**ACCIDENT**

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| **Aircraft Type and Registration:** | Bolkow 207, D-ENWA |
| **No & Type of Engines:** | One Lycoming O-360-A1A piston engine |
| **Year of Manufacture:** | 1965 |
| **Date & Time (UTC):** | 27 August 2007 at 1535 hrs |
| **Location:** | Near Stapleford Aerodrome, Essex |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - 2 |
| **Injuries:** | Crew - 1 (Fatal) Passengers - 1 (Fatal)<br>1 (Serious) |
| **Nature of Damage:** | Aircraft destroyed |
| **Commander's Licence:** | Private Pilot's Licence |
| **Commander's Age:** | 43 years |
| **Commander's Flying Experience:** | 158 hours (of which 24 were on type) estimated<br>Last 90 days – 11:10 hours estimated<br>Last 28 days – 6:25 hours estimated |
| **Information Source:** | AAIB Field Investigation |

**Synopsis**

The aircraft took off from a private airstrip with two adults and a young child on board. It failed to gain safe height and speed and stalled, crashing 270 m beyond the end of the strip. Only the adult passenger survived the accident. The aircraft was correctly configured for takeoff, and there was evidence that the engine was operating normally. Recorded data showed that the pilot had attempted to climb the aircraft above obstacles before achieving a safe climb speed. There was insufficient height for the pilot to recover once the aircraft had departed from controlled flight.

**History of the flight**

The aircraft was based at a private farm strip about 2 nm east of Stapleford Aerodrome in Essex. The pilot had intended to fly a local pleasure flight, accompanied by his partner and their three-year-old daughter. It was to be his passengers' first flight in the aircraft, which the pilot had acquired in September 2006.

Witness accounts indicated that there were no obvious problems encountered during the pre-flight sequence. The aircraft taxied to the southerly end of the strip (orientated approximately 03/21) in preparation for a northerly departure. The adult female passenger occupied the forward right seat and the young child was secured in a car safety seat which itself was secured to the aircraft's rear right seat.

The aircraft was seen taking off by the landowner, who was an experienced private pilot. He saw the aircraft become airborne about halfway along the 680 m strip and start its climb. He described the climb as appearing slow, and described what appeared to be some lateral instability, evidenced by minor wing rocking. The aircraft was also seen by witnesses at a stable complex, which was under the immediate takeoff flight path. All the witnesses described the aircraft as flying lower and more slowly than aircraft usually did when taking off from the strip, and also that the engine was running normally.

The aircraft crashed a few seconds later, in the grounds surrounding the stable complex, just before reaching the M25 motorway which ran alongside the grounds. Witnesses at the stables did not see the final seconds of the flight but were alerted by the sounds of the crash and almost immediate explosion. However, the strip landowner had kept the aircraft in view and described that, having gained little height since takeoff, the aircraft appeared to start a turn to the right, but this was followed immediately by a sharp left wing drop, and the aircraft then descended rapidly before disappearing behind trees. A further witness who saw only the last stages of the flight also described seeing the aircraft for a brief moment as it appeared between trees, flying very low. He also described seeing the left wing drop and a rapid descent.

The surviving adult passenger provided valuable information regarding the events leading up to the accident, though she did not recall the very last seconds of the short flight. She was not a pilot or a regular passenger, and had not flown in D-ENWA or from the strip before. She reported that the pre-flight activities were normal as far as she could tell, and that the pilot appeared to be his normal self, with no obvious concerns about the aircraft. He used a printed checklist and carried out engine run-up checks before takeoff. The passenger recalled being apprehensive about the takeoff, being aware of the trees at the end of the strip, so was looking down rather than ahead during the takeoff itself. It was shortly after lift off that she sensed that the aircraft was no longer climbing and looked up to see the trees ahead. She did not hear any unusual noises from the engine, nor notice any other indication that it was not running normally. Her last recollection was looking at the pilot and asking "what's wrong?" The pilot looked at her and was evidently concerned, but replied "I don't know."

No witnesses saw the actual impact. The aircraft came to rest inverted, a short distance beyond the initial impact site, and a fire started almost immediately at the front of the aircraft. People from the stable yard rushed to the scene, and extinguishers were bought from the nearby buildings whilst the emergency services were alerted. Fire rapidly took hold of the aircraft before anyone could get close enough to assist the occupants, and once it did so it was too dangerous for anyone to approach. The survivor appeared through the smoke, clearly in a dazed state, but able to stand. Although disorientated, she was calling for assistance, clearly aware that people were trapped within the wreckage. She attempted to get to them, but was restrained by the first people on the scene, an action which almost certainly saved her from much more serious injury from the now substantial fire.

**The accident site**

The accident site was in a field, the north-eastern edge of which bordered the M25 motorway. It was 270 m from the northern end of the airstrip. Between the end of the strip and the accident site the terrain consisted of rising ground on which there were a number of tall trees, paddocks, stables and farm outbuildings. The accident site was approximately 30 ft above the northern end of the strip.

**Engineering examination**

Examination of the accident site showed that the initial impact in the field was made by the aircraft's left wing tip. This was rapidly followed by its left main landing gear and the propeller. The fuselage came to rest inverted 23 m from the point of the initial impact and was consumed by a post-impact fire. At the time of the initial impact the aircraft was banked and rotating to the left and had a steep nose down attitude consistent with spinning to the left. The speed of the aircraft was low, in the order of 45 to 50 kt. From the direction of the wreckage trail the general track of the aircraft was 020°(M). Both propeller blades showed clear evidence of being driven at high power by the engine at the point of impact with the ground.

