ACCIDENT

Aircraft Type and Registration:	Piper PA-46-350P, G-LAMI
No & Type of Engines:	1 Lycoming TIO-540-AE2A piston engine
Year of Manufacture:	2022 (Serial no: 4636798)
Date & Time (UTC):	9 July 2022 at 1000 hrs
Location:	Wycombe Airpark, Buckinghamshire
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - 4
Injuries:	Crew - None Passengers - None
Nature of Damage:	Left wing, both landing gear and fuselage damaged
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	65 years
Commander's Flying Experience:	31,500 hours (of which 131 were on type) Last 90 days - 91 hours Last 28 days - 26 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

A syndicate of potential purchasers boarded G-LAMI for a sales demonstration flight. During the takeoff the commander realised there was insufficient runway remaining and rejected the takeoff. The aircraft skidded sideways and overran the end of the runway, stopping in the grass after the landing gear collapsed.

Several factors were identified which contributed to the unsuccessful takeoff including aircraft weight, pre-flight briefing and engine handling. The CAA is intending to publish an article in its *'Clued Up'* magazine about takeoff decision making and rejected takeoff (RTO) considerations in general aviation.

History of the flight

The accident flight was being conducted as a prospective buyer demonstration flight with the commander, the sales representative, one potential buyer as pilot flying (PF) and three passengers onboard. The intention was to depart from Wycombe Air Park heading towards Cardiff under IFR before returning to Wycombe.

The prospective buyers were already waiting in the airfield cafe when the commander arrived to prepare for the flight. Short introductions were made and there were issues with headset availability, which needed resolving. The commander felt he was under time pressure

to depart as the passengers had other commitments later in the day. The commander used the Garmin G1000 Integrated Flight Deck (IFD) system to obtain the fuel quantity on board, which he recorded as being 15 US gallons, and requested a further 50 US gallons to be uplifted which he calculated would leave 20 US gallons remaining after the flight. The commander had previous experience of operating small charter operations and was comfortable in estimating the weight of the passengers. He performed his pre-flights checks, takeoff calculations and filed the flight plan as the aircraft was towed to the fuel pumps and 199.93 litres (52.8 US gallons) was uplifted. By his calculations they would be at the MTOW and would require 1,700 ft of ground roll using flaps 10° for the takeoff. He did not calculate the 50 ft obstacle clearance performance.

The passengers arrived at the aircraft with the sales representative and one of the passengers was identified to occupy the right cockpit seat. He advised the commander of his experience and said he would like to do "as much flying as possible". He asked the commander why he would take the right seat and was informed that the commander preferred to fly in the left seat for demonstration flights. Before taxiing, a short pre-flight safety briefing was given regarding the emergency exits. Control of the aircraft was passed to the PF for the taxi whilst the commander did the pre-flight checks from memory. Power checks were completed before entering Runway 24 from point A1 and then backtracking to line up for Runway 06. The commander demonstrated a 180° turn and by his estimation they were approximately 10-15 m (30-50 ft) from the end of the runway. Rotation (70-75 kt) and lift off (78 kt) speeds were briefed and the commander selected flaps 10°.

The PF fully advanced the throttle and shortly afterwards the commander heard a Master Warning and saw there was a red warning message on the Crew Alerting System (CAS) indicating that the Manifold Absolute Pressure (MAP) had exceeded 42 inches Hg reaching approximately 44 inches Hg. The commander placed his hand on the PF's hand and reduced the throttle so that the MAP stabilised at approximately 36-37 inches Hg and continued with the takeoff roll.

About halfway along the runway the commander became concerned that insufficient airspeed had been achieved to continue with the takeoff. The PF recalled being told to rotate at about 55 kt and then he heard the stall warner as the aircraft pitched up. One of the passengers stated they felt the aircraft "bounce" and a witness remembers seeing a "wing wobble" associated with a momentary lift off. The commander then shouted "Stop! I have control" and immediately closed the throttle and applied as much braking as he felt possible.

The aircraft deaccelerated and swung to the right as it ran off the end of the runway onto the taxiway. It continued off the paved surface into the grass and in doing so caused both main landing gears to collapse. The commander estimated they were travelling "not much more than walking pace" as they went onto the grass and came to a stop shortly afterwards (Figure 1).

Figure 1

G-LAMI shortly after the accident

The commander completed the emergency shutdown procedure, checked the passengers were ok and commanded an evacuation. The sales representative opened the upper cabin door, but the lower half was jammed and so all the occupants had to climb out over it. The AFRS was on the scene quickly and there was a strong smell of fuel coming from the left wing.

