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SPECIAL BULLETINS

None

COMMERCIAL AIR TRANSPORT

FIXED WING

ROTORCRAFT

None

GENERAL AVIATION

FIXED WING

ROTORCRAFT

None

CONTENTS (Continued)

SPORT AVIATION / BALLOONS

ADDENDA and CORRECTIONS

(ALL TIMES IN THIS BULLETIN ARE UTC)

SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A321-211, G-NIKO
No & Type of Engines:	2 CFM56-5B3/P turbofan engines
Year of Manufacture:	2000
Date & Time (UTC):	29 April 2011 at 0830 hrs
Location:	Manchester Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 8 Passengers - 223
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	45 years
Commander's Flying Experience:	13,050 hours (of which 2,255 were on type) Last 90 days - 73 hours Last 28 days - 13 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

The aircraft took off from Manchester Airport on a flight to Heraklion Airport, Crete. The sidestick control felt heavy as the PF rotated the aircraft and, after lift off, he noticed the Lowest Selectable Speed (VLS)[1] indication on his Primary Flight Display speed-scale increasing. He reduced the aircraft's pitch attitude and the airspeed increased. The aircraft was then able to resume a climb.

The Zero Fuel Mass (ZFM) had been used instead of the Actual Take Off Mass (ATOM) for the takeoff performance calculations before departure and the Flight Management System (FMS) had been programmed with the incorrect speeds.

History of the flight

The flight crew reported at Manchester Airport at 0720 hrs for a scheduled two-sector duty to Heraklion, Crete and return, departing at 0820 hrs. The flight crew were operating an Airbus A321 aircraft but more often flew the smaller A320. The commander was designated as PF for the first sector.

Footnote

[1] The Airbus Flight Crew Operating Manual description of VLS is: *'The top of the amber strip along the speed scale indicates this speed. It represents the lowest selectable speed providing an appropriate margin to the stall speed. VLS information is inhibited from touchdown until 10 seconds after liftoff.'*

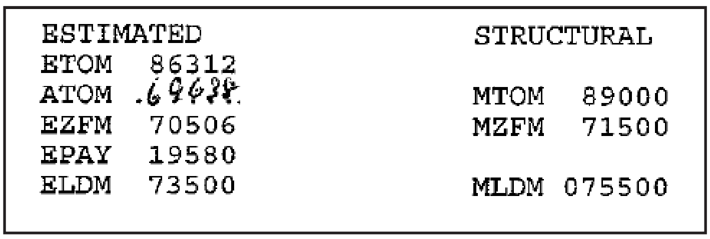
The weather conditions at Manchester were: surface wind from 040°M at 12 kt, temperature 12°C, dewpoint 7°C and pressure 1016 HPa. Runway 05L, with a TODA of 3,245 m, was in use for departures.

The loadsheet was generated by the handling company at 0837 hrs, 17 minutes after the scheduled departure time. The commander accepted the loadsheet from the dispatcher and checked it. While he was doing so, the co-pilot asked him for the takeoff weight so that he could begin the performance calculations. The commander read out what he thought was the Actual Take Off Mass (ATOM) but mistakenly read out the Zero Fuel Mass (ZFM) of 69,638 kg. The commander then wrote down that figure in a space provided on the navigation log for the ATOM (see Figure1). The Standard Operating Procedure (SOP) then required him to compare the Estimated (E)TOM, on the line above, with the ATOM. However, he actually compared the figure he had written down as the ATOM (69,638) with the EZFM on the line beneath.

The commander next entered some data into the FMS, which included entering the ZFM from the loadsheet in the INIT B page. The ZFM is a mandatory pilot entry which allows the FMS to compute TOM, speed management and predictions. The pilot cannot enter the TOM directly. The loadsheet was passed to the co-pilot who checked it and confirmed that it matched the commander's entry in the FMS.

The commander then used the figure which he had incorrectly written on the navigation log as the ATOM (69,638 kg) to perform his takeoff calculation. The SOPs required each pilot to carry out a takeoff performance calculation separately. In order to do this, the ATOM figure is taken from the loadsheet and each pilot uses a laptop computer on which to carry out the calculation. The calculations are compared and the takeoff data, speeds, flex thrust, configuration and trim position, are entered into the FMS.

In this case, the laptop computer calculated the following speeds: V_1 = 131 kt, V_R = 134 kt and V_2 = 135 kt, using Flap 2, Flex[2] 57°C and a green dot[3] speed of 214 kt. (The figures that would have been generated by the laptop computer for the correct ATOM of 86,527 kg were: V_1 = 155 kt, V_R = 155 kt and V_2 = 156 kt, with Flap 2, Flex 39°C and a green dot speed of 240 kt.) The SOP required the crew



ESTIMATED		STRUCTURAL	
ETOM	86312		
ATOM	.69638.	MTOM	89000
EZFM	70506	MZFM	71500
EPAY	19580		
ELDM	73500	MLDM	075500

Figure 1

Navigation log weights section

Footnote

[2] Reduced thrust assumed temperature.

[3] The green dot appears when the aircraft is flying in the clean configuration. It shows the speed corresponding to the best lift-to-drag ratio.

to crosscheck the green dot speed generated by the laptop computer against that generated by the FMS. However, although they crosschecked the performance figures between the two laptops, the crosscheck with the FMS green dot speed was missed.

Before the aircraft departed, a Last Minute Change (LMC) addition of one male passenger plus bag (+89 kg) was made to the loadsheet. This did not require a recalculation of the takeoff performance data.

Later, when the aircraft took off from Runway 05L, the commander noticed that the side stick control felt heavier than expected at rotation and, as the aircraft lifted off, the Lowest Selectable Speed (VLS) indication moved "too far" up the speed scale.[4] He reduced the pitch attitude and covered the thrust levers in case more power should be required. The aircraft accelerated and climbed, but at a slower than normal rate. When the aircraft was in the cruise, the crew checked the performance figures and realised that they had used the ZFM instead of the TOM for the takeoff performance calculation.

Discussion

The aircraft took off using less thrust and lower reference speeds than were required. The effect of the attempted rotation at too slow a speed was noticeable to the PF through the feel of the aircraft and the displays on the speed scale. He responded by reducing the pitch attitude, which allowed the aircraft to accelerate to a safe climb speed.

The ATOM was 17,000 kg heavier than the figure used by the crew for their performance calculations. This had a significant effect on both the thrust and speed computations. There were a number of errors that occurred but the first was the misreading of the ZFM, instead of the TOM, by the commander, in response to the co-pilot's request for the takeoff weight. Thus, at this early stage both pilots were using incorrect data. Later, there were a number of missed opportunities to detect the error through the SOPs. In particular, a crosscheck of the laptop computer green dot speed against the FMS calculated green dot speed should have highlighted a discrepancy. Direct entry of the TOM into the FMS is not possible and the TOM and green dot speed are computed from the ZFM entered by the pilot. Thus, the erroneous data entry into the laptop computer could not have been replicated in the FMS.

A takeoff with early rotation has the potential to cause a tailstrike, and a takeoff with inadequate thrust and speed could lead to a loss of control of the aircraft. The operator has highlighted this event to their flight crews through the issue of a Flight Safety Bulletin in order to stress the importance of accurate performance calculations. The operator has also made changes to the layout of the navigation log and to the SOPs concerning the crosscheck of the green dot speed.

Other events

There have been a significant number of reported incidents and several accidents, resulting from errors in takeoff performance calculations, around the world in recent years. There must also have been many similar events which were either unreported and/or unnoticed, some of which will have had the potential to cause accidents. Several studies of these events have been carried out, including the Australian Transport Safety Bureau (ATSB) Aviation Research and Analysis Report AR-2009-052, '*Take-off Performance Calculation and Entry Errors: A Global Perspective*', and the French Bureau d'Enquêtes et d'Analyses pour la sécurité de

Footnote

4 VLS is computed by the Flight Augmentation Computer using current angle of attack, speed, altitude, thrust, and CG.

l'aviation civile (BEA) Safety Study *'Use of Erroneous Parameters at Takeoff'*. The overall conclusions are that they occur irrespective of the airline or aircraft type, and the causes of the errors have many different origins. Many errors which occur are successfully detected but there is no single solution to ensure that such errors are always prevented or captured.

Industry awareness of the frequency of these errors has been raised but a solution has yet to be found. There have been some studies into the feasibility of a technological solution, namely Takeoff Performance Monitoring Systems (TPMS). These systems operate on the principle of satisfactory aircraft acceleration and would provide an alert to the flight crew if a takeoff was not progressing as expected. The AAIB made two Safety Recommendations concerning takeoff performance monitoring systems in the report on an incident involving G-OJMC (AAIB Bulletin 11/2009). Safety Recommendation 2009-080 stated:

> It is recommended that the European Aviation Safety Agency develop a specification for an aircraft takeoff performance monitoring system which provides a timely alert to flight crews when achieved takeoff performance is inadequate for given aircraft configurations and airfield conditions.

Safety Recommendation 2009-081 stated:

> It is recommended that the European Aviation Safety Agency establish a requirement for transport category aircraft to be equipped with a takeoff performance monitoring system which provides a timely alert to flight crews when achieved takeoff performance is inadequate for given aircraft configurations and airfield conditions.

The European Aviation Safety Agency has not yet accepted these Safety Recommendations but they are under consideration.

SERIOUS INCIDENT

Aircraft Type and Registration:	ERJ 190-200 LR Embraer 195, G-FBEJ
No & Type of Engines:	2 General Electric Co CF34-10E7 turbofan engines
Year of Manufacture:	2007
Date & Time (UTC):	27 June 2011 at 1835 hrs
Location:	Southampton Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 5 Passengers - 24
Injuries:	Crew - None Passengers - None
Nature of Damage:	Air conditioning pack failure
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	62 years
Commander's Flying Experience:	15,500 hours (of which 371 were on type) Last 90 days - 131 hours Last 28 days - 55 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent AAIB enquiries

The aircraft had departed with a single air conditioning pack operating, as permitted by the Minimum Equipment List. When passing FL100, the flight crew noticed smoke and a strong sulphurous smell in the flight deck. They donned oxygen masks, declared a PAN and elected to return to Southampton. After approximately five minutes the smoke and smell had cleared and the aircraft landed without further incident.

It was subsequently identified that the operable pack had failed in flight. It was returned to the manufacturer for investigation. Strip inspection of the unit revealed that the second stage turbine rotor had failed, resulting in seizure of the rotor. This is a known failure mode caused by a resonance condition in the second stage turbine. Service Bulletin SB 190-21-0029 was issued on 26 April 2010 to incorporate a modified turbine with more nozzle vanes to eliminate the damaging resonance. To date no modified packs have experienced a second stage rotor failure.

This pack had not been modified. As there is already a Service Bulletin in place to prevent such failures, no additional safety action is proposed.

SERIOUS INCIDENT

Aircraft Type and Registration:	Gulfstream G150, D-CKDM
No & Type of Engines:	2 Honeywell TFE731-40AR turbofan engines
Year of Manufacture:	2007
Date & Time (UTC):	6 February 2011 at 1317 hrs
Location:	Royal Air Force Northolt Airport, London
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 2 Passengers - 3
Injuries:	Crew - None Passengers - 1 (Minor)
Nature of Damage:	Fire damage to left brakes and tyres, left and right brakes seized
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	32 years
Commander's Flying Experience:	1,750 hours (of which 490 were on type) Last 90 days - 54 hours Last 28 days - 15 hours
Information Source:	AAIB Field Investigation

Synopsis

A takeoff was attempted from Runway 25 at Northolt Airport, London. When the commander pulled the control column back to rotate at rotation speed, V_R, and subsequently fully back, the aircraft only pitched up to 1º. The takeoff was rejected just before V_2, full braking was applied and the aircraft came to a stop at the end of the paved surface. A fire broke out around the left mainwheels which was suppressed quickly by the Rescue and Fire Fighting Service (RFFS).

The flight data showed that the aircraft's acceleration during the takeoff roll was below normal but the investigation did not reveal any technical fault with the aircraft. The most likely explanation for the lack of acceleration and rotation was that the brakes were being applied during the takeoff, probably as a result of inadvertent braking application by the commander, which caused a reduction in acceleration and a nose-down pitching moment sufficient to prevent the aircraft from rotating. However, it could not be ruled out that another factor had caused partial brake operation.

One Safety Recommendation is made, concerning the provision of flight data recorder conversion information.

History of the flight

The aircraft had been parked at Northolt for three days following a flight from Moscow Vnukovo Airport on 3 February 2011. There were no problems reported by the inbound crew and there were no items outstanding in the technical log.

On 6 February 2011 the flight crew of two pilots arrived to prepare the aircraft for a flight to Moscow. The pre-flight checks were carried out by the commander, who was also to be the pilot flying (PF) for the sector. All the checks were completed satisfactorily.

There were two passengers for the flight and a cabin attendant, who was not trained as a crew member, was also on board. When the passengers arrived they boarded the aircraft and the engines were started. Taxi clearance was obtained and the aircraft taxied off the apron, via Taxiway B, and backtracked to line up on the threshold of Runway 25 (Figure 1). The crew carried out the taxi checks, pre-takeoff checks and a briefing before departure.

The commander, in his briefing, noted that he would be using a static takeoff procedure, because of the relatively short runway length. The technique was to hold the aircraft on the toe brakes until full takeoff power had been achieved, and then to release the brakes.

The aircraft was held at the threshold for about two minutes, waiting for departure clearance to be issued, after which the takeoff commenced. The takeoff roll appeared normal to the crew and the standard calls and actions were made. On the call of rotate the commander started to pull back but there was no response from the aircraft. He pulled further back until the column was

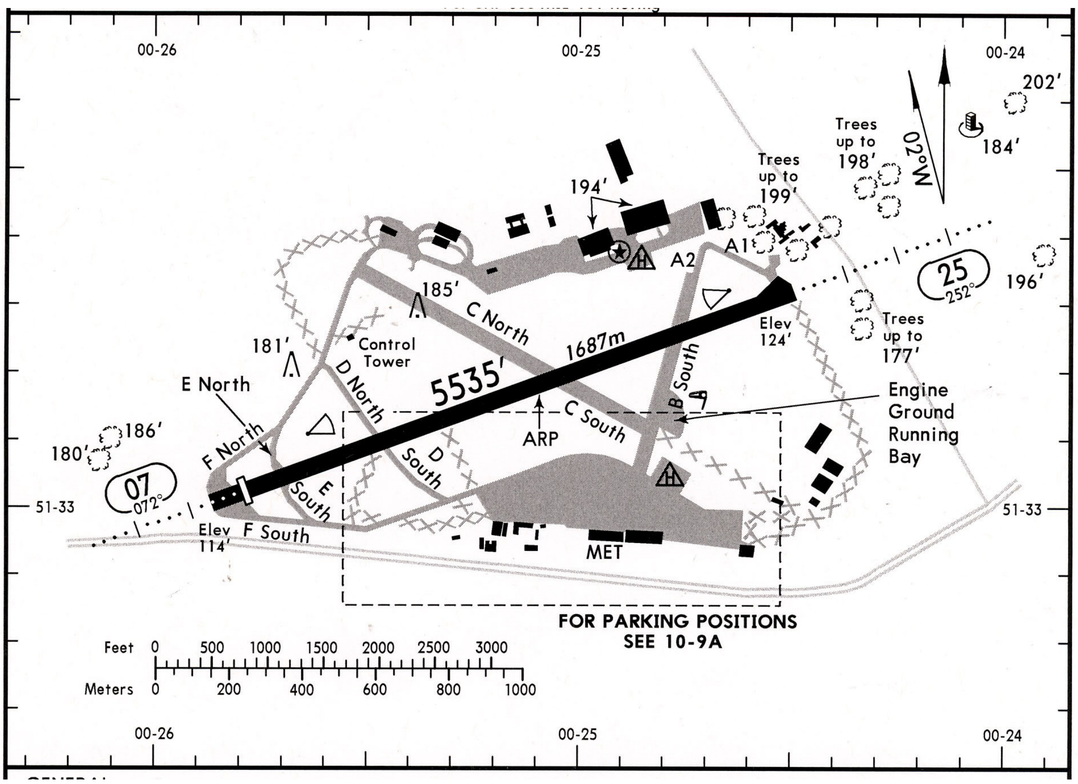


Figure 1

Northolt Airport

in the full aft position and still there was no rotation apparent. The aircraft was approaching the V_2 speed of 129 kt and the commander made an exclamation about the lack of rotation. The pilot not flying (PNF), seeing that the control column was fully back and realising that the aircraft would not rotate, retarded the thrust levers. Both pilots applied the brakes. The commander realised that there was not much runway remaining and used the tiller to steer to the right hand side of the runway before turning sharply left. The aircraft came to a stop at the end of and to the left side of the runway, on a heading of approximately 150°M.

After coming to a stop the commander made one attempt to taxi clear of the runway but the aircraft would not move. He then saw through his side window that there was smoke coming from the left mainwheels. The cabin attendant tried to open the entry door to evacuate the passengers but was not able to do so and the commander went back to assist. He opened the door, evacuated with the passengers and ensured that they moved clear of the aircraft. The PNF remained on board and completed the shutdown of the aircraft before leaving. As he exited, the fire service vehicles arrived and the fire was suppressed quickly. One passenger suffered a twisted ankle while disembarking from the aircraft.

The fire service vehicles had received the emergency call from ATC and deployed along the runway behind the aircraft. The driver of one vehicle observed that it was after the aircraft had come to a stop that a fire started around the left mainwheels.

Initial on-site examination of the aircraft

The aircraft had come to rest about 5 m from the end of the paved surface of Runway 25, orientated approximately 90º to the left of the runway centreline (Figure 2). The left main gear tyres and brakes had suffered fire damage (Figure 3). The left outboard tyre had two flat spots and had deflated as a result of a blown fuse plug, while the right main gear tyres were in good condition. The brake assemblies on both the left and

Figure 2

Final position of D-CKDM, about 5 m from the end of the paved surface of Runway 25 right main gear had seized so it was not possible to taxi or tow the aircraft. In order to tow the aircraft to a hangar the left main gear was jacked and lowered onto a trolley, while the seized brake disks and rotors from the right main gear were removed.

Personnel information

The commander had positioned to the United Kingdom on the day before the incident and the co-pilot had arrived at London Heathrow earlier in the morning. Neither pilot had operated from RAF Northolt previously. The pilots had flown together as a crew on many previous occasions but with their roles reversed.

The commander had recently completed his qualification to fly as Pilot in Command on type and this was his first flight as commander. His conversion training had all been conducted in D-CKDM and during the training and flight test he had completed 12 flight sectors occupying the left-hand seat. This flight was his first since the completion of his training.

The co-pilot, who was also a qualified captain on the type, had a total of 2,950 hours of flight time, 400 of which were on G150 aircraft.

The cabin attendant was on board to assist with the passengers and was not trained as a crew member.

Ground manoeuvring technique

The aircraft can be steered on the ground using the rudder pedals or the tiller. When using the rudder pedals the commander's technique was to place his feet on the pedals with his heels clear of the floor, so that the rudder was operated with the heels and the brakes by flexing forward the toe end of the foot. When taxiing he used the hand tiller for steering, keeping his feet in position on the rudder pedals. During the takeoff roll he maintained directional control using the rudder pedals, and guarded the tiller with his left hand up to a speed of 80 kt.

The commander reported that on some previous occasions he had inadvertently applied some brake while

Figure 3

Fire damage to the left main gear tyres and brakes (view looking forward); flat spot on left tyre taxiing but that it was immediately obvious to him as the deceleration was noticeable. He also commented that the contact with the pedal under his foot could be felt.

The co-pilot reported that his customary technique as PNF in the right-hand seat was to rest his feet flat on the floor and clear of the pedals and he stated that he was doing this during the incident takeoff. When operating as PF in the left-hand seat he would use the tiller for steering while taxiing and also for the initial part of the takeoff roll. His feet would be positioned so that the ball of the foot rested on the lower part of the pedal (the rudder bar) with the heels on the floor, unless braking was required in which case he would lift his feet up so that he could apply the brakes.

Aircraft information

Description of the aircraft

The Gulfstream G150 is a small business jet with a maximum takeoff weight of 26,100 lb. It first entered service in 2006 as a variant based on the G100 which was formerly known as the Astra SPX. D-CKDM was configured with seating for 2 pilots and 7 passengers. The aircraft has conventional mechanical elevator and rudder controls (with no hydraulic assistance), hydraulically-assisted ailerons and a horizontal stabiliser that is electrically actuated for trim.

The nosewheel steering can be controlled using the rudder pedals or the hand-wheel tiller. The rudder pedals can steer the nosewheel up to 3° left or right of centre, while the tiller can command up to 60° left or right of centre. The takeoff technique from the left-hand seat requires the co-pilot to hold the control column up to a speed of 80 kt, allowing the PF to use the tiller if required, and then for the PF to take over.

The braking system consists of four brake assemblies, one per mainwheel, which are operated by applying force to the top of the rudder pedals. The pedals mechanically actuate a power brake valve (PBV) which transmits hydraulic pressure to the brake assemblies via antiskid valves. A parking/emergency brake lever in the cockpit actuates the PBV independently of the pedals and is used to set the parking brake or to apply emergency braking in the event of a loss of the main hydraulic system. When the parking brake is applied, a pressure switch in the return hydraulic line illuminates a PARKING BRAKE ON EICAS message and triggers a discrete parameter recorded by the FDR.

Each brake assembly consists of a pressure plate, back plate, three rotating disks, two stationary disks and six pistons. The brake housing contains two separate hydraulic systems, each system actuating three of the six pistons. Under normal braking all six pistons are actuated, while under emergency braking or when applying the parking brake only three pistons are actuated. When hydraulic pressure is applied to the brakes, the pistons contact the pressure plate and compress the disk stack against the back plate. When the brake pressure is released, four return springs pull the pressure plate from the stack, forcing the pistons back into the piston cavities.

Maintenance history

At the time of the incident the aircraft had accumulated 780 flying hours and 371 cycles. The aircraft's last maintenance was carried out between 18 and 25 January 2011 at 764 hours. This maintenance check did not involve any work on the flight control or brake systems. All four brake assemblies were last replaced on 8 September 2010 and had accumulated 74 cycles at the time of the incident.

According to the aircraft manufacturer their fleet data indicated that the average life of a brake assembly was 305 cycles, with a high of 880 cycles and a low of 15 cycles. They stated that the life of a brake assembly was very variable and was affected by pilot technique, the length of the runway and the weight of the aircraft. However, they did not have data to explain why a brake assembly on one aircraft only lasted 15 cycles.

Performance

The MTOW of this aircraft is 26,100 lb (11,838 kg). The weight and CG calculations were completed by the operator's dispatch office and forwarded to the flight crew. The operator's calculations showed a takeoff weight of 24,228 lb and a CG of 32.96% mean aerodynamic chord (MAC). These figures were used to determine the required stabiliser trim position, which was -5.5°. Final weights, based on the number of passengers and bags loaded, were entered by the crew into the aircraft's flight management system (FMS) prior to flight. The FMS is fully integrated in the operation of the aircraft and provides V speeds and performance computations. The speeds calculated for the takeoff were V_1 118 kt, V_R 122 kt and V_2 129 kt.

The takeoff weight and CG were recalculated during the investigation as 24,417 lb and CG of 36.48% MAC. The revised figures took into account the actual passenger seating positions and the pilot's estimate of the amount of baggage in the baggage bay. These figures gave a stabiliser trim position of -4.3°; there was no change to the speeds. The balanced field length for this weight under the prevailing conditions was 4,555 ft and these revised figures were used for the calculations of braking effects during the investigation.

Meteorological information

The weather conditions at the time of the incident were dry with a strong and gusting south-westerly surface wind. At the start of the takeoff the controller advised the crew that the surface wind was from 240° at 18 kt with gusts up to 30 kt. The pilots stated that during the takeoff roll, although the general conditions were gusty, the airspeed indications were reasonably steady.

The METAR observed at 1329 hrs, 12 minutes after the incident was: Surface wind from 240° at 17 kt, visibility 40 km, cloud broken at 2,400 ft, overcast at 3,000 ft, temperature 12°C, dewpoint 5°C and pressure 1019 hPa.

Airfield information

RAF Northolt is a military airfield which accommodates some civilian aircraft operations. Runway 25 at Northolt is 1,684 m (5,535 ft) in length and 46 m (151 ft) in width. There is an initial downslope from the start of the takeoff position and an overall average downslope of 0.18%. There are arrestor beds in the overrun of each runway. The RFFS are situated abeam the centre of the runway and are linked to ATC by an alarm system and telephone.

