origin for datalog B was 14:50:56.29.

Figure 7 shows the recorded groundspeed along with the calculated true airspeed and calibrated airspeed for the entire flight. The true airspeed and calibrated airspeed were calculated using the winds aloft and atmospheric conditions from the HRRR model sounding, with the winds at lower altitudes adjusted to match

² [DA42 - Technical Specifications - Diamond Aircraft Industries](#)

the reported wind conditions at Y19. With winds from 170° at 7 kt, the airplane was experiencing a tailwind of 6.3 kt and a left crosswind of 2.6 kt.

Figure 8 shows the groundspeed, true airspeed and calibrated airspeed at the end of the flight. The speeds were fairly constant in the 2 min before the airplane crossed the threshold at 15:19:46.91. The airplane crossed the threshold at 123 kt groundspeed and at 112 kt calibrated airspeed (KCAS). ECU datalog A showed a transition from air to ground between 15:19:57.29 and 15:19:58.29, and ECU datalog B showed a transition from air to ground between 15:19:56.29 and 15:19:57.29. The airplane touched down at a groundspeed of 102 kt and at 92 KCAS. The airplane decelerated, but did not stop, and it departed the runway at 15:20:17.92 at a groundspeed of 33 kt. The ADS-B data ended at 15:20:18.00, just after the airplane departed the runway.

Figure 9 shows the groundspeed, true airspeed and calibrated airspeed at the end of flight relative to the distance along the runway. ECU datalog A showed a transition from air to ground between 1967 ft and 2136 ft from the threshold, and ECU datalog B showed a transition from air to ground between 1800 ft and 1967 ft from the threshold. Assuming the airplane was fully on the ground at 2136 ft from the threshold, there was 2263 ft of runway remaining for the airplane to stop.

Figure 10 shows the power lever position, torque and propeller RPM from both ECU datalogs for the end of flight as a function of time, and Figure 11 shows the same data relative to distance along the runway. Torque reduced to zero as the airplane crossed the threshold, and the power lever was reduced to zero 3 to 4 s before the airplane touched down. The departure from the runway coincided with rapid changes in the power lever position.

Figure 12 shows the pressure altitude, geometric altitude, calculated density altitude and the corrected smoothed altitude (calculated from the recorded rate of climb) for the end of flight as a function of time, and Figure 13 shows the same data relative to the distance along the runway. Figure 13 also shows the glide slope for the PAPI. The corrected smoothed altitude lies within 25 ft of the runway elevation of 1944 ft. Both the pressure altitude and the geometric altitude level off near the runway threshold of runway 31, which would suggest that the airplane touched down close to the threshold; the corrected smoothed altitude suggests a touchdown more consistent with the weight on wheels positions recorded on the engine ECU's.

The Airplane Flight Manual (AFM) [1] provides tabulated landing distance data for the maximum gross weight of 4407 lb, and for 4189, 3979 and 3748 lb. The tables provide ground roll distances for two flap settings (LDG and APP/UP) over a range of pressure altitudes and temperatures, and also for International Standard Atmosphere conditions. The pilot reported that the landing was performed with flaps APP or 20°. The flaps APP/UP tables were interpolated for a landing weight of 4007

lb to calculate a ground roll distance for the accident air density, which resulted in a ground roll of 1748 ft. This ground roll is calculated for a landing with no wind flown at the approach speed prescribed in the AFM.

For a landing weight of 4007 lb and flaps APP/UP, the AFM indicates the approach speed V_{REF} is 86 kt indicated airspeed (KIAS). The AFM also provides a table to convert between KIAS and KCAS for different flap settings. The tables indicate that the touchdown speed of 92 KCAS would equate to 92 KIAS for flaps APP/UP, meaning the touchdown occurred about 6 kt faster than V_{REF} (92 KIAS as opposed to 86 KIAS).

The AFM does not report the speed at touchdown in the landing distance tables. It will be assumed that the speed at touchdown is the same as V_{REF} .

The AFM states that the ground roll should be increased by 10 % for every 3 kt of tailwind. The airplane experienced a 6.3 kt tailwind component during the landing, which would have increased the ground roll by a factor of 1.21.

A simplified model of the ground roll [2] indicates that the if distance to stop from speed V_1 is D_1 , then the distance to stop from speed V_2 is $D_2 = (V_2/V_1)^2 D_1$. So if we take $V_1 = 86$ KIAS and $V_2 = 92$ KIAS, the ground roll would increase by a factor of 1.14.

A ground roll estimate for the accident landing would include a multiplier for the higher speed at touchdown and a multiplier for the tailwind, so the estimate of the ground roll would be $1.14 \times 1.21 \times 1748 \text{ ft} = 2411 \text{ ft}$. Since there was 2263 ft of runway remaining when the airplane touched down, the calculation shows the airplane did not have enough distance remaining to stop on the runway.

If the ground roll distances in the AFM are based on there being some deceleration during the flare so that the speed at touchdown is less than V_{REF} , then there would be a larger speed multiplier, which would increase the estimated required ground roll calculated above.

Ground roll distances for flaps LDG are about 73 % of the ground roll distances for flaps APP/UP. Assuming that ratio holds for the ground roll estimate above of 2411 ft with flaps APP, the ground roll estimate for flaps LDG would be 1760 ft. A ground roll of 1760 ft would have allowed the airplane to stop on the runway. For flaps LDG at 4007 lb, the approach speed V_{REF} is 84 KIAS, but the touchdown speed of 92 KCAS converts to 95 KIAS for flaps LDG. The touchdown speed would therefore have been 11 kt greater than V_{REF} , so the multiplier for the higher speed would have been 1.28 instead of 1.14, resulting in an estimated ground roll of 1965 ft, which again would have allowed the airplane to stop on the runway.

The simplified model of the ground roll [2] uses an assumption of constant acceleration. The AFM data can be used to calculate what that acceleration needs to be to match the initial speed and the total ground roll. If the initial groundspeed is V , and the distance to stop D , then the constant acceleration required is $a = -V^2/(2D)$. Table 1 shows the constant acceleration calculated for the accident conditions assuming no tailwind and assuming a 6.3 kt tailwind.

Table 1. Constant acceleration calculated from AFM ground roll and V_{REF} .					
Flaps	V_{REF}	Tailwind	Groundspeed	Ground roll	Acceleration
APP/UP	86 KIAS	0 kt	89.7 kt	1748 ft	-0.20 g
APP/UP	86 KIAS	6.3 kt	96.0 kt	2115 ft	-0.19 g

Figure 14 shows the acceleration in the accident calculated from the derivative of the groundspeed as a function of time, and Figure 15 shows the same data as a function of distance along the runway. Just after touchdown, the acceleration was about -0.10 g. The acceleration dropped below -0.20 g about 15:20:08, or about 9 s after the airplane touched down, and after it had traversed 1390 ft of the 2263 ft of runway remaining. The acceleration dropped below -0.24 g about 15:20:15, or about 17 s after the airplane touched down, and after it had traversed 2111 ft of the 2263 ft of runway remaining. The acceleration peaked at -0.32 g about 15:20:16, or about 18 s after touchdown and after 2136 ft of the 2263 ft of runway remaining. The average acceleration during the accident ground roll was -0.17 g.