Accident site

Inspection of the end of Runway 06 revealed two lines of black skid marks starting from the painted Runway 24 numbers (Figure 2 left). The distance between the lines was 3.6 m and were to the left of the runway centreline. The skid marks continued in an arc to the right (Figure 2 centre) and converged at a point where they left the paved surface (Figure 2 right). The left skid mark was darker and there was evidence of the tyre scrubbing sideways, whereas the right skid mark was lighter, and the skid was in the direction of travel. At the point where the main gears left the paved surface there was another skid mark, 4.2 m to the right, from the nose landing gear (Figure 2 right).

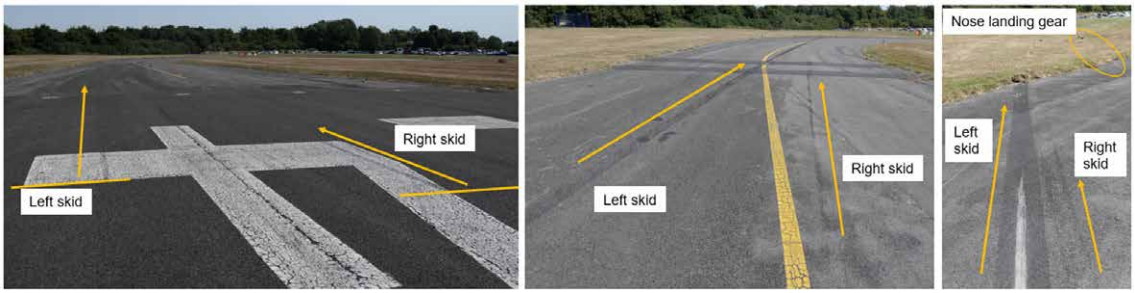


Figure 2

Skid marks on the runway

There was some evidence of the grass dying back and disrupted soil found approximately 260 ft from the end of the runway where the aircraft came to stop. To aid the recovery process the aircraft was partially defueled but no records were kept of the quantity of fuel removed from the aircraft.

Recorded information

The aircraft was fitted with a Garmin G1000 IFD system which stores multiple aircraft and engine parameters once a second on an SD memory card. The data was time stamped however the time did not correlate to the actual time, therefore it was re-labelled with T=0 at the last data point before the throttle was opened for the takeoff roll.

Using the positional data from IFD, it was possible to determine that after the 180° turn, the aircraft lined up to take off 31.7 m (104 ft) from the end of Runway 06 (Figure 3). It reached a peak ground speed of 71 kt (and KIAS of 71kt) after 30 seconds and had used 2,272 ft of the available runway. The positional track data overlaid with the skid marks seen with good correlation and the aircraft came to rest 259 feet from the end of the runway.

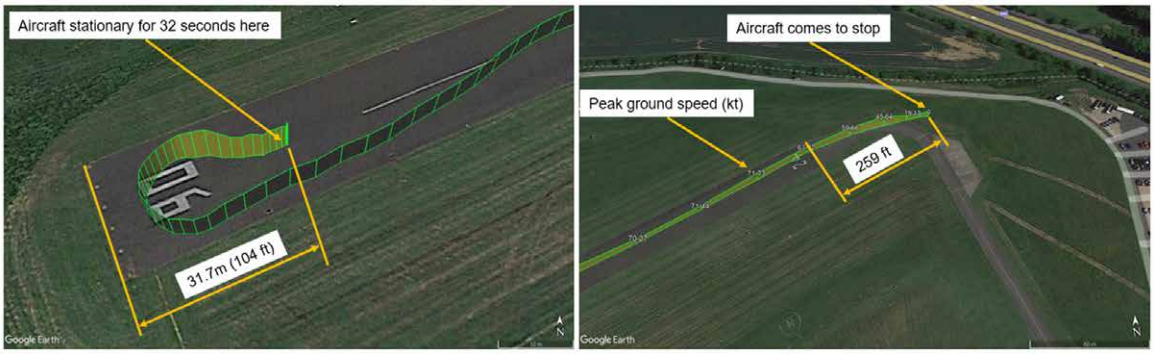


Figure 3

Take off roll start (left), Peak ground speed and stop point (right)

From the last time the IFD was powered on prior to the accident flight, the fuel quantity on board prior to refuelling was recorded as 37 US gallons. After refuelling, the IFD recorded the onboard fuel quantity as 94 US gallons which had reduced to 91 US gallons prior to starting the takeoff roll.

The ground speed, aircraft pitch, aircraft heading, MAP and engine rpm from the IFD was plotted against time in Figure 4 along with the calculated acceleration. At T=1 second the engine rpm starts to increase with a corresponding increase in MAP. The aircraft is moving at 2.4 kt at T=3 seconds when the MAP is 34.75 inches Hg, and the engine speed is 2,294 rpm. The MAP peaks 3 seconds later at 45.3 inches Hg and remains above the 42 inches Hg threshold for the CAS red warning for 4 seconds. It is then reduced and stabilised at 38 inches Hg for the remainder of the takeoff with the engine speed at 2,450 +/ 25 rpm.