Flight recorders

The aircraft was equipped with a Flight Data Recorder (FDR) and a 120-minute Cockpit Voice Recorder (CVR). A complete record of the incident was available from the FDR and CVR. The FDR also contained a record of the previous eight flights.

Salient parameters from the FDR included airspeed, engine N1, engine thrust reverser positions, longitudinal acceleration, lateral acceleration, parking brake, pitch attitude, flap, slat, horizontal stabiliser and spoiler positions. Longitudinal acceleration was sensed by an accelerometer mounted near to the centre line of the aircraft and recorded at a rate of four times per second on the FDR. The parking brake parameter was recorded at a rate of once per second. When the parking brake handle is set to the PARK position and a hydraulic pressure of 200 psi or greater is applied to the brakes, the FDR indicates that the parking brake has been applied. With the parking brake handle set to the OFF position and a hydraulic pressure of 80 psi or less is applied, the parking brake parameter will be recorded as being off. The FDR system did not record the positions of the control column, control wheel, elevator, brake pressure or brake pedals.

The incident takeoff is shown in Figure 4. The engine start was normal and, having configured the aircraft for a flap 20° takeoff with stabilizer trim set to -5.45°, the parking brake was released and the aircraft taxied from the south side apron towards Runway 25. Shortly after releasing the parking brake and the aircraft having started to move, both the commander and co-pilot confirmed that they had checked the correct operation of the brakes. The aircraft entered Taxiway B South before being cleared to enter the runway and backtrack before being positioned for takeoff, near to the threshold of Runway 25. The flight crew did not refer to any problems whilst taxiing. Checklists were carried out, which included a full and free check of the flight controls.

Whilst waiting for departure clearance, the parking brake indicated that it was set to the ON position for a period of 7 seconds. This occurred about 80 seconds after the aircraft had come to a stop at the threshold and approximately 35 seconds prior to the commencement of the takeoff roll. The aircraft was subsequently cleared for takeoff. The commander having previously briefed that he would be carrying out a static takeoff, increased both engines to the maximum takeoff power of 91% N1 (Figure 4). Having confirmed that the engine power was set and the co-pilot was holding the control column, the commander advised "BRAKE RELEASE" and the aircraft started to accelerate. During the initial acceleration phase, the longitudinal acceleration remained predominantly stable at about 0.2 g, and as the airspeed reached 80 kt, the commander took over the control column. At about the same time, the longitudinal acceleration started to reduce, and at 119 kt (V_1), it had stabilised at just greater than 0.1 g. The aircraft was about 860 m from the end of the runway at this time. Approximately one second later, at an airspeed of 122 kt, the co-pilot called "ROTATE". Three seconds later, the commander confirmed that the aircraft was not responding to his control column input and two seconds later the thrust levers were closed, which was shortly followed by deployment of the airbrakes and the rapid deceleration of the aircraft. The flight crew stated that they had applied heavy manual braking at this time. During the five seconds between the rotate command and the rejection of the takeoff, the pitch attitude of the aircraft had increased by less than 2°, from about 1° nose-down to just less than 1° nose-up, and the airspeed had reached a maximum of 128 kt. About two seconds prior to closing of the thrust levers, the longitudinal acceleration had further reduced to nearly 0 g. The aircraft was about 570 m (± 40 m) from the end of the runway at this time.

As the aircraft decelerated, reverse thrust was applied and, approaching the end of the runway the aircraft made a left turn onto a heading of 150° before coming to a stop. The commander then attempted to taxi the aircraft from the runway, but the aircraft would not move. About two minutes later, just as the RFFS were arriving, the aircraft was evacuated when a fire was noticed around the area of the left wheel brake assembly. Both engines were also shut down at this time.

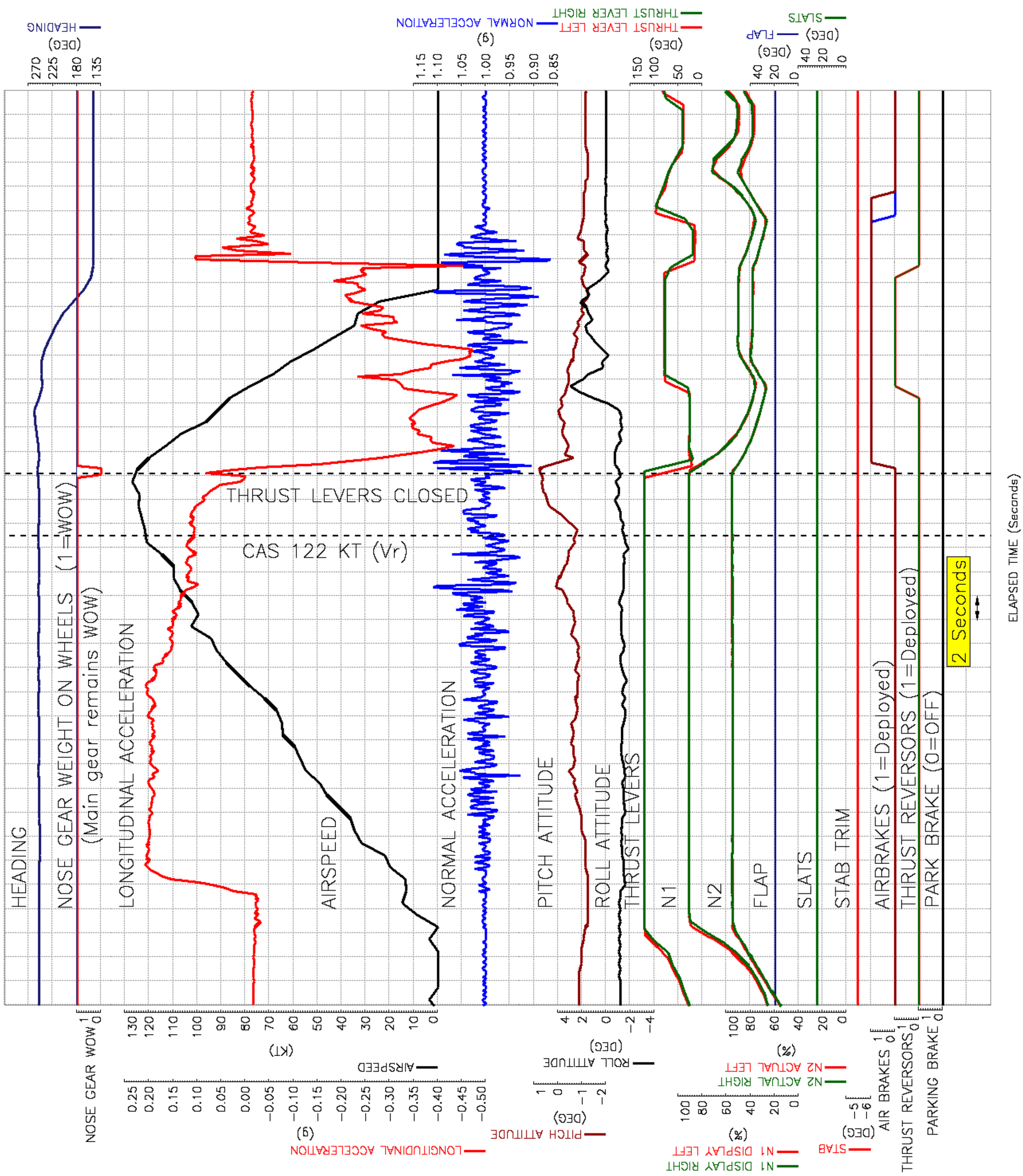


Figure 4

D-CKDM - Rejected takeoff at Northolt

Takeoff performance comparison

The aircraft's longitudinal acceleration profile during the incident takeoff run was compared with the eight previous takeoffs and the subsequent flight from Northolt (Figure 5). The takeoffs were confirmed as having used almost identical power settings as during the incident, of about 91% N1. Takeoff weights were obtained for all of the flights, with weights ranging from 26,023 lb to 17,502 lb. The takeoff weight of the incident flight was 24,417 lb. From the ten takeoffs, the incident takeoff run was found to have the lowest peak acceleration of about 0.2 g. The next lowest was 0.28 g, which was during the heaviest takeoff with the aircraft weighing 1,606 lb more than at the time of the incident. The highest longitudinal acceleration was 0.42 g which was recorded when the aircraft weight was at its lightest, weighing 6,915 lb less than at the time of the incident. Two of the takeoffs (one being from Northolt Runway 25) were within 958 lb of the incident takeoff weight (Figure 5). Both of these takeoffs had very similar acceleration profiles to each other, with similar peak longitudinal accelerations of about 0.3 g. Being of a similar weight and having used the same takeoff technique, aircraft configuration, runway and almost identical power settings to that of the incident takeoff, it may have been expected that the magnitude and acceleration profile of the subsequent takeoff from Northolt Runway 25 would have been very similar to that during the incident takeoff run. However, the aircraft accelerated about 0.1 g less during the incident takeoff run.

The manufacturer was provided with a copy of the FDR data. Their analysis concluded that the reduction in acceleration had been a result of the brakes being applied during the takeoff run.

FDR documentation requirements

Aircraft manufacturer

FDRs record binary data containing encoded parametric information. The binary data can then be converted to engineering units (knots, feet etc.) by referencing detailed documentation specific to the aircraft installation. The organisation most likely to possess the information and expertise required to generate such documentation is the aircraft manufacturer or the design organisation responsible for the FDR installation. To assist aircraft manufacturers or design organisations in producing such documentation, both the CAA and FAA have published guidance information within CAP 731 and AC20-141B respectively.

For aircraft issued with an EASA type-certificate, which includes the Gulfstream G150, Commission Regulation (EC) No 1702/2003 of 24 September 2003 Part 21 requirement 21A.61 '*Instruction for continued airworthiness*' states:

> *'(a) The holder of the type-certificate…shall furnish at least one set of complete instructions for continued airworthiness…to each known owner of one or more aircraft…upon issue of the first certificate of airworthiness for the affected aircraft…and thereafter make those instructions available on request to any other person required to comply with any of the terms of those instructions. …'*

Analysis and Safety Recommendation - FDR documentation requirements

The regulation quoted above does not explicitly reference FDR documentation and this is not reflected in any guidance material. However, correspondence with the CAA and EASA established that Part 21

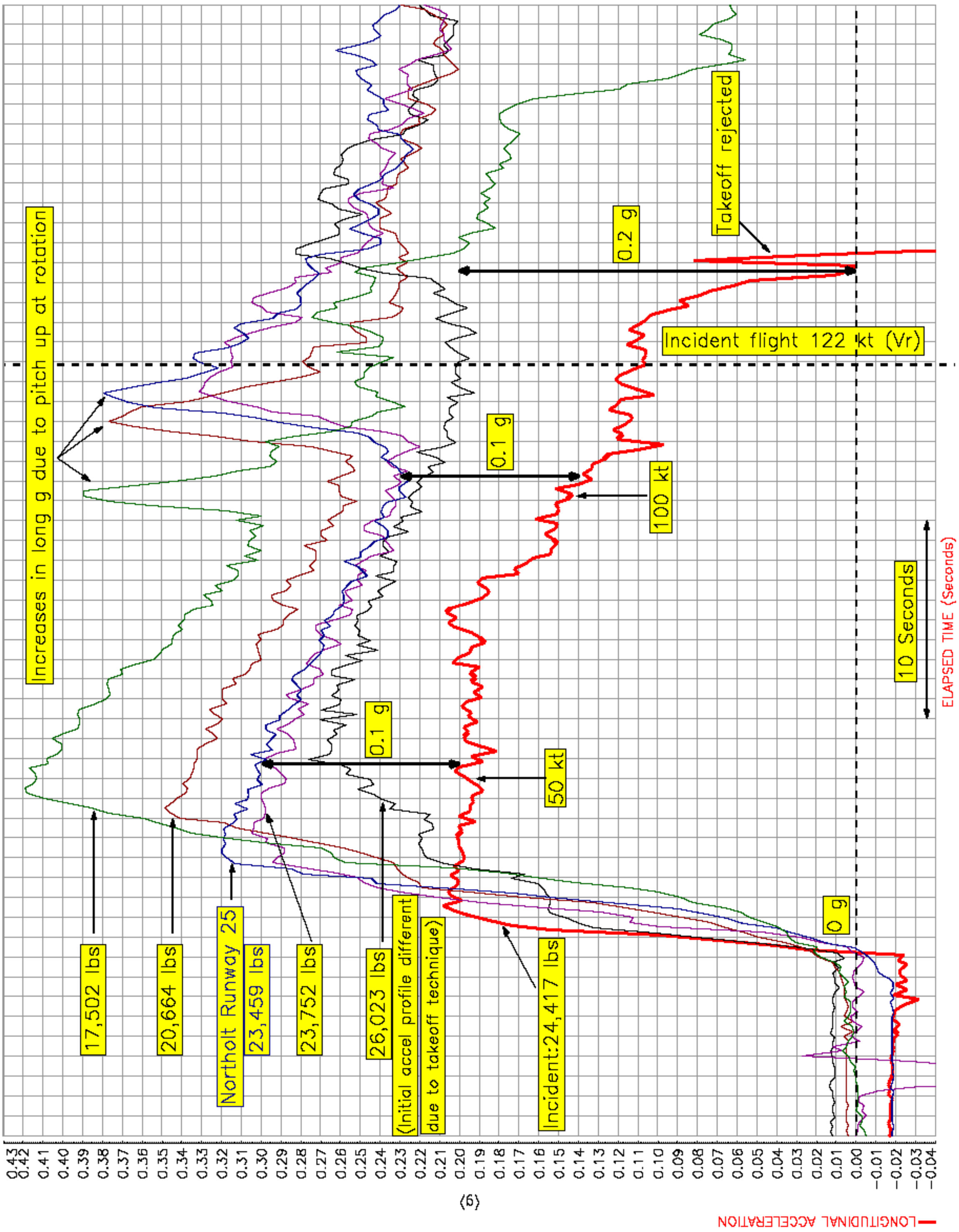


Figure 5

Comparison of incident takeoff with four previous takeoffs and subsequent takeoff from Northolt Runway 25 requirement 21A.61 implicitly includes the provision of FDR documentation that will enable the conversion of the binary record to engineering units. The same is true for requirements 21A.107 and 21A.120, which are applicable to holders of minor and major design change approvals respectively.

During the course of the investigation, the aircraft manufacturer provided five documents relating to the FDR system in D-CKDM. Following an initial delay, it was confirmed that a combination of three of the documents were required to enable the identification and conversion of parameters to engineering units. Further, the documentation was also found to contain anomalies such as conflicting information relating to the source of the normal acceleration parameter and the listing of parameters that were not recorded.

The accuracy of FDR documentation is fundamental to air safety investigation. Therefore, the following Safety Recommendation is made:

Safety Recommendation 2011-085

It is recommended that the Gulfstream Aerospace Corporation issue flight data recorder engineering unit conversion information for G150 aircraft in a single document that follows the guidance given in Federal Aviation Administration AC 20-141B and UK Civil Aviation Authority CAP 731.

Aircraft operator

Commission Regulation (EC) 859/2008, referred to as EU-OPS, provides common technical requirements and administrative procedures applicable to commercial transportation by aeroplane. EU-OPS 1.160, '*Preservation, production and use of flight data recorder recordings*', (a) (4) states:

'(4) When a flight data recorder is required to be carried aboard an aeroplane, the operator of that aeroplane shall:

…(ii) Keep a document which presents the information necessary to retrieve and convert the stored data into engineering units.'

ICAO Annex 6 (ninth edition) Appendix 8 '*FLIGHT RECORDERS*' 2.3.3 also states:

'2.3.3 Documentation concerning parameter allocation, conversion equations, periodic calibration and other serviceability/maintenance information shall be maintained by the operator. The documentation needs to be sufficient to ensure that accident investigation authorities have the necessary information to read out the data in engineering units.'

The operator of the aircraft was unable to provide the AAIB with the documentation necessary to enable the conversion of the FDR binary data to engineering units. The AAIB drafted a Safety Recommendation to the operator, therefore, to ensure retention of documentation to enable conversion of stored flight data recorder information into engineering units (as required by EU-OPS 1.160). However, it is understood that Triple Alpha Luftfahrt, the operator, filed for bankruptcy in July 2011 and ceased operations, so the Recommendation is not made.

Detailed examination of the aircraft

Flight control system examination

The elevator control system was tested and operated fully and freely. The maximum nose-up elevator deflection was measured at 22° which was within specification. Elevator and elevator tab free play checks were also carried out and found to be satisfactory.

The horizontal stabiliser was found set to -5° based on the index marks at the tail (full travel is -11° to +1°) and this corresponded to an indication of -5.5° on the digital stabiliser position display in the flight deck. This was within the normal green band for the takeoff flap setting of 20°. A complete operational check of the horizontal stabilizer was carried out in accordance with the maintenance manual and no faults were found.

Pitot-static system test

A pitot-static system calibration and leak check was carried out in accordance with the maintenance manual and all measurements were within the required tolerances.

Brake system examination

The rotors and stators of the brake assemblies had seized and were beyond repair so the assemblies were removed and replaced with new ones so that brake system functional checks could be carried out on the aircraft. A number of hydraulic fluid samples were taken and analysed, and although some contained very small particles, the aircraft manufacturer did not consider the levels unusual. The hydraulic filters were also examined and contained only very small particles. Following brake replacement the air needed to be bled from the system. Since this required allowing hydraulic fluid to drain from the brakes, there was a risk that any evidence of contamination inside the PBV could be lost during the flushing process. It was therefore decided to remove the PBV for a stand-alone bench test and strip examination, and to install a new PBV for the on-aircraft functional checks. With the new PBV and new brake assemblies installed all the brake system functional checks in the aircraft maintenance manual were carried out with no faults or anomalies found; these included testing the parking brake and emergency braking system.

The PBV passed all the functional checks when bench tested, and a strip examination did not reveal any evidence of internal contamination.

Brake assemblies examination

The brake assemblies were examined by the brake manufacturer. They determined that the steel disks had welded themselves together on all four brake assemblies, and they stated that it was not uncommon for steel brakes to weld themselves together following a high-speed rejected takeoff. The brake pistons were all extended as can be seen in Figure 6 where the left inboard brake assembly is compared to a new one. The left brake assemblies had suffered more heat damage than the right brake assemblies and this was attributed to the fire. The brake assemblies were leak tested which resulted in one piston on the left outboard brake assembly leaking with a constant flow at 1,500 psi. One piston on the left inboard brake assembly also started leaking with a constant flow at 1,250 psi. None of the right brake assembly pistons exhibited any leakage at 3,000 psi. The leaks were attributed to deformed O-ring seals. The manufacturer could not determine if the brakes were leaking before the stop, but based on the condition of the brake disks, which were deformed due to normal operating pressure and excessive heat, there had been sufficient heat generated to deform the seals and cause the leak during the stop or immediately after. The fire probably started when leaking hydraulic fluid made contact with the hot brake disks.

The manufacturer concluded that the damage, discolouration and deformation of the brake assemblies were typical and acceptable following a high-speed rejected takeoff.

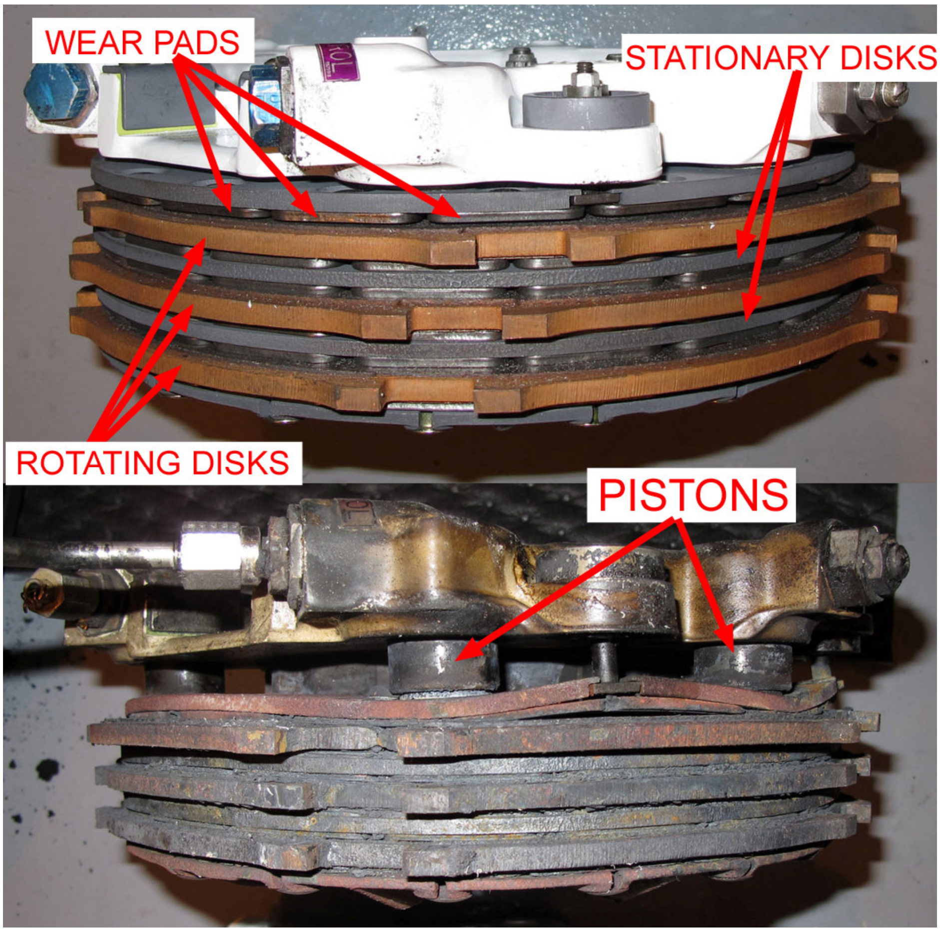


Figure 6

Comparison of new brake assembly (upper image) to the left inboard brake assembly from D-CKDM (lower image)

Brake pedal angle versus brake pressure

The relationship between brake pedal angle and brake pressure was measured using an inclinometer attached to a brake pedal and a pressure gauge attached to one of the brake assemblies. The aircraft was raised on jacks so that the initial brake resistance could be felt by trying to rotate the wheel by hand. The tests showed that at about 0.7° of pedal deflection the first resistance to rotation could be felt, with a brake pressure of about 100 psi. At about 0.9° of pedal deflection the wheels could no longer be rotated by hand and this equated to a brake pressure of 130 psi. At 0.9° of pedal deflection the top of the pedal was deflected by 2.8 mm. A pedal angle of 2° (6.3 mm pedal deflection) produced 380 psi. The maximum braking pressure of about 1,700 psi was achieved at 5.9° pedal angle (18.4 mm pedal deflection).

Post-incident taxi testing and test flight

Following the examinations, functional checks, and rectification work on the aircraft, a taxi test was carried out at Northolt by two of the manufacturer's test pilots. Multiple brake applications were made from speeds of up to 18 kt. The test pilots reported that the brakes operated normally with no tendency to stick. They noted, during the taxi tests, that a small amount of pedal deflection (feet lightly resting on the brake pedals) would produce a measurable reduction in taxi speed, but the braking effect was not necessarily perceptible to the pilot.

The aircraft then departed for a flight to Luton. The aircraft's weight was 23,459 lb, 958 lb below the incident takeoff weight and the aircraft accelerated and rotated normally (Figure 5).

Operator information

The aircraft was being operated in accordance with the operating company's AOC and Operations Manual. The company operated a number of other aircraft but commonly, as in this case, pilots were assigned to a specific aircraft. Both pilots had been flying D-CKDM for the previous few months. The owner of the aircraft was on board on the incident flight.

Other information

Brake pressure required to cause the reduction in takeoff acceleration

The aircraft's acceleration during the incident takeoff roll was significantly below normal for the aircraft's weight and the air temperature and pressure at the time. Compared to the aircraft's subsequent takeoff from Northolt under similar weight and weather conditions, the incident takeoff acceleration was about 0.1 g less at 50 kt and 100 kt (Figure 5) and about 0.2 g less at 128 kt just prior to the takeoff rejection. The engine data from the FDR revealed that the engines were performing normally, so the aircraft manufacturer calculated what brake pressure would have been required to explain the reduction in acceleration. It was determined that a reduction in acceleration of 0.1 g would have been caused by a brake pressure application of about 300 psi, between a groundspeed of about 5 kt and 100 kt. A reduction in acceleration of 0.2 g would have required a brake pressure of about 425 psi at 128 kt.

Brake pressure required to prevent rotation

Brake application causes a rearward force to be applied to the aircraft at the location where the tyre contacts the ground. Since this location is below the aircraft's centre of mass, brake application causes an aircraft nose-down moment. The aircraft manufacturer was asked to calculate what brake pressure would have been required to produce a nose-down moment high enough to counteract the nose-up moment caused by full nose-up elevator deflection, and thereby prevent rotation. They determined that a brake pressure of about 310 psi would be sufficient to prevent the aircraft from rotating at an airspeed of 128 kt, the maximum airspeed D-CKDM achieved.