The acceleration during the ground roll results from forces of drag, thrust and braking friction. The braking friction is proportional to the weight of the airplane minus the lift. Higher speeds increase the lift and the drag, but braking friction is more effective at slowing the airplane than drag, so the retarding force on the airplane tends to increase as it slows, and the acceleration becomes more negative.

The peak acceleration of -0.32 g is consistent with good braking performance, and the skid marks reported at the end of the runway indicate that the brakes could be locked up, but the airplane generally did not achieve the acceleration expected from the ground roll distance in the AFM.

E DISCUSSION

The airplane approached and crossed the threshold of runway 31 at a groundspeed of 123 kt and an airspeed of 112 KCAS, with a 6.3 kt tailwind component. The AFM indicates that V_{REF} is 86 KIAS (86 KCAS) for a landing weight of 4007 lb and flaps APP/UP. The engine ECU datalogs show the airplane was fully on the ground at 2136 ft past the threshold, with 2263 ft of runway remaining. The airplane touched down at a groundspeed of 102 kt and at 92 KCAS, or 6 kt faster than V_{REF} . The airplane slowed, but departed the runway at 33 kt groundspeed.

Data from the AFM coupled with estimates from a model assuming constant acceleration indicate there was not enough runway remaining for the airplane to stop on the runway, given the touchdown nearly halfway down the runway at a speed 6 kt above V_{REF} plus the tailwind. The acceleration was consistent with good braking just before the airplane departed the runway, and the airplane left skid marks, which would indicate that the brakes were functional.

An estimate of the ground roll assuming flaps LDG indicates the airplane should have been able to stop on the runway using that flap setting.

Submitted by:

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REFERENCES

1. Airplane Flight Manual, DA 42 NG, Diamond Aircraft Industries GMBH, Austria, 2012.
2. Aerodynamics for Naval Aviators, H.H. Hurt, Jr., NAVAIR 00-80T-80, 1965. Available from the Federal Aviation Administration at [00-80T-80.pdf](#)

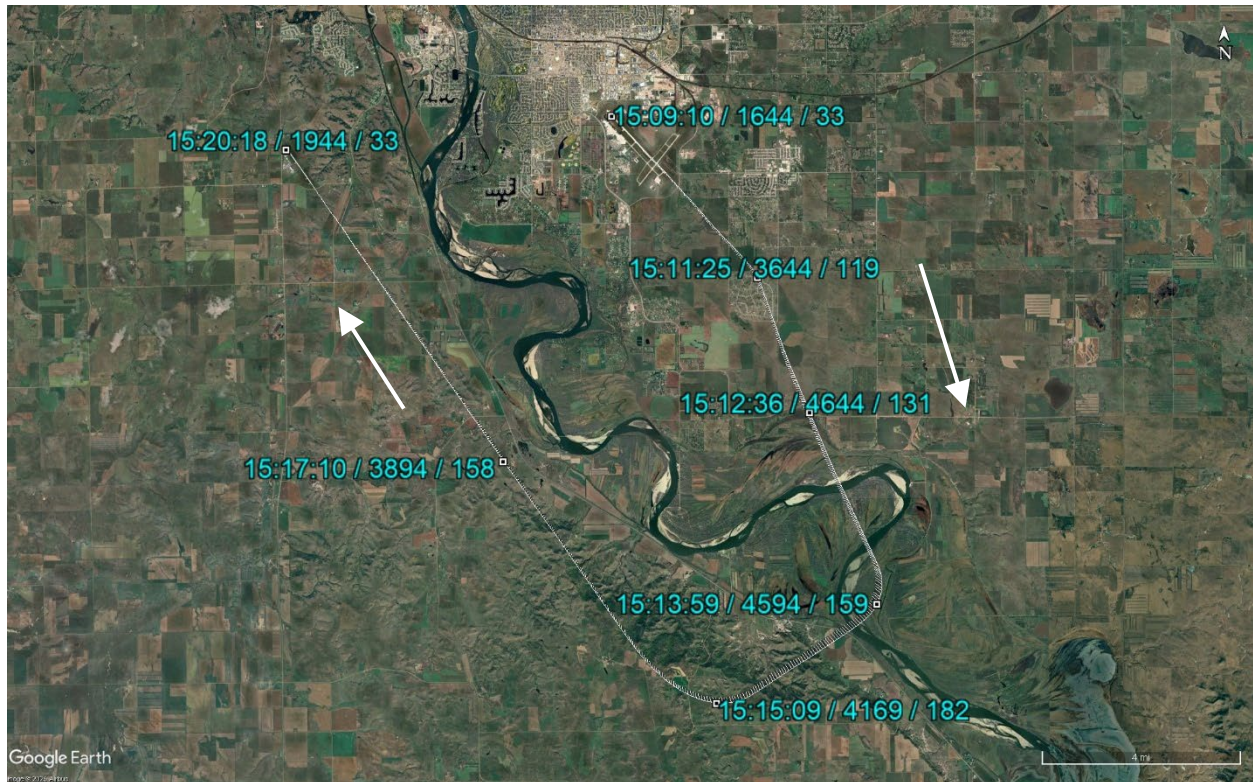


Figure 1. Overhead view of the entire flight. Annotations indicate the time CDT, altitude MSL (ft) and groundspeed (kt).