The ground speed increases under constant acceleration between T=11 to T=29 seconds with a corresponding increase in IAS until the aircraft pitch increases to 13° nose up at T=31 seconds where the acceleration decreases. 1 second later the ground speed and IAS peak at 71 kt after which the throttle is closed, and the aircraft deaccelerates rapidly. As the aircraft pitched up, the heading veered slightly to the left, then swung 100° to the right after the brakes were applied and it came to a stop in 7 seconds.

The PF recorded the flight on the SkyDemon application on his mobile phone and it recorded the peak speed at 71 kt in the flight debrief report.

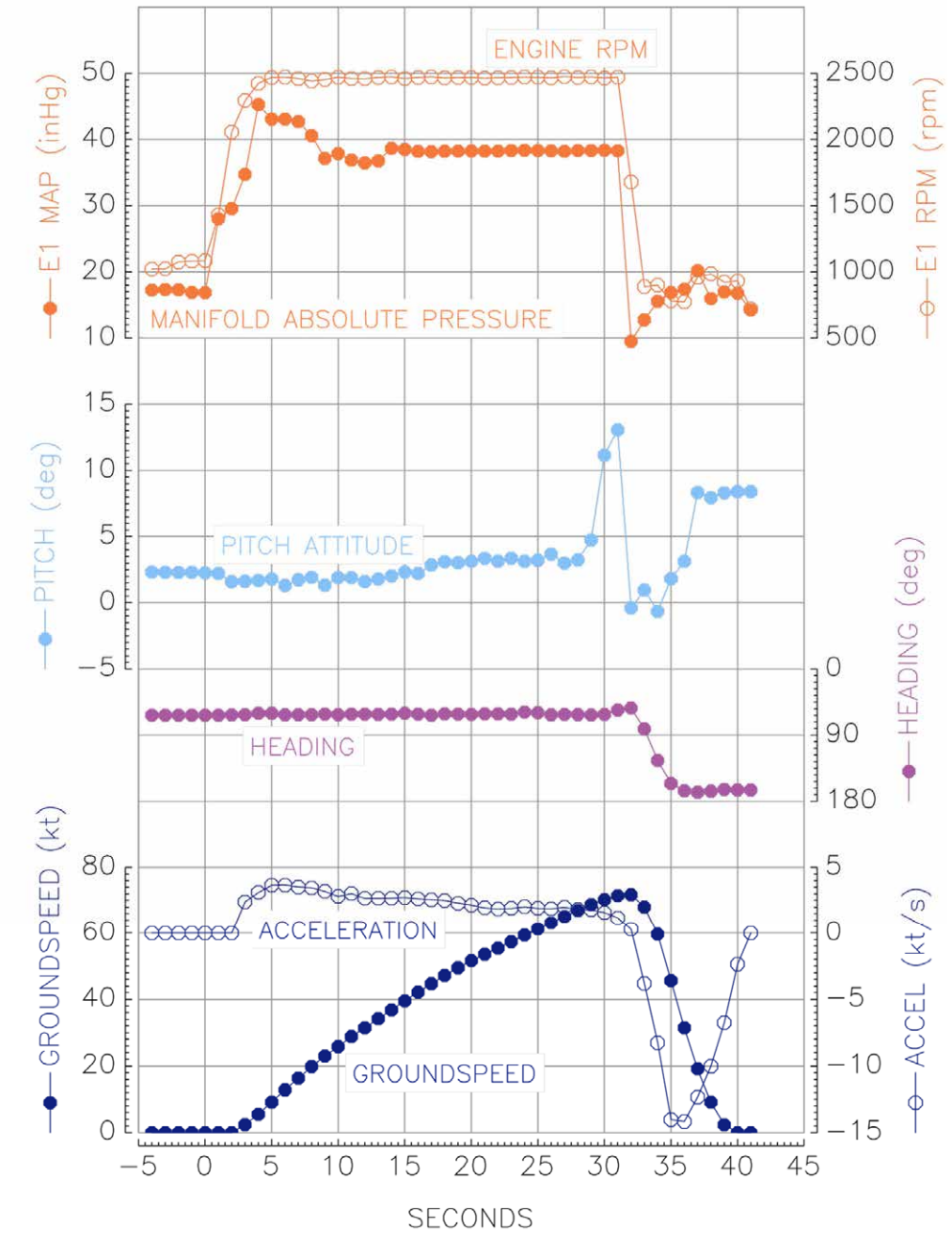


Figure 4

Garmin G1000 IFD data

Aircraft information

G-LAMI was a Piper Malibu Mirage PA-46-350P which had just been ferried across the Atlantic Ocean from the manufacturer in Florida. The aircraft logbook had 26 flying hours recorded at the time of the accident. The PA-46 is an all-metal single engine piston aircraft

with a pressurized cabin with space for six people. The 350P version has a Lycoming TIO-540-AE2A engine with twin-turbo chargers and was fitted with a Hartzell three-bladed, composite, constant-speed propeller. The IFD system was shown on three large cockpit displays and aircraft access was via a two-part cabin door in the rear left side of the fuselage.