Examination of the trees between the strip and the accident site did not show any evidence of them having been struck by the aircraft.

A detailed examination of the flying control system found no disconnections. The wing flaps were found to be set at 15°, the normal takeoff position. The pitch trim was found to be set at a position slightly forward of neutral. The engine and propeller were taken to an overhaul facility for examination. External and internal examination showed no evidence of a failure, disconnect or partial seizure within either the engine or the propeller mechanism. Both units were in very good mechanical condition. Evidence from the engine and propeller control systems showed good evidence that the engine throttle was fully open, the fuel mixture was set at full rich, the carburettor heat was set to the 'cold' position and the propeller was set at full fine pitch. Witness marks within the propeller mechanism showed that at impact the pitch angles of the two propeller blades had coarsened slightly from the full fine pitch angle. This is consistent which the speed at which the aircraft was flying.

The electrically operated stall warning horn, mounted on the right side of the instrument panel, was recovered undamaged. When tested it was found to function satisfactorily. It was not possible to test the stall warning vane that was mounted in the wing leading edge due to damage from the post-impact fire.

**Pilot information**

The pilot gained his Private Pilot's Licence (Aeroplanes) in December 1999 after training on Cessna 152s. At the time of the accident, his licence was valid, and he held a current certificate of revalidation of his Single Engine Piston (Land) rating as well as a current JAA Class two medical certificate. In late 2000 he joined a Cessna 172 group based at North Weald. In 2001 he completed a full-time course of study for the Airline Transport Pilot's Licence theoretical examinations but did not subsequently pursue a career in civil aviation.

The pilot had acquired D-ENWA whilst it was still based at Melle in Germany, and it was flown by an experienced Bolkow 207 pilot to North Weald Aerodrome in September 2006. Under the terms of a 'Notification to Pilots' (Number ll-4/95) issued by the German Federal Office of Civil Aviation, the pilot was entitled to fly the German registered aircraft in the UK on the basis of his CAA licence, providing that it was only flown in visual flying conditions, and during the hours of daylight.

The pilot had no previous experience on tailwheel aircraft, so he undertook a tailwheel conversion course on D-ENWA. This was conducted at an approved training organisation, by an instructor who was very experienced on tailwheel aircraft. The pilot logged five hours flying during the course, of which one hour was solo. This course was started on 25 October 2006 and ended with the solo flight on 9 December 2006. The instructor who

conducted the training reported that the pilot achieved a satisfactory standard in handling the aircraft. He also described the pilot as being enthusiastic towards his flying whilst apparently being aware of his limitations in terms of experience.

The course flying was conducted from a level, 800 m paved runway and did not include short or soft-field takeoff techniques. The pilot apparently did not ask for any extra advice concerning strip operations and the instructor stated that, as far as he was aware, the pilot intended to continue operating the aircraft from North Weald, which has paved runways. He did not know that the pilot was in fact, intending to base the aircraft at a farm strip. The instructor said that, had he known this, he would have been able to tailor the course accordingly.

The pilot's personal flying logbook was recovered from the aircraft wreckage. Although incomplete, an estimate of flying hours was possible, assisted by the aircraft logbook and records from the farm strip and other sites. The flying hours given for the pilot are believed to be accurate to within 5% of total. Including the conversion course, the pilot had flown some 24 hrs on type over 35 flights during a period of 10 months.

The pilot had taken off from the strip on 11 occasions prior to the accident. On only two of these was it reasonably certain, based on historical wind data, that takeoff had been made in the same direction as on the accident flight. On two further occasions it was a possibility, as winds were light and variable. On all other occasions takeoff was made in the opposite, southerly direction.

The pilot had not routinely practised circuits in the aircraft. After his tailwheel course finished on 9 December 2006, his next flight was to the farm strip, via Earls Colne Airfield, on 16 December. He did not fly D-ENWA again until 9 April 2007. From then on, he only once logged more than one takeoff and landing per flight, that being on 18 April 2007 when he flew to Sibson aerodrome near Peterborough and logged four landings before returning to the strip.

**Meteorological information**

The probable weather conditions at the time of the accident were provided in a report by the Met Office. There was a large high pressure cell affecting the area, giving rise to a dry, light north-westerly to northerly airflow, of limited instability. There would have been scattered 'fair weather' cumulus clouds at about 4,000 ft amsl, and a visibility of between 25 and 40 km. There was no reported weather in the vicinity of the accident site. The surface temperature would have been about 19ºC.

The possibility of unusual wind effects was considered. The mean surface wind at the time was estimated as being from 320º(M) at 5 kt. Thermal activity would have been sufficient to induce surface variations in the wind direction and speed. However, as the airmass was not excessively unstable, the maximum gusts would be that of the gradient wind, which was 12 kt. Variations in wind direction were possible, as seen in the meteorological reports from London (Stansted) Airport, 14.5 nm to the north. It was therefore considered that the wind direction at the accident site could also have varied by as much as 40º either side of the mean 320º.