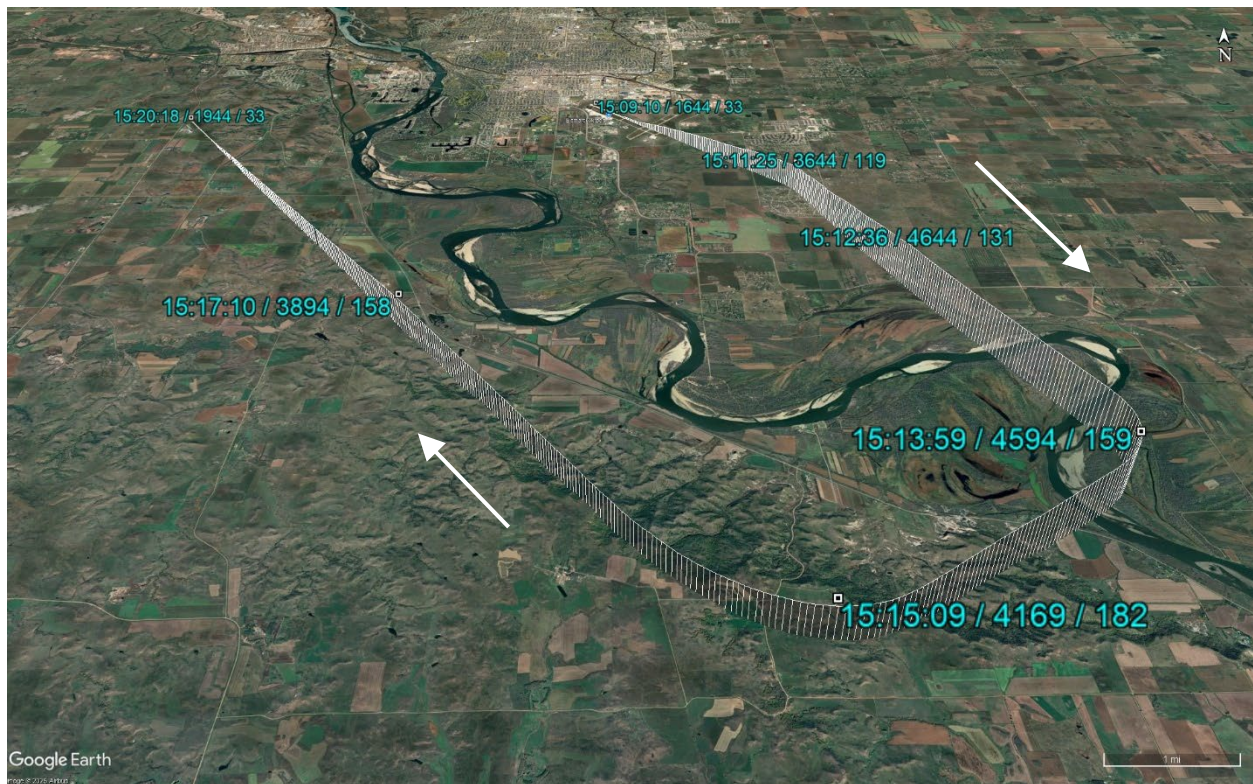


Figure 2. Oblique view of the entire flight. Annotations indicate the time CDT, altitude MSL (ft) and groundspeed (kt).

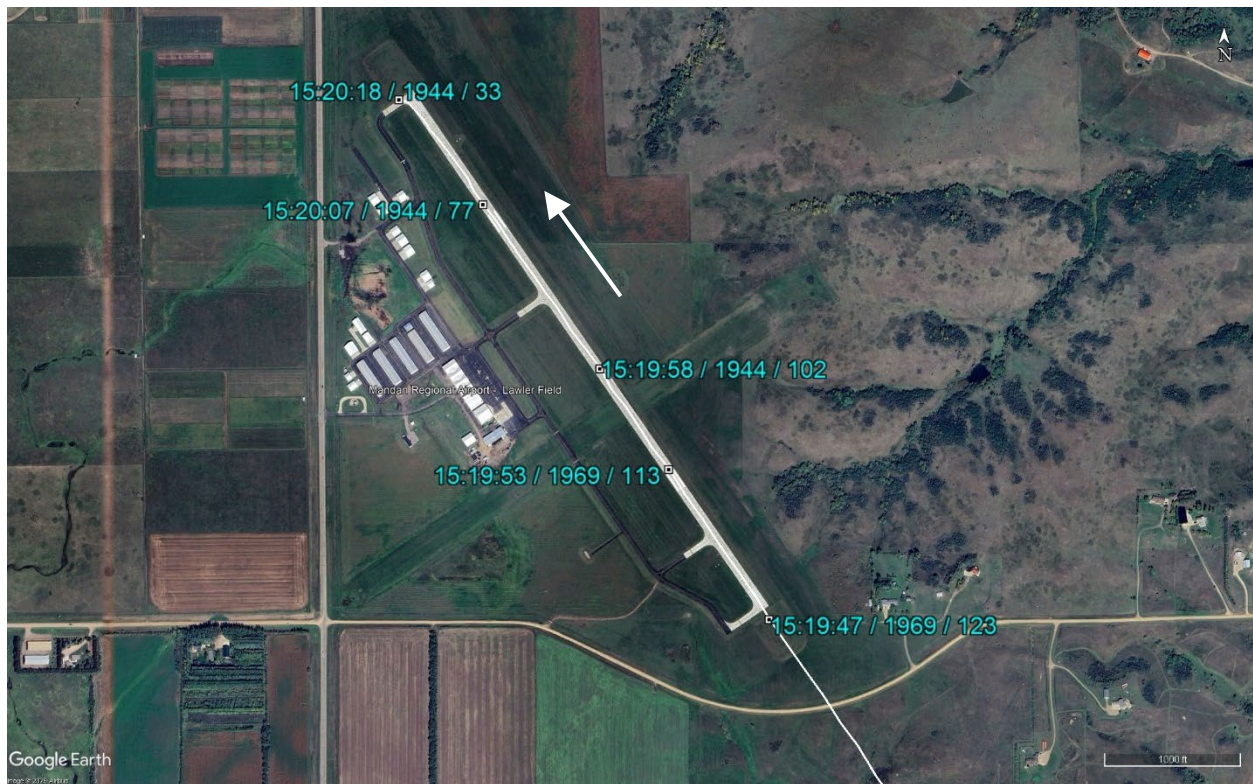


Figure 3. Overhead view of the of the path along the runway. Annotations indicate the time CDT, altitude MSL (ft) and groundspeed (kt).

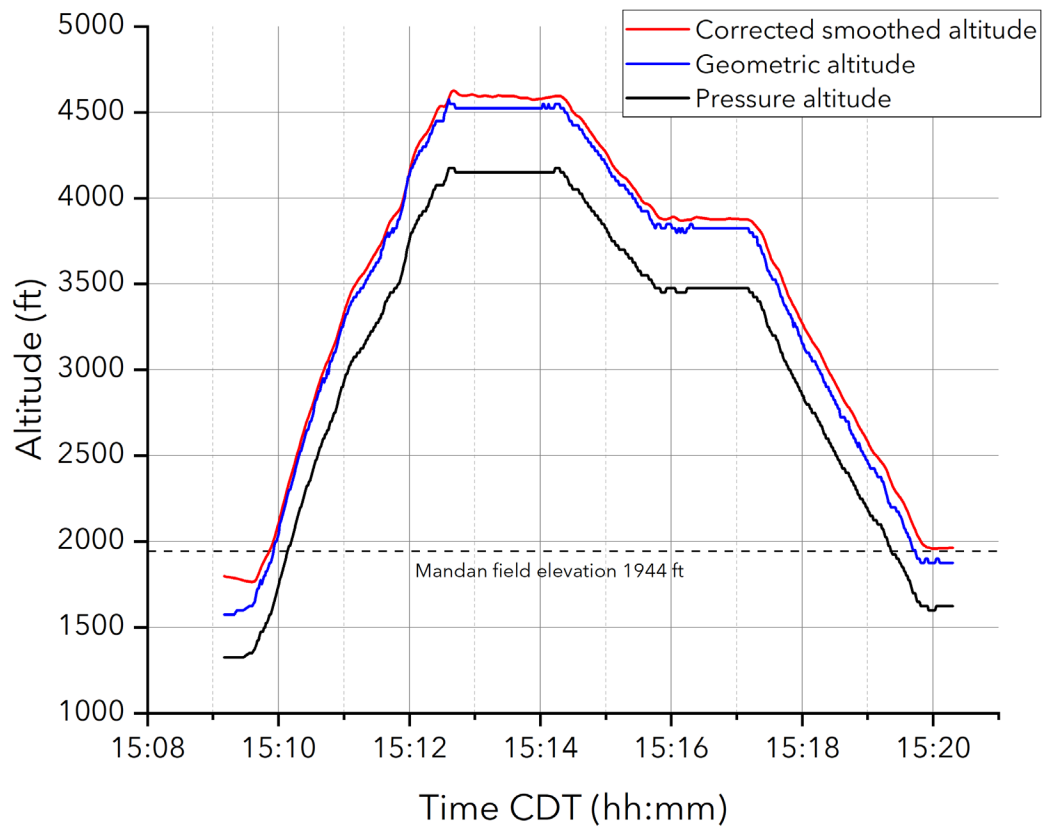


Figure 4. Pressure altitude, geometric altitude and corrected, smoothed pressure altitude calculated by integrating the rate of climb, all from the ADS-B data. Also shown is the Mandan Y19 runway elevation of 1944 ft.