The aircraft landing gear was a tricycle configuration with the single main wheels 3.7 m apart and the nosewheel 2.44 m forward of the main landing gear. A hydraulic actuator in each wheel well, attached to the main wing spar, retracted the main wheels.

The aircraft basic empty weight was 3,207.3 lb with an MTOW of 4,340 lb and the MLW was 4,123 lb.

Aircraft examination

The aircraft was inspected by the AAIB after it had been recovered following the accident. The left-wing top surface was creased outboard of the landing gear attachment with damage to the wing tip structure (Figure 5 top left). There was a puncture hole in the top surface (Figure 5 lower left) near the retraction jack actuator and the actuator had failed in compression and bending (Figure 5 top right). The actuator mounting lug on the wing spar had sheared (Figure 5 lower right) and the tyre had lateral abrasion marks (Figure 5 top right).

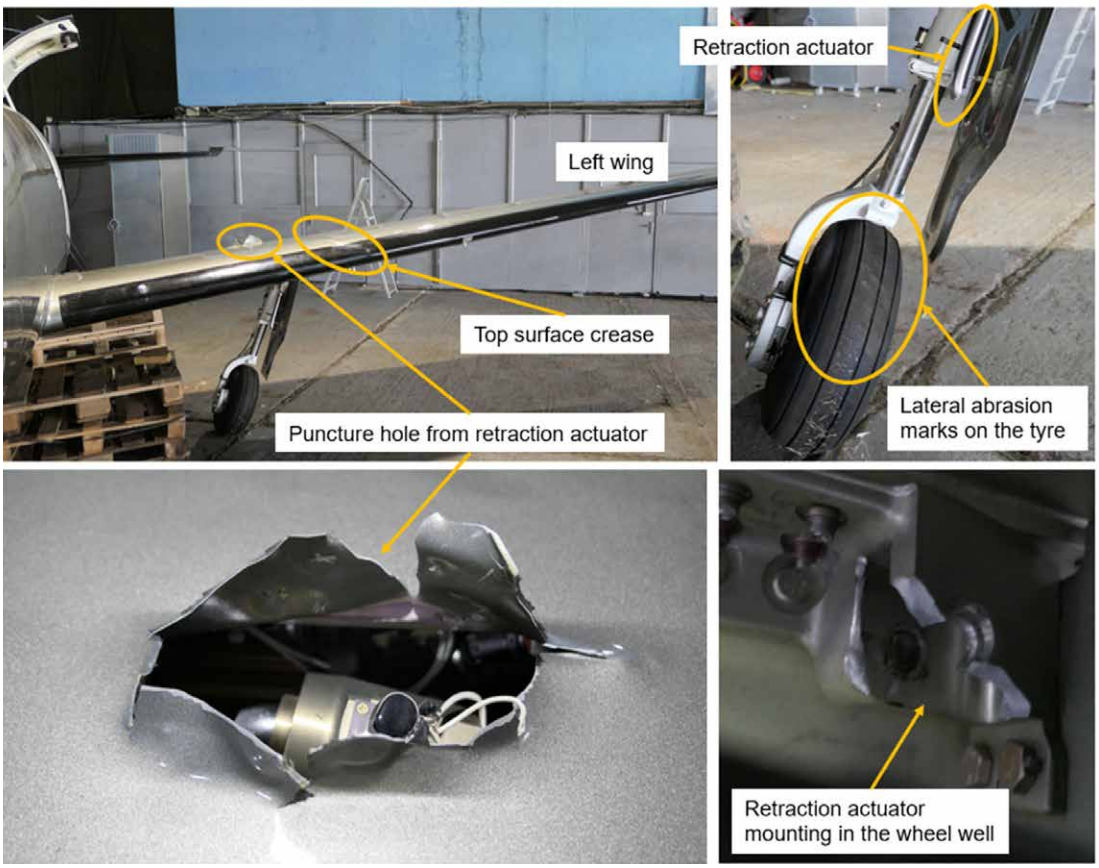


Figure 5

Left wing and landing gear damage

The right landing gear retraction actuator had failed in tension overload and the landing gear fairing had been damaged where it had contacted the weather radar pod (Figure 6 left). There were deep abrasion marks on the left side of the nosewheel rim with corresponding damage to the tyre (Figure 6 right).