Analysis

Recorded data

The examination of the recorded flight data showed that during the takeoff roll the aircraft's acceleration was about 0.1 g less than it should have been and, although the correct rotate speed was achieved, the aircraft did not rotate. The examination of the aircraft did not reveal any reason why the aircraft should not have been able to rotate and take off. The aircraft was configured correctly, its weight and balance were within limits, and there was nothing to restrict full nose-up elevator deflection. The stabiliser trim, although not accurately set for the actual weight and CG, would not have made a significant difference.

The only remaining factor that could have prevented the aircraft from rotating with full nose-up elevator at 128 kt was the application of some hydraulic brake pressure. Brake application causes a nose-down pitching moment and the manufacturer determined that 310 psi of brake pressure would have been sufficient to prevent the aircraft from rotating. Brake application would also explain the aircraft's lack of acceleration. About 300 psi of brake pressure would have resulted in a 0.1 g reduction in acceleration. Just prior to the takeoff being aborted, the aircraft's acceleration dropped to 0 g, about 0.2 g less than normal. This level of acceleration would have been caused by a brake pressure of about 425 psi, which is more than the brake pressure required to prevent rotation. These pressures assume symmetric braking on all four brake assemblies. The pilot did not experience any directional control difficulties so it is probable that symmetric braking was applied.

Examination of brake systems

Tests of the parking brake and emergency braking systems did not reveal any anomalies or tendency to stick. If the parking brake had been set during the takeoff roll a flight deck warning would have been triggered, based on the parking brake pressure sensor, and the FDR brake parameter discrete would have shown this. The brake assemblies were severely damaged in the incident so it was not possible to rule out a problem with the brake packs themselves, but it is unlikely that a failure of the brake packs would have occurred simultaneously on both sides to cause the symmetric brake application observed.

Tests showed that a pedal angle of only 2° was required to produce a brake pressure of 380 psi, which results in a 6.3 mm deflection of the upper part of the pedal. Thus, the pedals need only a relatively small deflection to produce the amount of brake pressure required to cause the reduced acceleration and prevent rotation. The manufacturer's test pilots noted that, during taxi, by resting the feet on the pedals some brake pressure could be applied, which was almost imperceptible but could be recognised by the reduction in expected taxi speed.

Reduced acceleration

The most likely remaining explanation for the lack of acceleration and rotation is that pressure was inadvertently applied to the brake pedals by one of the pilots. The co-pilot's technique was to keep his feet flat on the floor as PNF so it is unlikely that he touched the pedals during the takeoff. The commander's technique of holding the toes clear of the upper part of the pedals while placing the heels on the rudder bar allows the possibility that some pressure could have been applied to the brake pedal without his being conscious of it. When using this technique the foot position required to achieve steering without braking can be awkward, requiring the foot to be actively held up at an angle, and any change in the foot position could allow it to contact the pedal.

The static takeoff technique used was to apply full engine power before brake release. As the brakes were released there would have been a tendency for the aircraft to swing, so some steering inputs would have to be made. The commander reported that the tiller was not used during the initial part of the takeoff so it may be that while he maintained directional control with the rudder pedals some brake pressure was inadvertently applied and subsequently maintained. When the aircraft did not rotate as expected he pulled back fully on the control column. In doing so he may have used the pedals to gain extra leverage, thereby applying stronger brake pressure. At this time, between V_R and V_2, the data shows a significant reduction in acceleration.

Additional factors

There were some factors which could have acted to cause operational pressure on the crew. Although the commander had flown a number of sectors in the left-hand seat during training, this was his first flight in command of the aircraft and this represents an unusual circumstance. Other operational considerations were that the runway was relatively short and neither pilot was familiar with the airfield.

It is interesting to note that neither pilot noticed the lack of normal acceleration of the aircraft, even though the acceleration had reduced to nearly zero at one point. A particular aircraft's performance will be different for every takeoff and this demonstrates that pilots are not always able to judge how the takeoff is progressing.

The decision to reject the takeoff was made by the co-pilot. As the pilot monitoring he was probably in a better position to observe and assimilate the information that the aircraft was not performing as expected. The commander at the time would have been engaged in handling the aircraft and was probably confused by the lack of response to his control inputs.

The runway at Northolt is relatively short for this size of aircraft although the balanced field length for the conditions existing at the time of the incident was 1,000 ft less than the available runway. With the reduced acceleration of the aircraft, extra runway was used during takeoff and the remaining runway was too short a distance in which to stop. The action of turning the aircraft to the right, and then to the left, probably prevented the aircraft from running off the end of the paved surface.

The cabin attendant was not able to open the cabin door after the aircraft came to a stop. The door operated normally when opened by the commander, so it is probable that the cabin attendant, who was not trained as a crew member, was unable to open the door because of the unusual circumstances.

Future safety developments

Takeoff performance monitoring systems

In the D-CKDM incident the pilots had not detected that the aircraft's acceleration was significantly below normal. If a system could be developed, and certificated, to measure takeoff acceleration and compares it to expected values based on weight, pressure altitude and temperature, then it could provide an early warning to pilots that the takeoff is not progressing normally and may need to be aborted. In the D-CKDM incident the aircraft's below-normal acceleration was already apparent in the FDR data at a speed of 20 kt, so a warning in this event could have resulted in the flight crew performing a safer low-speed rejected takeoff. Such a system falls under the category of what is entitled a 'Takeoff Performance Monitoring System'. A more advanced system would also measure the aircraft's position and airspeed along the runway and predict if V_1 or V_R were likely to be achieved within a safe distance either to continue the takeoff or abort it.

On 14 October 2004 a cargo Boeing 747-200 (registration 9G-MKJ) departing from Halifax airport in Canada failed to become safely airborne and struck its tail against a concrete berm at the end of the runway, resulting in an accident that fatally injured all seven people onboard. The flight crew had used a reduced thrust setting that was too low for the takeoff weight, and although the aircraft's acceleration was below normal, the flight crew did not abort the takeoff or take action to increase thrust until it was too late. A report on this accident is available on the Transportation Safety Board of Canada's website (www.tsb.gc.ca, report number A04H0004). One of the safety recommendations made in the report is that:

'The Department of Transport, in conjunction with the International Civil Aviation Organization, the Federal Aviation Administration, the European Aviation Safety Agency, and other regulatory organizations, establish a requirement for transport category aircraft to be equipped with a take-off performance monitoring system that would provide flight crews with an accurate and timely indication of inadequate take-off performance.' (Recommendation A06-07)

The AAIB made two Safety Recommendations concerning takeoff performance monitoring systems in 2009. These followed from a serious incident involving an Airbus A330 (registration G-OJMC) departing from Montego Bay in Jamaica on 28 October 2008. In this incident the flight crew used a reduced takeoff thrust setting and 'V' speeds based on a takeoff weight of 120,800 kg when the actual takeoff weight was 236,900 kg. The flight crew perceived that the aircraft was accelerating normally, but when the commander pulled back on the stick to rotate the aircraft it 'did not feel right' to him, so he selected maximum thrust and the aircraft was able to climb away. Based on this incident and a number of other similar incidents highlighted in the AAIB report (Bulletin 11/2009), the AAIB made the following two Safety Recommendations:

It is recommended that the European Aviation Safety Agency develop a specification for an aircraft takeoff performance monitoring system which provides a timely alert to flight crews when achieved takeoff performance is inadequate for given aircraft configurations and airfield conditions. (Safety Recommendation 2009-080)

It is recommended that the European Aviation Safety Agency establish a requirement for transport category aircraft to be equipped with a takeoff performance monitoring system which provides a timely alert to flight crews when achieved takeoff performance is inadequate for given aircraft configurations and airfield conditions. (Safety Recommendation 2009-081)

The European Aviation Safety Agency has not yet accepted these Safety Recommendations but is considering them and has commented that an acceptable reliability of such a system has yet to be demonstrated. One aircraft manufacturer and one avionics manufacturer have also stated that they are investigating the feasibility of developing a Takeoff Performance Monitoring System.

ACCIDENT

Aircraft Type and Registration:	Acrosport 2, G-CGAK
No & Type of Engines:	1 Lycoming O-360 A1A piston engine
Year of Manufacture:	2010
Date & Time (UTC):	20 August 2011 at 1236 hrs
Location:	Duxford Airfield, Cambridgeshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to the right landing gear, wing and propeller. , engine shock-loaded
Commander's Licence:	Private Pilot's Licence
Commander's Age:	55 years
Commander's Flying Experience:	2,821 hours (of which 70 were on type) Last 90 days - 29 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and AAIB enquiries

Synopsis

Following a normal landing, the right landing gear collapsed during the ground roll as a result of a failure of the right landing gear cross-strut.

History of the flight

The pilot, who was also a flying instructor, made what he considered to be a normal "into wind" landing and during the ground roll the right landing gear collapsed.

The owner of the aircraft advised the investigation that in March 2011, approximately 15 flying hours and 20 landings prior to the accident, the aircraft landed firmly on the right main wheel. No damage was detected at the time, or during the subsequent pre-flight inspections, and the aircraft handled normally up to the time of the accident.

Description of main landing gear

The Acrosport 2 is equipped with a fixed main landing gear that incorporates a suspension unit in the cross-strut. During the landing the leg pivots outwards and the spring in the cross-strut compresses and absorbs the landing loads. See Figure 1.

The cross-strut consists of an inner tube, which is connected to the axle of the mainwheel, and an outer

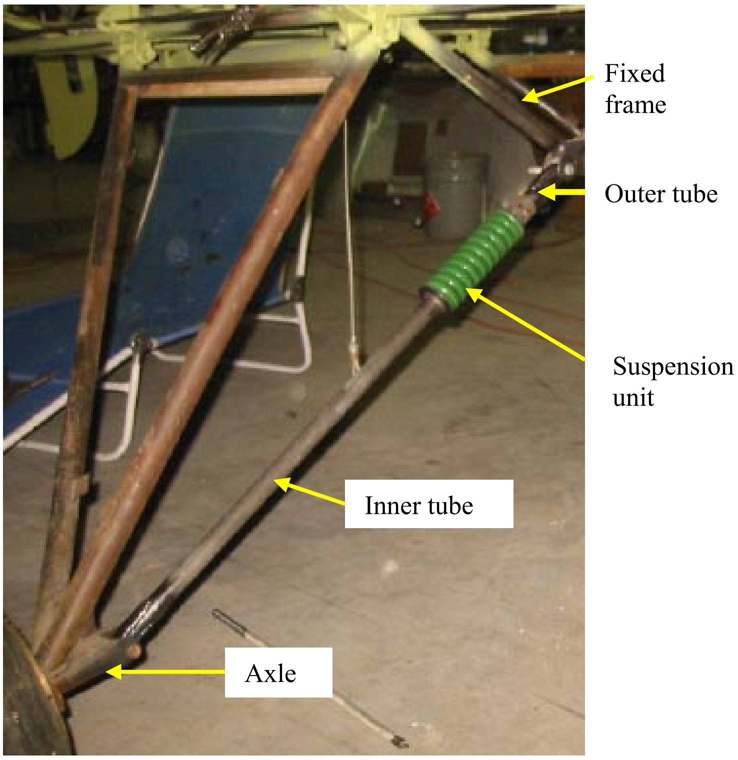


Figure 1

Right landing gear cross-strut

tube which is connected to a fixed frame at the fuselage. See Figure 2. A spring is fitted over the outside of the outer tube and is retained in place by a lower collar welded to the tube and an upper collar which is held in place by Bolt 'A'. Bolt 'A' passes through a slot in the outer tube and a hole in the inner tube and insert. As the landing leg moves outwards, the inner tube moves downwards causing the upper collar to compress the spring. On G-CGAK an insert had been welded in two positions into the end of the inner tube in order to increase the maximum 'tear out' force that the tube could sustain.

Damage to landing gear

Right cross-strut

The repair organisation reported that on the right cross-strut the welds securing the insert to the inner tube had failed, allowing the insert to separate from the inner tube. Additionally, Bolt 'A' had bent and pulled out of the end of the inner tube. See Figure 3.

Left cross-strut

While the left cross-strut and landing gear remained intact, there were a number of cracks on the side of the inner tube below the axis of the hole for Bolt 'A'. See Figure 4.

Comment

The damage to left and right inner tubes was consistent with the aircraft having landed heavily with Bolt 'A' on the right strut bottoming on the end of the slot in the outer tube. This damage could not have been sustained in the firm landing that occurred in March 2011 as it is unlikely that the right cross-strut would have remained intact during the subsequent flights.

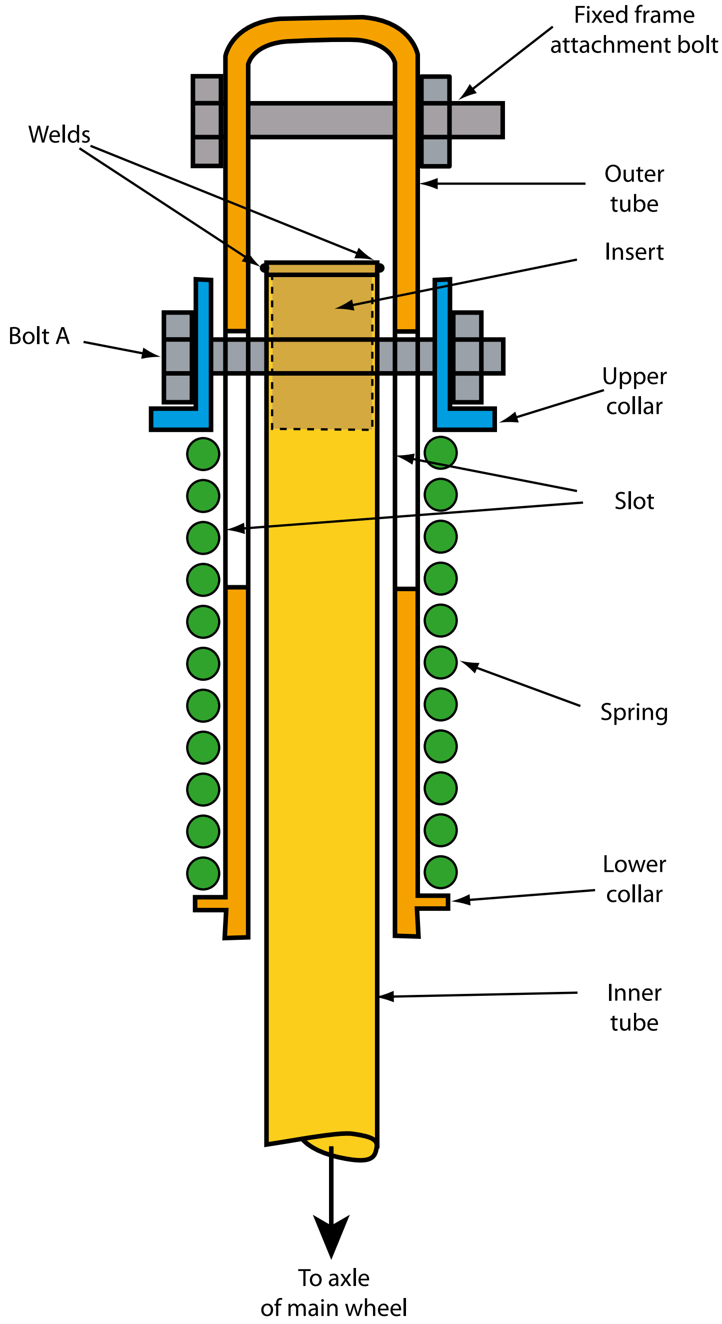


Figure 2

Schematic drawing of the cross-strut

It is a possibility that the right inner tube might have been damaged during the firm landing in March 2011, with Bolt 'A' having been partially torn out of the inner tube such that there was a reduced amount of intact metal left between the hole for Bolt 'A' and the end of the inner tube. This would have left the end of the inner tube in a weakened state and additional damage may have accumulated during the following landings. Eventually, the bolt would have been torn out of the end of the inner tube and the landing gear would collapse. It should be noted that following the firm landing it would not have been possible to identify damage at the end of the inner tube without first having disassembled the cross-strut.

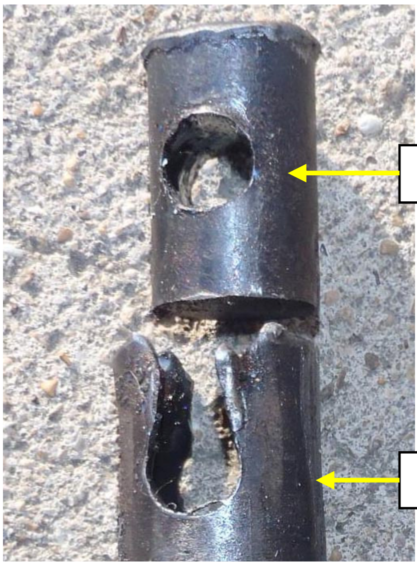


Figure 3

Right inner tube

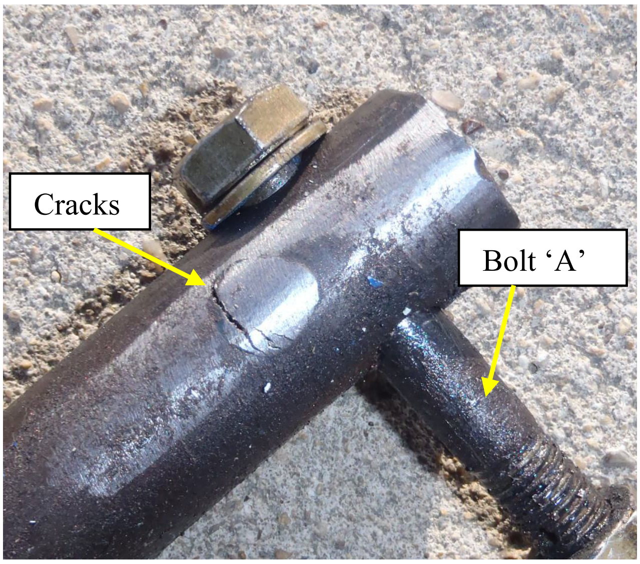


Figure 4

Left inner tube

The aircraft had only flown 32 hours since it had been built from plans and consideration was given to the possibility that the welds on the insert or the hole in the inner tube might not have been correctly formed. It is also possible that there might have been a defect in the material used to form the inner tube such that it was not strong enough to withstand the normal landing forces indefinitely. However, the AAIB was not presented with evidence to support or eliminate these possibilities.

ACCIDENT

Aircraft Type and Registration:	Alpi Pioneer 400, G-CGVO
No & Type of Engines:	1 Rotax 914-F piston engine
Year of Manufacture:	2011
Date & Time (UTC):	29 August 2011 at 1015 hrs
Location:	Shobdon Aerodrome, Herefordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Detached noseweheel, damage to propeller tips, paint damage and detached left door
Commander's Licence:	Private Pilot's Licence
Commander's Age:	67 years
Commander's Flying Experience:	1,551 hours (of which 43 were on type) Last 90 days - 21 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and additional AAIB inquiries

Synopsis

As the aircraft rotated during takeoff, the left-hand door suddenly opened and became detached. The aircraft landed heavily on its nose landing gear on the runway, resulting in the nosewheel breaking off and consequent damage to the propeller tips. The aircraft featured doors of a 'gull-wing' design and it is likely that there was insufficient engagement of the latching bolts with the door frame. The latching mechanism has subsequently been redesigned.

Aircraft details

The Alpi Pioneer 400 is a low-wing monoplane and is a four-seat development of the Pioneer series of aircraft, with access to the interior being via gull-wing doors, as opposed to sliding-canopy designs used on earlier models. The aircraft did not yet have a full Permit to Fly in the United Kingdom; progress towards this objective was being managed by the Light Aircraft Association (LAA) in conjunction with the CAA and, at the time of the accident, was being operated under a Permit Flight Release Certificate granted by the LAA. This enabled a programme of test flights to be undertaken.

History of the flight

Prior to the accident flight the aircraft had been loaded to within a few kilograms of its maximum all-up weight for the first time. The pilot stated that he had checked that the doors were secure but, just as the aircraft was rotating into the takeoff attitude, the left-hand door suddenly opened and detached from the aircraft. The pilot landed the aircraft back on the runway from a height of around 5 ft but the touchdown was initially on the nosewheel and was sufficiently heavy to cause it to break off. The propeller tips were damaged as the aircraft nose contacted the ground.

The aircraft had achieved a total of 12 hrs 50 mins total flight time over 23 flights.

The investigation

On this aircraft type, the cabin entry doors are made from carbon fibre with some internal foam stiffening; the windows are moulded Perspex. The gull-wing design entails each door being attached to the fuselage at the top edge by a hinge on an extension. In fact the hinge functions more as a ball joint, as there are no conventional hinge pins; thus there is a lack of rigidity in comparison to a door with two separate hinges. The door latching mechanism consists of three conical pins which emerge from the door frame at the front, lower centre and rear, operated by an over-centre handle. The three pins engage a blind, shallow hole in the front door post, a deeper hole in the rear post and an override plate on the door sill.

The detached left door was recovered from the runway and it was noted that the handle was in the closed position.

The aircraft was later examined by an LAA Inspector, who made several comments on the design of the door mechanism. These included the apparent limited engagement depth of the pins and the fact that the handle rotated through 90º as opposed to the more usual 180º. Also, the blind hole at the front appeared unnecessarily shallow, with the attendant possibility of a 'crippling' load being applied to the door in the event the pin 'bottomed out'.

The LAA reported that the aircraft manufacturer has redesigned the door latching mechanism to include significantly greater depth of engagement of the locking pins.

ACCIDENT

Aircraft Type and Registration:	Aquila AT01, G-GAEB	
No & Type of Engines:	1 Rotax 912-S3 piston engine	
Year of Manufacture:	2010	
Date & Time (UTC):	22 July 2011 at 1750 hrs	
Location:	Blackpool Airport, Lancashire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Damage to nose gear	
Commander's Licence:	Commercial Pilot's Licence	
Commander's Age:	50 years	
Commander's Flying Experience:	238 hours (of which 6 were on type) Last 90 days - 15 hours Last 28 days - 8 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The aircraft bounced twice during landing, damaging the nose gear. The pilot reported that she had omitted to set the propeller pitch to FINE and to select carburettor heat to OFF on finals, which led to a poor recovery from the first bounce. She had undertaken training on a Diamond Twinstar the previous month (for which these two actions are not required) and had low hours on the Aquila, both of which she believed were contributory factors to the accident.

ACCIDENT

Aircraft Type and Registration:	Avid Speedwing, G-RAFV
No & Type of Engines:	1 Jabiru Aircraft PTY 2200A piston engine
Year of Manufacture:	1992
Date & Time (UTC):	2 August 2010 at 1900 hrs (and 22 June 2010 at 1810 hrs)
Location:	Firs Farm, Leckhampstead, West Berkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to right landing gear, lower fuselage tubes, cockpit cross truss and wheel axles
Commander's Licence:	Private Pilot's Licence
Commander's Age:	54 years
Commander's Flying Experience:	408 hours (of which 22 were on type) Last 90 days - 14 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent form submitted by co-owner for previous event on 22 June 2010

Synopsis

On 2 August 2010 the aircraft ground looped during a landing at a farm strip. This had occurred previously, on 22 June 2010, to a co-owner. The pilot in the August event reported that only light lateral force was required for the tailwheel to castor freely, with weak centering springs making directional control difficult. With the mechanical problem rectified, the pilot reported the ground handling much improved. The accidents were not reported to the AAIB at the time as the two pilots did not appreciate that this is a statutory requirement.

History of the flight

On 2 August the pilot was returning to the Firs Farm airstrip after a local flight of circuit familiarisation, on an evening with light winds. He reports that the touchdown was uneventful, straight and well under control but then, whilst rolling out, he lost directional control of the aircraft, despite the stick being held fully back. A yaw to the right developed while the aircraft was still rolling at speed and as this tightened the aircraft left the strip. The ground loop ended abruptly when the aircraft ran into deep tractor ruts along the side of the runway and the right-hand landing gear collapsed, with further airframe structural damage. Both occupants exited safely through the pilot's door.

The pilot commented in his report that this was the second ground loop this aircraft had suffered in a few months. Investigation showed that only light lateral force was required for the tailwheel to "break out" and castor freely, with weak centering springs. This made directional control on the ground very difficult and that, with the mechanical problem rectified, the pilot reported that "the ground manners were much improved".