Video evidence from a Police Air Support Unit helicopter supported the Met Office estimates. The video, which commenced about 20 minutes after the accident and whilst smoke was still issuing from the wreckage, showed a fairly consistent surface wind direction of 320º, occasionally veering for short periods to about 350º.

A section of footage showing the farm strip windsock enabled a wind estimate there of 340º(M) at 5 to 8 kt. Therefore, it is probable that the headwind component for takeoff was about 5 kt.

Historical wind data was obtained for each takeoff made by the pilot in the accident aircraft. In the case of the farm strip takeoffs, the data is from North Weald Airfield, 5.3 nm to the north. In general, the pilot flew only on light wind days, normally in less than 10 kt. On the four occasions that he flew from the farm strip in more than 10 kt of wind (to a maximum of 17 kt), the wind was almost directly aligned with the strip's southerly takeoff direction.

**Recorded information**

Track log[1] data was downloaded from a GPS unit recovered from the aircraft. The frequency with which the data points were logged by the GPS unit was dynamically controlled by algorithms in the unit's controlling software, based on rates of change of height, track, and ground speed.

The data provided the average speed of the aircraft during six consecutive segments of the accident takeoff. During the first 50 m segment the average ground speed had been 12 kt, 28 kt during the following 120 m segment, 42 kt over the next 175 m segment, 53 kt over the next 250 m, 50 kt over the next 211 m and 46 kt over the final 50 m segment. The last three segments were recorded after the aircraft had taken off, with heights of about 30 ft, 100 ft and 100 ft recorded respectively. The average climb rate between the 30 ft and first 100 ft point was 555 ft/min. The impact point was about 80 m from the final GPS position. Figure 1 shows a visual plot of the flight path for the final three segments and the ground impact position.

In addition to the accident flight, data was recorded for the five previous takeoffs. These were: the farm strip, Northweald and Bembridge on 16 August 2007, the farm strip on 18 August 2007, and Tibenham on 20 August 2007. Figure 2 shows the average ground speed and altitude data from all six takeoffs. Figure 2a shows the three recorded takeoffs from the farm strip (with the accident flight annotated), whilst Figure 2b shows the other three takeoffs, which were from paved runways. The individual plots are not aligned with any datum, but have been overlaid to allow direct comparison. An estimate of the point of lift-off is shown, based mainly on estimated headwind component.

Of the six takeoffs recorded by the GPS, it is likely that only one had a headwind component exceeding 10 kt. This takeoff is shown in Figure 2a as the blue plot of 18 August 2007 (headwind component about 15 kt). The other strip takeoff, on 16 August 2007 was with little or no headwind component. Of the hard surface takeoffs shown at Figure 2b, two were made at airfields with paved strip lengths of 837 m and 1,250 m (Bembridge and Tibenham) and one at North Weald, with 1,920 m available. The headwind component for these takeoffs is estimated to have varied between nil and 9 kt.

**Pathology**

Post-mortem examinations of the pilot and his daughter were carried out by an aviation pathologist. Amongst the pilot's significant injuries were fractures to both lower legs, a spinal injury and evidence of a relatively minor head injury. Although it could not be established for certain, the spinal injury may have caused some paralysis and the head injury had the potential to render the pilot unconscious. There was no evidence

**Footnote**

[1] A track log contains a sequence of data points, with each point containing time, aircraft position, instantaneous groundspeed, track and GPS altitude.