Figure 6

Right landing gear damage (left), nose landing gear damage (right)

The fuselage to the aft of the cabin door was deformed with evidence of skin buckling. There was no evidence of the propeller striking the ground. The braking system showed no evidence of any defects that would have prevented normal operation.

Weight and balance[1]

The pilot stated that his pre-flight calculations showed the Take Off Weight (TOW) would be at the maximum permissible. However, after the event he recalculated the TOW as 1,996 kg (4,400 lb) and concluded they were overweight by 27 kg (60 lb).

He estimated the combined crew and passenger weight was 370 kg (815 lb) and calculated there was 62 US gallons of fuel onboard, weighing 169 kg (372 lb)[2] at the point of takeoff. The AAIB requested the weight of each of the passengers and crew, which totalled 435 kg (959 lb) and the IFD recorded 91.4 US gallons onboard weighing 549 lb at takeoff. This would have resulted in a TOW of 4,716 lb, which equates to 375 lb overweight.

The pilot stated he calculated the required fuel quantity to ensure that 20 US gallons would remain at landing and this resulted in the landing weight as 1,870 kg (4,122 lb) however, the AAIB calculated the landing weight would have been at 4,286 lb or 163 lb overweight using the increased passenger and crew weight.

Footnote

1 Weight and Balance calculations in the Piper POH are performed in ft and lb. Where values were reported in m and kg conversions are supplied in (ft) and (lb).

2 A density of 6.01 lb per US gal for AVGAS 100LL.

Aircraft performance

The takeoff ground roll and 50 ft obstacle clearance performance calculations were evaluated using the data obtained during the investigation (Appendix 1 and 2). The Pilots Operating Handbook (POH) graphs were extrapolated (under advice from the aircraft manufacturer) to include the higher TOW. The conditions used were:

OAT: 23°, Airfield pressure altitude: 27 ft, TOW: 4716 lb, Wind: Calm.

The takeoff performance graphs in the POH are all based upon flaps 0°, full throttle and 2,500 rpm before brake release on a paved, level and dry runway with a lift off speed of 78 KIAS. The pilot used flaps 10° as it was included in the normal takeoff procedure in the POH and he thought this would decrease the ground roll. The aircraft manufacturer did not have any data to quantify the difference in performance between flaps 0° and flaps 10° but confirmed that it would decrease the ground roll distance.

Applying the general safety factor of 1.33, as recommended in the CAA Skyway Code, resulted in a takeoff ground roll of 1,950 ft x 1.33 = 2,593 ft. The takeoff over 50 ft obstacle clearance distance was 3,150 ft.

The aircraft manufacturer had not published any performance graphs to calculate the braking distance required following a rejected takeoff. The landing ground roll distance calculations assume throttle closed, flaps 36°, braking heavy and a full stall on touchdown on a paved, level dry runway. G-LAMI was on the edge of stall with flaps 10° when the throttle was closed and heavy braking applied. To obtain the approximate braking distance required the calculations were performed but extrapolated for the increased TOW. The calculations showed a landing ground roll of nearly 1,200 ft would have been required (Appendix 3). This is equivalent to approximately half of the runway length.

Meteorology

The pilot reported the weather he had obtained was wind 5 kt from 350°, greater than 10 km visibility and 20°C. The actual weather reported was similar but with calm winds.

The weather was obtained from nearby RAF Benson for the time of the accident and was reported as winds of 6 kt from 320°, clear conditions, temperature of 23°C and a QNH pressure setting of 1031 hPa.

Aerodrome information

Wycombe Air Park has five runways; two asphalt 06/24 and three grass 06/24 & 35 (Figure 7). Runway 06 has a TORA of 730 m (2,395 ft) with a tall stand of trees (visible in Figure 2 left) 2,800 ft from the threshold and the M40 motorway beyond. Entry to Runway 06 is via the Alpha taxiway which joins to the Runway 24 threshold thereby necessitating a backtrack along Runway 24 or taxiing along the grass Taxiway Bravo which runs parallel.