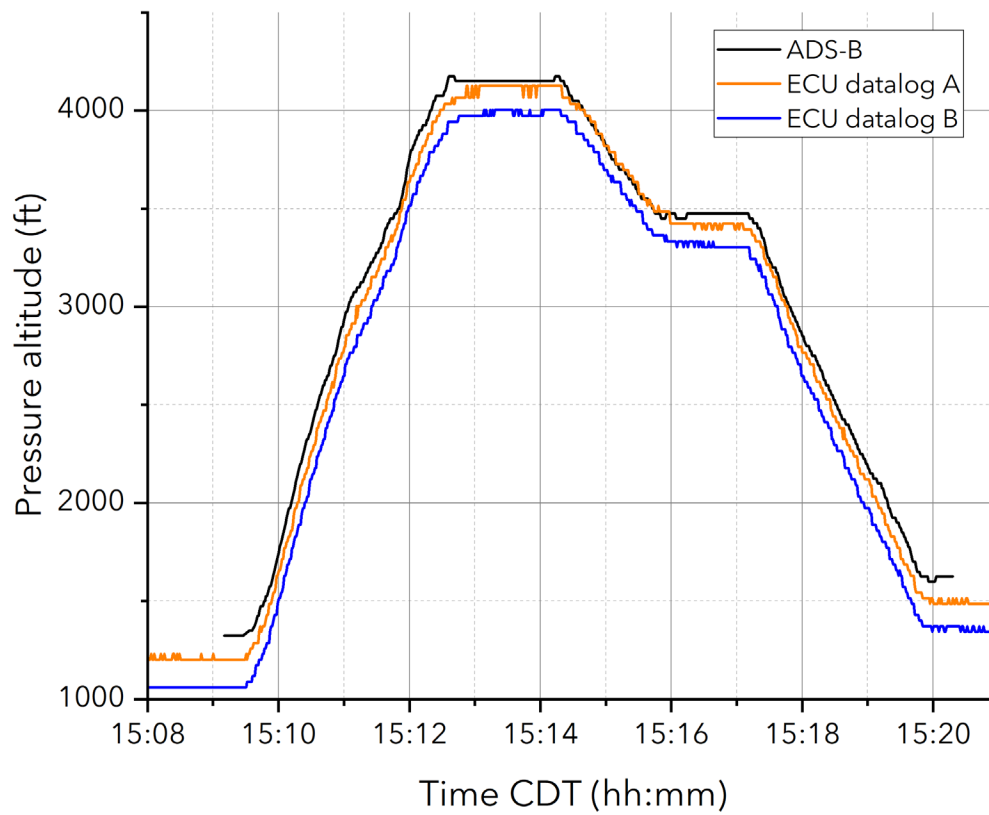


Figure 5. Pressure altitude from ADS-B and from the engine ECU datalogs A and B, shifted to align in time.

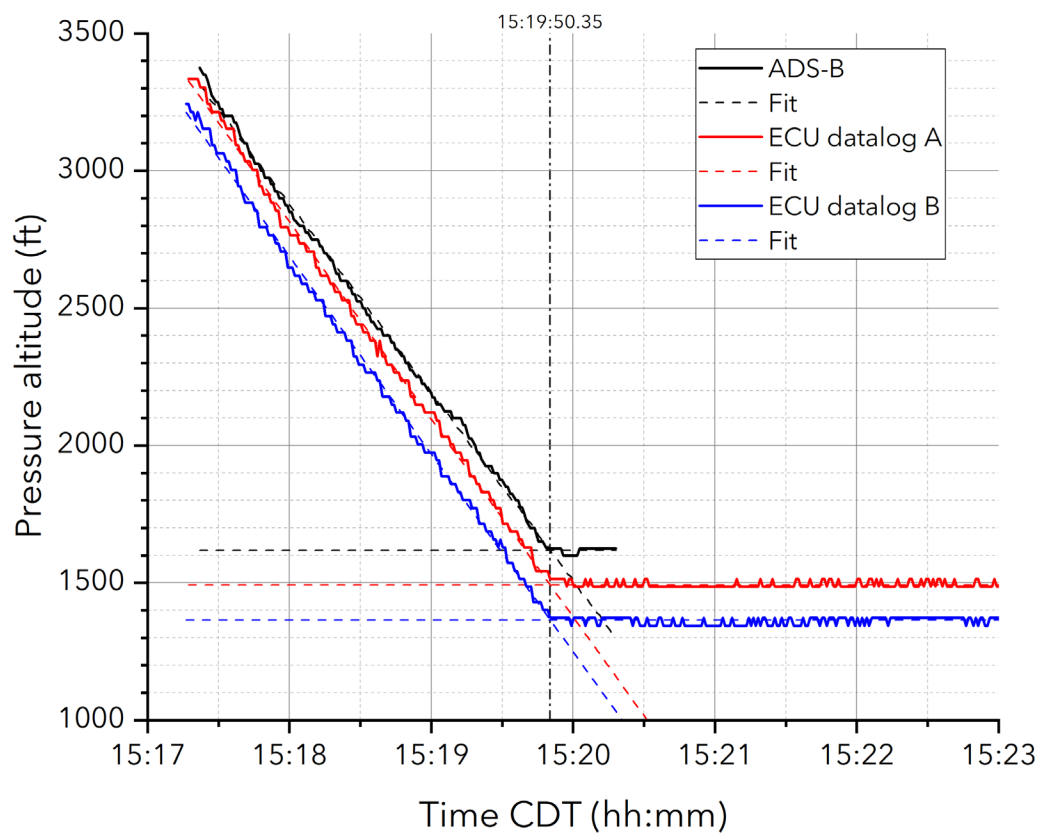


Figure 6. Time alignment of the pressure altitude data using the intersection of lines fit to the last 1800 feet of the descent and level-off.

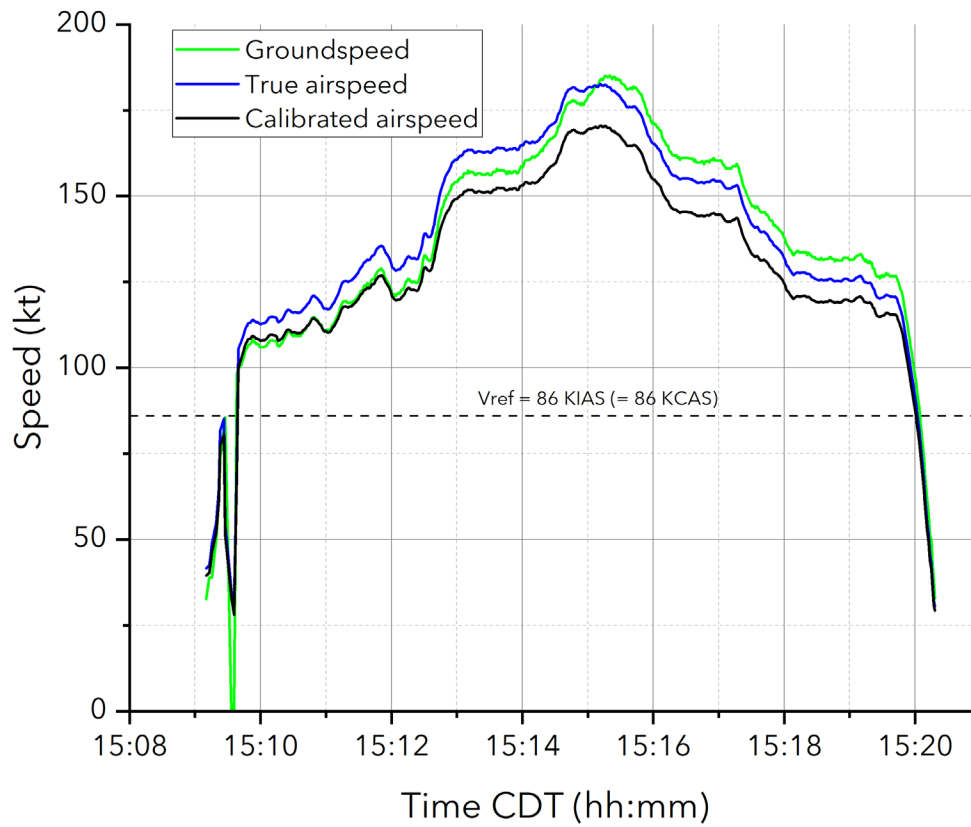


Figure 7. Groundspeed, true airspeed and calibrated airspeed for the entire flight.

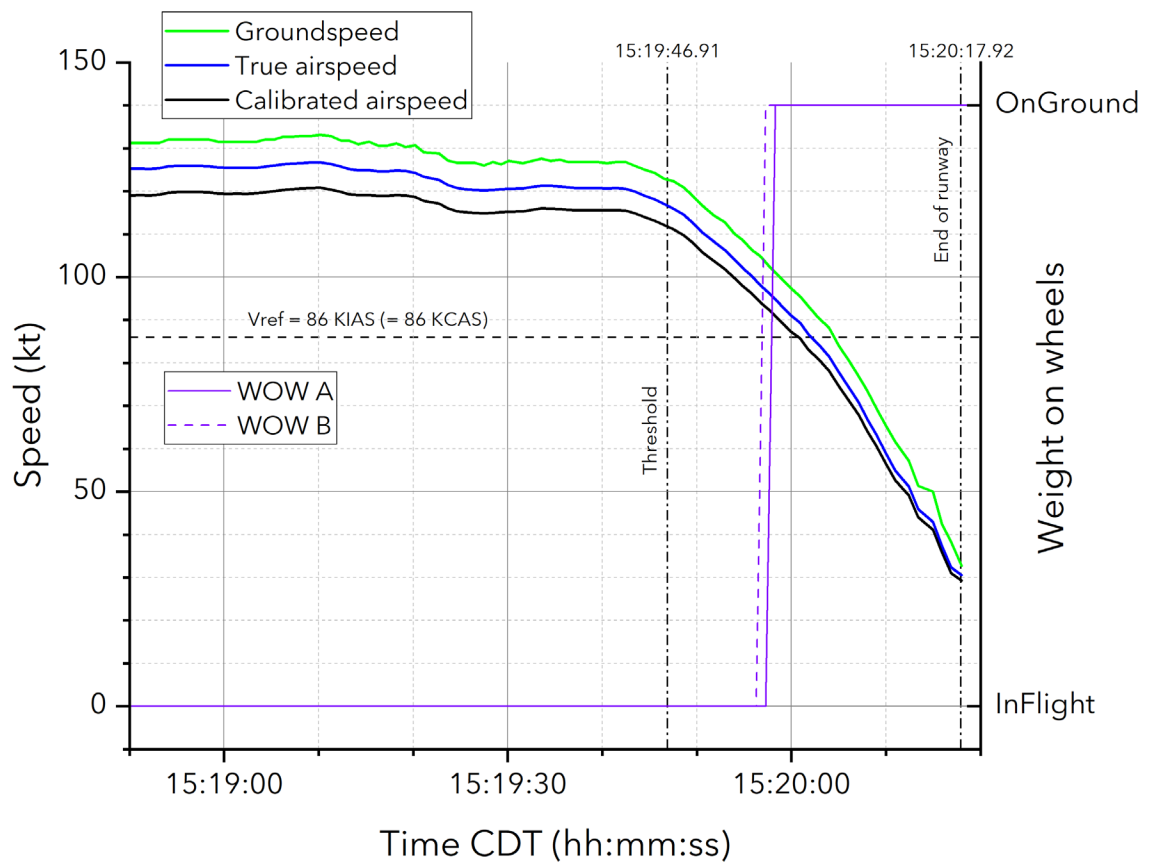


Figure 8. Groundspeed, true airspeed and calibrated airspeed for the end of the flight as a function of time, along with the weight on wheels (WOW) from engine ECU datalogs A and B.

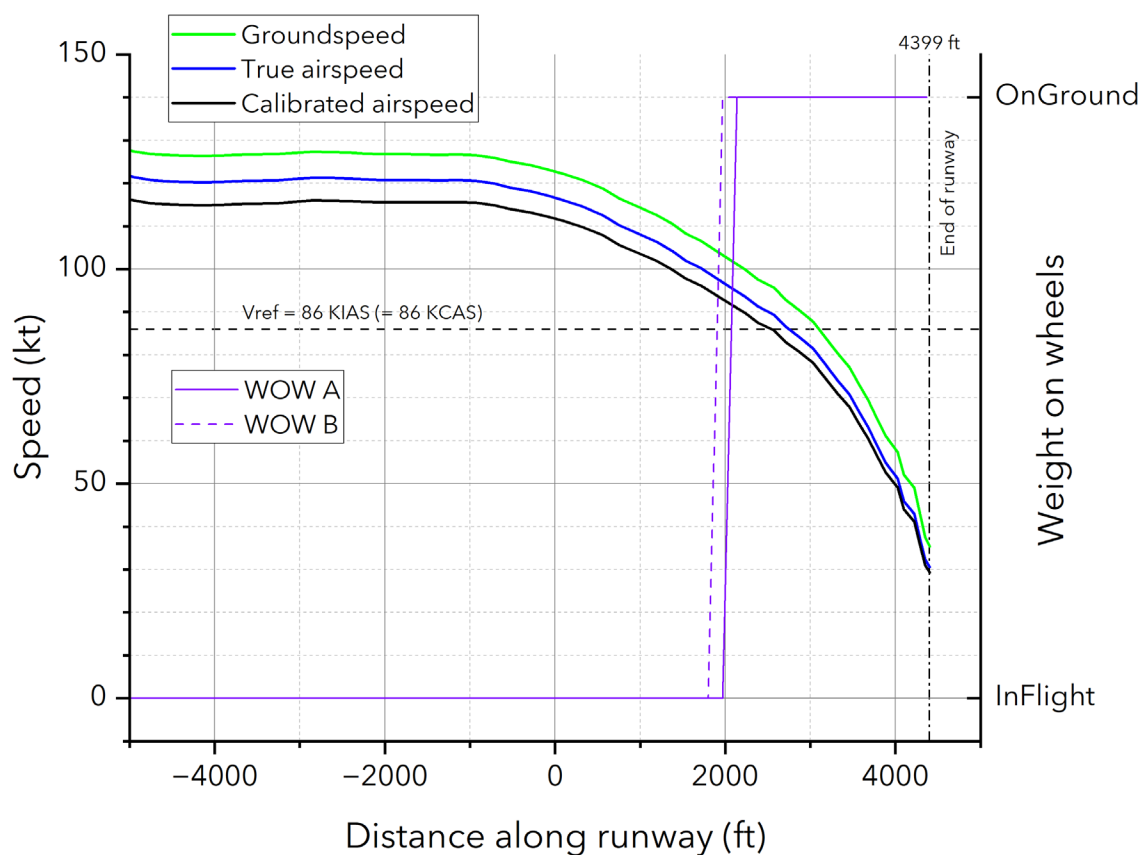


Figure 9. Groundspeed, true airspeed and calibrated airspeed for the end of the flight as a function of distance along the runway, along with the weight on wheels (WOW) from engine ECU datalogs A and B.

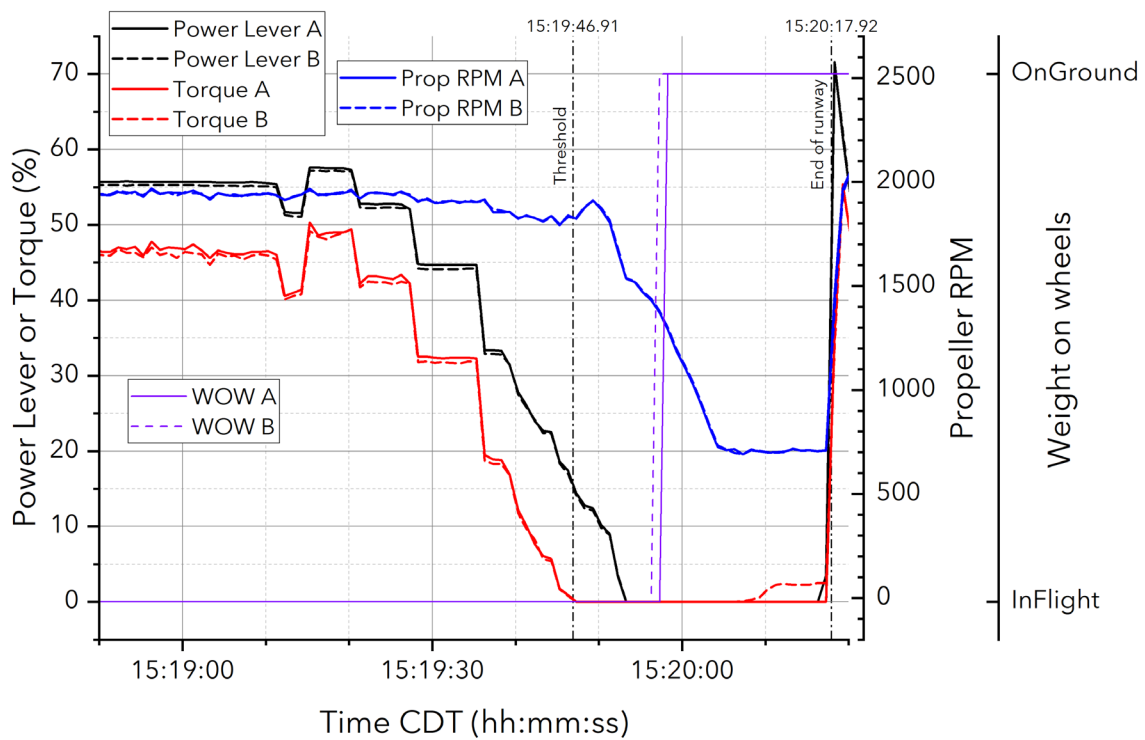


Figure 10. Power lever position, torque, propeller RPM and weight on wheels (WOW) from engine ECU datalogs A and B for the end of flight as a function of time.

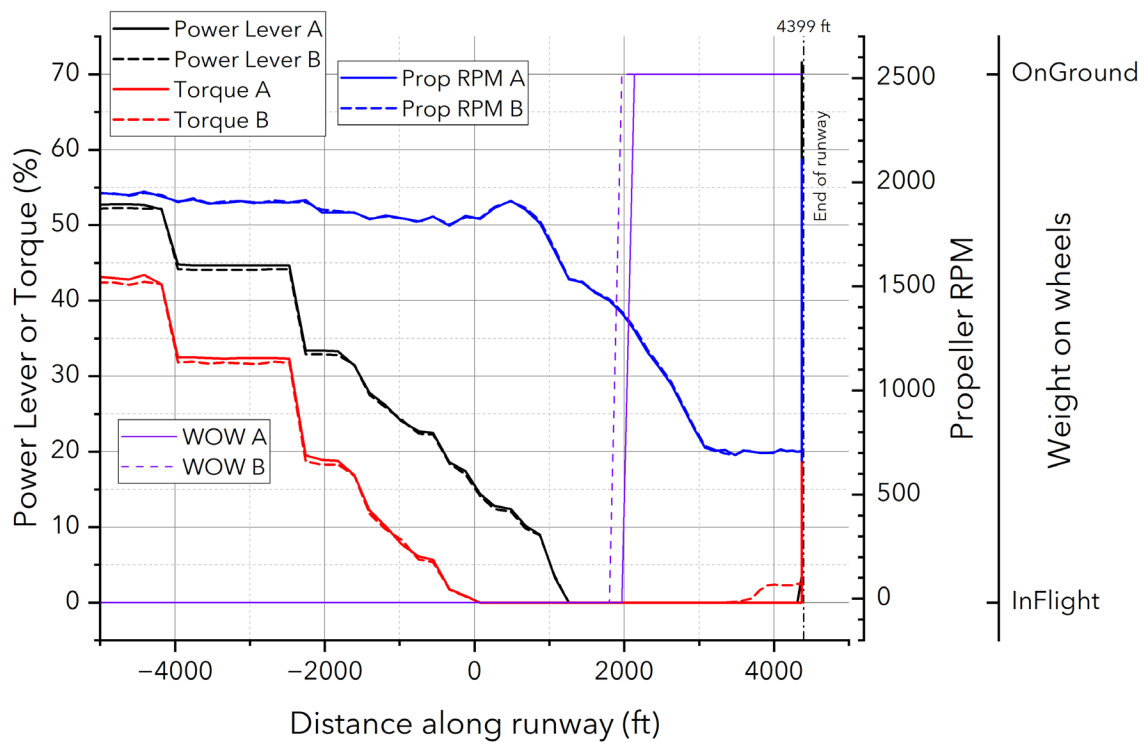


Figure 11. Power lever position, torque, propeller RPM and weight on wheels (WOW) from engine ECU datalogs A and B for the end of flight as a function of distance along the runway.

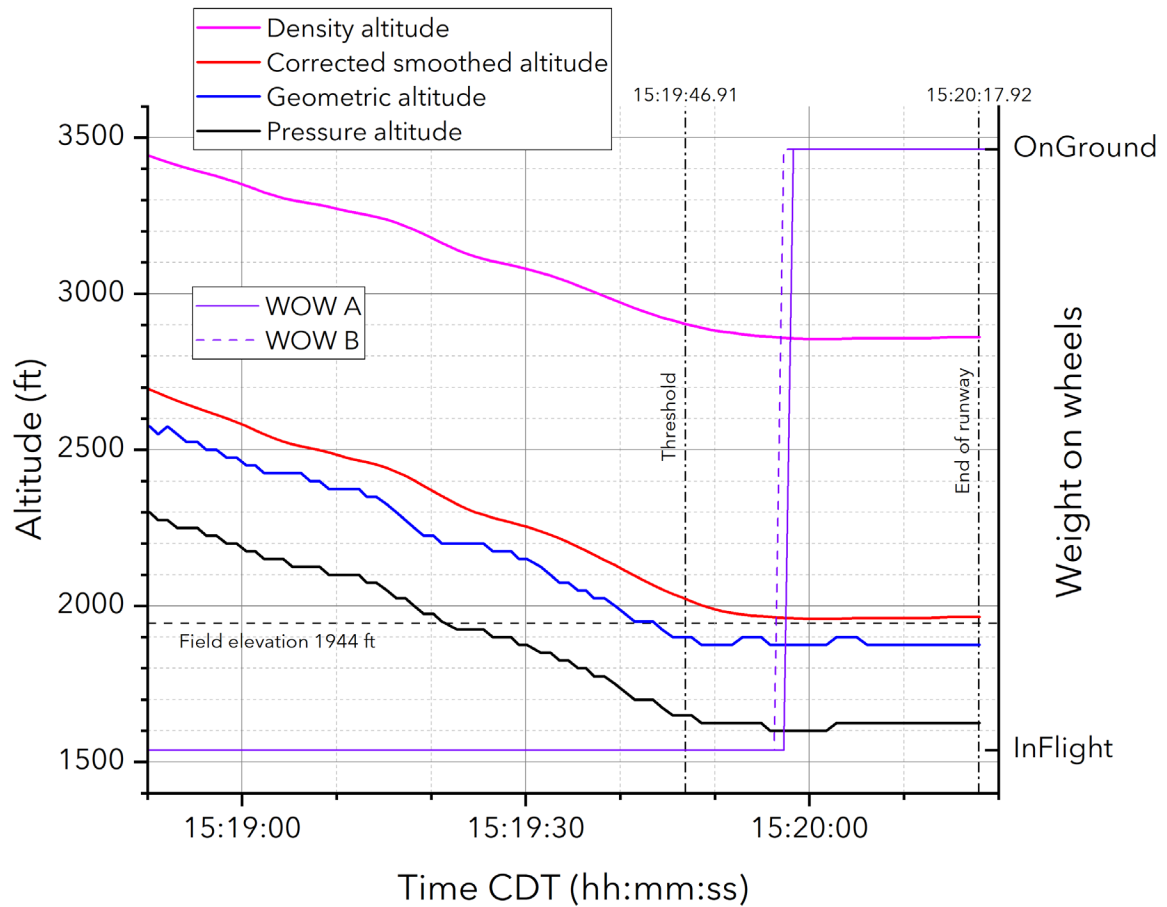


Figure 12. Density altitude, corrected smoothed pressure altitude, geometric altitude and pressure altitude for the end of flight as functions of time, along with weight on wheels from engine ECU datalogs A and B.

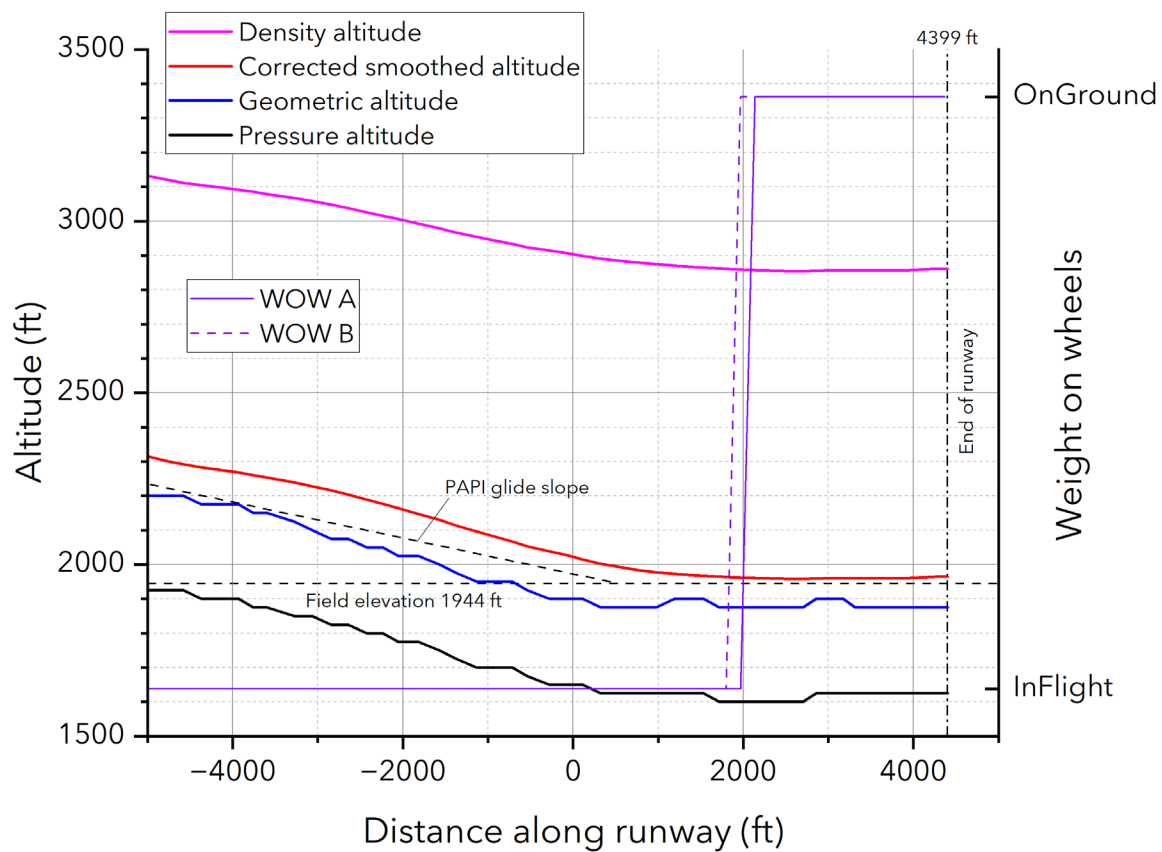


Figure 13. Density altitude, corrected smoothed pressure altitude, geometric altitude and pressure altitude for the end of flight as functions of distance along the runway, along with weight on wheels from engine ECU datalogs A and B.

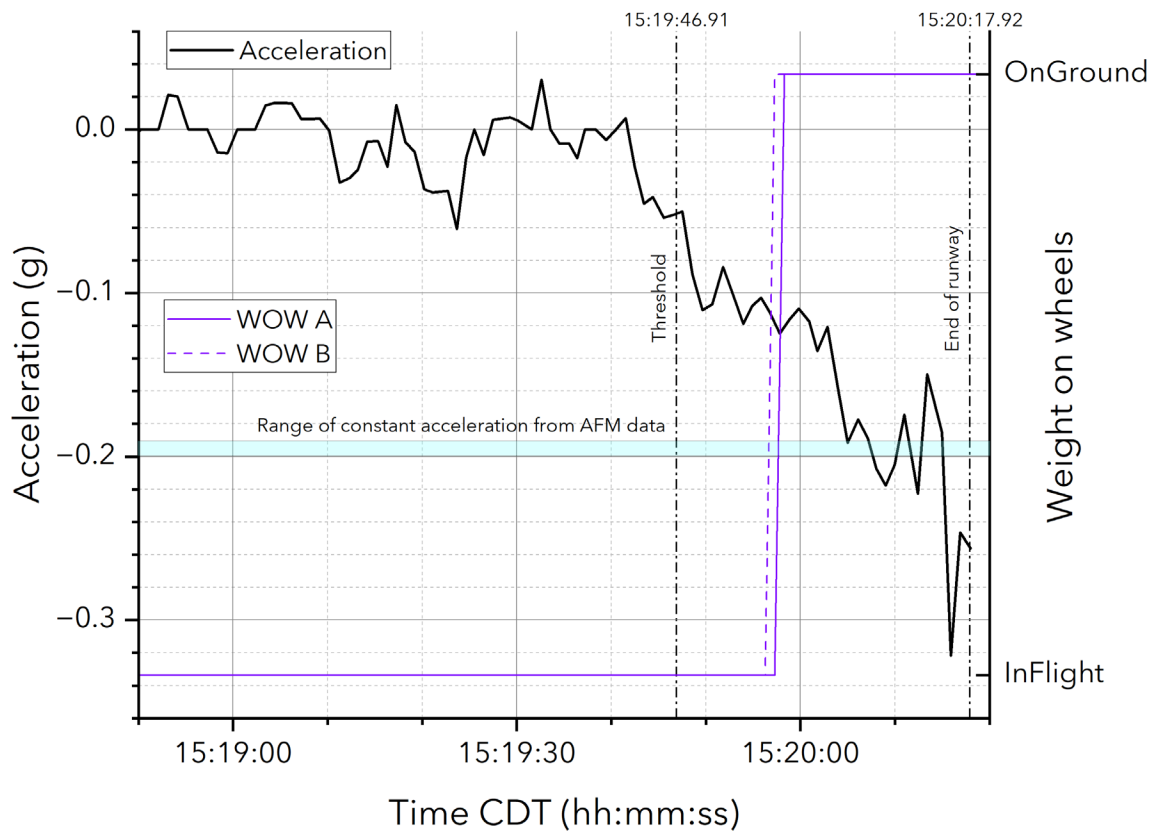


Figure 14. Acceleration at the end of flight as a function of time, along with weight on wheels from engine ECU datalogs A and B. The range of constant acceleration calculated from the AFM data in Table 1 is indicated in the blue box.

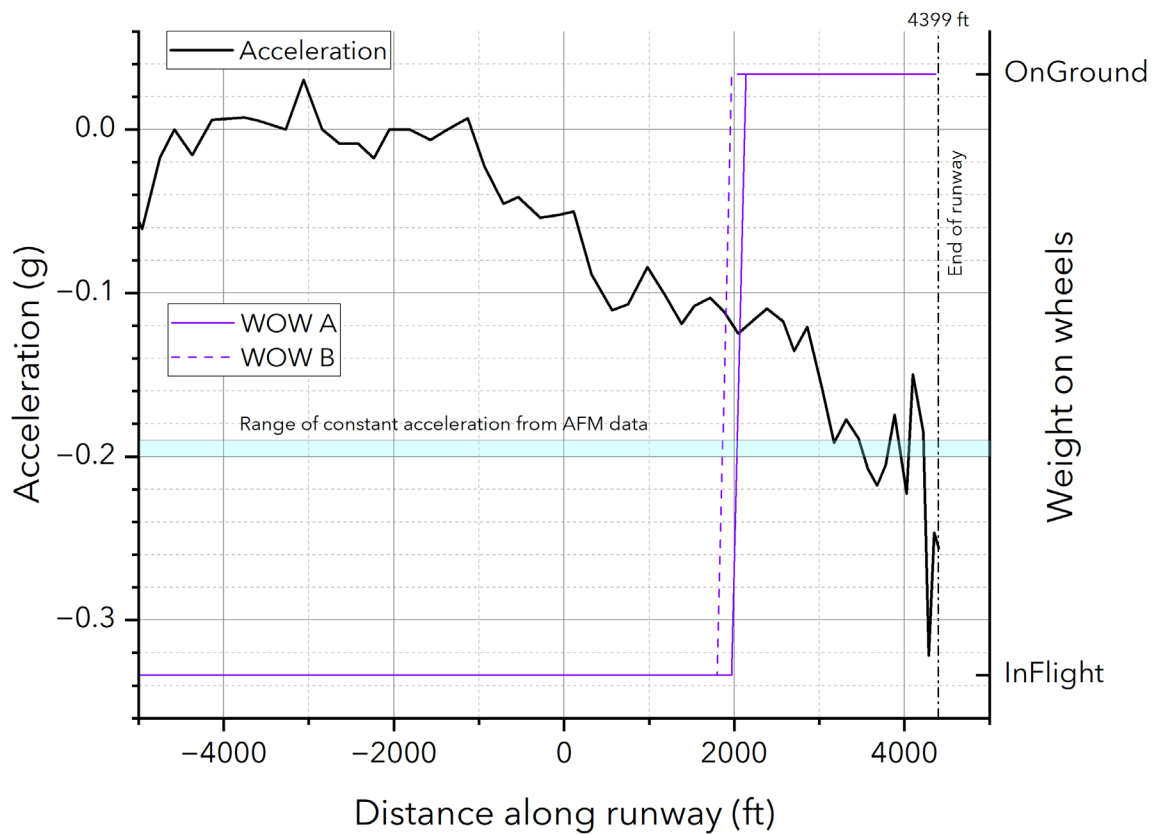


Figure 15. Acceleration at the end of flight as a function of distance along the runway, along with weight on wheels from engine ECU datalogs A and B. The range of constant acceleration calculated from the AFM data in Table 1 is indicated in the blue box.