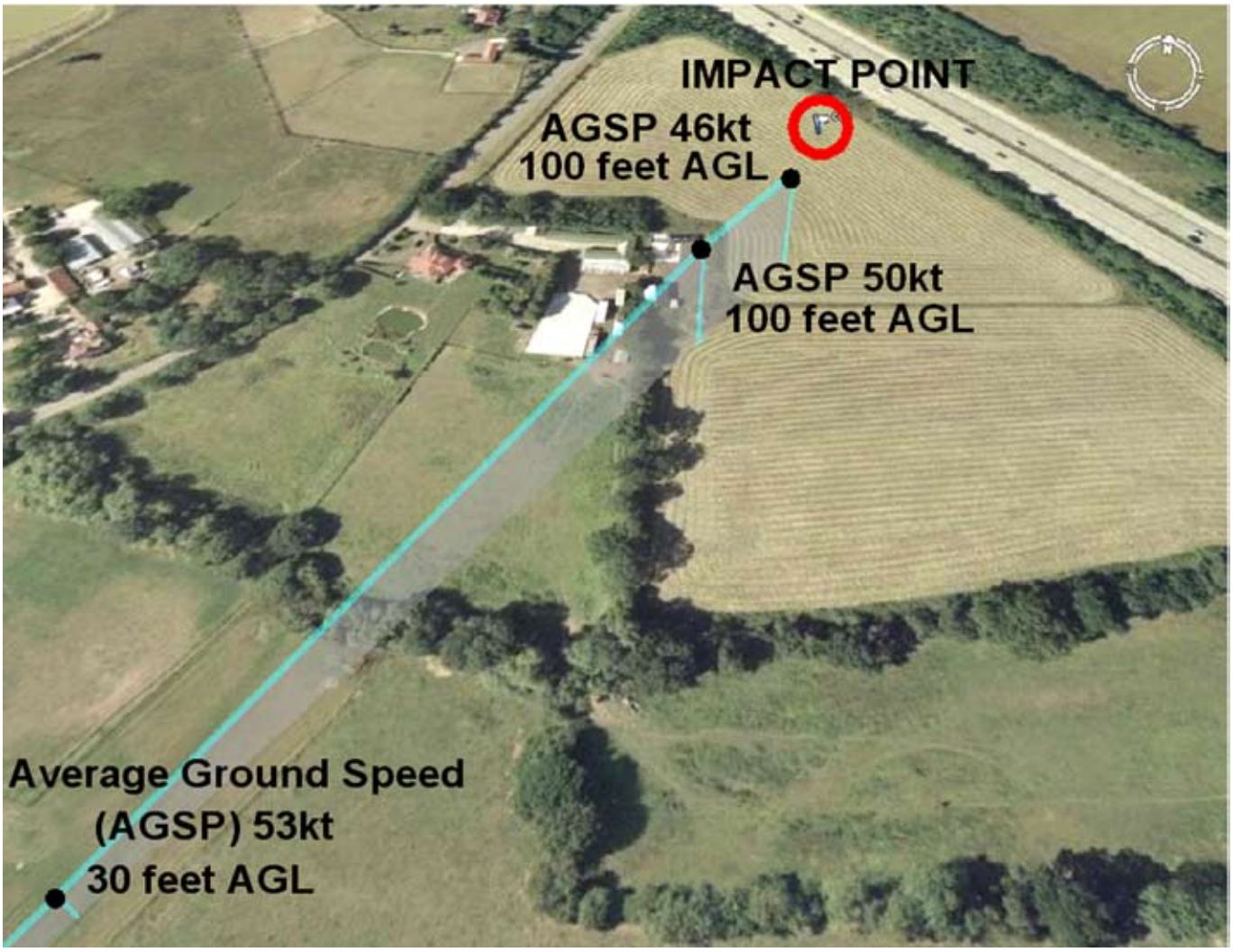


**Figure 1**

Visual plot of GPS data

of a pre-existing medical condition that could have contributed to the accident. The pathologist concluded that both the pilot and his daughter (who had remained secured in the car safety seat) had died from the effects of the post-crash fire.

**Survivability**

Despite the severe impact, the accident was survivable, but for the effects of the fire. The female passenger survived the accident with a laceration wound to her forehead, bruising, (some of which was consistent with wearing a seat harness at impact) and cuts. She could not recall details of the final moments of the flight or the immediate post-crash events. Her first recollection was of sitting on the ground being attended by people from the stable yard. The survivor was therefore unable to say how she had escaped from the aircraft.

The aircraft was equipped with safety harness at each front seat position, and car-type lap straps for the rear seats. The front seat harnesses were of a four-point arrangement, with two lap straps and two shoulder straps meeting at a quick release fitting (QRF). Both front seat QRFs were recovered, along with a limited

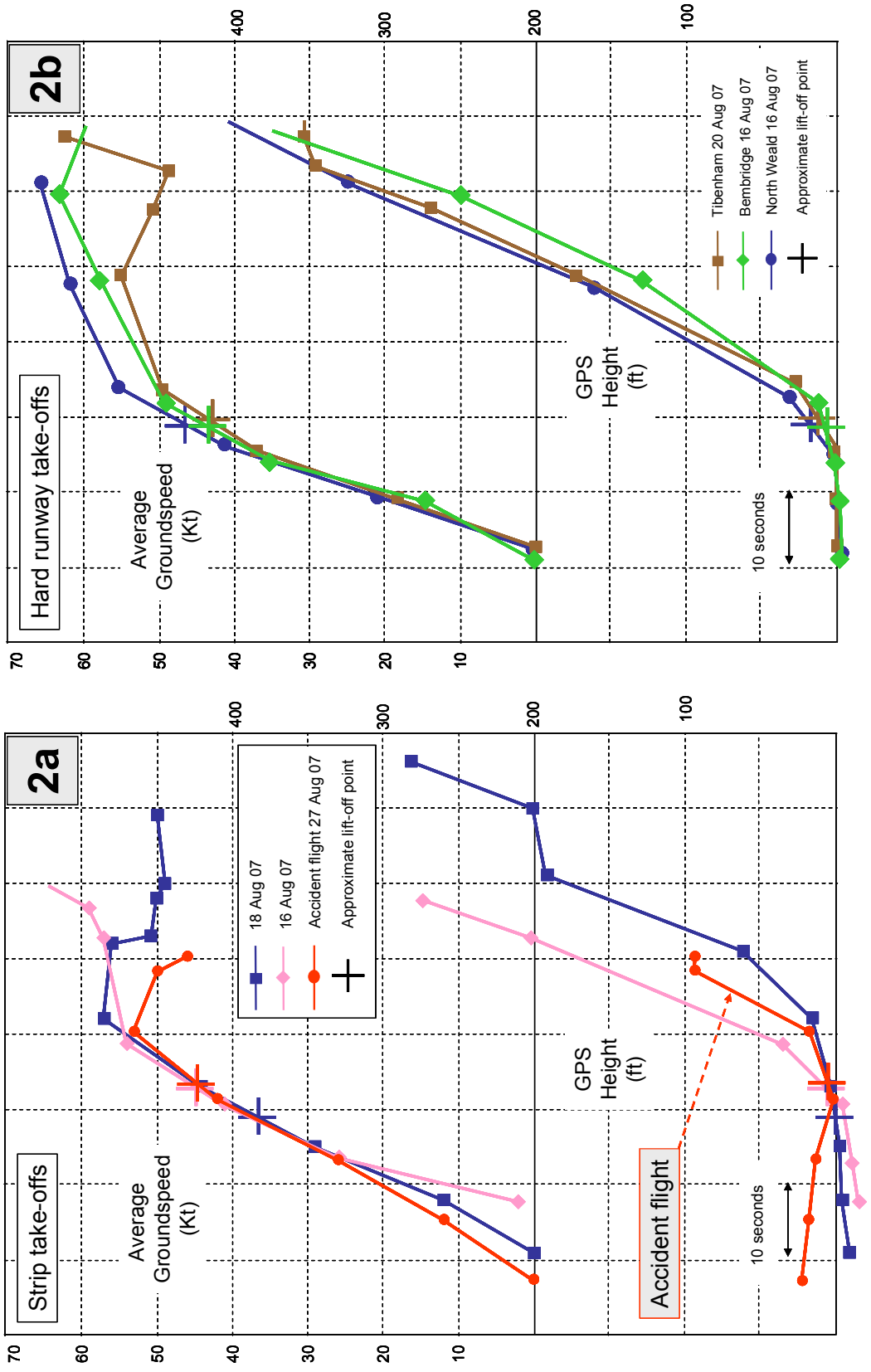


**Figure 2**

GPS data from previous takeoffs

amount of seat belt material. Each QRF, permanently attached to one lap strap, had recesses for the remaining strap lugs, which could be released simultaneously by rotation of the central part of the QRF against a light spring pressure. The front seat harnesses were anchored at three points (one for each lap strap and a combined point for the shoulder straps) to a transverse metal frame, which formed the internal rigid structure of the seat back. In the accident aircraft, the permanently attached lap straps were on opposite sides of the two QRFs, giving a symmetrical arrangement. However, when the harness arrangements on two other Bolkow 207s were examined, in each case the QRF was permanently attached to the right hand lap strap of both front seats.

When found, one QRF had the lugs still attached for the remaining lap strap and the right shoulder strap, but the left shoulder strap lug was missing. The other QRF had none of the free lugs still attached. Both QRFs were damaged by fire but, apart from some initial stiffness, operated correctly. Two shoulder strap lugs were found separately, with some seat belt material attached. One of these could positively be identified as belonging to the survivor's (right seat) harness; however it was not possible to determine which QRF was associated with which seat.

**The farm strip**

About the time that the pilot was undergoing his tailwheel conversion course, he negotiated an agreement to base his aircraft at the farm strip. The strip owner did not require any form of competency check to operate from the strip, but did brief the pilot on strip procedures. The person who administered the strip operation said that the pilot had informed her that he had sought expert advice on the suitability of the Bolkow 207 for strip operations, and she had the impression that this had been the instructor who had completed the pilot's tailwheel conversion.

The strip itself was 680 m from hedge to hedge, with an overall down slope of 1.6% in the northerly takeoff direction. The orientation of the strip was 028º/208º(M) and the mean elevation was 230 ft. A tree line crossed the upwind boundary, with further tree lines beyond, including on either side of the M25 motorway. The trees at the end of the strip were about 30 to 40 ft tall, but higher to either side. The taller trees in the vicinity reached an estimated 60 to 70 ft. The M25 ran in a cutting, approximately 290 m from the departure end of the strip. Beyond this was a large field, with power lines. Figure 3 shows the view from the police ASU helicopter whilst hovering over the strip, looking towards the accident site. The pylon is at a distance of 1,000 m from the strip.

**Aircraft performance**

Mass and balance calculations were made using the aircraft's known empty mass and estimates of the mass of the persons and additional items on board. From the aircraft's recent flying and fuelling history, it was estimated that about 22 imperial gallons were on board at the time of the accident, which was about half the fuel capacity of the aircraft. The estimated takeoff mass was 2,300 lbs, with centre of gravity at the forward limit. The maximum takeoff mass was 2,640 lbs.

A combined aircraft Operating Handbook and Flight Manual was recovered from the pilot's home, and a home-made plasticised check-list in English was found in the aircraft wreckage. As the aircraft was previously based in Germany, it is likely that the checklist was made by the pilot himself. Information from those who had flown with the pilot suggested that he routinely used the checklist. Part of a further plasticised document

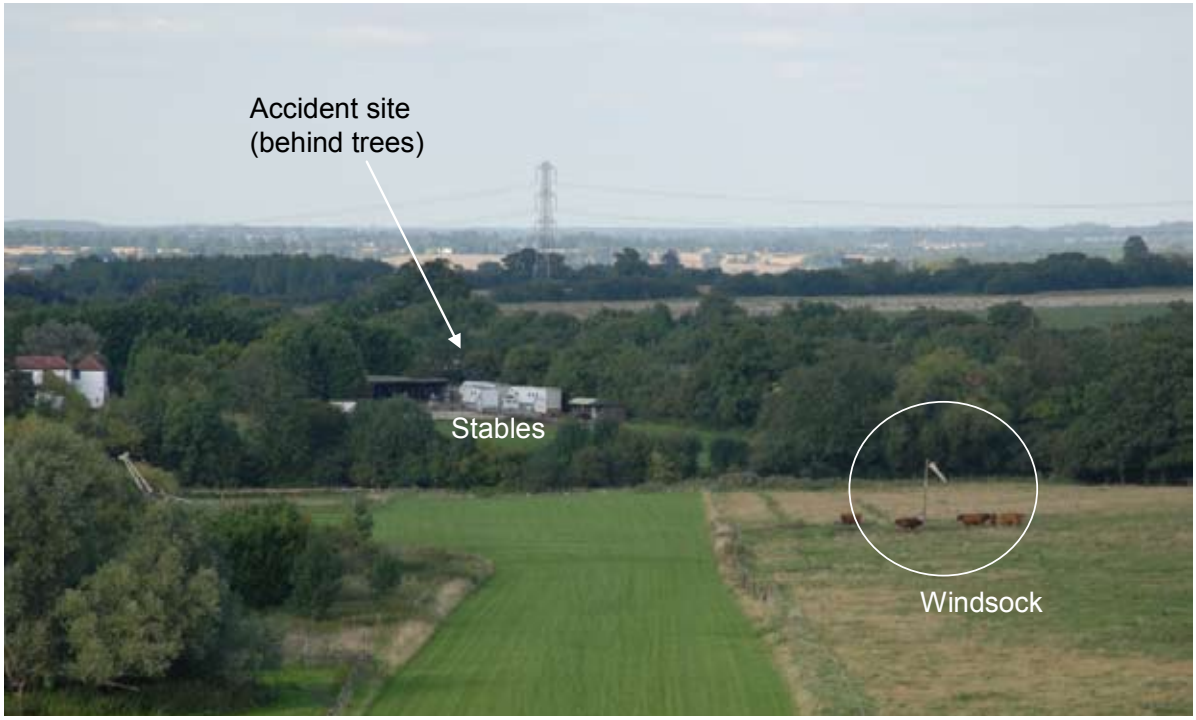


**Figure 3**

Departure end of the strip

was recovered, which contained aircraft performance information and leading particulars. This document is also presumed to have been constructed by the pilot, as it was in English and bore his printed name.

The Flight Manual gave performance data for an aircraft of maximum mass in still wind conditions. At maximum mass in the ambient conditions, the distance required to clear a 50 ft obstacle was calculated as 493 m. However, this was for a hard, level runway, and did not include a safety margin. Although not specifically stated in the Flight Manual, the manufacturer's performance figures are only valid if the recommended flying techniques are used. The plasticised performance document found in the wreckage was damaged, but did include two performance figures, one believed to be a landing figure, and the other believed to be that of the takeoff distance to 50 ft, which was given as 480 m. This figure equated to the Flight Manual figure for a takeoff at a temperature of 15ºC. From the layout of the surviving part of the document, it was thought unlikely that it included any additional takeoff performance data, such as from grass runways.

For takeoffs from grass runways, it is widely recommended that a factor of 20% (a figure quoted in Civil Aviation Authority (CAA) publications and elsewhere) should be added to the Flight Manual figures, to account for the increase in rolling resistance and therefore ground run. This would increase the total distance required to clear a 50 ft obstacle to 591 m. Additionally, although private flights are not obliged to add further additional safety factors to the calculated performance figures, the advice from the CAA is to do so. A factor of 33% is recommended, to allow for variations in weather conditions or pilot performance. This would further increased the takeoff distance required by an aircraft at maximum mass to 786 m.

The Flight Manual gave an expected climb rate of 700 ft/minute at the best climb speed of 70 kt with the flaps up. The advice was to retract flaps from the takeoff setting only after clearing obstacles and achieving a safe altitude.

D-ENWA had recently undergone its annual Certificate of Airworthiness (C of A) inspection. This was carried out at a maintenance facility in Hampshire, under the supervision of the same person who had ferried the aircraft from Germany. He was a light aircraft engineer, CAA approved flight test pilot, and also a Bolkow 207 owner with considerable experience on the type. When the owner of D-ENWA delivered it to the maintenance facility, he expressed a concern that the aircraft may not be performing correctly. He thought that this may have been engine-related, but did not give any reasons for his concern. However, nothing was found which could have contributed to a lack of power. As part of the German C of A process, a flight test was conducted on 9 August 2007, 18 days before the accident. This test included a check of the aircraft's rate of climb through an altitude gain of 3,000 ft. Although the test report was passed to the pilot and has not been found, the test pilot was confident that the performance achieved by D-ENWA was typical of the type. This assessment was also passed verbally to the pilot.

**Takeoff techniques**

The normal takeoff technique for the Bolkow 207 was described in the Operating Handbook. It was to allow the aircraft tail to come up to the horizontal position during the takeoff roll, and to lift off at about 55 kt. The aircraft was then to be levelled just above the ground until reaching the climb speed of 70 kt. This is the technique the pilot would have learnt during his tailwheel conversion course.

The 'short field' technique differed from the normal technique; the Operating Handbook included the following information for a short field takeoff:

> *'Maintain a tail-low attitude (tail wheel on the ground) during take-off roll and let the aeroplane fly itself off at a speed of approx. 43 to 49 KTS'*

and

> *'Push control column and keep aeroplane just above the ground until reaching a flying speed of 70 KTS'*

For both types of takeoff, the recommended climb speed was 70 kt. This takeoff method would also be applicable to soft field takeoffs, or any occasion when it was deemed desirable to lift off as soon as possible (such as poor surface condition).

A friend of the pilot and fellow C172 group member who had flown with the pilot in D-ENWA on a few occasions, described his impressions of the strip and the pilot's techniques. He described the pilot as very diligent in his approach to flying, and appeared to be comfortable operating from the strip. He reported a noticeably better takeoff and climb performance from hard runways than from the strip. He felt that the strip did not allow room to accelerate to the climb speed, and would personally have preferred a longer strip to operate from. He thought that the pilot would generally climb the aircraft at a lower airspeed until clear of the trees before accelerating to the climb speed.

**Aircraft stalling characteristics**

According to the Operating Handbook, the aircraft tended to drop a wing when stalling with power applied and a slight sideslip. Recovery from the wing drop

could be made by timely application of aileron and rudder, combined with a relaxing of 'up' elevator input. With power off, the aircraft tended to naturally adopt a natural nose-down attitude as a result of flow separation until speed was regained. According to the Operating Handbook, the aircraft stall speed in straight and level flight with 15º flap, idle power and at maximum weight, was 54 kt. With power applied, the stall speed would be expected to be slightly lower. The aircraft was fitted with a stall warning indicator on the upper right side of the instrument panel, which was designed to operate at 5 to 8 kt above the actual stall, producing both visual and audible signals.

D-ENWA was deliberately stalled during its post C of A inspection flight test on 9 August 2007. The test pilot reported that the aircraft's stalling characteristics were as expected, and the aircraft readily recovered if the correct techniques were used. Speaking generally of the type, he described power-on stalls as being likely to generate a wing drop (usually the left wing), which could be quite sudden.

After a Bolkow 207 landing accident in May 2002, a test pilot from the CAA's Flight Department flew a Bolkow 207 with the intention of investigating the type's stalling characteristics. He reported that the aircraft was docile in the stall with no greater tendency to roll than other aircraft of that era. With 15 degrees of flap, an aircraft mass of 2,025 lb, and idle power, the stall warning occurred at 57 kt and the aircraft stalled at 55 kt, exhibiting a slight right wing drop. During further slow speed flight with go-around power set, it was noted that the aircraft did not depart from controlled flight despite the speed decaying below 50 kt, indicating that the stall speed had significantly reduced due to the airflow resulting from the applied power.

**Analysis**

*General*

From witness accounts, evidence from the crash site, and recorded data, it is clear that the aircraft failed to gain a safe height and speed after takeoff. It appears to have suffered a power-on stall, during which the left wing dropped and the aircraft descended rapidly from a height of about 100 ft. At the low height at which the aircraft stalled, it would not have been possible to regain controlled flight before the aircraft struck the ground.

The pilot had been correctly qualified to operate the German registered aircraft and to use it to carry passengers. He had also undergone training to familiarise himself with the characteristics of tailwheel aircraft and the Bolkow 207 in particular. However, during this training the pilot apparently did not request instruction or advice in short or soft field operations, and did not receive additional training in these specific techniques.

*Technical examination*

The aircraft was badly damaged in the accident, and much of the airframe was consumed in the post-crash fire. However, it was possible to state that the aircraft was correctly configured for takeoff, with an appropriate takeoff flap setting, trim setting and propeller pitch selection. A detailed examination of the engine revealed nothing that would contribute to a power loss. On the contrary, the engine appeared in good condition internally, and examination of the propeller blades showed that a high engine power was applied at the time of the accident. The propeller pitch change mechanism was also subject to a detailed examination and no pre-existing faults were found.

Accounts by eye witnesses, including the surviving passenger, indicated that the engine appeared to

be operating normally at a time when the aircraft was already in difficulty. Although the pilot had previously expressed some concern about the aircraft's performance, this had presumably been resolved to his satisfaction, otherwise it is unlikely that he would have embarked on a flight from the strip with his family on board. The C of A test flight showed that the aircraft's performance was typical of the type. Recorded GPS data from recent takeoffs showed a broadly consistent level of performance during the ground roll, and the aircraft was seen to lift off on the accident flight at a reasonable point along the runway.

The stall described by witnesses is typical of the type of stall which occurs when engine power is applied. In this case the aircraft would be expected to stall at slightly lower airspeed, and be more likely to suffer a wing drop. Such stalls, though delayed in onset when compared to power-off stalls, are normally more pronounced when they do occur.

The loss of airframe components meant that it was not possible to rule out a partial power loss due to other causes, such as an airframe fuel supply problem (though it is known there was adequate fuel on board for the planned flight). However, the available evidence supports the conclusion that the aircraft's engine and propeller combination was developing a significant amount of power at impact, and that their operation was not a contributing factor in this accident.

*Aircraft performance*

The performance data in the Operating Handbook was valid for hard runways only, and required factoring to produce equivalent figures for a grass runway. It must be presumed that the pilot was aware of the need to factor the figures since this is well publicised, though the performance figures on the card recovered from the aircraft were not factored. Nevertheless, the aircraft was capable of taking off from the grass strip on the day of the accident.

The performance data also assumes a standard level of pilot performance; it does not include an allowance for incorrect or variable techniques. Although not mandatory, if such a factor had been applied (as recommended by the CAA), the takeoff distance required at maximum weight would have exceeded that available by about 100 m. However, the aircraft was an estimated 340 lbs below its maximum weight, was taking off down-slope and had the advantage of a slight headwind component, so it should have been capable of taking off safely[2].

*Takeoff technique*

When the pilot carried out his tailwheel conversion course he would have learnt the normal takeoff technique in which the tail is raised as the aircraft accelerates and the aircraft lifts off at around 55 kt IAS. However, the short field technique differed in that the aircraft was kept in a tail-low attitude until lift off; this was described in the Operating Handbook. Using this technique, the aircraft would become airborne at the slowest possible speed, but also only just above its stall speed and in a high-drag attitude. In both cases the correct technique was to accelerate just above the runway until reaching the climb speed of 70 kt.

While an aircraft of this kind is just above the ground after takeoff, it benefits from the advantage of 'ground effect' which impedes the development of vortices associated with high-lift conditions, and therefore less induced drag results. However, if the aircraft is flown

**Footnote**

[2] The adequacy of the strip length is discussed in this report only with respect to this accident. It is not unusually short for a private strip and other types frequently operate from the strip without difficulty.

out of ground effect without first accelerating, induced drag increases markedly as these vortices develop. If the aircraft does not have sufficient power, it may be unable to climb further, or may fail to clear obstacles under the takeoff flight path. This scenario is a potential risk area for all aircraft, but is normally associated with tailwheel aircraft because of their natural tail-low configuration. By accelerating to the best climb speed, a much improved ratio of lift to drag is achieved, allowing the aircraft to climb safely and efficiently.

The GPS data, when corrected for the light headwind, showed that the aircraft's average airborne airspeed was well below the recommended climb speed, the average over the last 50 m segment being about 51 kt. Although the aircraft did climb initially, this appears to be at the expense of airspeed, which reduced during the period of recorded airborne data.

The recorded data also showed previous occasions when the initial climb profile exhibited similar characteristics to the accident flight. This is most notable in the data for 18 August 2007. Although on this occasion the aircraft was climbing into a stronger headwind (about 15 kt), this alone would not account for the significant sustained drop in groundspeed combined with almost level flight over a 10 second period. The takeoff on 16 August was made in very light crosswind conditions so any headwind effect would have been minimal. On this occasion airspeed was also low and increased only slowly as the aircraft climbed.

It is probable that the pilot of D-ENWA had adopted a strip takeoff technique in which he elected to fly the aircraft away from the ground at low airspeed before accelerating to the normal climb speed. Even if the aircraft had been a few knots above the lift off speed, as is probably the case on the day of the accident, there would have been reduced climb performance and little margin above the stall. Any attempt to increase the climb rate would risk placing the aircraft further into the low speed / high drag scenario already described.

It is not known at which point the pilot adopted this takeoff technique. It is probable that he had been using the technique for some time without appreciating the potential danger, and it may be the reason for the apparent lack of performance which he reported at the time of the aircraft's C of A check.

The takeoff technique which the pilot is believed to have used would have degraded the aircraft's overall takeoff performance, and brought it closer to obstacles under its flight path. The pilot's decision to adopt the technique is presumed to be due to his perception that the strip would not allow the correct technique to be used, and still be able to clear the trees at its end. This may have been heightened when taking off in a northerly direction by the downward slope of the strip, which may have created an illusion that the trees were higher than they really were. Additionally, the stable complex would have been sensitive to noise, which would have been a further incentive to achieve a reasonable height as soon as possible. Although the pilot did not routinely fly in strong winds, the lack of significant headwind (probably only 5 kt) on the day of the accident may also have been a contributory factor.

*The stall*

From the surviving passenger's account, it is clear that the pilot was aware that the aircraft was not performing correctly, but that he did not know why. With the engine running normally, the lack of performance would have been confusing if the pilot had not fully appreciated the dangers of attempting to climb at too low an airspeed. At low height and with the trees ahead, his natural instinct

would have been to try to climb by raising the nose (the trees to each side being higher). If this had been his reaction, the effect would have been to further degrade the aircraft's climb performance and place it closer to the point of stall.

A forced landing into the field in which the aircraft crashed would not have been an option by the time the pilot realised the aircraft was not performing as expected. The only available landing area at that stage was in the large field beyond the motorway. The pilot would have been aware of the presence of the motorway, and the need to maintain height in order to clear it. The shortest route to the area would have required a right turn through about 20º, and it may be this was the reason the aircraft was seen to start a right turn. Unfortunately the aircraft slowed to a point where it stalled before the pilot could reach the open area.

**Conclusion**

The aircraft failed to achieve a safe height or speed after takeoff and stalled. The available evidence indicated that the pilot's takeoff technique was incorrect, in that he attempted to climb above obstacles under the takeoff flight path before accelerating the aircraft to a safe speed. The aircraft was correctly configured for takeoff, and there was evidence that the engine was operating normally.

The pilot was known to be diligent and conscientious, but it is unlikely that he sought professional advice on takeoff techniques applicable to the private strip, so he was probably unaware of the dangers associated with the takeoff technique he had adopted. Faced with a confusing and deteriorating situation so soon after takeoff, the pilot probably attempted to reach an open area beyond the M25 motorway, but the aircraft stalled before he could do so. Once the aircraft had stalled, there would not have been sufficient height to regain controlled flight.