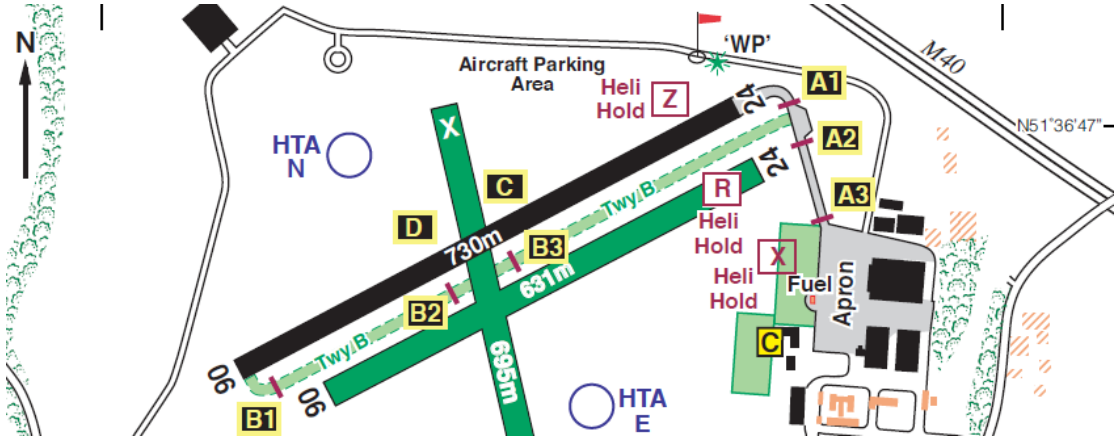


Figure 7

Wycombe Air Park runways and taxiways

Personnel

The commander had accumulated a total of 31,500 hours flying over 38 years on various aircraft types including large commercial air transport aircraft. He had 131 hours on all types of the PA-46 with 1.5 hours on the 350P. He had not flown the PA-46-350P in the last 28 days.

The PF had a total of 1,700 hours of which 900 hours were on the Piper PA-32 Saratoga. He also held a PPL(H) with 700 hours. He had not flown a PA-46-350P before nor was he familiar with the G1000 IFD.

Analysis

G-LAMI was being flown for a prospective purchaser demonstration flight, when the commander rejected the takeoff when he realised there was insufficient runway remaining to successfully takeoff. The aircraft skidded off the end of the runway and the landing gear collapsed. There were several factors identified which contributed to the takeoff being rejected.

Pre-flight preparation

The commander felt under time pressure to take off and he reflected this may have had an influence on the accuracy and effectiveness of his pre-flight preparations. He only had a limited understanding of the PF's flying experience and capabilities.

The commander had previous experience of operating small charter operations and so was familiar with estimating the weight of passengers. Whilst it was not possible to determine the commander's estimated individual weights for the passengers, the total was 65 kg less than the weight obtained during the investigation.

The commander used the IFD to check the fuel quantity onboard prior to refuelling, and noted it was 15 US gallons onboard. After refuelling and taxiing to the runway he calculated

there was 62 US gallons onboard. The data subsequently recovered from the IFD memory card showed there was 37 US gallons onboard prior to refuelling and 94 US gallons at takeoff. The commander was not able to explain the difference.

The combined underestimation of the crew and passenger weight, with the increased fuel weight resulted in G-LAMI being 4,716 lb at takeoff, or 376 lb overweight. This additional weight would have had a negative impact on the takeoff performance by increasing the takeoff ground roll. The commander used the aircraft manufacturer's takeoff performance graphs to determine that he required 1,700 ft to takeoff with his calculated weight. But using the recalculated weight and applying the general safety factor of 1.33 the takeoff ground roll required was 2,593 ft. The takeoff ground roll was 200 ft longer than the TORA of 2,395 ft. The commander used flaps 10° which would have shortened the takeoff roll but the aircraft manufacturer was unable to provide any quantifiable improvement in takeoff distance. The 50 ft obstacle clearance performance was not calculated by the commander during his pre-flight planning, but it was noticed during the runway inspection that there were many trees at the end of the runway and the M40 motorway beyond them. It was not possible to determine their height, but the distance calculation showed G-LAMI needed 3,150 ft to clear a 50 ft obstacle and the trees were approximately 2,800 ft from the threshold of Runway 06/24.

The takeoff

There are two ways to enter and line up for Runway 06; the grass Taxiway Bravo or back-tracking Runway 24. The commander chose to backtrack Runway 24 to demonstrate the turning capability of the aircraft and performed a 180° turn at the Runway 06 threshold. As a result of the turn the aircraft was not able to use the full TORA but the commander estimated he had used only 30-50 ft. He deemed this acceptable based upon his takeoff performance calculation. But the aircraft was over 100 ft from the end of the runway by the time the aircraft was lined up, thereby making the ground roll 300 ft longer than the TORA.

The manufacturers takeoff performance graphs are based upon several criteria including that the takeoff roll is commenced by bringing the engine to full power before releasing the brakes and then maintaining the MAP at 42 inches Hg until the aircraft is airborne. From the IFD data it was possible to determine that the engine was at about 70% power when the takeoff roll commenced with the manifold pressure exceeding the maximum of 42 inches Hg after 3 seconds. The commander promptly reduced the MAP to 36 inches Hg before increasing it to 38 inches Hg which was then held for the remainder of the takeoff. The adjustment took approximately 10 seconds.