The previous event with this aircraft, while being flown by a co-owner, had occurred on 22 June 2010 at the same airstrip. On this occasion directional control had been lost at lower speed, about 20 kt, and the damage, which occurred when the aircraft encountered the tractor ruts to the right of the runway, was confined to the structure supporting the tailwheel.

Both accidents met the criteria for a '*Reportable Accident*' within the '*Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996*' but were not initially reported by the pilots to the AAIB. At the time of the subsequent Permit renewal for this aircraft, the LAA (Light Aircraft Association) brought this requirement to the owners' attention and they subsequently supplied completed accident report forms on both accidents to the AAIB.

ACCIDENT

Aircraft Type and Registration:	Beagle B121 Series 1 Pup, G-AXPM
No & Type of Engines:	1 Continental Motors Corp O-200-A piston engine
Year of Manufacture:	1969
Date & Time (UTC):	22 April 2011 at 1504 hrs
Location:	Panshanger Aerodrome, Hertfordshire
Type of Flight:	Private
Persons on Board:	Crew - None Passengers - None
Injuries:	Crew - N/A Passengers - NA
Nature of Damage:	Propeller, landing gear and wings damaged, engine shock loaded and wingtip of parked aircraft damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	62 years
Commander's Flying Experience:	681 hours (of which 377 were on type) Last 90 days - 7 hours Last 28 days - 6 hours
Information Source:	AAIB Field Investigation

Synopsis

Following a 50-hour check, the aircraft's ignition switch was left in the RIGHT position, with no key in the switch, due to the use of an incorrect key. During the next pre-flight inspection the pilot perceived that the ignition switch was in the OFF position. As he turned the propeller by hand, as required by the aircraft's EXTERNAL INSPECTION checklist, the engine started and ran at full power. The aircraft broke free of its tie-downs, struck a parked aircraft and crashed into an earth embankment. Safety action has been taken concerning the content of the aircraft's flight manual and service manual checklists.

History of the event

The aircraft had undergone a 50-hour maintenance check on the day preceding the accident. As the aircraft's maintenance organisation could not locate the ignition key for the aircraft, the engineer performing the inspection used another key, from a selection of spare keys that he kept. The 50-hour check included an engine ground run. After the ground run, the engineer withdrew the ignition key from the ignition switch whilst the switch was still in the RIGHT magneto position.

The following day the pilot arrived at the aircraft with the intention of making a local flight. The aircraft was parked on a hardstanding, secured by tie-downs to hard points under both the left and right wings. After removing the wheel chocks, fuselage cover and pitot tube cover, the pilot proceeded to follow the pre-flight inspection tasks as set out in the aircraft's approved flight manual EXTERNAL INSPECTION checklist (Figure 1):

The pilot looked through the aircraft's left cabin door at the ignition switch, saw that no key was present in the switch and perceived that the switch was in the OFF position. He then proceeded to check that the aircraft's parking brake was set to ON, carburettor heat set to COLD, the throttle set fully OPEN and the mixture was set to FULL RICH. The pilot then turned the engine through by hand. He did this by standing beside the propeller, facing rearwards on the right side of the aircraft, and pulling the propeller downwards with his right hand.

On the second propeller rotation, the engine fired and immediately ran at full power. As the pilot dived for cover beneath the right wing, the aircraft broke free from both of its wing tie-downs and accelerated away, in a westerly direction. After clipping the left wingtip of a parked Cessna 310, the aircraft crashed into an earth embankment approximately 200 m from its parking position, and came to rest nose-down in a ditch. It

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SECTION 6

NORMAL PROCEDURES

This section contains essential information on the handling characteristics of the aeroplane. A description of the aeroplane and its' systems will be found in Section 4 of this Handbook.

EXTERNAL INSPECTION

Cabin	-	check ignition OFF, brakes ON (handle pulled out and horizontal), throttle fully open, carb. heat cold and mixture FULL RICH
Engine	-	turn through at least four complete revolutions
External surfaces	-	check for damage, oil leaks, security of panels and cleanliness of windows and windscreen
Tyres	-	check for correct inflation, cuts, creep and oil damage
Brakes	-	check for security and oil leaks
Locks and covers	-	remove and stow
Steering arm	-	remove from nosewheel and stow

Note : If required, the stall warning device may be checked by switching ON the battery master switch, lowering the flaps and moving the vane of the stall warning detector up and down to ensure that the warning horn sounds.

Figure 1

Beagle B121 Pup Series 1 EXTERNAL INSPECTION checklist (AAIB highlights) sustained significant damage to its propeller, landing gear and wings in the accident.

The pilot did not receive any injuries. Following the accident, he took photographs of the ignition switch in an undisturbed state and also after he had used his own key to turn the ignition switch to the OFF position (Figure 2).

Inspection of the ignition switch

The ignition switch was recovered from the aircraft for further inspection, in addition to the key used by the maintenance engineer who completed the 50-hour check, and the owner's ignition key. It was found that by using the maintenance engineer's key, it was possible both to rotate the ignition switch fully, and also to withdraw the key from the switch with the switch in any of the OFF, RIGHT, LEFT or BOTH positions.

When the pilot's ignition key was tested in the switch, it was also possible to rotate the switch fully, but it was only possible to withdraw the key from the switch in the OFF position, which is the design intent.

The ignition switch was disassembled for further inspection and no internal faults were discovered.

Aircraft information

The Beagle B121 Pup Series 1 is a low-wing monoplane, powered by a single Continental O-200-A piston engine. It was certified in the United Kingdom in March 1968, to BCAR Section K airworthiness requirements. There are currently 54 Beagle B121 Pup aircraft on the UK register, and most of these aircraft entered service between 1967 and 1970. Later Series 2 and 3 of Beagle B121 Pup are similar in most respects to the Series 1, apart from the type of engine installed. All series of the aircraft are equipped with an electric starter motor, and it is usual to start the engine using this.

The current version of the EXTERNAL INSPECTION checklist for the Beagle B121 Pup Series 1, contained in section six of the approved flight manual, (document B. S. 3/1, Figure 1), was last revised in January 1974. The current revisions of the flight manuals for Series 2 and 3 of Beagle B121 Pup also contain similar EXTERNAL INSPECTION checklist instructions.

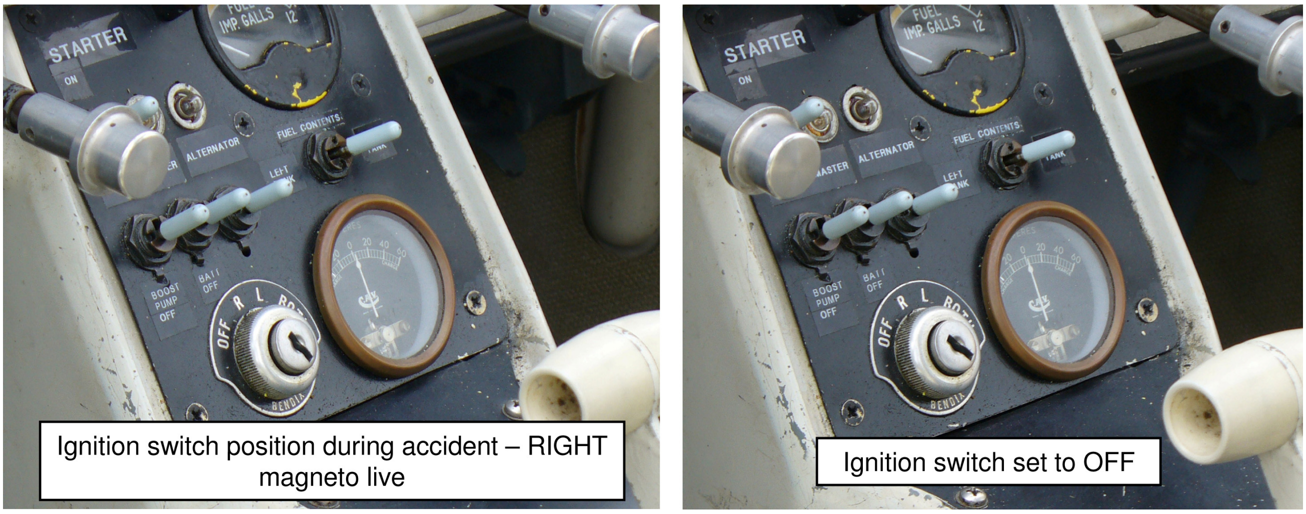

Figure 2

Ignition switch positions during and after the accident

The service manual applicable to all series of the aircraft (document 121/02/3-68) was last amended, to A.L. 10, in June 1969. The service manual PRE-START CHECKS checklist contains similar instructions to the flight manual in relation to turning the propeller by hand, with the mixture set to FULL RICH and the throttle set fully OPEN.

Airworthiness control of the Beagle B121 Pup

All series of Beagle B121 Pup aircraft are currently classified by the EASA as 'Orphan Aircraft', as they are not supported by a Type Certificate holder with a valid Design Organisation Approval. The Type Certificate for these aircraft has therefore been replaced by an EASA Specific Airworthiness Specification, and they are individually issued with an EASA Restricted Certificate of Airworthiness. Due to its orphan aircraft status, any continued airworthiness actions deemed necessary for the Beagle B121 Pup aircraft are directly controlled by the EASA.

Lack of previous occurrences

The AAIB's records were checked for previous occurrences of uncommanded engine starts on Beagle B121 Pup aircraft, but none were recorded. A commercially available pilot's checklist for the aircraft was purchased, to compare against the aircraft's approved flight manual. The commercial checklist's EXTERNAL CHECKS did not contain any instructions relating to setting the aircraft's throttle or mixture controls, nor did it require the propeller to be rotated by hand.

Two other pilots who were familiar with the Beagle B121 Pup were consulted in regard to their pre-flight inspection procedures for this aircraft type. Both pilots confirmed that during pre-flight inspections of the aircraft, they set the mixture to IDLE CUT-OFF and the throttle to CLOSED.

Analysis

The accident occurred because the propeller was rotated whilst the right magneto was live, despite no key being present in the ignition switch. When the pilot visually checked the ignition switch by looking into the cockpit from the left cabin door, he confirmed that no key was in the switch but parallax error made it difficult to differentiate between the RIGHT and OFF switch positions. In addition, the lack of a key in the switch reinforced the pilot's perception that the switch was in the OFF position, as this is what he had become accustomed to expect during seven year's ownership of the aircraft.

The aircraft's EXTERNAL INSPECTION checklist required that the pilot configured the aircraft in a state in which the engine would start, and run at full power, if for any reason the propeller was rotated whilst ignition system was live. In this respect, the checklist design was a dormant failure. It required a single breach of the only available defence – reliance on the ignition system being OFF – to create the dangerous situation where the engine would start, and run at full power, after being turned over by hand.

The cause of the ignition being left in a live condition in the accident was the use of an incorrect key by the maintenance engineer sustituting for the correct key. However, a similar hazardous condition could have arisen in the case of a broken magneto primary lead, or an internal electrical fault in a magneto.

It is likely that the lack of previous similar accidents is partially due to the use of commercially available checklists that do not contain pre-flight inspection tasks that place the engine in a configuration to start, when rotated by hand, in the event of a live ignition system.

Safety action

Following the discovery of deficiencies in the aircraft's EXTERNAL INSPECTION checklist, the UK support organisation for the aircraft prepared suitable amendments to the approved flight manuals for all series of Beagle B121 Pup. These were submitted to the EASA using the Form 36 procedure (*Application for Approval of a Stand-Alone or Minor Change Related Revision of Flight Manual*), and were accepted. The revised flight manual pages were promulgated to aircraft owners in September 2011. Amendments to the aircraft's service manual PRE-START CHECKS are currently in the process of being approved by the CAA.

ACCIDENT

Aircraft Type and Registration:	Cessna 120, G-BUJM
No & Type of Engines:	1 Continental Motors Corp C85-12F piston engine
Year of Manufacture:	1946
Date & Time (UTC):	30 July 2011 at 1105 hrs
Location:	Yeovilton Airfield, Somerset
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Left mainwheel, tailwheel mounting, right landing gear mounting
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	9,870 hours (of which 3 were on type) Last 90 days - 55 hours Last 28 days - 10 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

After a normal approach and touchdown in a headwind of 8-10 kt, considered normal by the pilot, the aircraft yawed to the right. The pilot and instructor applied full left rudder and left brake but the aircraft continued to yaw right, stopping after approximately 270° of right yaw. Both occupants were wearing a lap and diagonal harness and were uninjured.

ACCIDENT

Aircraft Type and Registration:	Cessna 182F Skylane, G-ASLH
No & Type of Engines:	1 Continental Motors Corp O-470-R piston engine
Year of Manufacture:	1963
Date & Time (UTC):	28 July 2011 at 1320 hrs
Location:	Bourn Airfield, Cambridgeshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to nose gear, propeller and engine
Commander's Licence:	Private Pilot's Licence
Commander's Age:	69 years
Commander's Flying Experience:	111 hours (of which 15 were on type) Last 90 days - 9 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft touched down heavily and bounced. The pilot considered that he was too high on the approach and his rate of descent rate was too high.

ACCIDENT

Aircraft Type and Registration:	Cessna U206A Super Skywagon, G-ATLT
No & Type of Engines:	1 Continental Motors Corp IO-520-F piston engine
Year of Manufacture:	1966
Date & Time (UTC):	23 July 2011 at 0815 hrs
Location:	Grindale Airfield, near Bridlington, Yorkshire
Type of Flight:	Aerial Work (Parachuting)
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to the right wing outer main spar and associated wing structure
Commander's Licence:	Private Pilot's Licence
Commander's Age:	66 years
Commander's Flying Experience:	1,330 hours (of which 382 were on type) Last 90 days - 40 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft was landing on Runway 06, a close-mown grass strip about 500 m long and 30 m wide, surrounded by ground crop. The surface wind was from 340° at 10 kt and the pilot reported that a stand of trees, near the runway, generated turbulence over the threshold. The pilot landed deeper into the runway than he intended and found the braking action to be poor or negligible on the wet grass surface. As the end of the runway approached, he turned the aircraft to the left and it slid sideways. The right main landing gear slipped off the end of the runway surface into the crop which, at this point, was about one foot lower than the runway surface. At some point during the sideways movement, the right wing contacted the ground with sufficient force to cause damage to its outer section. The pilot concluded that the accident was the result of windshear, turbulence and the wet grass surface.

CAA General Aviation Safety Sense leaflet 7, *Aeroplane Performance,* states that wet grass can increase the landing distance required (LDR) by 35%, and that '*very short grass may be slippery, distances required may increase by up to 60%*'.

ACCIDENT

Aircraft Type and Registration:	1) DHC-1 Chipmunk 22, G-BDDD 2) Vans RV-4, G-IIGI
No & Type of Engines:	1) 1 De Havilland Gipsy Major 10 MK.2 piston engine 2) 1 Lycoming O-320-E2C piston engine
Year of Manufacture:	1) 1951 2) 1987
Date & Time (UTC):	3 September 2011 at 1045 hrs
Location:	Northampton (Sywell) Aerodrome, Northamptonshire
Type of Flight:	1) Private 2) Private
Persons on Board:	1) Crew - 1 Passengers - 1 2) Crew - 1 Passengers - None
Injuries:	1) Crew - None Passengers - None 2) Crew - None Passengers - N/A
Nature of Damage:	1) Left wingtip and spar fitting, propeller, right wing leading edge and rear fuselage 2) Tail section, rear fuselage and engine cowling
Commander's Licence:	1) Private Pilot's Licence 2) Private Pilot's Licence
Commander's Age:	1) 54 years 2) 29 years
Commander's Flying Experience:	1) 1,407 hours (of which 136 were on type) Last 90 days - 4 hours Last 28 days - 1 hour 2) 2,500 hours (of which 13 were on type) Last 90 days - 73 hours Last 28 days - 15 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Both aircraft had landed on Runway 21R for the LAA Sywell Rally; the RV-4 had landed first and marshalls were holding it at A2. The pilot of the Chipmunk stated that, whilst taxiing, he looked down to find his taxiway chart and failed to see either the stationary RV-4 on the taxiway ahead or the marshal signalling for the aircraft to hold until it was too late to take corrective action. The collision did not cause any injuries but both aircraft sustained significant damage.

ACCIDENT

Aircraft Type and Registration:	DH82A Tiger Moth, G-ANPE
No & Type of Engines:	1 De Havilland Gipsy Major I piston engine
Year of Manufacture:	1940
Date & Time (UTC):	30 September 2011 at 1057 hrs
Location:	Duxford Aerodrome, Cambridgeshire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to wings, fuselage, engine and propeller
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	47 years
Commander's Flying Experience:	350 hours (of which 131 were on type) Last 90 days - 29 hours Last 28 days - 20 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

The aircraft touched down in a three-point attitude and bounced back into the air, at which point the pilot decided to go around and selected full power. The aircraft remained airborne but failed to climb, drifting downwind to the right of the runway and towards a fence. The lower port wing struck the fence and the aircraft tipped onto its starboard wingtips and then onto its nose. There were no injuries.

The pilot considered that, having selected full power, he did not lower the nose sufficiently to allow the aircraft to accelerate and climb away. Consequently, it flew parallel to the ground, neither climbing nor accelerating, until it hit the fence.

ACCIDENT

Aircraft Type and Registration:	DH82A Tiger Moth, G-APAO
No & Type of Engines:	1 De Havilland Gipsy Major 1C piston engine
Year of Manufacture:	1940
Date & Time (UTC):	25 September 2011 at 0940 hrs
Location:	Duxford Aerodrome, Cambridgeshire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Mainplane and front spar
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	47 years
Commander's Flying Experience:	349 hours (of which 130 were on type) Last 90 days - 28 hours Last 28 days - 19 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

G-APAO was parked to the left of another Tiger Moth. The pilot reported that as he taxied he tried to turn left through approximately 90° but was prevented from doing so by the tendency of the tail-wheeled aircraft to turn into wind, which was blowing from the right. He decided to turn right through 270° instead but, when the aircraft was heading downwind, its turning circle became larger than he expected and he found himself in close proximity to the other Tiger Moth. He was unable to stop his aircraft, which had no brakes, or turn away from the Tiger Moth before he collided with it.

ACCIDENT

Aircraft Type and Registration:	Gardan GY80-160 Horizon, G-ATGY
No & Type of Engines:	1 Lycoming O-320-B3B piston engine
Year of Manufacture:	1965
Date & Time (UTC):	1 October 2011 at 1455 hrs
Location:	Yeovilton Airfield, Somerset
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 2
Injuries:	Crew - None Passengers - None
Nature of Damage:	Landing gear, propeller and engine shock-loaded
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	67 years
Commander's Flying Experience:	14,328 hours (of which 14 were on type) Last 90 days - 98 hours Last 28 days - 25 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent AAIB enquiries

Synopsis

Following a normal landing, during which the aircraft touched down on the mainwheels, the landing gear collapsed during the ground roll, shortly after the nosewheel had been lowered onto the runway.

History of the flight

The pilot undertook a 20-minute local flight following which he lowered the landing gear by turning the gear winding handle as far as it would go in the 'down' direction, confirmed that the green 'gear down' indicator light had illuminated and made a normal approach to Runway 09. The aircraft landed normally on its mainwheels and shortly after the nosewheel was lowered onto the runway, it collapsed and the tips of the propeller blades struck the ground. The mainwheels then collapsed and the aircraft ran off the right side of the runway and came to a stop on the grass. The pilot later noticed that the forward part of the landing gear winding handle, located between the two front seats, had come away from the control pedestal. See Figure 1.

System information

The aircraft is equipped with a tricycle landing gear that can be partially retracted into wells located under each wing and the fuselage. The landing gear is manually operated by a winding handle located on a pedestal between the two front seats, with 19 turns of the handle required to extend the gear. This winding

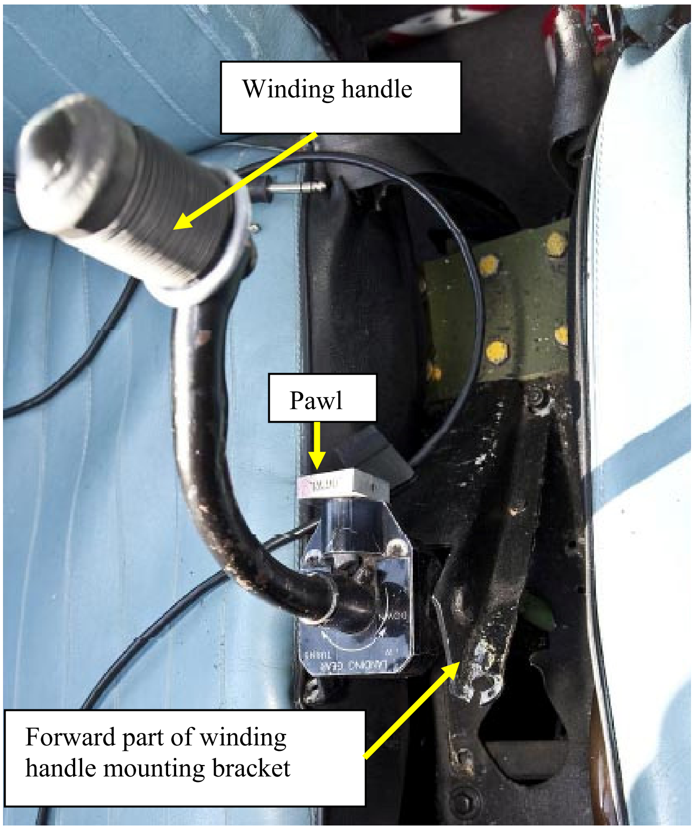

Figure 1

Landing gear winding handle

handle operates a screw jack which through a system of bell cranks, struts and a torque tube cause the landing gear to extend or retract. See Figure 2. Brace struts, located between the main legs and the torque tube, move over-centre (by 0.7 +/- 0.05 mm) as the gear is extended, locking the main legs in the down position. Similarly, a nose leg brace strut also moves over-centre (0.8 +/- 0.1 mm) to lock the nose leg in the down position. A pawl at the base of the winding handle engages a ratchet assembly which prevents the handle from moving in flight.

The landing gear is also equipped with two position indicator lights operated by microswitches: a green light illuminates when the landing gear is fully down and a red light illuminates when the landing gear is in transit (interim position). A warning horn will also sound if the landing gear is not in the extended position and the throttle is moved to the idle position.

The procedure for lowering the landing gear is to rotate the winding handle 19 turns, when it should then stiffen as the three brace struts go over-centre. The handle should then be rotated a further ¼ of a turn before engaging the pawl, which locks the winding handle in place.

Previous occurrences

There have been a number of occurrences in both the UK and France when the landing gear on Gardan 80 aircraft has collapsed on landing. In June 1970, following a number of landing gear incidents, none of which caused injury to the pilot or passenger, the aircraft manufacturer issued a Service Bulletin

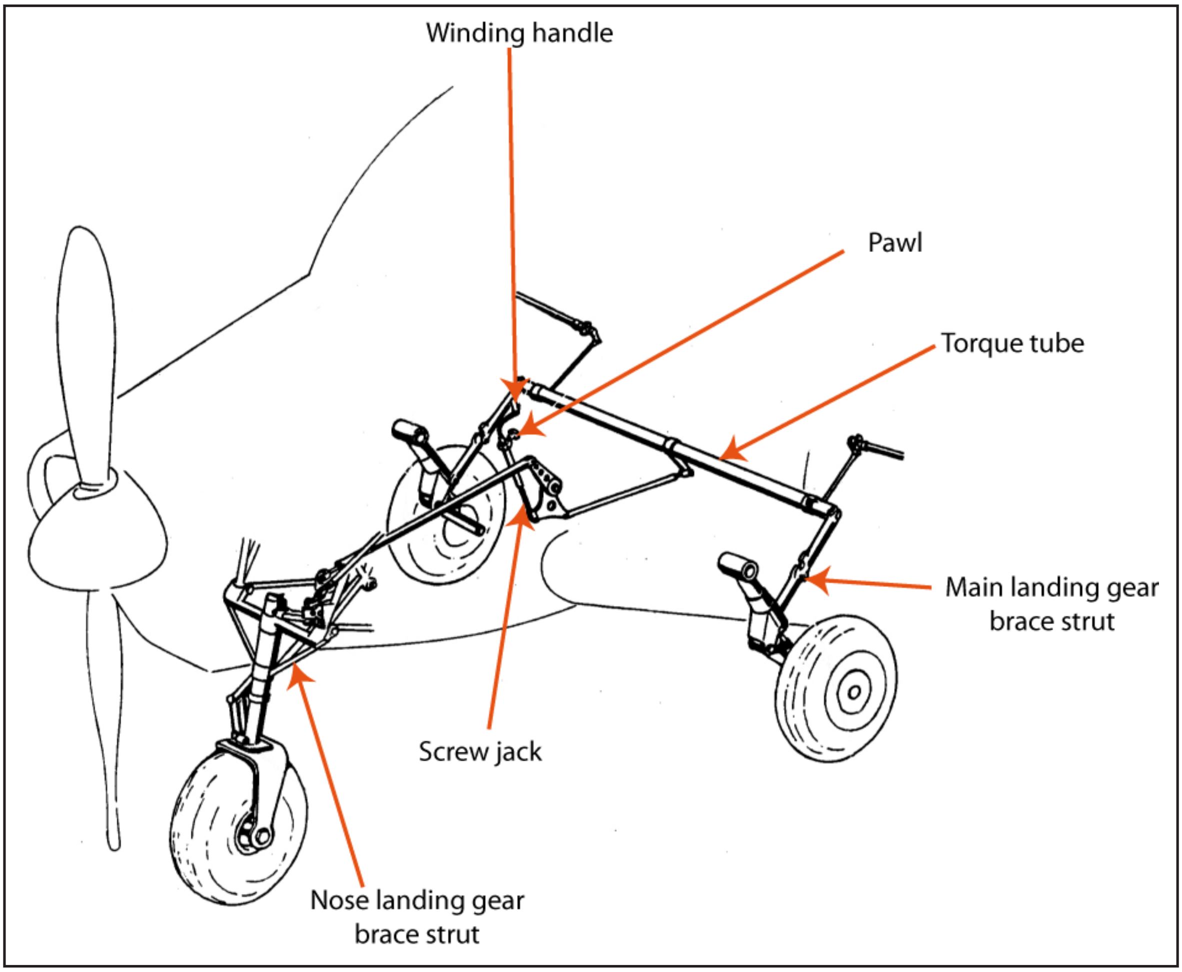

Figure 2

Landing gear operating mechanism

(SB 31/1) which required the examination and testing of the landing gear every 100 flying hours or following a *'rough'* landing.

G-ATGY underwent its annual inspection approximately nine flying hours prior to the incident during which SB 31/1 was carried out.

Comment

The landing gear position microswitches only give the relevant position of the screw jack and do not detect if the brace struts have moved into the over-centre position. The pilot reported that he had a 'green' gear indicating light and the nose landing gear retracted during the ground roll shortly after the nosewheel made contact with the runway. This suggests that the nosewheel brace strut might not have been fully over-centred and, consequently, the nose landing gear would have started to collapse rearwards as the wheel was lowered onto the runway. As it collapsed, a force would have been transmitted through the control linkages sufficient to detach the forward part of the winding handle securing bracket away from the pedestal. At the same time, the main landing gear torque tube would have rotated, causing the main landing gear brace strut to move out of the over-centre position and thereby allowing the main landing gear to retract under the weight of the aircraft.

ACCIDENT

Aircraft Type and Registration:	Jodel D112, G-AYCP
No & Type of Engines:	1 Continental Motors Corp A65-8F piston engine
Year of Manufacture:	1952
Date & Time (UTC):	15 September 2011 at 1130 hrs
Location:	White Fen Farm, Benwick, Cambridgeshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to the propeller, nose bowl, cowling and canopy
Commander's Licence:	Private Pilot's Licence
Commander's Age:	65 years
Commander's Flying Experience:	288 hours (of which 5 were on type) Last 90 days - 5 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot was flying circuits to grass Runway 36. The weather conditions were fine and the wind was light and variable. The aircraft landed after the third circuit and, as it slowed down, it suddenly veered to the left, departed the grass strip and entered a ploughed field. The wheels sank into the soft ground and the aircraft flipped over onto its back. The pilot, who was uninjured, was able to vacate the aircraft via the canopy.

The pilot considered that, due to his inexperience on tail-wheeled aircraft, he had not used sufficient rudder to keep the aircraft straight at lower speeds. When he checked the left main landing gear after the accident, he could find no evidence of binding brakes or other mechanical fault that could cause the aircraft to veer left suddenly.

ACCIDENT

Aircraft Type and Registration:	Jodel D117A, G-ASXY
No & Type of Engines:	1 Continental Motors Corp C90-14F piston engine
Year of Manufacture:	1958
Date & Time (UTC):	13 March 2011 at 1331 hrs
Location:	Grovesend, near Swansea
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 1 (Fatal) 1 (Serious) Passengers - N/A
Nature of Damage:	Aircraft damaged beyond economic repair
Commander's Licence:	Private Pilot's Licence
Commander's Age:	73 years
Commander's Flying Experience:	1,138 hours (of which 687 were on type) Last 90 days - 3 hours Last 28 days - 1 hour
Information Source:	AAIB Field Investigation

Synopsis

Following a partial engine failure the commander carried out a forced landing. The aircraft subsequently overshot the selected field, clipped the top of some trees and its left wing struck a power cable suspended on a line of telegraph poles. On striking the cable the aircraft rotated about its left wing and struck the ground, inverted. The commander was fatally injured and the co-pilot suffered serious injuries. The cable was obscured by the trees.

History of the flight

The commander and co-pilot were members of a syndicate of seven people who jointly owned and flew G-ASXY. They had planned to fly from Cardiff International Airport to Haverfordwest Airfield, Pembrokeshire, for a coffee and possibly fuel. It was agreed that the co-pilot would assist the commander by making all radio transmissions and helping with the navigation.

The aircraft was kept in a hangar on the south side of Cardiff Airport. Prior to pushing the aircraft out of the hangar the commander put one litre of oil in the engine, while the co-pilot dipped the fuel tanks to ensure there was sufficient for the flight; he could not recall the exact fuel level. After pushing the aircraft out of the hangar, the commander and co-pilot completed a pre-flight inspection and the commander then strapped himself into the aircraft. The co-pilot remained outside so that he could swing the propeller and remove the chocks after the engine checks had been completed. The engine started on the first attempt and the commander then carried out the engine run-up and magneto checks. The co-pilot noted that the engine took a long time, about 10 minutes, to warm up. After the full power checks, the co-pilot removed the chocks, put them in the rear of the aircraft and climbed aboard.

After noting the airfield information, ATC clearance was received to taxi to Holding Point Hotel, for Runway 30. As the aircraft approached the hold it was given takeoff clearance. The front tank was selected for takeoff and the aircraft took off at 1304 hrs.

After takeoff, the aircraft climbed to 2,500 ft amsl and tracked towards Neath, north-west of Swansea, to avoid the coastal danger areas near Kidwelly. In the cruise, the commander set 2,200 rpm and accepted the IAS attained; this was about 100 kt. As the aircraft approached Port Talbot, the co-pilot changed frequency to Swansea Radio and made initial contact when they were overhead Neath.

At about 1327 hrs, 23 mins after take off, when the aircraft was west of the Morriston area of northern Swansea, the engine rpm suddenly dropped to 1,000 rpm. The commander said, "I think we've got an engine failure," and immediately leant over and changed the fuel selector from the front to the rear tank and selected FULL power. He then held the aircraft level before establishing a 50 kt glide. The co-pilot transmitted a MAYDAY to Swansea Radio. The commander pointed out the field he had selected and the co-pilot suggested that an adjacent one, to the left/south-west, may be better; the commander did not reply. The commander then flew one left hand orbit before establishing the aircraft on final approach to the field he had selected. An eyewitness, who initially saw the aircraft above him, stated that his attention was initially drawn to the aircraft when he heard its engine "missing". At this point, he estimated it was approximately 200-300 ft above him, just before it flew onto its final approach. He then watched it make its approach but lost sight of it.

The aircraft flew across the selected field at a height of about 15 ft agl. When it was about a third of the way across, the commander said, "we're not going to make it." When the aircraft reached the end of the field it banked left, clipped the top of some trees and struck a power cable suspended on telegraph poles. It rotated about its left wing and struck the ground, inverted.

Two eyewitnesses were quickly on the scene, followed a few minutes later by another two, including a police officer. The co-pilot was helped out of the aircraft first, followed by the commander. An air ambulance arrived soon thereafter. Despite the efforts of a paramedic and the police officer, the commander was declared dead at the scene. The co-pilot, who was seriously injured, though conscious, was taken to hospital by the air ambulance.

Co-pilot's comments

The co-pilot stated that he did not remember seeing the commander select carburettor heat in the cruise or after the engine failure. He added that the engine noise after the power loss was as if it was at idle; it did not splutter or cough. They did not consider the surface wind for the forced landing and the commander did not sideslip the aircraft, as he had done regularly when they had practised forced landings on the previous occasions they had flown together. He did not use the airbrake.

He commented that, from his experience of practising forced landings in G-ASXY, the aircraft's engine idles at about 750-800 rpm in flight.

The co-pilot asked the other syndicate members if they had experienced carburettor icing in G-ASXY. Most of them believed they had not.

Commander's experience

The commander had owned a share of G-ASXY since 1985 and, as well as some flying on a range of other aircraft types, he had nearly 700 hours experience on the accident aircraft. He had held a UK Private Pilot's Licence since 1979 and his Single Engine Piston rating was valid until 16 September 2011.

The commander's logbook showed that he had flown three other forced landings, the last one being in the accident aircraft in October 1997. Anecdotally, others, including the co-pilot, have said he had flown several more, though there was no evidence to substantiate this.

Medical information

The post-mortem was carried out by a consultant aviation pathologist. There was evidence that the commander had had severe coronary artery disease. However, this was regarded as coincidental, given the circumstances of the accident. The pathologist concluded that the commander died as a result of the injuries sustained in the impact. Toxicology revealed no signs of drugs or alcohol.

Weather information

An aftercast for the flight was obtained from the Met Office. In summary, it stated that the situation at the time of the accident in the Swansea and Cardiff area would have been dominated by a generally clear, cool north-westerly flow on the rearward side of a slow moving area of low pressure, centred near Belfast. Shallow cumulus cloud was present in South Wales, with a base around 2,000 ft amsl, but satellite imagery suggested that there was no significant cloud in the immediate accident area at the time.
Surface visibility ranged from 25 to 40 km and surface temperatures ranged from +8°C to +10°C. Between the surface and 3,000 ft the temperature fell from around +8°C to 0°C. The surface wind in the area of the accident was estimated to be from 280° at 11 kt.

The temperature and dew point at Cardiff at the time of takeoff were +8°C and +2°C, respectively. The temperature at the cruising altitude of 2,500 ft was +1°C and the dew point was -7°C. The Cardiff temperature and dew point were such that moderate carburettor icing may have occurred at cruise power or serious icing could have developed at descent (idle) power. The cruising altitude temperature and dew point were such that there was a likelihood of light carburettor icing at cruise or descent power. Figure 1 is the Carburettor Icing chart published in the CAA's General Aviation Safety Sense Leaflet 14 – *Piston Engine Icing*.

Field selection

The fields selected by both pilots were of level pasture with short grass. They appear to have been the largest in the locality. The field chosen by the commander was approximately 320 m in length, with its long axis orientated 350°/170°M. The adjacent field suggested by the co-pilot was approximately 720 m in length and orientated 340°/160°M. These axes were 60-70° off the estimated surface wind. Figure 2 shows an aerial view of the selected fields.

Engineering

Accident site

The aircraft was found lying inverted in meadowland, slightly north of a row of trees forming the field boundary and bordering a minor road. The ground impact site was adjacent to an overhead power

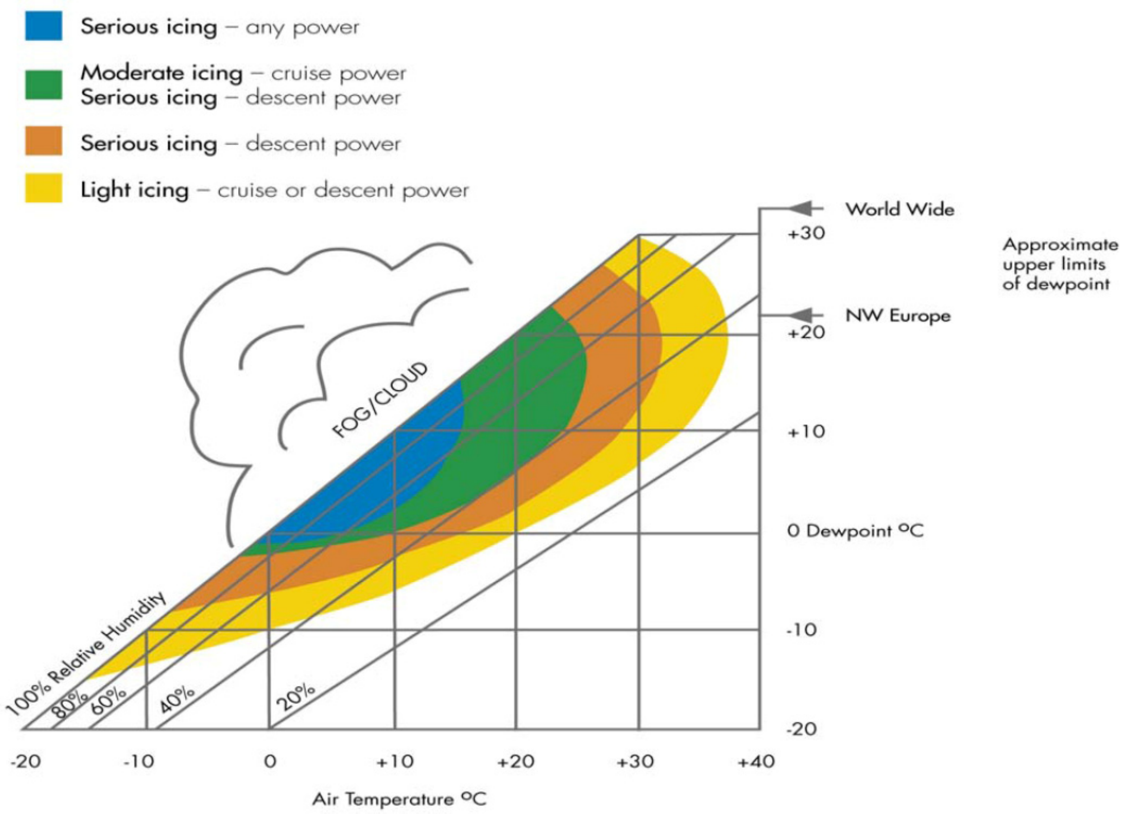

Figure 1

Carburettor icing chart

Figure 2

Fields adjacent to the accident site

cable running approximately parallel with the field boundary. The cable was observed to have separated from the insulator attaching it to the nearest support pole. Examination of the cable strands (now at head level, following separation of one mounting/insulator) indicated that it had been struck by a soft object which had slid a short distance parallel to the cable axis whilst remaining in contact with the strands.

The leading edge of the left outboard wing of the aircraft was separated and lying close to the cable. Examination of the remaining left wing structure and the leading edge indicated that the latter had been separated as a consequence of the cable having penetrated the leading edge skin as far as the front spar before sliding outboard relative to the structure, approximately along the face of the spar, severing the skin and ribs. Fragments of tree branch lying in the field, in the vicinity of the main wreckage, indicated that the aircraft had struck the row of trees before striking the cable. No defined region of damage could be identified in the upper boughs of the tree row to determine the roll attitude at the initial contact with branches. The absence of any horizontal swathe, however, suggested that the aircraft was steeply banked, making a narrow passage through the tree tops not identifiable from the ground.

Examination of the aircraft confirmed that it had fallen to the ground inverted and with translational motion to the north, the fuselage axis being orientated to the east. An overall assessment of the accident site indicated that the aircraft penetrated the upper branches of the row of trees whilst banked steeply to the left, striking the cable with its left wing after exiting the tree row. The contact with the cable restrained the left wing, rotating the aircraft, thereby accelerating the right wing. This resulted in differential lift, causing the aircraft to become inverted whilst continuing to rotate about its normal axis. After rotating through some 270°, with only residual lateral motion in a northerly direction, the aircraft fell to the ground. A blade of the wooden propeller separated during the impact sequence although the direction of failure was not clear.

The morning after the accident, limited quantities of fuel were successfully recovered from both fuel tanks on the aircraft.

Significant aircraft features

The aircraft was powered by a Continental C90 engine driving a two-bladed wooden propeller. The engine utilised a Stromberg carburettor and was supplied with fuel by two tanks, one mounted immediately behind the engine bulkhead and one in the fuselage aft of the passenger compartment. The fuel selector valve, mounted on the aft face of the engine bulkhead, was operated by means of a knob on the instrument panel driving a rotating shaft with a ratchet connection to the valve spindle. Both tanks were of approximately semi-circular lower cross section. A significant volume of unusable fuel normally remains in conventional wing-mounted or other approximately flat bottomed tanks. The curved lower profile of the design of the tanks on G-ASXY greatly reduced the amount of unusable fuel, if not eliminating it. Fuel passed via the selector valve, through a drain sump to the engine driven mechanical pump close to the lowest point on the engine. No electric pump was fitted.

A changeover flap was mounted in an air box forming the induction system. The box was attached to the bottom of the updraft carburettor barrel. In the normal position of the flap, the box supplied the carburettor with ambient air entering from the front via a filter. In the alternate position, it admitted air via a scat hose from a heat exchanger. This consisted of a small box surrounding one of the four individual exhaust pipes. Air was admitted to the box through narrow slots remaining on either side of the pipe where the box was not completely closed.

Detailed examination and testing

The aircraft was salvaged and the engine cylinders examined internally, with a boroscope, via the spark plug holes. No evidence of internal distress was noted. Dark colouration of cylinder heads and valves strongly suggested rich operation. Interior surfaces of the exhaust pipes were also black in colour, again consistent with rich operation. Throttle, carburettor heat and mixture controls were all correctly connected.

The engine was removed from the aircraft and installed on a dynamometer test rig. It was subjected to an extended test run, during which it was found to produce slightly less than rated power at maximum permitted rpm. It was then throttled back to 1,000 rpm whilst leaving the simulated propeller characteristics unaltered. The measure power output was then approximately 5 bhp.

The aircraft fuel and venting systems were then examined. Flow tests indicated that the system had been selected to the rear tank at the time of impact. Unobstructed flow was available from that tank to the flexible pipe supplying the engine driven pump. With the tank selector re-positioned to the front tank, correct flow was present from that tank to the supply line to the pump. No evidence was found to suggest that either the front or rear tank vent systems were obstructed.

Although the engine produced less than rated power when tested, it was confirmed that this was the normal result when the rig was used and that this engine performed as well if not better than the average of similar units.

Since the magneto earthing arrangements did not feature in the test, the four-position magneto switch was removed from the instrument panel and tested electrically. It was then dismantled. It was found to operate correctly on test and no evidence of internal defect capable of producing intermittent operation was found.

Occasions have occurred when magneto coils and/or harnesses on piston engines have suffered age-related deterioration. This has sometimes manifested itself in the form of ignition failure during flight when the temperature of the magneto and harness has stabilised at a high figure. Breakdown of insulation then occurs leading to ignition failure. On subsequent tests, at room temperature, the ignition performance returns to normal. The difference in cooling arrangements between those on the dynamometer rig and those experienced on the unit installed in the aircraft raise the possibility that the magnetos may have been running hotter in flight than under test. Accordingly arrangements were made to test the magnetos on a rig with heating applied to the bodies. An extended test run under these conditions failed to produce any loss of magneto performance.

The possibility of a restriction of the air supply was reviewed and the presence of the rich mixture symptoms noted. The possibility of some mis-setting of mixture in the carburettor, leading to excessively rich operation when flying with some carburettor icing present was considered. A strip examination of that unit, when undertaken, revealed no evidence of such mis-setting. The fine mesh fuel filter was found to be clean.

Analysis of the fuel samples recovered from the two tanks indicated that neither deviated significantly from the specification for 100LL grade aviation gasoline.

In view of the absence of any direct indication of the cause of the power loss, the significance of the features of the dynamometer test rig and the method of test were reviewed. It was determined that the head of fuel available to the fuel pump, when installed in the dynamometer test rig, was approximately six feet. The corresponding head with either aircraft tank close to minimum contents and the aircraft axis horizontal was only approximately two feet. Thus, the fuel supply under the test conditions did not fully represent conditions in the aircraft. Therefore, the mechanical fuel pump was removed and tested. It was found to perform correctly.

In all, no physical evidence was found to account for the loss of engine power.

Recorded information

Radar data was recorded for the accident flight. This data was from the radar head at Cardiff Airport which provided low level radar coverage for the Cardiff area. All the radar returns were primary so no height information was available for the flight.

Figure 3 shows the accident track from 1320:49 hrs, north of Cardiff Airport, to 1329:50 hrs, approximately 1 nm south of the accident site. Between 1323:43 hrs and 1324:19 hrs radar contact was lost. This loss of contact was probably due to the aircraft's altitude reducing briefly to a level that placed it out of line of sight of the radar head.

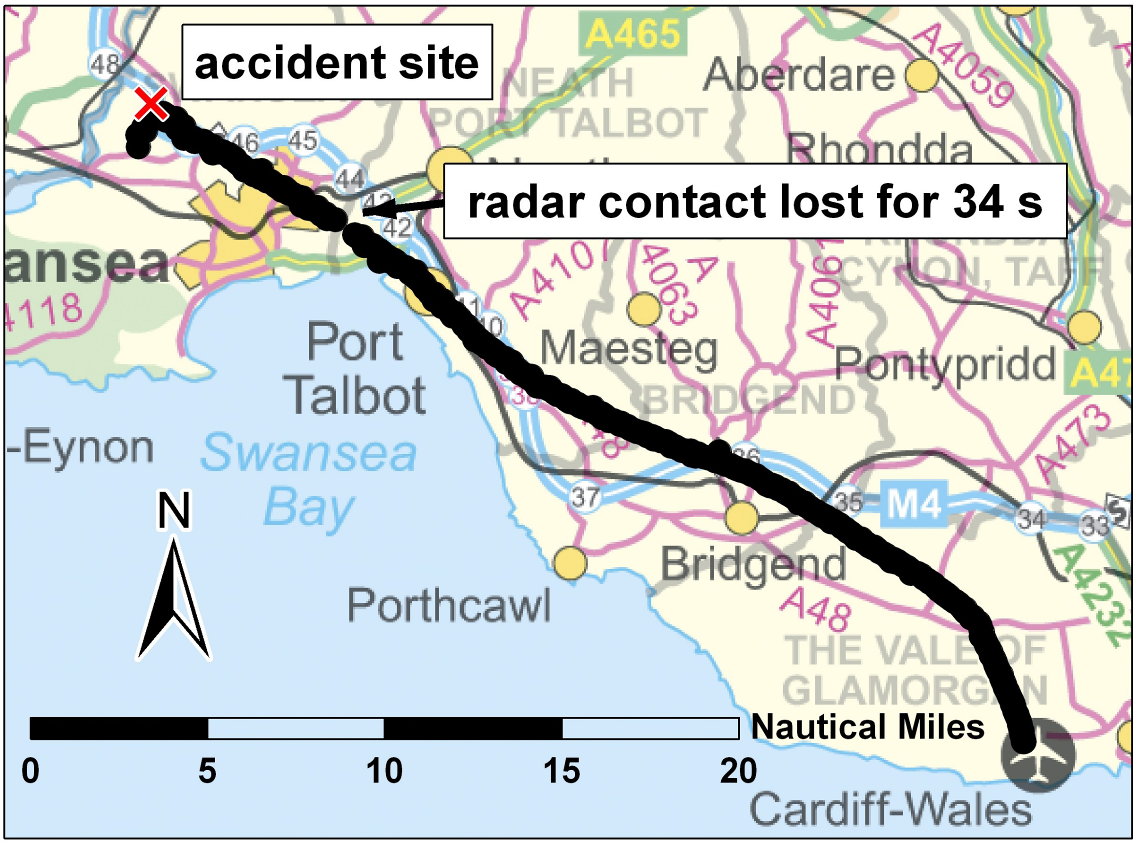

Figure 3

Radar track of G-ASXY and position of accident site

Shortly before the radar contact was briefly lost the track becomes jittery in nature, suggesting that the radar tracker software was having difficulty in tracking the aircraft at this range and altitude. Also, due to the jittering and other software issues, the software's calculation of the aircraft's groundspeed was unreliable.

Radar data issues

Cardiff radar is only recorded by the Air Traffic Service (ATS) Unit at Cardiff Airport, and is not part of the UK's national coverage that is recorded by the National Air Traffic Service (NATS). The provision of these 'local' recordings, in support of an accident investigation, is detailed in Civil Aviation Publication (CAP) 670 - *ATS Safety Requirements*. This document sets out the safety regulatory framework and requirements associated with the provision of an air traffic service. The requirements for an ATS Unit to record all surveillance data, provided to it or obtained by it, for the purposes of providing an air traffic service, are set out in CAP 670, SUR 10, Part 3. These requirements include the automatic recording and retention of surveillance data obtained 'through the wall' (TTW) from local and/or remote sources, including third party providers. Requirements relating to '*Replay Functions and Facilities*' include the capability to create, upon request, an extract of the data recorded TTW, from which an aircraft track can be generated[1]. SUR 10 also requires ATS Units and third party providers to provide, when required by either the AAIB or the CAA for use in an investigation, a copy of the aircraft tracks.

For this investigation, the ATS Unit at Cardiff were able to provide, on request, the track data in compliance with the extant version of CAP 670 (ie Amendment 11), which was current at the time of the accident. This version, however, did not specify the format in which the data was to be provided.

The format of the recording made at Cardiff Airport enabled it be replayed in a form that replicated a radar controller's screen. Multiple replays were made, during each of which the position and groundspeed of the aircraft were manually noted from a display box on the screen. This process was time-consuming and caused a delay in provision of the data, in a more useable format, to the investigation. Also, the groundspeeds displayed, calculated using the aircraft's latitude and longitude, appeared to be inconsistent with the indicated unit of knots, even taking into account the jittery nature of the aircraft's position.

Amendment 12 is the latest version of CAP 670 (issued 28 April 2011) and includes a revision to SUR 10 that notes:

> *'in most cases this data is provided as a spreadsheet formatted as .xml files or similar.'*

Compliance by ATS Units with this amendment is required by 1 January 2012.

A further planned amendment to CAP 670, SUR 10 will also include a time limit within which ATS Units and third party providers should make data available for investigative purposes. The date of the amendment and time limit are, however, yet to be agreed.

Partial loss of power

The guidance on forced landings given to student pilots, by instructors, is understandably not very prescriptive. After the initial exercises are complete there are many variations that can be taught, often well beyond the

Footnote

1 ATS Units that use analogue radar systems, from which the recording of the through-the-wall data is not possible, will be permitted to record surveillance data captured at the display using screen shots recorded 'at the glass' (ATG).

text given in JAR-FCL 1 - *Flight Crew Licensing (Aeroplane)*. The general theme is the same whether the engine failure is total or partial; the principles of finding a suitable landing area, assessing the wind, completing a forced landing pattern or intercepting that pattern at a suitable point all hold firm.

In conducting the forced landing pattern, students are taught a series of checks to be completed at the appropriate stages of the emergency. The extent of checks required is determined by the nature of the failure. A benign engine failure eg carburettor icing, fuel starvation, ignition failure, would generate the need for an attempted restart drill whereas a fire or seizure would immediately require the engine to be secured. Most, if not all, PPL(A) training textbooks, checklists and Pilots' Operating Handbooks advise engine shutdown checks, sometimes referred to as a 'crash drill' or 'security drill', in the event of a complete engine failure. These engine shutdown checks would normally be completed downwind during the standard forced landing pattern. For a partial loss of power, an engine would normally be left running until the point at which arrival at the proposed landing area could be assured; the shutdown checks would then be completed. The shutdown checks ensure that a forced landing is executed with the engine in a safe condition and that power will not suddenly be restored at a critical moment. It also isolates the aircraft's fuel and electrical systems, reducing the risk of a post-accident fire.

Analysis

General

The accident was the result of the aircraft overshooting the field selected for a forced landing, following a partial loss of power, and striking a power cable.

The engine was running at 1,000 rpm during the forced landing. As a result, it was producing thrust in excess of that normally generated with the engine at its in-flight idle speed of approximately 750 rpm. This would have reduced the aircraft's rate of descent and changed the commander's sight line angle. Had the commander secured the engine, once he was assured of making his selected field, he would have removed the excess thrust and would have been less likely to overshoot the field. Additionally, if he had sideslipped the aircraft and/or used the airbrake, the aircraft's touchdown point would have moved closer to the start of the intended field.

The long axis of the selected field was about 70° off the wind. This is likely to have reduced the headwind component from 11 kt to about 4 kt. As practice forced landings are generally flown into wind, being off the wind would have reduced the aircraft's angle of descent.

Engineering

Following the accident, the engine performed correctly on the dynamometer test. Fuel was recovered from both tanks and the design geometry of each tank is such that virtually all fuel within remains useable, until the tank is empty. Thus the presence of any fuel in both tanks indicates that engine fuel starvation could only occur if the fuel cock was selected to the OFF position or a defect or blockage in the fuel system (including the venting) existed. No such defect or blockage was found.

Despite the absence of severe icing conditions in the aftercast for the area in which the aircraft was flying, the possibility that 'pure' carburettor icing occurred cannot then be ruled out. It is thought that the icing phenomenon both reduces inlet airflow and increases the depression in the throat, thus sucking a greater volume of fuel into the reduced airflow. The combination generally results in an increasingly rich mixture occurring until the engine suffers a 'rich cut' and a major drop in rpm.

The meteorological aftercast data did not indicate that the conditions in the cruise were those known to be excessively prone to causing carburettor icing and other syndicate members who had flown significant hours on G-ASXY did not report any tendency for the engine to suffer from this phenomenon. It is fair to say, however, that the aftercast is based on remote measurement and some variation in the humidity within an air mass can be expected. The absence of any evidence to account for engine failure, the correct operation of the engine on test and the black appearance of the exhausts and cylinder interiors when first examined, all combine to make the build-up of carburettor icing the most likely cause of the power loss.

The possibility of ice build-up initiating during extended operation with low throttle opening on the ground, while the commander waited for the engine to warm up, and not being cleared before takeoff exists. This would enable a slow rate of build-up in flight to cause eventual power loss earlier than would occur during flight in similar conditions with the carburettor beginning the flight free from any ice. Other variables include the possibility of operation with lower than normal throttle opening. Although it is far from clear why an icing-related power loss occurred on this flight, the absence of any other evidence-based explanation leaves this as the only realistic possibility.

Conclusions

In cruise flight the aircraft suffered a partial loss of power. The investigation could not determine, with certainty, what caused this but considered that it could have been due to carburettor icing. During the subsequent forced landing, the aircraft overshot the field selected for the landing, clipped the top of some trees and its left wing struck a power cable, which was suspended on a line of telegraph poles and obscured by the trees. On striking the cable the aircraft rotated about its left wing and struck the ground, inverted. The commander was fatally injured and the co-pilot suffered serious injuries.

ACCIDENT

Aircraft Type and Registration:	Monnett Moni, G-INOW
No & Type of Engines:	1 KEF 107 piston engine
Year of Manufacture:	1985
Date & Time (UTC):	3 July 2011 at 0957 hrs
Location:	Sandown Airport, Isle of Wight
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to nose and main landing gear, canopy, left wing spar and left inner wing
Commander's Licence:	Private Pilot's Licence
Commander's Age:	52 years
Commander's Flying Experience:	276 hours (of which 19 were on type) Last 90 days - 18 hours Last 28 days - 8 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and additional AAIB inquiries

Synopsis

Shortly after lifting off the runway, the engine lost power such that the aircraft was unable to gain height. The pilot turned the aircraft to the left in order to avoid obstacles ahead but, as the engine continued to lose power, the aircraft lost altitude and eventually stalled into marshy ground from a height of around 6 ft. No definitive explanation for the engine power loss was found, although accumulations of miscellaneous debris in the fuel system may have restricted the fuel flow at takeoff power.

History of the flight

The pilot had planned a local flight and had conducted the normal pre-flight checks and engine power check. The aircraft took off on Runway 05, with the engine developing full power. Takeoff speed was around 55 mph and the pilot levelled the aircraft at a height of 6-10 ft above the runway in order to accelerate to the climb speed of 70 mph. However, as the aircraft started to climb, there was a sudden loss of engine power, followed by a loss of airspeed. The pilot lowered the nose to maintain approximately 60 mph, but realised that he was not going to be able to clear some trees that bordered a golf course beyond the end of the runway. He therefore turned the aircraft to the left, with the engine running at low rpm, and briefly considered returning to the airfield. By now however, the aircraft had descended to a low level and there were more trees ahead. The pilot tried moving the throttle control in an attempt to make the engine pick up, but to no avail. Shortly afterwards, the engine stopped completely and the aircraft stalled into marshy ground from a height of around 6 ft. The impact angle was reported to be around 20º and the aircraft came to an immediate halt. This resulted in the pilot hitting his head on the canopy, which broke into pieces, causing minor facial injuries.

After switching off the fuel and electrics the pilot vacated the aircraft without difficulty. He then called the Sandown tower by mobile phone to inform them that he was safe, although the emergency services had already been alerted.

Subsequent investigation

The KEF is a two-stroke engine and the pilot mixed the two-stroke oil with motor fuel transported in plastic jerry cans prior to refuelling the aircraft.

Some weeks after the accident the pilot examined the engine and found no evidence of a mechanical failure. However, upon inspecting the fuel system he noted that the fuel filter element contained some visible debris. He then inspected the fuel tank, which was made from aluminium, and observed a small amount of brown/black residue lying at the bottom. However, there was a more significant accumulation of the residue on the wire mesh filter at the fuel tank outlet. He sent a sample of the residue, together with the filter, to the AAIB for subsequent laboratory analysis.

It was apparent that there was no significant oily deposit in the filter, which suggested that there was little likelihood of incomplete fuel/oil mixing. The laboratory report detailed the debris types found as a result of scanning electron microscope (SEM). Much of the debris consisted of fine, off-white to black particles, including organic and fluorocarbon material. In addition there were some black rubber particles, including chlorinated rubber. The remainder consisted of small amounts of unidentified fibrous matter, paint or sealant particles and a few metallic particles. It is likely that there was no single origin for the debris, with the rubber particles being typical of seals or 'O' rings and fuel tubing, the organic matter possibly originating from the jerry cans and the metallic debris coming from the fuel tanks and associated fittings.

The analysis of the debris did not reveal the cause of the engine failure. Whilst the nature of the debris was typical of that found in fuel systems, it is possible that accumulations of it in the tank outlet screen and in the filter, either singly or in combination, caused a restriction in the fuel flow such that it may have resulted in fuel starvation at takeoff power.

INCIDENT

Aircraft Type and Registration:	Naval Aircraft Factory N3N-3, G-ONAF
No & Type of Engines:	1 Wright Aeronautical Corporation R-760 piston engine
Year of Manufacture:	1942
Date & Time (UTC):	3 September 2011 at 1258 hrs
Location:	Tournerbury Farm, Hayling Island
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Tailwheel, lower rear fuselage and rudder
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	7,155 hours (of which 38 were on type) Last 90 days - 101 hours Last 28 days - 35 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft was on a positioning flight and being flown at a height of 1,200 ft, to remain clear of cloud, when the engine lost power. The pilot carried out a forced landing in a field during which the tailwheel detached, resulting in minor damage to the lower rear fuselage and rudder. There were no injuries. The engine was subsequently inspected and a ground run was carried out; no anomalies were identified. The pilot reported that the ambient conditions were conducive to serious carburettor icing and he candidly commented that operating the aircraft at a relatively low height meant that the application of full carburettor heat after the power loss was too late to rectify the situation.

ACCIDENT

Aircraft Type and Registration:	Nipper T.66 RA45 Series 3, G-CORD
No & Type of Engines:	1 Ardem 4C02 MK.X piston engine
Year of Manufacture:	1967
Date & Time (UTC):	19 August 2011 at 1330 hrs
Location:	Weybourne (Muckleburgh) Airfield, Holt, Norfolk
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - Minor Passengers - N/A
Nature of Damage:	Extensive
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	67 years
Commander's Flying Experience:	620 hours (of which 368 were on type) Last 90 days - 9 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reported that he flew to Weybourne (Muckleburgh) Airfield, Holt, Norfolk in "good" weather. Runway 34 was in use and the surface wind was from approximately 340º at 10-15 kt. This was his first visit to Weybourne.

Upon arrival the pilot flew a low pass along the runway to check its surface condition and to assess the surface wind using the wind sock. He commented that the approach was slightly fast, primarily because of difficulty keeping the IAS under control after flying over a hill on the extended centre line. After the aircraft touched down, just beyond the intersection of Runway 03/21, the nosewheel dug into the hard ground and collapsed. The aircraft subsequently flipped over, coming to rest inverted; the pilot vacated it with assistance. As a result of the accident he sustained a small cut to his head and bruising from his 5-point harness. The aircraft was extensively damaged.

The pilot attributed the accident to a slightly fast approach onto the downward sloping, rough surfaced runway.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28R-200 Cherokee Arrow, G-GYMM
No & Type of Engines:	1 Lycoming IO-360-C1C piston engine
Year of Manufacture:	1971
Date & Time (UTC):	14 August 2011 at 1335 hrs
Location:	Shobdon Airfield, Herefordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Wings damaged beyond economic repair
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	506 hours (of which 55 were on type) Last 90 days - 5 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot and telephone inquiries by the AAIB

Synopsis

Whilst landing at Shobdon, the aircraft touched down heavily and bounced. Major damage was later found to both wings.

History of the flight

The aircraft was landing after an uneventful flight from Gloucester Airport. An overhead circuit join was followed by a visual approach to Runway 27, flying finals with full flap selected at 75 kt, the recommended speed for the aircraft's weight. The wind was 280°/9 kt. Everything appeared normal until, during the roundout, the aircraft unexpectedly hit the ground heavily and bounced. The pilot landed after the bounce and taxied to the parking area.

When performing the walk-round inspection prior to the return flight to Gloucester, the pilot noticed wrinkling of the left wing skin and decided to leave by road whilst the aircraft was inspected. The inspection revealed severe distortion of both wings to the extent that the aircraft was declared an economic total loss.

The pilot stated that he was unsure of what had caused the heavy landing, which he sensed had been due to premature contact with the ground but believed that he may have misjudged the roundout. Witnesses in the control tower recalled that the approach had been flown well but the aircraft appeared to flare at a height of about 10 feet above the runway before dropping rapidly onto its mainwheels and bouncing. The severity of the heavy landing was sufficient for the two controllers to comment on it to each other, but they were surprised when they later learned of the extent of the damage to the aircraft.

ACCIDENT

Aircraft Type and Registration:	Piper PA-38-112 Tomahawk, G-BWNU
No & Type of Engines:	1 Lycoming O-235-L2C piston engine
Year of Manufacture:	1978
Date & Time (UTC):	3 August 2011 at 1355 hrs
Location:	Little Rissington Airfield, Wiltshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to the left wing tip and left wing leading edge
Commander's Licence:	Private Pilot's Licence
Commander's Age:	75 years
Commander's Flying Experience:	733 hours (of which 534 were on type) Last 90 days - 27 hours Last 28 days - 10 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot landed at Little Rissington Airfield earlier in the day and discovered, when taxiing to the parking area, that there was a significant lip at the junction between a grass and a concrete taxiway. When he taxied out to depart, he was concerned that going down across the lip might cause a propeller strike, so he decided to try and find another route to the runway. He turned along what appeared to be a reasonable taxiway but was, in fact, an access road to the airfield, with a barbed wire fence on the left. The left wing fairing of the aircraft struck some wire and then a concrete post. The pilot was alerted to the situation by a "ticking" noise but was unable to stop before the wing hit the post. The weather conditions were clear and Runway 23 was in use.

ACCIDENT

Aircraft Type and Registration:	Rebel, G-BWFZ
No & Type of Engines:	1 Lycoming O-320-D3G piston engine
Year of Manufacture:	1999
Date & Time (UTC):	10 July 2011 at 1303 hrs
Location:	Old Sarum Airfield, Wiltshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Landing gear, fuselage and cockpit
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	75 years
Commander's Flying Experience:	352 hours (of which 21 were on type) Last 90 days - 7 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot was engaged in a training flight. After some demonstration circuits, the instructor handed control to the pilot who flew some low passes along the runway to familiarise himself with the correct attitude for landing. On the third pass, it was planned to allow the aircraft to settle onto the grass runway.

Approximately halfway down the runway, whilst concentrating on the correct landing attitude, the pilot noticed that the airspeed had reduced and the aircraft bounced before landing again heavily. The pilot stated that he had applied power during the bounce but had been unable to prevent the subsequent heavy contact with the runway. The right main landing gear collapsed and dug into the ground causing the aircraft to turn to the right through approximately 150°. Both occupants were wearing lap and diagonal harnesses and were uninjured.

ACCIDENT

Aircraft Type and Registration:	Reims Cessna F172N Skyhawk, G-BHMI
No & Type of Engines:	1 Lycoming O-320-H2AD piston engine
Year of Manufacture:	1980
Date & Time (UTC):	26 July 2011 at 1512 hrs
Location:	Caernarfon Airport, Gwynedd
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to nosewheel and propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	76 years
Commander's Flying Experience:	350 hours (of which 150 were on type) Last 90 days - 12 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

The pilot had flown from Woodvale to Caernarfon, where the runway in use was Runway 26. The flight had been normal but the pilot reports that on his first approach at Caernarfon the touchdown was heavy and the aircraft bounced, so he performed a go-around. The second landing was much more satisfactory but the nose leg collapsed, probably from damage incurred in the first touchdown. The pilot considers that a contributory factor in the heavy first touchdown may have been a reversal of wind direction during the final approach.

ACCIDENT

Aircraft Type and Registration:	Sukhoi SU29, HA-YAO
No & Type of Engines:	1 Vedeneyev M-14 PF piston engine
Year of Manufacture:	1999
Date & Time (UTC):	26 June 2011 at 1335 hrs
Location:	Rougham Airfield, Suffolk
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Private Pilot's Licence
Commander's Age:	68 years
Commander's Flying Experience:	1,297 hours (of which 200 were on type) Last 90 days - 30 hours Last 28 days - 13 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

Immediately after takeoff, the aircraft drifted to the right of the runway, crossing a line of parked aircraft, two of which it struck with its tail wheel.

History of the flight

HA-YAO took off from grass Runway 27 at Rougham Airfield with its smoke system on. Surface wind was reported as southerly at 12 kt. After lifting off, the aircraft drifted north of the runway towards a line of parked aircraft lying parallel to the runway and a crowd of people beyond[1]. Its tail wheel struck two of the parked aircraft and the aerodrome radio operator in the mobile control room sounded the crash alarm. The aircraft climbed into the circuit where a visual inspection was carried out by a pilot in another aircraft who reported seeing no damage. HA-YAO landed back at the airfield without further incident.

Information from witnesses

The mobile control room was situated north of Runway 27 approximately two thirds of the way along its length in line with the parked aircraft. The radio operator in the mobile control room saw HA-YAO takeoff and veer to the north. She sounded the crash alarm because she lost sight of the aircraft as it crossed

Footnote

[1] An airshow was taking place at the airfield. HA-YAO was not planned to display.

the line of parked aircraft. She stated that the aircraft passed north of the mobile control room "at a very low level" before climbing into the circuit. She was asked by the Senior Airfield Fire Officer (SAFO) to ask the pilot to remain airborne until the local authority emergency services joined the airfield fire service on site in case there was a problem on landing. While she was calling the emergency services, the aircraft landed.

The SAFO was located next to the mobile control room and, when he realised the aircraft was landing, he ensured all personnel drew back from near the runway where they had been searching for debris.

The pilot reported that, because he is unable to see over the nose of the aircraft during takeoff, he normally keeps straight on the runway by looking at features to the left of the aircraft. In this case he was looking at a fence to the left of the runway during takeoff. After lift-off he "heard a thump from the tail" and, as he climbed into the circuit, informed the aerodrome radio operator that he thought he might have hit something. Following the visual inspection, the pilot decided to land back on Runway 27 as soon as possible. He did not think he had flown over the crowd and stated that, as the aircraft climb attitude is 30° nose-up and its climb rate is over 4,000 ft/min, he believed its height when it passed the mobile control room would have been at least 800 ft. He stated that the smoke system was turned on unintentionally.

Pilot's assessment of cause

The pilot considered that a combination of crosswind and a swing to the right caused by the propwash had caused the aircraft to drift right. He also believed that the fence had been an unsuitable feature to help him keep the aircraft straight during the takeoff. Although he heard the request to remain airborne, the pilot thought it prudent to land as soon as possible because he thought there might have been damage to his aircraft that had been missed during the visual inspection.

ACCIDENT

Aircraft Type and Registration:	Wittman W8 Tailwind, G-BDBD
No & Type of Engines:	1 Continental Motors Corp O-200-A piston engine
Year of Manufacture:	1963
Date & Time (UTC):	2 August 2011 at 1500 hrs
Location:	Wellsbourne Airfield, Warwickshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Propeller, engine, engine mount, left landing gear, landing gear mount, left wing damaged
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	56 years
Commander's Flying Experience:	15,630 hours (of which 248 were on type) Last 90 days - 198 hours Last 28 days - 67 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft commander was conducting a 'checkout' flight for a PPL qualified pilot under the LAA coaching scheme. The aircraft was only fitted with one set of brake pedals for use by the occupant of the left seat, which in this case was the pilot undergoing the check. The commander occupied the right seat. Following an uneventful flight, the commander carried out a normal landing on Runway 18, with a light wind from the south-west. After the touchdown and initial rollout, the aircraft began to drift to the right. The commander reported that normal input of the rudder did not correct the drift, so he asked the pilot in the left seat to apply the left brake pedal. The drift to the right then rapidly increased until the aircraft left the runway and ground looped to the right. The left landing gear leg collapsed and the aircraft suffered extensive damage. Both pilots considered that an inadvertent application of the right brake pedal rather than the left, might have contributed to the loss of control. The commander reported that inspection of the aircraft following the event had also identified a pre-accident partial failure of the left gear leg mount.

ACCIDENT

Aircraft Type and Registration:	Zenair CH 601HD Zodiac, G-CBDT
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2002
Date & Time (UTC):	5 May 2011 at about 1600 hrs
Location:	A private airstrip 19 nm southeast of Penrith, Cumbria
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	63 years
Commander's Flying Experience:	591 hours (of which 93 were on type) Last 90 days - 11 hours Last 28 days - 6 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft crashed after it struck trees, following an approach to a private landing strip situated in a small valley. There was no evidence that a technical malfunction played a part in the accident. The cause of the accident was not positively determined but adverse wind conditions and pilot medical factors were possible contributory factors.

History of the flight

The pilot owned G-CBDT and operated it from a private airstrip at his residence on the western edge of the Pennines, in Cumbria. The day before the accident, he had taken off from the airstrip at about 0800 hrs and flown to Caernarfon Airfield in Gwynedd, where he met other members of a flying association for an organised visit to RAF Valley, on Anglesey. He telephoned his wife at home to say that he had arrived safely.

After arrival at Caernarfon, the pilot refuelled the aircraft with 35 litres of Avgas before departing on the visit and a local sightseeing trip. He stayed overnight in Caernarfon with other group members and continued with the visit programme the next day until after lunch, when he prepared to return home. The pilot was reportedly in good health during the time of the visit, and had normal social interaction with others in the group. The details of his preparation for the return flight are not known; the pilot's wife had checked the local weather conditions for passing to her husband if he should telephone ahead but he did not.

G-CBDT took off from Caernarfon at 1419 hrs. There was no record of the pilot's return route, but flight time by the most likely route would have been about 1 hr 40 mins, giving an arrival time back at the airstrip of about 1600 hrs.

When the pilot had not returned home by early evening, his wife walked to the adjacent airstrip, only part of which was visible from the house. She found the wreckage of G-CBDT to one side of the airstrip, with the pilot still secured by his seat harness within the wreckage. Emergency services attended but the pilot had received fatal injuries.

Accident site

The aircraft came to rest 58 m to the east of the airstrip, on a heading of 165ºM. It was approximately 28 m from a wooded area that was immediately to the east of the airstrip (Figure 1). Wreckage from the aircraft, together with ground impact scars, formed a trail 67 m in length, running between the western end of the wooded area and the aircraft's final position.

Fresh damage to trees in the wooded area adjacent to the landing strip indicated that the aircraft had struck the trees before impacting the ground beyond. Five individual tree strikes were observed, varying in height between 4 and 6 m above ground level, along a line inclined approximately 14º to the horizontal, in the direction of landing. Damage to the trees indicated that the outer 2 m of the aircraft's left wing had been in contact with the trees. The red lens from the aircraft's left wingtip navigation light was recovered on the ground between the wooded area and the runway, close to broken branches from the tree strikes (Figure 1).

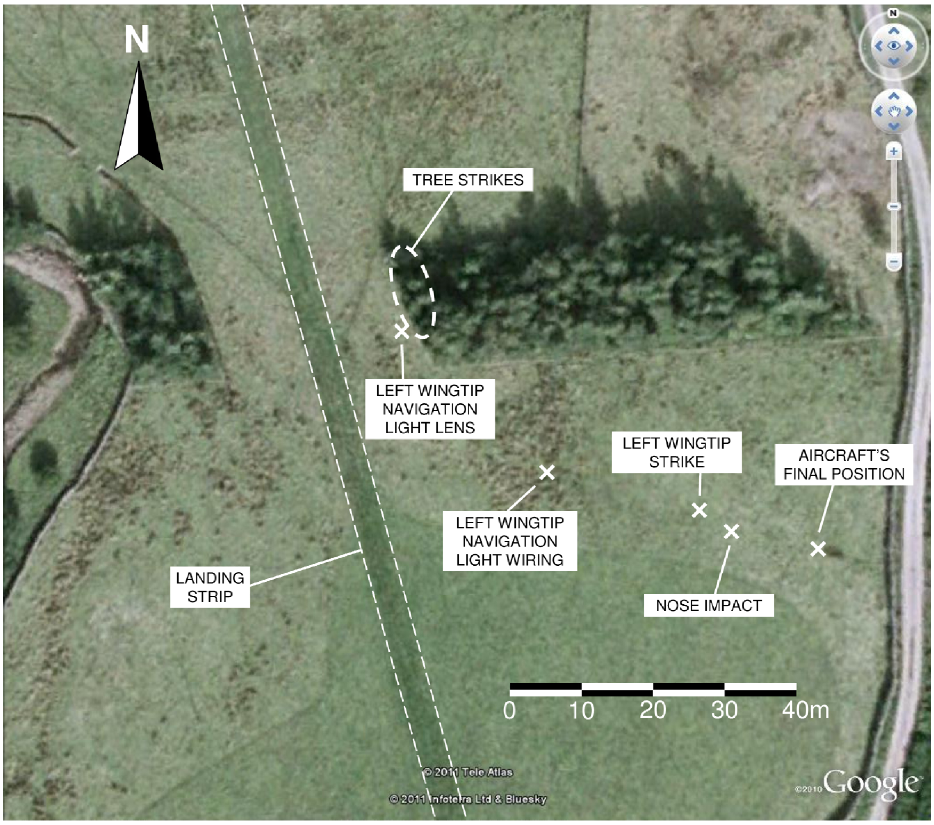

Figure 1

Wreckage plot

A ground impact mark, made by the left wingtip, was evident in the wreckage trail 21 m from the aircraft. This was followed by a 17 cm deep nose impact crater, 13 m from the aircraft. Another ground scar, adjacent to the nose impact crater but laterally offset from it by 75 cm, had been made by the nose undercarriage leg, following detachment of the nosewheel fork assembly from the bottom of the leg. Two sheared bolts of the type used to secure the nosewheel fork to the leg were found in this ground scar.

Two parallel propeller slash marks were evident in the soil immediately before the nose impact crater. Both slash marks were approximately 30 cm in length, and were laterally spaced 33 cm apart. A small quantity of engine oil had leaked onto the ground from the engine oil cooler and the oil tank. No significant fuel spillage was apparent, no fire had occurred and a total of 27 litres of fuel was recovered from the fuselage tank. An auxiliary fuel tank mounted in the right wing was inspected but this did not contain any additional fuel.

Wreckage examination

The leading edge of the left wingtip had sustained impact damage over the outer 1.5 m, with traces of soil and grass found trapped in the folds of the metal structure. The inboard trailing edge of the left wing was buckled, consistent with an impact load sustained at the left wingtip. The outer 2.8 m of the left wing had bent forwards by 70º and the left wing's rear spar had failed in tension, 42 cm outboard of the rear spar bolted joint. The nature of this damage indicated that the forward failure of the wing had occurred after the left wingtip ground strike, probably due to inertial loading of the wing as the aircraft came to rest.

The right wing was largely intact, apart from a 1.1 m length of leading edge impact damage at the wingtip. The left side of the fuselage, behind the cockpit, had partially collapsed in buckling, consistent with the fuselage experiencing compressive loading during a nose-down ground impact. All three propeller blades had broken off at the hub, indicating that the engine was rotating at impact. Fragments of propeller blades were scattered up to 33 m from the nose impact point.

The engine had been pushed rearwards during the nose impact, forcing the left rearmost cylinder's exhaust pipe into the engine's external oil tank. The oil tank filler cap had detached, allowing oil to escape and coat the forward fuselage. The oil tank itself had been pushed into the firewall, causing the firewall to displace rearwards by about 11 cm.

The aircraft's flying controls were examined at the accident site and determined to be continuous, with no evidence of pre-existing control restrictions or any reduction in the range of control movement. The elevator trim tab, which was controlled by an electrical servo, was in a neutral position in line with the right elevator. The engine throttle control was of the 'plunger' type and this was found in the fully forward (throttle fully open) position. However, the rearward migration of the engine oil tank had bent the throttle control torque tube where it was mounted on the firewall, drawing the throttle control fully forward. The throttle position was therefore considered to be unreliable.

Photographs taken by the local police force showed that, prior to recovery of the pilot from the aircraft, the pilot's lap belt and shoulder harness had been fastened. The points at which the harness attached to the aircraft's structure were examined and found to be in good condition, with no evidence of mechanical overload. The single piece canopy transparency had a broken section measuring approximately 60 cm in height by 30 cm in width, adjacent to the pilot's left shoulder.

The aircraft was recovered to the AAIB's facility at Farnborough for further detailed examination. The engine was removed from the aircraft and dismantled. It was free to rotate, was in good mechanical condition and all the engine damage observed could be related to the ground impact sustained during the accident. Both carburettors were disassembled and fuel was present in both carburettor bowls. A single GPS unit had been fitted to the instrument panel but was later found to contain no recorded data pertinent to either the outbound or return flight. No other sources of onboard recorded information were found during inspection of the aircraft.

Aircraft description

The Zenair CH 601D is a two-seat aircraft, fitted with a Rotax 912ULS piston engine, rated at 100 HP, and a fixed-pitch three-bladed composite propeller. The propeller is driven by the engine via a reduction gearbox and its operational range lies between approximately 620 rpm at idle, and 2,390 rpm at the maximum engine limit. The aircraft has a fixed tricycle undercarriage. Both occupants are provided with a three-point harness consisting of a lap belt and a single shoulder belt. In the case of the pilot, sitting in the left seat, the shoulder belt routed over his left shoulder to a buckle release by his right hip.

Aircraft records

The aircraft's airframe and engine logbooks were reviewed. They showed that the aircraft's last annual LAA Permit to Fly maintenance inspection had taken place on 29 July 2010 and that the aircraft had a current LAA Permit to Fly. A weight and balance calculation was performed after the accident, based on the quantity of fuel recovered from the aircraft, baggage found in the aircraft and the pilot's mass. This analysis showed that, when the accident occurred, the aircraft was operating within its maximum authorised total mass and that the centre of gravity was within permitted limits.

Pilot information

The pilot gained a Private Pilot's Licence (Aeroplanes) in 1998. Soon afterwards, he finished construction of a Rans S6 aircraft, which he first flew in June 1999. In 2001 he acquired G-CBDT as a part-built project and, following completion, first flew the aircraft in August 2004. From then until the date of the accident, the pilot owned and flew both aircraft, which were kept at a small hangar at the airstrip. The majority of the pilot's flying was in the Rans S6; in the year immediately prior to the accident, only one quarter of his logged 42.4 flying hours were in G-CBDT. The pilot's last flights in G-CBDT (prior to the flight to Caernarfon) were made on 22 March 2011. Apart from one other day in March 2011, the pilot had not flown the aircraft since August the previous year.

The pilot had applied for, and been granted, a National Private Pilot's Licence (NPPL) in 2004, and had surrendered his original PPL(A). The pilot's flying licence was found to contain medical certificates dating back to 1997, when he started flying training. Since 2003, the pilot had been flying on a medical declaration[1], which held a validity period of five years. The latest medical declaration found was dated 16 May 2003, which therefore expired in May 2008.

Footnote

[1] The medical requirements for a NPPL are less onerous than for a JAR-FCL licence, being equivalent to the DVLA group 2 standard, which is applicable to drivers of heavy goods vehicles and buses. A declaration of fitness must be endorsed by an applicant's General Practitioner, who must have access to their medical records.

In information published by the CAA, a pilot's GP should retain on file a copy of the medical declaration. However, the pilot's GP had no later copy on file, nor record of a consultation or examination around the time of expected renewal. Holders of NPPLs are required to forward a copy of completed medical declarations to the appropriate National PPL administrative body (in this case, the National Pilots' Licensing Group Limited (NPLG Ltd)). Enquires with NPLG Ltd revealed that the most recent declaration on their file for the pilot was that dated 16 May 2003. It was concluded that the pilot most probably did not have a valid medical declaration at the time of the accident.

Airstrip information

The grass airstrip was orientated 17/35, with the landing QDM being measured at 172°M. With an elevation averaging 980 ft amsl, the airstrip was about 460 m long with a prepared central strip 5 m wide. It was surrounded on all sides by higher ground, which reached about 1,100 ft amsl immediately to the north and about 1,400 ft amsl within 0.5 nm in the sector from the north-east, through south, to the west. Thus, the airstrip sat in a small valley (Figure 2). The highest ground in the vicinity was at 2,170 ft amsl, 1.7 nm to the south-east.

A line of trees straddled the strip about 125 m from its start, with a gap in the trees of about 30 m through which the strip passed. The portion of strip before the trees was of softer ground than the remainder, and was generally only used for takeoff. Therefore, the touchdown point for landing was effectively in line with the trees. There were two windsocks, one close to the northern end of the strip and a second about 160 m from the southern end.

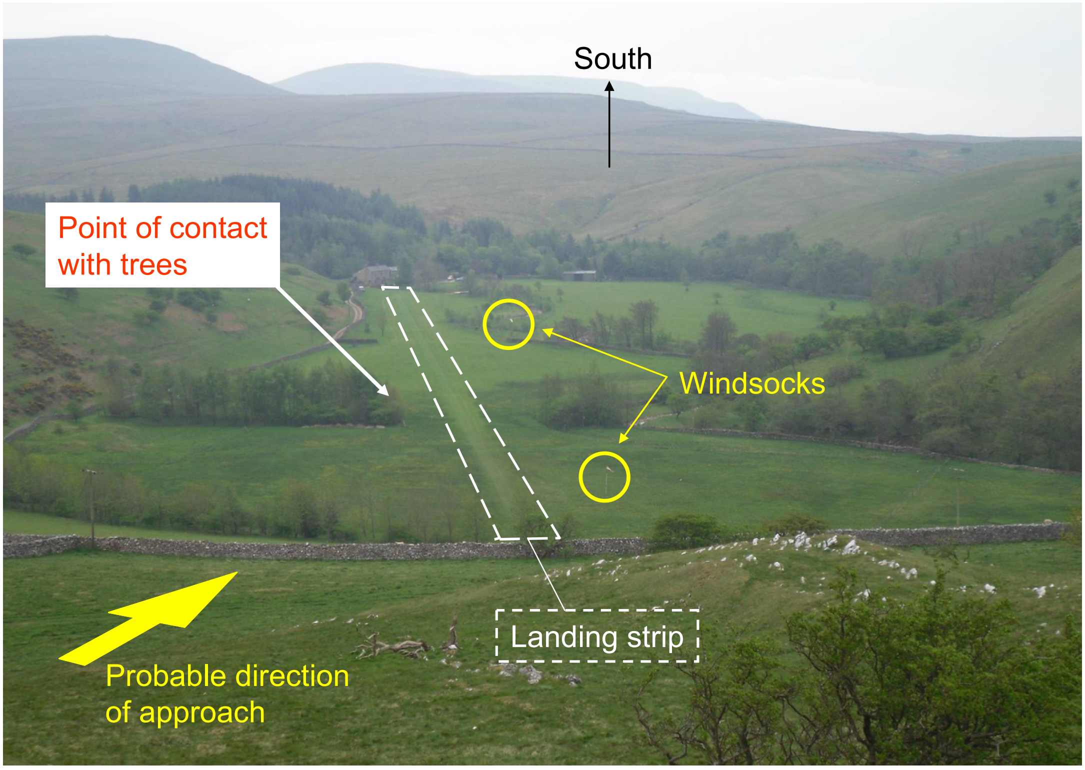

Figure 2

View of the airstrip from high ground to the north

The pilot had been flying from the airstrip since 1999. His family reported that he would approach the strip from the north, using one of two approach paths. Each was through a col in higher ground, such that the strip could be approach either 'straight in' or from a left base position, the former requiring a steeper approach and the latter requiring a relatively late left turn to align with the landing direction.

The pilot was reported to have been cautious with regard to adverse wind conditions. It was not unusual for him to discontinue an approach and divert to a more favourable airfield if conditions were not suitable for landing. It was felt that, on the accident flight, the pilot would most probably have made an approach to the airstrip from the left base position, since the steeper straight in approach was more suited to the Rans S6 which was equipped with wing flaps, unlike G-CBDT.

Meteorological information

Four days before the accident, the pilot contacted the Met Office by e-mail to enquire whether strong winds which were affecting the area would persist until his departure for Caernarfon on 4 May. In his reply, the Regional Advisor said that the winds would moderate and that the pilot could expect south or south-easterly surface winds of about 5 to 10 kt for departure, although they may be expected to increase a little over the following 24 hours. With no significant weather expected, the Advisor said he was reasonably confident that the outbound and return flights could be made under Visual Flight Rules.

The pilot's wife had thought it possible he may telephone home for a weather update before departing from Caernarfon, although as it transpired he did not. Using the internet, she obtained a report of conditions at Kirkby Stephen[2], timed at 1309 hrs (about one hour before G-CBDT took off from Caernarfon). The report gave a surface wind of south to south-east at 15 mph, gusting to 20 mph (13 to 17 kt). Increasing amounts of rain were forecast, with a cloudbase of 1,800 m (about 6,000 ft). The pilot's wife recalled that some rain fell during the afternoon, but had cleared before evening.

Personnel from the emergency services who attended the scene soon after 1900 hrs that evening reported that quite a gusty wind was blowing. It was noted that the two windsocks were indicating markedly different directions: the upwind windsock indicated a headwind approximately aligned with the landing direction, while that closer to the threshold indicated a brisk crosswind, blowing from right to left across the direction of approach. There were no reports or estimates of actual wind conditions in the late afternoon, when G-CBDT was most likely to have been making its approach.

The Met Office provided a report on the likely conditions at the airstrip on the afternoon of the accident, which would have been heavily influenced by the local topography. The gradient wind (at 2,000 ft amsl) was estimated to have been from 170° at 15 to 20 kt, with a theoretical wind at airstrip level (about 1,000 ft amsl) of 160° at 15 kt. However, the surface wind at airstrip level would have been subject to much greater variation, due to topography, than the 2,000 ft wind, giving the potential for significant windshear between the airstrip and about 2,000 ft, with variations likely in wind speed and direction. The topography and wind direction would suggest that the surface wind and 2,000 ft wind would have been relatively closely aligned at the upwind (southerly) end of the airstrip, while blocking

Footnote

2 Kirkby Stephen was about 1.5 nm north-west of the airstrip, at an elevation of about 600 ft amsl.

and funnelling effects of the topography would be likely to have produced a marked variation in wind direction at the approach and touchdown (northerly) end of the strip.

Pathology and survivability

A post-mortem examination was conducted by a specialist Consultant Aviation Pathologist. In his report, the pathologist concluded that the pilot had died as a result of head and neck injuries sustained in the accident. Although these may not have been immediately fatal, the pilot would most likely have been rendered unconscious in the accident, and immediate medical attention would have been unlikely to have altered the fatal outcome.

Evidence from the accident site and the presence of a preserved survivable cockpit space within the aircraft, together with the general pattern of the pilot's injuries, suggested a relatively low energy impact. While a four-point harness would have provided better restraint to the pilot's upper body, his head would still have been free to flail and similar injuries may still have resulted. The pilot was not wearing a safety helmet but as there was no evidence of a significant direct impact to the pilot's head, the use of one was thought unlikely to have had a beneficial effect in this accident. However, an air bag system may have had the potential to alter the survivability of the accident.

The pilot had a recent history of transient episodes of an irregular heart rhythm. His condition precluded the pilot from meeting DVLA group 2 medical standards, although he met the group 1 standards, which meant that he could only fly solo or with another qualified pilot. This fact was bought to the pilot's attention by his cardiologist and was acknowledged by the pilot. Although the possibility of the pilot being incapacitated by his heart condition could not be entirely discounted, his previous episodes had not been incapacitating. Autopsy evidence suggested that the pilot's left hand had been on one of the controls (most likely the throttle, being on the pilot's left side) at the time of the accident. While this suggested the pilot was physically flying the aircraft, the possibility of a subtle incapacitation could not be ruled out.

Toxicological examination revealed no evidence of alcohol or exposure to carbon monoxide. However, O-desmethyltramadol was present at a blood concentration of less than 50 μg/litre. This is a metabolite[3] of tramadol, a prescription-only opiate-like drug used for the treatment of moderate to severe pain. No tramadol was detected on toxicology but O-desmethyltramadol can produce some of the effects and side effects of tramadol, which include dizziness, somnolence and nausea.

The toxicology results indicated that the pilot had taken either tramadol or O-desmethyltramadol at some point before the accident, most likely within the preceding 24 hours. However, the results did not allow reliable conclusions to be drawn about whether the pilot would have been experiencing any of the effects of the drug at the time of the accident.

The reasons for the pilot having taken tramadol or O-desmethyltramadol are unknown. His GP did not prescribe it and was unaware of any reason why he should have taken it. Similarly, the pilot's family had no knowledge of the pilot ever taking the drug or of any reason why he might have done so. Under the terms of the medical declaration for the NPPL, the pilot would have been required to discuss any conditions which

Footnote

[3] A substance formed through metabolic processes.

would necessitate use of the drug and the drug itself. It is unlikely that any condition for which the use of tramadol would be required would be compatible with piloting an aircraft.

Analysis

A detailed inspection of the aircraft did not reveal any technical defects that may have contributed to the aircraft striking the trees adjacent to the airstrip. There was strong evidence that the propeller was rotating under power when the aircraft struck the ground, and a subsequent strip inspection of the engine did not reveal any internal mechanical defects.

The distance between the nose impact crater and the ground mark made by the nose undercarriage leg was compared against the manufacturer's three-view drawing of the aircraft. This analysis indicates that aircraft attitude was approximately 45º nose-down at the point of nose impact.

The distribution of ground impact marks at the accident site indicated that the aircraft had initially struck the ground with the left wingtip whilst the aircraft was in a left-wing low attitude, before impacting heavily on its nose at an angle of approximately 45º nose-down. It then bounced, whilst continuing to rotate, causing a light ground impact with the right wingtip before the aircraft came to rest in a level pitch attitude whilst yawing to the left, causing both main landing gear legs to collapse to the right, but remaining attached to the airframe.

The spacing of the parallel propeller slash marks at the accident side, in combination with the propeller operational rpm range, indicated that the aircraft's impact speed was within a range between 20 kt and 74 kt. However, in the absence of any recorded information, it was not possible to refine this estimate any further.

The pilot had not flown G-CBDT a great deal since the previous summer, and the majority of his flying had been in the Rans S6 he owned. However, his overall flying currency was good and it is unlikely that the relative lack of currency on G-CBDT was a significant factor in the accident. Similarly, the pilot was very familiar with the airstrip and would be expected to be equally familiar with unusual local wind effects due to its unusual topography.

The pilot was reported to be cautious about using the strip in adverse conditions and had proved willing to divert to an alternative landing site if necessary. His enquiry to the Met Office prior to his trip supports this; it seems most likely that his main concern about wind was in the effect it would have in the immediate vicinity of the airstrip. Nevertheless, it is quite possible, based upon known wind conditions and observations later in the day, that the pilot was faced with demanding wind conditions for his landing, which could have included significant horizontal and vertical wind shear.

The aircraft struck trees some way to the left of the strip centreline, approximately level with the probable point of intended touchdown. The overall angle of the line of damage through the trees indicated a climbing flight path, although it could also have been produced, at least to some extent, by the aircraft rolling to the right. Combined with the height of the damage above ground and the final position of the wreckage, it was considered most likely that the pilot was attempting to execute a late go-around[4] when the aircraft struck the trees.

Footnote

4 A manoeuvre in which the approach and landing is discontinued and the aircraft is climbed to a safe height.

It could not be determined how the pilot came to have O-desmethyltramadol in his system, but it appears that he took either tramadol or O-desmethyltramadol at some time during his stay in North Wales. Although it is not possible to say whether the pilot would have been experiencing any of the effects of the drug at the time of the accident, the possibility exists that his performance may have been impaired because of it.

Conclusion

The cause of the accident was not positively determined. There appeared to have been no fault with the aircraft at the time of the accident. The evidence suggested that the pilot was flying a late go-around when the aircraft's left wing struck trees adjacent to the landing strip. Three factors were identified which, either singly or together, may have contributed to the accident. These were the weather conditions at the airstrip at the time of landing, a potentially distracting or incapacitating heart condition, and the possible adverse effects on the pilot's performance caused by the presence in his system of the drug O-desmethyltramadol.

ACCIDENT

Aircraft Type and Registration:	EV-97 Teameurostar UK, G-CEND
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2007
Date & Time (UTC):	2 August 2011 at 1630 hrs
Location:	Northampton (Sywell) Aerodrome, Northamptonshire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damaged firewall
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	878 hours (of which 21 were on type) Last 90 days - 27 hours Last 28 days - 11 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft bounced on landing during the student's first solo flight. He attempted to control the bounce, but believes he applied incorrect inputs resulting in two further bounces. The aircraft suffered damage to the engine firewall.

History of the flight

The student, a qualified flex wing pilot, was undertaking a conversion course to fly fixed wing aircraft and had undergone 21 hours of training for this purpose. On the day of the accident he had flown three circuits with his instructor to a sufficiently high standard for the instructor to send him on his first solo flight. The weather was "good" with light winds along the runway and after briefing the exercise, the student took off to fly a solo circuit.

The student reported that the flight had gone well until, on landing, the aircraft landed firmly on the main wheels and bounced. He maintained idle power and attempted to control the bounce with the flying controls, but the aircraft bounced twice more, each time landing first on the nosewheel. The aircraft finally settled on the runway and the student brought it to a halt, switching off the engine. He was uninjured and initially there appeared to be no damage to the aircraft, although a subsequent inspection identified damage to the engine firewall.

The student pilot remembered little of the events after the initial bounce but believed he either over-controlled the aircraft or applied controls in the wrong sense, reverting to what would have been natural inputs to make in the same situation on a flex-wing aircraft. He reported that he had practised bounced landing procedures whilst training with his instructor and considered he should have applied power on bouncing the first time.

ACCIDENT

Aircraft Type and Registration:	EV-97 TeamEurostar UK, G-RMCM
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2010
Date & Time (UTC):	18 August 2011 at 1200 hrs
Location:	Peterborough (Conington) Airport
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Substantial
Commander's Licence:	Student
Commander's Age:	57 years
Commander's Flying Experience:	95 hours (of which 40 were on type) Last 90 days - 11 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the student and further enquiries by the AAIB

The instructor had released the student pilot for a solo flight after a satisfactory dual training detail. During the landing on this solo flight the aircraft bounced and the student decided to go around in accordance with his training. As he applied full power the aircraft pitched up, veered left and stalled. The left wing dropped and the aircraft impacted a field to the left of the runway. The student sustained a minor injury to his left arm but was able to vacate the aircraft unaided. He candidly reported that he probably did not apply the correct control inputs when he initiated the go-around.

ACCIDENT

Aircraft Type and Registration:	Gemini Flash IIA, G-MVGM
No & Type of Engines:	1 Rotax 503 piston engine
Year of Manufacture:	1988
Date & Time (UTC):	31 July 2011 at 1200 hrs
Location:	Cromer Airfield, Norfolk
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Keel tube in wing, control bar, monopole, right wing and pod
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	32 years
Commander's Flying Experience:	124 hours (of which 2 were on type) Last 90 days - 6 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent enquiries by the AAIB

After an uneventful local flight, the pilot landed back at Cromer Airfield on grass Runway 22. The landing was reported as smooth but, as the speed reduced, the trike veered to the left. This, and the corrective action, set up an oscillation resulting in the aircraft tipping onto its left side and nose at an estimated speed of between 10 and 15 mph. Both pilot and passenger, wearing a lap strap and full harness respectively and both wearing helmets, were uninjured.

The pilot considered that, given the low speed, the option not to correct the initial turn to the left and to allow the aircraft to run into the adjoining stubble field may have been better. He also reported that a subsequent examination of the trike did not find any pre-existing failures but that general levels of wear may have contributed to the event.

ACCIDENT

Aircraft Type and Registration:	Jabiru UL-450, G-BZGT
No & Type of Engines:	1 Jabiru Aircraft PTY 2200A piston engine
Year of Manufacture:	2000
Date & Time (UTC):	17 October 2010 at 1015 hrs
Location:	Farm strip, Weston Zoyland, Somerset
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Lacerations to top of wing and nosewheel bracket twisted
Commander's Licence:	Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	505 hours (of which 156 were on type) Last 90 days - 37 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Shortly before touching down, the pilot attempted to apply more right aileron, but was unable to do so. The aircraft bounced on touchdown and during the landing roll the left wing struck some crops and the nosewheel mechanism was damaged. Subsequent inspection found that the right seat headset cable had restricted the movement of the exposed aileron bell crank and pushrod assembly located behind the seats.

History of the flight

The aircraft has two seats positioned side by side. Behind the seats is the fuel tank, to the top rear of which are mounted the electrical connectors for the left and right headsets; the radio is fitted to the instrument panel. Located between the lower rear of the seats and the forward section of the fuel tank is an exposed bell crank and pushrod assembly which transfers lateral movement of the control stick to the ailerons.

During the previous two days, the pilot had flown a number of times with different passengers. On the day of the accident he returned from his second flight to land on grass Runway 27. He was flying from the left seat, with the unused right headset placed over the front of the right seat back. The flight had been uneventful, and with the wind from approximately 310° at 10 kt, the pilot adopted a right wing-down attitude as he positioned the aircraft onto the final approach. As the aircraft neared the threshold, the pilot attempted to apply more right aileron, but noticed that movement of the control stick had become stiff and he was unable to increase the bank angle with aileron alone. He applied right rudder, positioning the aircraft's nose more into wind, before applying left rudder during the flare. The aircraft bounced slightly on touchdown and, during the rollout, the left wing struck some crops at the side of the runway. The aircraft came to a stop on the left side of the runway and the uninjured pilot vacated the aircraft unaided.

A subsequent examination found that the right headset cable had become lodged below the aileron bell crank, restricting its movement. The pilot stated that he normally secured both headset cables to the overhead panel using a removable strap, and that he usually checked this as part of his pre-flight inspection.

Since the accident the pilot has permanently attached the headset cabling to the overhead panel. He also advised that he was assessing the possibility of installing a panel to cover the exposed area of the aileron bell crank and pushrods. The manufacturer advised that it does not produce such a panel, but is aware that some aircraft have been fitted with panels, of varying designs, by other owners. For this class of aircraft within the UK, information and guidance on the approval of modifications can be obtained from the LAA.

ACCIDENT

Aircraft Type and Registration:	Rans S6-ES, G-TSOB
No & Type of Engines:	1 Jabiru Aircraft Pty 2200A piston engine
Year of Manufacture:	2005
Date & Time (UTC):	5 August 2011 at 1805 hrs
Location:	Audley End Airfield, Essex
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nose leg, propeller, wing strut, fin
Commander's Licence:	Student
Commander's Age:	26 years
Commander's Flying Experience:	21 hours (of which 21 were on type) Last 90 days - 21 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The student pilot, flying solo, was completing the second circuit of a planned 45-minute solo consolidation flight. Runway 36 was in use. For the first circuit the wind was calm but during the second circuit the windsock indicated a cross and tail wind. This was estimated to be from 160º at 7 kt. On late finals, the pilot noted that the airspeed was slightly higher than planned and that the anticipated touchdown point was further down the runway, but before the halfway point.

The initial touchdown was on the main gear but the aircraft bounced and pitched nose-up. The pilot eased the back pressure on the elevator control but, as the aircraft sank back to the ground, the aircraft pitched nose down, touching down on, and damaging, the nose gear. The aircraft bounced briefly again before landing. During the landing roll the damaged nose gear dug into the ground and detached. The aircraft then pitched over to the inverted position before coming to rest, causing damage to the wing struts and fin. The pilot, who was wearing a lap and diagonal belt harness, was uninjured and made the aircraft safe before exiting.

ACCIDENT

Aircraft Type and Registration:	Rotorsport UK MTOSport, G-CGLX
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2010
Date & Time (UTC):	24 August 2011 at 1813 hrs
Location:	Rufforth Airfield, Yorkshire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Fuselage, rotor and mast, propeller, tail and horizontal stabiliser assembly
Commander's Licence:	Student
Commander's Age:	62 years
Commander's Flying Experience:	88 hours (of which 53 were on type) Last 90 days - 17 hours Last 28 days - 8 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

On the day of the accident the student had flown two training flights in the morning and one in the early evening before being cleared to fly his fourth solo circuit using asphalt Runway 23. The approach and initial touchdown on the mainwheels appeared normal but, as the nosewheel came into contact with the runway surface, the student reported that he felt a slight shimmy through the combined rudder and nosewheel steering pedals before the aircraft then yawed slightly to the left. The student recalled trying to apply corrective right pedal but aircraft veered further to the left before it rolled onto its right side and came to a stop. The pilot, who was wearing a full harness and protective helmet, sustained minor injuries.

In his statement, the student considered that he may have had his foot positioned incorrectly on the right pedal.

ACCIDENT

Aircraft Type and Registration:	Thruster T600N 450, G-KDCD
No & Type of Engines:	1 Rotax 582 UL-DCDI piston engine
Year of Manufacture:	1998
Date & Time (UTC):	5 July 2011 at 1115 hrs
Location:	Stoke Airfield, Rochester, Kent
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to pod, wings and propeller; detached nosewheel and bent tubes in cockpit cage
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	65 years
Commander's Flying Experience:	130 hours (of which 73 were on type) Last 90 days - 2 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reports that he was landing on Runway 06 at Stoke Airfield, which has a length of 400 metres. There was a light crosswind but very late on the approach the wind changed to a tailwind of some 10 kt. The pilot reports that he "flared late", hitting the ground "too fast" and the aircraft bounced back into the air nose high. The aircraft stalled and nosed into the ground. Neither the pilot nor the passenger was injured and they were able to leave the aircraft safely.

ACCIDENT

Aircraft Type and Registration:	Thruster T600T 450 Jab, G-BZJD
No & Type of Engines:	1 Jabiru Aircraft PTY 2200A piston engine
Year of Manufacture:	2001
Date & Time (UTC):	3 July 2011 at 1552 hrs
Location:	Old Hay Airfield, Paddock Wood, Kent
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Nose and landing gear damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	274 hours (of which 24 were on type) Last 90 days - 10 hours Last 28 days - 8 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot was on a local flight from Old Hay Airfield, Paddock Wood, Kent and returned to the circuit for what would be his ninth landing of the day. The weather at the time was dry with generally light winds. On the previous landings the pilot had used both Runway 10 and 28 due to a variable wind. Having observed the windsock the pilot elected to use Runway 10.

The pilot described the approach as normal. However, after touching down, as the aicraft passed the end of a line of trees on the northern side of the strip, the aircraft bounced slightly and the left wing lifted. It then bounced again and, despite applying power, the aircraft did not respond before veering right, off the strip into long grass. As the aircraft stopped it tipped forward and came to rest on its nose. The landing gear was also damaged as a result of the bounces. The pilot and his passenger vacated the aircraft uninjured.

The pilot considered the accident was the result of a sudden gust of wind around the line of trees, of approximately 10 kt from the north.

BULLETIN CORRECTION

AAIB File: EW/C2011/01/01

Aircraft Type and Registration:	Cameron O-120 hot air balloon, G-BVXF
Date & Time (UTC):	1 January 2011 at 0947 hrs
Location:	Midsomer Norton, Somerset
Information Source:	Field Investigation

AAIB Bulletin No 10/2011, page 113 refers

In the report published in Bulletin 10/2011, the supplementary oxygen system was mistakenly identified as being supplied with a cylinder pressure of '200 psi'. This was a typographical error – the system was supplied with a cylinder pressure of **200 bar**.

This was corrected in the online version of the report on 31 October 2011.

Aircraft Accident Report No: 2/2011

This report was published on 24 November 2011 and is available on the AAIB Website www.aaib.gov.uk

REPORT ON THE ACCIDENT TO AEROSPATIALE (EUROCOPTER) AS332 L2 SUPER PUMA, G-REDL 11 NM NE OF PETERHEAD, SCOTLAND ON 1 APRIL 2009

Registered Owner and Operator	Bond Offshore Helicopters Ltd
Aircraft Type	AS332 L2
Nationality	British
Registration	G-REDL
Place of Accident	11 nm NE of Peterhead, Scotland
Date and Time	1 April 2009 at 1255 hrs

Synopsis

The Air Accidents Investigation Branch (AAIB) was notified of the accident by Aeronautical Rescue Co-ordination Centre (ARCC) Kinloss at 1326 hrs on 1 April 2009 and the investigation began the same day. In accordance with established international arrangements the Bureau d'Enquetes et d'Analyses Pour la Securité de l'Aviation Civile (BEA), representing the State of Manufacture of the helicopter, and the European Aviation Safety Agency (EASA), the Regulator responsible for the certification and continued airworthiness of the helicopter, were informed of the accident. The BEA appointed an Accredited Representative to lead a team of investigators from the BEA, Eurocopter (the helicopter manufacturer) and Turbomeca (the engine manufacturer). The EASA, the helicopter operator and the UK Civil Aviation Authority (CAA) also provided assistance to the AAIB team.

The accident occurred whilst the helicopter was operating a scheduled passenger flight from the Miller Platform in the North Sea, to Aberdeen. Whilst cruising at 2,000 ft amsl, and some 50 minutes into the flight, there was a catastrophic failure of the helicopter's Main Rotor Gearbox (MGB). The helicopter departed from cruise flight and shortly after this the main rotor and part of the epicyclic module separated from the fuselage. The helicopter then struck the surface of the sea with a high vertical speed.

An extensive and complex investigation revealed that the failure of the MGB initiated in one of the eight second stage planet gears in the epicyclic module. The planet gear had fractured as a result of a fatigue crack, the precise origin of which could not be determined. However, analysis indicated that this is likely to have occurred in the loaded area of the planet gear bearing outer race.

A metallic particle had been discovered on the epicyclic chip detector during maintenance on 25 March 2009, some 36 flying hours prior to the accident. This was the only indication of the impending failure of the second stage planet gear. The lack of damage on the recovered areas of the bearing outer race indicated that the initiation was not entirely consistent with the understood characteristics of spalling (see 1.6.5.7). The possibility of a material defect in the planet gear or damage due to the presence of foreign object debris could not be discounted.

The investigation identified the following causal factor:

1. The catastrophic failure of the Main Rotor Gearbox was a result of a fatigue fracture of a second stage planet gear in the epicyclic module.

In addition the investigation identified the following contributory factors:

1. The actions taken following the discovery of a magnetic particle on the epicyclic module chip detector on 25 March 2009, 36 flying hours prior to the accident, resulted in the particle not being recognised as an indication of degradation of the second stage planet gear, which subsequently failed.
2. After 25 March 2009, the existing detection methods did not provide any further indication of the degradation of the second stage planet gear.
3. The ring of magnets installed on the AS332 L2 and EC225 main rotor gearboxes reduced the probability of detecting released debris from the epicyclic module.

Seventeen Safety Recommendations are made.

Findings

1. The flight crew were properly licensed and qualified to conduct the flight and were well rested. Their training was in accordance with the operators requirements.
2. The helicopter was certified, equipped and maintained in accordance with the existing regulations.
3. The helicopter was in cruising flight at 2,000 ft in daylight when the accident occurred. Neither weather nor the crew's actions were factors in the accident.
4. The first indication to the crew of a problem with the helicopter was the loss of MGB oil pressure and triggering of the master warning. Two and a half seconds prior to this indication, the co-pilot had made a radio transmission stating that the helicopter was serviceable.
5. Immediately after the loss of MGB oil pressure the helicopter began to descend and failed to respond to control inputs.
6. The main rotor system separated from the helicopter approximately 20 seconds after the loss of MGB oil pressure.
7. Separation of the main rotor occurred after the conical housing had become separated from the remainder of the MGB, thus forcing the lift struts to react engine torque. They were not designed for this and their attachments failed as a consequence.

8. During separation, the main rotor blades struck the helicopter's tail boom in several locations, severing it from the fuselage.

9. The fuselage fell into the sea at a high vertical speed and the impact was non-survivable for all occupants.

10. The loss of MGB oil pressure and subsequent separation of the main rotor system were the result of a rupture of the MGB epicyclic module case, which is integral with the epicyclic ring gear.

11. A section of a failed second stage epicyclic planet gear become entrained between the remaining second stage planet gears and the ring gear overloading the ring gear and module case, causing them to rupture.

12. The second stage planet gear failed due to the presence of a crack in the outer race of the gear bearing which propagated in fatigue until the gear failed. It then broke into several sections, three of which were recovered.

13. The morphology of the fatigue crack in the second stage planet gear, suggested that it had initiated from a point at or close to the surface of a highly loaded section of the bearing outer race, approximately 14 mm from the edge of the raceway.

14. The origin of the crack was in a section of the failed gear which was not recovered.

15. Production records for the failed gear showed that it met the quality control standards applicable during manufacture.

16. During the investigation, the use of advanced computational techniques, confirmed that the design of the second stage planet gear met the requirements applicable at the time of certification.

17. Stress analysis identified the possibility of crack propagation, in a manner similar to that observed on the failed gear, should a crack of sufficient depth, originating at or close to the race surface, exceed the depth of the carburised layer.

18. Two planet gears removed from other MGBs, due to extensive spalling, were found to exhibit cracks associated with the spalled area and within the carburised layer which showed a radial growth component. These cracks had grown beyond the carburised layer.

19. Computer modelling showed that the radial growth of spalling cracks could be explained by the bearing rollers sliding.

20. A metallic particle was discovered on G-REDL's epicyclic module magnetic chip detector on 25 March 2009, 36 flying hours prior to the accident.

21. The particle had been released from a position approximately 14 mm from the edge of the outer race of the failed gear. It had been released from a section of the failed gear which was not recovered.

22. Two indentations in the particle suggested that other debris was present in the epicyclic module.

23. No material or manufacturing process anomalies were found on the recovered pieces of the failed gear.

24. Spalling may have contributed to the failure of the second stage gear, however, the spalled area must have been less than is typically observed in such cases and have been confined to a maximum of 25.5% of the gear, which was not recovered.

25. The reason for the initiation of the crack in the failed second stage gear could not be established fully and the possibility of a material defect within the gear or foreign object debris could not be discounted.

26. The helicopter manufacturer operated a Continue Airworthiness programme in which components rejected in operation or during overhaul were inspected.

27. When the Continued Airworthiness programme for the AS332 L2 was initiated, it was determined that damage to planet gear outer races would not adversely affect the continued airworthiness of the helicopter.

28. Not all planet gears which had been rejected for spalling were sent to a laboratory for additional investigation.

29. The AS332 L2 does not provide an alert to the flight crew when the epicyclic module magnetic chip detector detects a particle.

30. An accident to a SA 330J Puma helicopter in 1980 bore many similarities to the G-REDL accident and also resulted from a stage 2 planet gear failure. In the former accident, large quantities of metallic debris had been collected over a number of weeks before failure and the inner race had typical evidence of severe spalling.

31. The use of oil analysis may have assisted in the identification of the deterioration of the MGB components.

32. The ring of magnets, introduced on the AS332 L2 and EC225 MGBs, reduced the possibility of detection of metallic debris, generated in the epicyclic module, by the main module magnetic chip detector or by inspection of the oil filter.

33. The discovery of a magnetic particle on the epicyclic module chip detector, during the initial stages of the 25 hour check on 25 March 2009, was the only indication of the degradation of the second stage planet gear.

34. The identification of a potential HUMS trend on the MGB combiner / bevel gear at the time the magnetic particle had been discovered, together with multiple epicyclic magnetic chip detection alerts, indicated to the operator's engineers that they were dealing with a complex MGB problem for which they sought the assistance of the manufacturer.

35. The EDR procedure was not used.

36. The use of verbal and email communication between the operator and manufacturer on 25 March 2009 led to a misunderstanding or miscommunication of the issue.

37. The maintenance recommendations provided by the helicopter manufacturer were based on their belief that small particles had been found on the main module chip detector and that the maintenance actions contained in AMM task 60.00.00.212 had already been completed.

38. The maintenance task to remove the epicyclic module and examine the ring of magnets on the oil separator plates, contained in AMM task 60.00.00.212.001, was not carried out.

39. The standard practices procedure used to identify the origin of metallic particles within the MGB was generic and open to interpretation.

40. The particle discovered on 25 March 2009, from visual examination, was identified as 'scale', but the material was misidentified as being silver or cadmium plating.

HUMS and recorded flight data

41. HUMS recorded 667 epicyclic magnetic chip detection warnings on 24 March 2009. These were not investigated due to the absence of an alert generated by the HUMS ground station.

42. Alerts will not be displayed on the HUMS ground station summary screens,if the HUMS data card is not closed down correctly.

43. HUMS recorded 76 chip detection warnings for the first operation from Aberdeen on 25 March 2009, and 94 for the second operation, also from Aberdeen. For both operations, the first recorded detection was during engine start.

44. The CVFDR was fitted in accordance with regulatory requirements.

45. CVFDR audio analysis revealed that three minutes and 24 seconds prior to the first warning to the flight crew, frequencies were identified which were consistent with the presence of second stage ring gear defect and a possible increasing misalignment of the left accessory gearbox oil cooler drive shaft.

46. Three minutes and three seconds prior to the loss of MGB oil pressure, HUMS recorded an epicyclic chip detection warning. Three further detections were recorded over the next minute and 43 seconds.

47. HOMP ceased recording 34 seconds prior to the CVFDR due to the presence of a memory buffer.

48. After the loss of MGB oil pressure, atmospheric pressure data recorded by radar and CVFDR became inaccurate.

49. The CVFDR ceased recording prior to other onboard systems, probably due to the activation of the g-switch.

50. Review of HUMS vibration data available at the time of the accident revealed no unusual trends related to the epicyclic module.

51. HUMS vibration monitoring capability of detecting degradation in epicyclic stage planet gear bearings is limited.

52. There is currently no formal requirement or process for component strip reports to be provided after components are removed from service due to HUMS alerts.

Safety Recommendations

The following Safety Recommendations were made during the course of this investigation.

Safety Recommendation 2009-048

It is Recommended that Eurocopter issue an Alert Service Bulletin to require all operators of AS332 L2 helicopters to implement a regime of additional inspections and enhanced monitoring to ensure the continued airworthiness of the main rotor gearbox epicyclic module.

Safety Recommendation 2009-049

It is Recommended that the European Aviation Safety Agency (EASA) evaluate the efficacy of the Eurocopter programme of additional inspections and enhanced monitoring and, when satisfied, make the Eurocopter Alert Service Bulletin mandatory by issuing an Airworthiness Directive with immediate effect.

Safety Recommendation 2009-050

It is Recommended that Eurocopter improve the gearbox monitoring and warning systems on the AS332 L2 helicopter so as to identify degradation and provide adequate alerts.

Safety Recommendation 2009-051

It is recommended that Eurocopter, with the European Aviation Safety Agency (EASA), develop and implement an inspection of the internal components of the main rotor gearbox epicyclic module for all AS332 L2 and EC225LP helicopters as a matter of urgency to ensure the continued airworthiness of the main rotor gearbox. This inspection is in addition to that specified in EASA Emergency Airworthiness Directive 2009-0087-E, and should be made mandatory with immediate effect by an additional EASA Emergency Airworthiness Directive.

Safety Recommendation 2009-074

It is recommended that the European Aviation Safety Agency, in conjunction with Eurocopter, review the instructions and procedures contained in the Standard Practices Procedure MTC 20.08.08.601 section of the EC225LP and AS332 L2 helicopters Aircraft Maintenance Manual, to ensure that correct identification of the type of magnetic particles found within the oil system of the power transmission system is maximised.

Safety Recommendation 2009-075

It is recommended that the European Aviation Safety Agency, in conjunction with Eurocopter, urgently review the design, operational life and inspection processes of the planet gears used in the epicyclic module of the Main Rotor Gearbox installed in AS332 L2 and EC225LP helicopters, with the intention of minimising the potential of any cracks progressing to failure during the service life of the gears.

The following additional Safety Recommendation are made.

Safety Recommendation 2011-032

It is recommended that, in addition to the current methods of gearbox condition monitoring on the AS332 L2 and EC225, Eurocopter should introduce further means of identifying in-service gearbox component degradation, such as debris analysis of the main gearbox oil.

Safety Recommendation 2011-033

It is recommended that Eurocopter review their Continued Airworthiness programme to ensure that components critical to the integrity of the AS332 L2 and EC225 helicopter transmission, which are found to be beyond serviceable limits are examined so that the full nature of any defect is understood.

Safety Recommendation 2011-034

It is recommended that the European Aviation Safety Agency (EASA) review helicopter Type Certificate Holder's procedures for evaluating defective parts to ensure that they satisfy the continued airworthiness requirements of EASA Part 21.A.3.

Safety Recommendation 2011-035

It is recommended that the Federal Aviation Administration review helicopter Type Certificate Holder's procedures for evaluating defective parts to ensure that they satisfy the continued airworthiness requirements of Federal Aviation Regulation Part 21.3.0.

Safety Recommendation 2011-036

It is recommended that the European Aviation Safety Agency (EASA) re-evaluate the continued airworthiness of the main rotor gearbox fitted to the AS332 L2 and EC225 helicopters to ensure that it satisfies the requirements of Certification Specification (CS) 29.571 and EASA Notice of Proposed Amendment 2010-06.

Safety Recommendation 2011-041

It is recommended that the European Aviation Safety Agency research methods for improving the detection of component degradation in helicopter epicyclic planet gear bearings.

Safety Recommendation 2011-042

It is recommended that the Civil Aviation Authority update CAP 753 to include a process where operators receive detailed component condition reports in a timely manner to allow effective feedback as to the operation of the Vibration Health Monitoring system.

Safety Recommendation 2011-043

It is recommended that Eurocopter introduce a means of warning the flight crew, of the AS332 L2 helicopter, in the event of an epicyclic magnetic chip detector activation.

Safety Recommendation 2011-045

It is recommended that the European Aviation Safety Agency require the 'crash sensor' in helicopters, fitted to stop a Cockpit Voice Recorder in the event of an accident, to comply with EUROCAE ED62A.

Safety Recommendation 2011-046

It is recommended that the Federal Aviation Administration require the 'crash sensor' in helicopters, fitted to stop a Cockpit Voice Recorder in the event of an accident, to comply with RTCA DO204A.

Safety Recommendation 2011-047

It is recommended that the Civil Aviation Authority update CAP 739, and include in any future Helicopter Flight Data Monitoring advisory material, guidance to minimise the use of memory buffers in recording hardware, to reduce the possibility of data loss.

FORMAL AIRCRAFT ACCIDENT REPORTS
ISSUED BY THE AIR ACCIDENTS INVESTIGATION BRANCH

2010

1/2010 Boeing 777-236ER, G-YMMM
at London Heathrow Airport
on 28 January 2008.

Published February 2010.

2/2010 Beech 200C Super King Air, VQ-TIU
at 1 nm south-east of North Caicos Airport, Turks and Caicos Islands, British West Indies
on 6 February 2007.

Published May 2010.

3/2010 Cessna Citation 500, VP-BGE
2 nm NNE of Biggin Hill Airport
on 30 March 2008.

Published May 2010.

4/2010 Boeing 777-236, G-VIIR
at Robert L Bradshaw Int Airport
St Kitts, West Indies
on 26 September 2009.

Published September 2010.

5/2010 Grob G115E (Tutor), G-BYXR
and Standard Cirrus Glider, G-CKHT
Drayton, Oxfordshire
on 14 June 2009.

Published September 2010.

6/2010 Grob G115E Tutor, G-BYUT
and Grob G115E Tutor, G-BYVN
near Porthcawl, South Wales
on 11 February 2009.

Published November 2010.

7/2010 Aerospatiale (Eurocopter) AS 332L Super Puma, G-PUMI
at Aberdeen Airport, Scotland
on 13 October 2006.

Published November 2010.

8/2010 Cessna 402C, G-EYES and
Rand KR-2, G-BOLZ
near Coventry Airport
on 17 August 2008.

Published December 2010.

2011

1/2011 Eurocopter EC225 LP Super Puma, G-REDU
near the Eastern Trough Area Project Central Production Facility Platform in the North Sea
on 18 February 2009.

Published September 2011.

2/2011 Aerospatiale (Eurocopter) AS332 L2 Super Puma, G-REDL
11 nm NE of Peterhead, Scotland
on 1 April 2009.

Published November 2011.

AAIB Reports are available on the Internet
http://www.aaib.gov.uk