The aircraft accelerated constantly along the runway until it reached a speed of approximately 71 KIAS when the nose pitched up to 13°. A witness recalled hearing the stall warner sound at this moment and there was a notable reduction in the acceleration. Discussions with the aircraft manufacturer revealed that the aircraft should be rotated when the lift off speed of 78 KIAS is reached when trying to keep the ground roll to a minimum.

The combination of reduced power before brake release, followed by the need to manage the MAP during the roll and finally, the early rotation, resulted in further extending the takeoff ground roll. It was not possible to quantitively determine by how much these factors would have extended the roll but as already shown the TORA was insufficient before taking these into account.

The takeoff rejection

As the aircraft rotated, the commander judged that the takeoff would not be successful and he took control of the aircraft from the PF, closed the throttle and applied the maximum braking effort he could. There is no data available from the aircraft manufacturer to calculate the amount of runway required following a rejected takeoff at or near the lift off speed. Using the aircraft configuration and the landing ground roll performance calculations it was possible to approximate that nearly half of the runway would be needed to bring the aircraft to a stop. The aircraft was approximately 120 ft from the end of the runway when it started to decelerate. When the aircraft reached the end of the runway the main wheels went over the painted Runway 24 numbers and the tyres started to skid. The distance between the skid marks on the numbers was about the same as the width of the main landing gear indicating that the aircraft was travelling straight forward at this time. Furthermore, the IFD heading was still aligned to the runway orientation as it passed the end of the runway. The skid continued over the asphalt taxiway surface with more retardation coming from the right wheel and so the aircraft veered to the right which was reflected in the IFD data with a change in heading to 165°. When the aircraft reached the edge of the taxiway the aircraft was approximately sideways to the runway orientation and the distance between the skid marks made by the main and nose landing gear further support this.

As the left main landing gear reached the curb the lateral forces exerted on it caused the retraction actuator to buckle, snap and puncture the wing top skin. The landing gear collapsed causing the left wing to be damaged as it travelled across the grass. The nose landing gear remained intact which resulted in the rear fuselage contacting the ground behind the cabin door. The right landing gear retraction actuator was overloaded in tension as it crossed the curb and when it failed, the landing gear over extended and was damaged by contact with the weather radar pod.

Summary

Given the pre-flight time pressures it is possible that the commander misread the fuel quantity onboard and underestimated the weight of crew and passengers which rendered his takeoff calculations inaccurate.

Added to this, the takeoff was further compromised by the start position on the runway, not achieving maximum power before brake release or during the takeoff roll and the early rotation. The MAP CAS warning was a result of the PF not fully understanding the operation of the throttle which could have been mitigated by a more detailed pre-flight briefing. The need to correct the MAP during the early part of the ground roll also contributed to the takeoff being rejected.

The decision to reject the takeoff should be considered in conjunction with the 50 ft obstacle clearance calculations and the possible consequence had they continued with the takeoff. It is probable that the aircraft would not have cleared the trees and could have ended up on the M40 motorway.

The AAIB has worked with the CAA on a previous investigation where decision making with respect to rejecting a takeoff was considered. The report into G-REJP[3] considered that pilots should have a structured self-briefing before takeoff to assist clear decision making and prompt action in the event the takeoff does not proceed normally. In addition, the CAA intends to produce an article in its *'Clued Up'* magazine about takeoff decision making and RTO considerations in general aviation; to include, for example, encouraging pilots to specify, before each takeoff, a runway decision point, and to consider the actions required to stop the aircraft.

Conclusion

The commander made the decision to reject the takeoff when he realised there was insufficient runway remaining to takeoff. Due to the change in braking surface when the aircraft ran over the painted runway numbers, it started to skid and veered to the right. This resulted in the aircraft skidding off the taxiway and coming to rest in the grass with the aircraft pointing approximately 100° to the runway heading. The landing gear collapsed, and the fuselage was damaged.

Several factors were identified which contributed to the takeoff being rejected. The aircraft was 376 lb above the MTOW due to misidentification of the fuel onboard prior to refuelling and an underestimation of the total weight of passengers. Both of these factors may have been a consequence of the commander feeling under time pressure during the pre-flight preparations. The takeoff was started over 100 ft into the runway after the backtrack and 180° turn. The PFs lack of understanding on how to handle the MAP at the start of the takeoff resulted in a CAS warning and the subsequent reduction in MAP setting lengthened the takeoff roll. This may have been due to the lack of a pre-flight briefing of the PF and an assumption on his skill level by the commander, both of which potentially occurred due to the perceived time pressure.

The CAA is intending to publish an article in its *'Clued Up'* magazine about takeoff decision making and RTO considerations in general aviation.

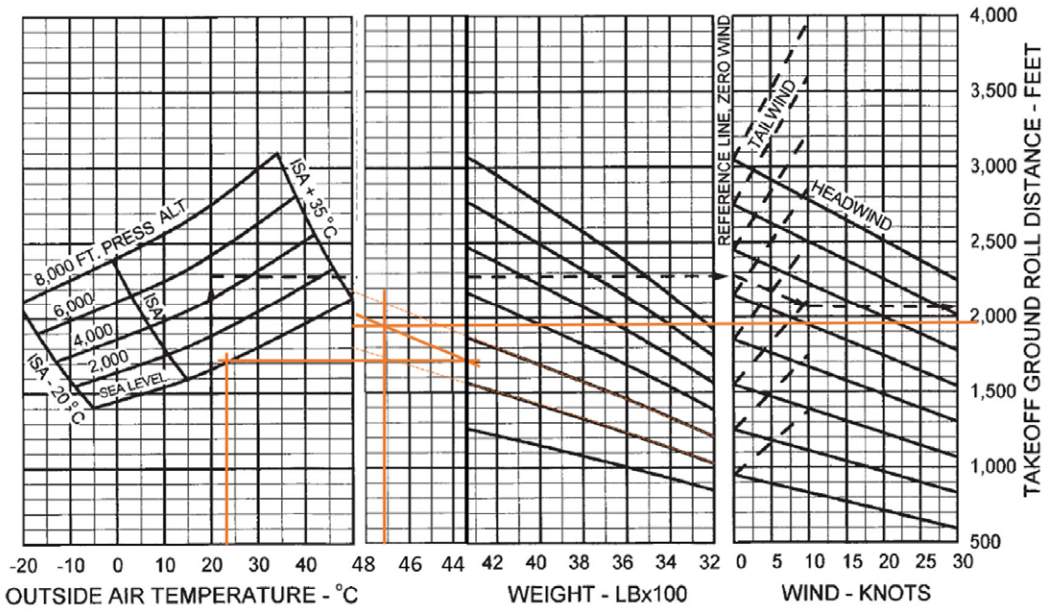
Appendices 1 to 3 - see next page.

Footnote

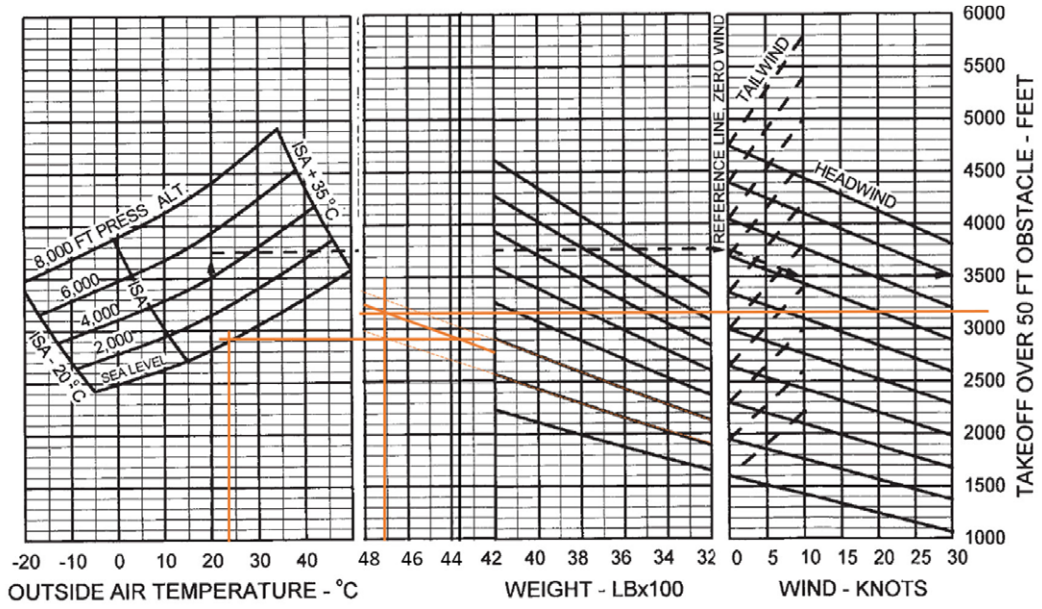
[3] Report published in the October 2022 Bulletin (https://www.gov.uk/aaib-reports/aaib-investigation-to-europa-xs-g-rejp) [accessed November 2022].

Appendices

Appendix 1 - Takeoff ground roll calculation:



Appendix 2 - 50 ft obstacle clearance calculation:



Appendix 3 – Estimated braking distance calculation: