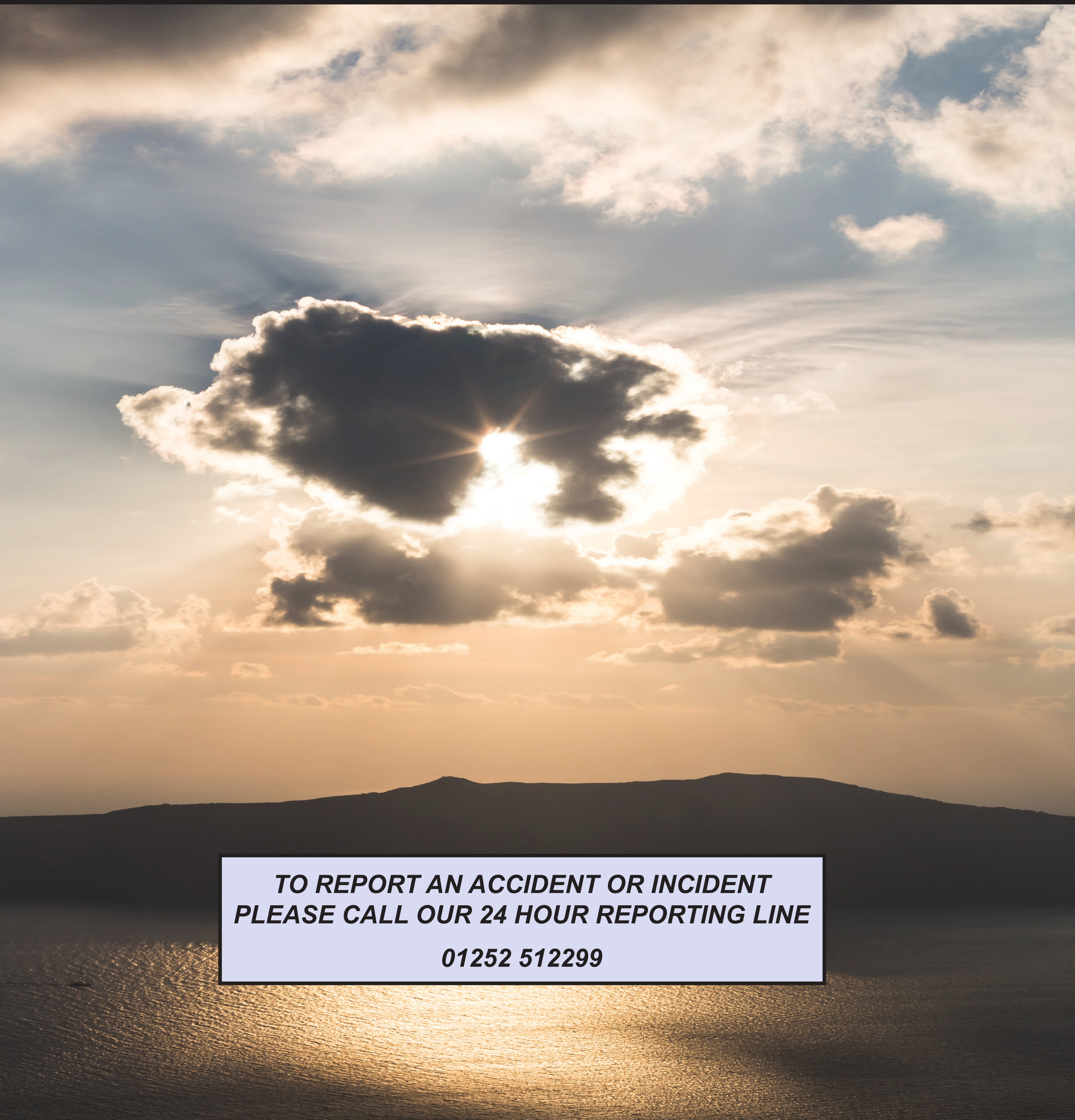
AAIB
Air Accidents Investigation Branch

AAIB Bulletin 7/2016



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AAIB Field Investigation Reports

A Field Investigation is an independent investigation in which AAIB investigators collect, record and analyse evidence.

The process may include, attending the scene of the accident or serious incident; interviewing witnesses; reviewing documents, procedures and practices; examining aircraft wreckage or components; and analysing recorded data.

The investigation, which can take a number of months to complete, will conclude with a published report.

ACCIDENT

Aircraft Type and Registration:	Airbus A321-231, G-EUXF
No & Type of Engines:	2 International Aero Engine V2533-A5 turbofan engines
Year of Manufacture:	2004 (Serial no: 2324)
Date & Time (UTC):	19 July 2015 at 2122 hrs
Location:	Glasgow Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 7 Passengers - 200
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to underside of aft fuselage and drain mast
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	54 years
Commander's Flying Experience:	10,980 hours (of which 6,864 were on type) Last 90 days - 143 hours Last 28 days - 57 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft landed on Runway 23 at Glasgow in calm weather conditions. During the flare there was a continuous progressive aft sidestick control input, which was maintained after touchdown. The aircraft bounced slightly and the nose-up pitch continued to increase, reaching a maximum recorded value of 9.5° at the second touchdown. The aft fuselage and aft galley drain mast contacted the runway surface. The flight crew were not aware there had been a tailstrike until after their arrival on stand, when the damage was reported by a ground crew member.

History of the flight

The flight crew reported at 1325 hrs for a three-sector flight duty. The commander was the pilot flying (PF) for the first two sectors, from London Heathrow to Hamburg and return. These two sectors were operated with an Airbus A319.

The operator's Standard Operating Procedure (SOP) is for the Pilot Monitoring (PM) for the sector to act as the handling pilot from top of descent until below 1,000 ft aal on the approach. The PF then takes control for the landing when visual contact is achieved. On the second sector to Heathrow, the arrival route, flown by the co-pilot, was abbreviated when ATC offered a straight-in approach to Runway 27L. The commander noted that the increase in workload was well managed by the co-pilot.

The third sector of the day, to Glasgow, was operated on a different aircraft, an Airbus A321, G-EUXF. The sector involved tankering fuel, with a planned landing weight of 74,600 kg; the maximum landing weight for this aircraft was 75,500 kg. The co-pilot was the PF for this northbound sector.

The pilots reported that the approach briefing was carried out before the top of descent and that it included a review of the greater potential for a tailstrike on the A321. The descent and approach for Runway 23 proceeded uneventfully, with the aircraft being vectored for a CAT 1 ILS approach in visual flight conditions. At 1,000 ft aal the aircraft was fully configured for landing, stable, with flap FULL and the autopilot engaged. The V_{LS}[1] (lowest selectable speed), based on the weight data for the aircraft, was 140 kt and the corresponding V_{APP} (approach speed) was 145 kt.

The co-pilot took control, disconnected the autopilot and flew the final approach manually with the autothrust engaged. At 50 ft agl the flare was initiated, using a progressive aft sidestick input, and at 25 ft agl the thrust levers were closed. Sensing that the pitch attitude had not increased enough and that the flare was a bit "flat", the co-pilot continued to pull further back on the sidestick.

After touchdown the operator's SOP requires the commander, as the PM, to select reverse thrust. He reported that, on touchdown, he looked down to locate the thrust levers, prior to making the selection, and this may have diverted his attention from monitoring the landing attitude.

The recorded data showed an initial touchdown at 138 kt, with a pitch attitude of 7.4° and a normal acceleration of 1.5 g; the ground spoilers deployed. The aft sidestick input was reduced but a net nose-up pitch command was maintained. The aircraft lifted off the ground for a short time before making a second touchdown, recorded at a pitch attitude of 9.5° and normal acceleration of 1.7g. The operator's SOP requires the PM to announce 'PITCH' if the nose-up pitch attitude exceeds 7.5°. At some stage the commander said 'OK PUSH THE NOSE DOWN' but it was too late to prevent the tailstrike. Reverse thrust was selected 4 seconds after the second touchdown.

The co-pilot reported that the touchdown seemed heavier than normal and the pitch attitude rather high but, because no 'PITCH' callout was heard, the co-pilot was not overly concerned. Neither pilot perceived that the aircraft had bounced or that a tailstrike might have occurred. The landing was completed and the aircraft was taxied clear of the runway and onto a parking stand.

After the aircraft parked on stand, a post-flight report (PFR) printout was generated. The commander checked it and noted that there had been a pitch exceedence on landing. Several of the cabin crew had noticed an unusual noise during the landing and the senior cabin crew member reported this to the commander. A ground maintenance engineer then came on board and advised the commander that there was damage to the aircraft. They

Footnote

1 A description of the 'characteristic speed', $V_{LS,}$ is provided later in this report.

both disembarked to carry out an inspection and observed scrape marks on the aft lower fuselage area and the aft galley drain mast.

Air Traffic Control (ATC) were contacted by a member of the public who had seen sparks coming from the aircraft as it landed. On receipt of this information, a runway inspection was ordered and carried out. A scrape mark was seen on the runway surface but there was no sign of any debris.

Recorded information

The aircraft's flight data recorder (FDR) and cockpit voice recorder (CVR) were downloaded and their recorded information was analysed. The salient FDR data for the tailstrike event is presented at Figure 1.

Figure 1 starts with the aircraft descending through 180 ft agl, at 145 KIAS (V_{APP}), just under 15 seconds before touchdown. At about 50 ft agl, nose-up pitch inputs were made by the co-pilot to commence the flare. The aircraft responded and started to pitch up (from a nominal 4° nose-up) at a rate of 1.5°/sec. The sidestick was progressively pulled further back throughout the flare and the thrust levers closed at about 25 ft agl. There was a small check in the aft-stick at -10° input[2] before reaching a recorded peak value of 12° prior to touchdown. The aircraft pitch attitude levelled off at 7.4° nose up for 1 second during which the aircraft touched down, at 138 KIAS, with a maximum recorded normal acceleration of 1.5g.

The aft-stick input was maintained but reduced to -6.5° just as the ground spoilers deployed. The aircraft continued to pitch nose-up and became airborne again, before touching down at 134 KIAS with a nose-up pitch attitude of 9.5° (the PFR recorded a maximum pitch attitude of 9.8° at touchdown[3]) and a maximum recorded normal acceleration of 1.7g. It remained at this pitch attitude for about 0.5 s before reducing as the aircraft was de-rotated. The nosewheel touched down 3 seconds later.

Comparison with previous landings recorded on FDR

For comparison, Figure 1 also shows the pilot pitch input, aircraft pitch attitude and aircraft radio altimeter height for ten previous landings recorded on the FDR. These are aligned in time at the point when the aircraft descended through 30 ft agl. The recorded minimum (nose-up) pitch attitude at touchdown was 3.9° and the maximum was 6.3°, giving an average of about 5°. The range of aft-stick inputs on these landings vary considerably compared with the control inputs on the tailstrike event. Similar peak aft inputs are evident; however, these appear transient.

Footnote

2 The maximum aft-stick position is -16°.

3 The difference between the FDR and PFR recorded value is due to the fact that the FDR records at a lower resolution (0.35°) as well as temporal differences in sampling. Note, however, that the accuracy of the pitch attitude sensor is ±0.3°.

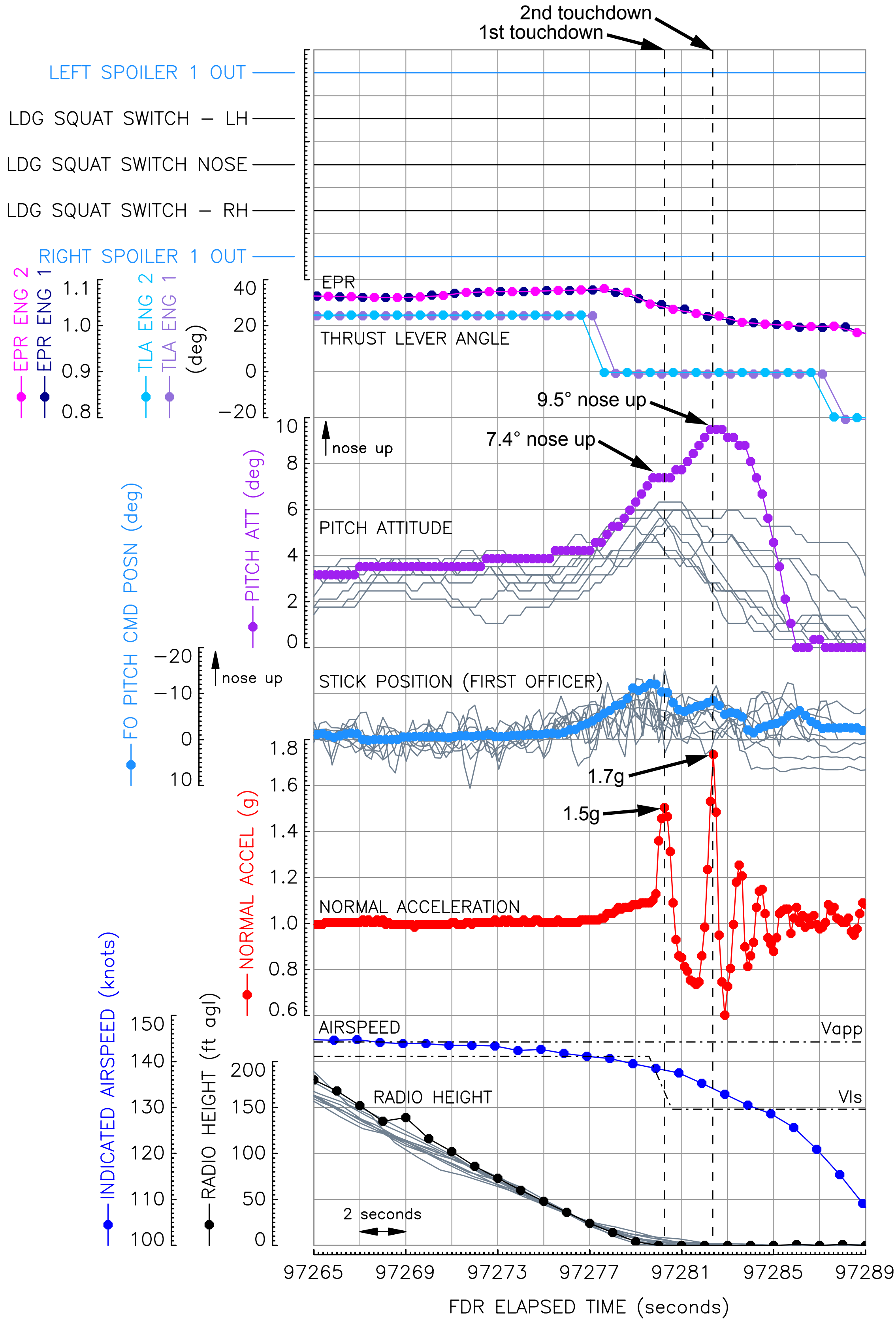

Figure 1

FDR data for the tailstrike event and elements of ten previous landings (grey traces)

Figure 2 compares the tailstrike event with one of the previous landings (light blue traces), also aligned in time at 30 ft agl. The flight profile and aircraft attitudes are similar until about 50 ft agl when the flare is initiated. The earlier flight shows a positive aft sidestick input to a maximum of 7° over 3 seconds, without any loss in airspeed. However, for the tailstrike event, the aft stick input is initially slower but reaches a maximum of 12° aft over a period of 4 seconds, just prior to touchdown, during which the airspeed decays by about 4 kt. For both landings, the thrust levers are reduced to idle at 25 ft RA. However, the airspeed decays more gradually on the earlier flight and touchdown occurs 5 seconds later than on the tailstrike event.

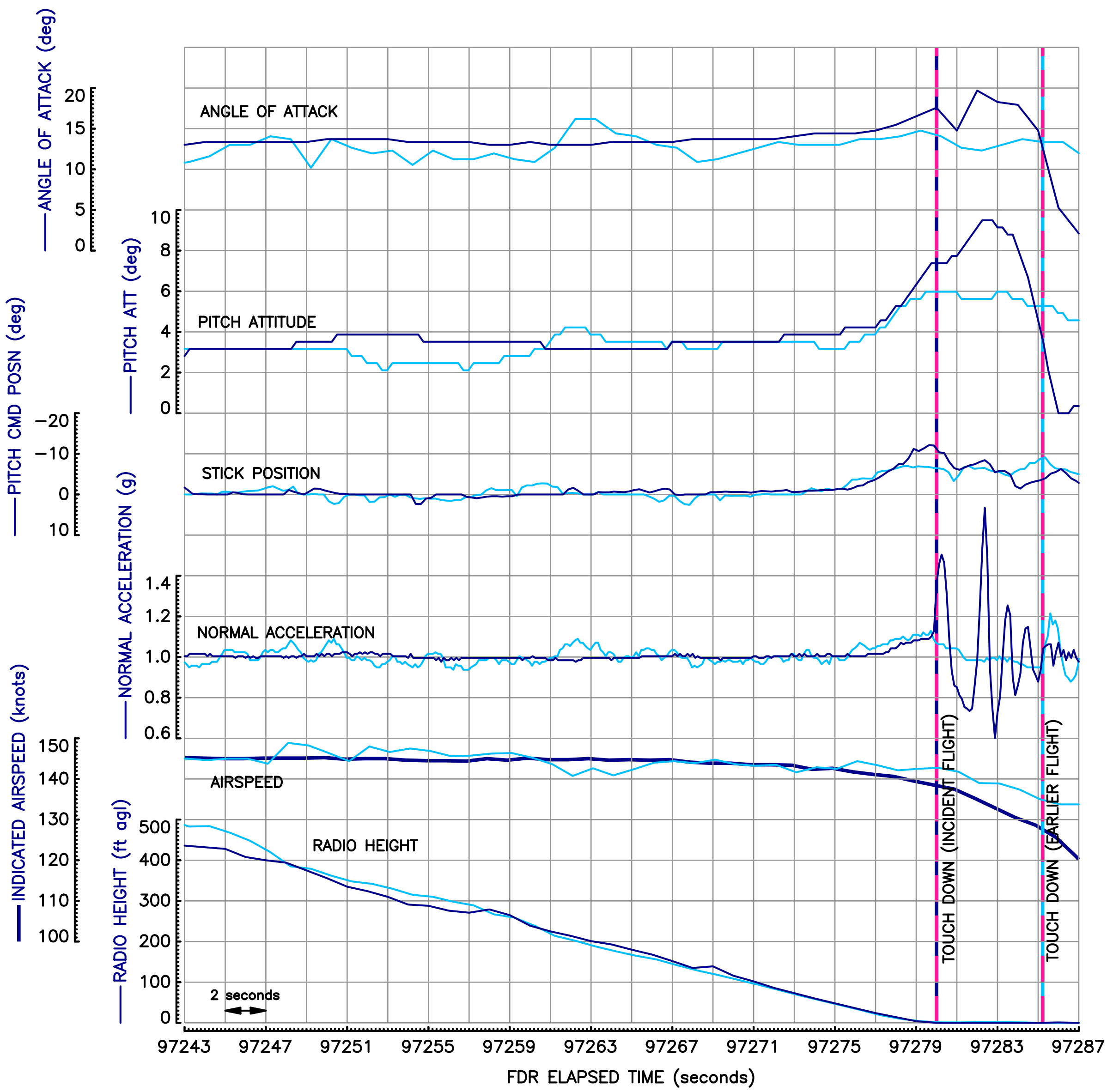

Figure 2

Comparison of data on the tailstrike event (dark blue)
with an earlier landing on G-EUXF (light blue)

Meteorological information

The weather conditions were fine and clear with no reported turbulence. The surface wind was from 250° at 5 kt. Sunset was at 2048 hrs, 34 minutes before landing.

Pilot information

The co-pilot had recorded a total of 302 flying hours, of which 143 hours were on type. It was noted in line-training records that the landings were inconsistent, so an additional simulator training detail was incorporated into the training programme. Following this, the line-training was continued and completed successfully on 13 July 2015. The co-pilot flew a total of 60 sectors during line-training, of which 13 sectors were on an Airbus A321. Ten further line sectors were flown before the accident flight, none of which were on an A321.

The co-pilot was aware of the potential for a tailstrike on the A321 but recalled being advised during training that 11° nose-up was the pitch attitude for ground contact on landing.

Damage to the aircraft

The aircraft suffered abrasion damage to the external fuselage skin panels between frames 63 to 65 and associated internal damage to those frames. There was also abrasion damage to the aft galley drain mast.

Aircraft information

The Airbus A321 entered service in 1994. The aircraft has a longer fuselage than the A320 and different tailstrike geometry. The manufacturer advises that, with the main gear oleo fully compressed and wings level, the pitch attitude limit for the A321 is 9.7° and for the A320 it is 11.7°.

Characteristic speeds

The Airbus Flight Crew Operating Manual (FCOM) description of lowest selectable speed (V_{LS}) is: '*It represents the lowest selectable speed providing an appropriate margin to the stall speed.*' and '*For landing VLS is equivalent to 1.23 VS1G of the selected landing configuration.'* It is represented by the top of an amber strip along the airspeed scale on the Primary Flight Display (PFD) and is derived from aerodynamic data. Another value for $V_{LS,}$ derived from weight data entered by the crew, is displayed on the Multipurpose Control and Display Unit (MCDU).

V_{APP}, the approach speed, is computed by the Flight Management and Guidance System (FMGS) using crew-entered weight data and headwind component. It is displayed on the MCDU and can be modified by the flight crew. The minimum V_{APP} with autothrust engaged is V_{LS} + 5 kt; with manual thrust it is equal to V_{LS}. The FMGS computed speed target for the approach is represented by a magenta triangle; it is variable and moves with the gust variation. It cannot be less than V_{APP}.

The planned landing weight from the loadsheet data was 74,600kg, giving a computed V_{LS} of 140 kt. The V_{LS} displayed on the airspeed scale (derived from aerodynamic data) was recorded as 141.125 kt. The flight crew may modify the V_{APP}, to maintain a 5 kt margin above the displayed V_{LS}, however this was not done for this flight. The recorded target speed (magenta triangle) for the latter stages of the approach was 144.25 kt.

Flare technique

The Airbus Flight Crew Training Manual (FCTM) states that, from stabilised conditions, the flare height is about 30 ft. The following advice is provided: *'Start the flare with positive (or "prompt") backpressure on the sidestick and holding as necessary.'*

Flare mode

Flare Mode is a control law for inducing 'feel' for the pilot during the flare manoeuvre. The system memorises the pitch attitude at 50 ft and that attitude becomes the reference attitude for pitch control. As the aircraft descends through 30 ft the system begins to reduce the pitch attitude to -2° (nose-down) over a period of 8 seconds. This provides the pilot with normal feedback during the flare.

Ground spoilers

The conditions required for the ground spoilers to extend automatically on touchdown are: ground spoilers armed, both main landing gear on the ground and both thrust levers at or below the idle position. On the A321 there is a nose-up pitch effect during ground spoiler deployment, which has to be countered by the pilot.

Reverse thrust

The manufacturer's FCOM procedure is for the PF to select and control reverse thrust.

Tailstrike frequency

A manufacturer's report 'Avoiding Tail Strike'[4], which compared the rate of tailstrikes between 1994 and 2001, showed that A321 events on takeoff were at a comparable rate to the A320, between one and two per million departures. However, the rate for tailstrikes while landing, the A321 was 13 to 14 per million arrivals. This was some six times higher than the equivalent A320 rate, which was two to three per million arrivals.

Further data provided by the aircraft manufacturer indicated that, for the years 2010 to 2014, the rate of tailstrikes while landing had reduced to about one event per million cycles on the A320. During the same period, the frequency was about twice this rate on the A321. The manufacturer believed that much of this reduction was as a result of product improvements and raised awareness amongst flight crew. It was also considered that some of the improvement may be due to a better global environment, for example, a greater number of ILS installations and more consistent operational standards.

Footnote

[4] http://www.smartcockpit.com/docs/Avoiding_Tailstrikes_by_Airbus.pdf

Guidance material

The manufacturer has published guidance to address tailstrike occurrences during landings. Flight Operations Briefing Note (2007)[5] entitled: *'Landing Techniques, Preventing Tailstrike at Landing'* cited a number of common reasons for tailstrikes, including the response to a bounced landing. The advice given in the event of a bounce is:

> *'If the bounce results from a firm touchdown associated with a high pitch rate, it is important for the flight crew to control the pitch, so that it does not continue to increase.'*

An additional note includes the information that:

> *'usually, no single factor will result in a tailstrike. However, the combination of several factors significantly reduce the tail clearance margin...'*

Also, in the *Summary of Key Points:*

> *'Avoid increasing the pitch, or letting the pitch increase (e.g. ground spoilers effect) after a bounce.'*

An article entitled '*A320/ Prevention of tailstrikes',*[6] in the manufacturer's safety magazine '*Safety First*', Issue No 6 July 2008, identified that '*most of the tailstrikes on A320 family aircraft occur during landing in manual mode (Auto Pilot OFF), when the sidestick is maintained in the aft position after touch down.*'

Flight Operations Briefing Note (2007) also includes the following note:

> *'Flight crewmembers may not always be aware that a tailstrike has occurred during landing, because the impact may not be felt. In these cases, a walk-around inspection performed by the flight crew before the next flight will ensure that the marks on the aircraft from the tailstrike are detected, and repaired, if required.*
>
> *However, shallow damage that the flight crew did not detect, and that was therefore not repaired, may result in increased long-term risks (e.g. structural damage in flight, when the aircraft is pressurized).'*

In April 2000[7] the AAIB reported on an investigation into a tailstrike event where damage was sustained to the aircraft which went unnoticed during the turn-around between sectors. The lower fuselage skin had been ruptured and on the subsequent sector the aircraft failed to pressurise.

Footnote

[5] http://www.airbus.com/fileadmin/media_gallery/files/safety_library_items/AirbusSafetyLib_-FLT_OPS-LAND-SEQ08.pdf [Accessed 22 July 2015]

[6] A320 family aircraft includes A321 http://www.airbus.com/fileadmin/media_gallery/files/safety_library_items/AirbusSafetyLib_-FLT_OPS-LAND-SEQ08.pdf [Accessed 12 December 2015]

[7] AAIB Bulletin 4/2000

Modifications

The manufacturer has introduced a number of modifications aimed at tailstrike prevention on the A321. These have included enhancements to the Elevator and Aileron Computer (ELAC) standard and modifications to flight deck indications, to increase pilot awareness of the aircraft's pitch attitude during the landing phase.

The newer ELAC standards (L84 and L93) introduced a control law whereby the maximum commanded pitch attitude on the ground is limited. The values are shown in Table 1. The limitation is triggered by the ground spoiler extension, thus ensuring that it will be active only during a landing.

PITCH RATE CHANGE	< 3°/s	> 3°/s
A320	9°	6°
A321	7°	4°

Table 1

Maximum commanded pitch attitude on ground

Additionally, a pitch limit indicator on the Primary Flight Display, and a 'PITCH PITCH' automatic aural warning were made available. These enhancements were provided as options, dependent upon the modification state of the aircraft. They had not been embodied on G-EUXF.

Flight Data Monitoring programme

Following this event, the operator reviewed pitch attitudes during landings carried out on their A321 fleet, using information from its Flight Data Monitoring (FDM) programme. This showed a normal distribution curve for pitch attitudes on touchdown in the range of 4.5° to 5.5° pitch-up. The average landing weight was 69,000 kg. A review of high pitch events, 7.5° nose-up or greater, suggested that these events were more likely at above average landing weights.

Analysis

The weather conditions were fine and did not have any influence on the event. The autothrust was engaged for the approach and the target approach speed, V_{APP}, was 145 kt. The displayed target speed (magenta triangle) was recorded as 144 kt and the V_{LS} displayed at the top of the amber strip was 141 kt, thus the 5 kt margin between V_{LS} and V_{APP} was reduced to 3 kt. As the aircraft descended below 150 ft agl the pitch was increased slightly and the airspeed gradually reduced below V_{APP}, reaching a combination of 4° nose-up pitch attitude and 141 kt (V_{LS}) at the flare height. The thrust increased but not by enough to maintain the target airspeed. At the flare height, the aircraft energy state was lower than that seen in a typical previous flight. This was further reduced by the thrust levers being retarded to IDLE.

The pitch attitude of 4° nose-up at 50 ft, before the flare was initiated, was higher than average and consequently the nose-down pitch rate (6° over 8 s) targeted by the flare mode would have been above average. Therefore, the feedback from the initial aft sidestick input by the co-pilot may have felt stronger than usual. The sidestick input was small at first, but progressive, and the pitch attitude correspondingly increased. However, the initial input was not positive enough to check the rate of descent, which did not significantly reduce before touchdown, leading to a firm touchdown.

The aircraft touched down with a nose-up pitch attitude of 7.4°, just less than the 7.5° threshold at which the PM is required announce ‘PITCH’. The aft sidestick input was then reduced but some nose-up demand was maintained. The pitch attitude remained at 7.4° for a second then continued to increase. The ground spoilers deployed and the pitch attitude was still increasing as the aircraft briefly lifted off again. The commander looked down at some point to select reverse thrust which may have diverted his attention from the increasing pitch attitude.

The pitch attitude only increased through 7.5° after the first touchdown. Within two seconds, the maximum pitch attitude was reached as the aft fuselage struck the ground. With any rapidly increasing pitch attitude, the SOP monitoring call becomes correspondingly less effective.

The operator’s requirement for the PM to select reverse thrust after touchdown is a variation from the manufacturer’s procedures. A glance down to locate the thrust levers could have diverted the commander’s attention from the visual observation of the landing phase, although during this landing reverse thrust was not selected until after the second touchdown.

The advice from the manufacturer in the event of a bounced landing is that any tendency to pitch up must be controlled. However, in practice it is not necessarily apparent to flight crew when an aircraft has bounced and neither crew member perceived the bounce.

Safety action

> The operator has taken a number of measures since this event to prevent a reoccurrence. These include additional information and training for flight crew on A321 specific differences, together with a review of current landing training guidance and PM actions during the landing phase. The fuel tankering policy is also being reviewed. In addition, the operator is considering introducing an experience restriction for co-pilots performing landings on the A321.

Conclusions

The technical and training measures put in place by the manufacturer have been effective in reducing the tailstrike rate on the global fleet over the last ten years.

It is difficult to pinpoint a precise reason why this tailstrike occurred. As described in the manufacturer’s bulletins, it is likely to have been the result of a combination of factors.

These include an airspeed which had reduced below the target towards $V_{LS,}$ and an initial tentative but progressive flare input which did not sufficiently alter the flightpath of the aircraft. Although the initial touchdown was at a high pitch attitude, probably the most significant contributor to the tailstrike was the continued aft sidestick input after touchdown, which resulted in the pitch attitude continuing to increase.

ACCIDENT

Aircraft Type and Registration:	Cessna Citation 560XL, SE-RHJ	
No & Type of Engines:	2 Pratt & Whitney PW545A turbofan engines	
Year of Manufacture:	2000	
Date & Time (UTC):	29 November 2015 at 1350 hrs	
Location:	On descent into Farnborough Airport, Hampshire	
Type of Flight:	Commercial Air Transport (Passenger)	
Persons on Board:	Crew - 2	Passengers - 9
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Right engine upper cowling detached in flight, impact damage to horizontal and vertical stabilisers	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	41 years	
Commander's Flying Experience:	3,700 hours (of which 2,200 were on type) Last 90 days - 4 hours Last 28 days - 4 hours	
Information Source:	AAIB Field Investigation	

Synopsis

During the descent into Farnborough Airport the majority of the right engine upper cowling detached, damaging the leading edges of the vertical and horizontal stabilisers. The investigation concluded that the cowling probably detached because a number of the fasteners had not been secured during maintenance.

History of the flight

The aircraft had departed Göteborg City Airport, Sweden, bound for Farnborough, Hampshire. During the descent, at approximately FL200, there was a sudden bang and the aircraft started to vibrate. The crew reduced speed and disengaged the autopilot; the engine parameters were normal and the aircraft remained in trim. They were concerned that something at the rear of the aircraft was damaged but nothing untoward could be seen through the cabin windows. They configured the aircraft for landing and decided not to use thrust reverse. The landing was uneventful.

Investigation

The aircraft was recovered to a local maintenance organisation where the majority of the right engine upper cowling was observed to be missing, Figure 1. Damage on the leading edges of the vertical and horizontal stabilisers was consistent with them being struck by debris.

Figure 1

Right engine cowlings following recovery of the aircraft to the hangar

The upper cowling is attached to the engine by 19 quick release fasteners; 10 on the leading edge and 9 on the trailing edge. The fasteners are locked by turning them clockwise approximately ¼ turn, moving a cross pin up a cam until a mechanical stop where the cross pin drops into a locking detent. A spring within the fastener assembly governs the preload and prevents the fastener coming loose due to vibration.

The remnants of the upper cowling that remained with the aircraft had been pulled from the fasteners, which, with the exception of four, remained securely locked, Figure 2. Three fasteners were missing from the inboard leading edge and one was missing from the inboard trailing edge. The empty locking receptacles were confirmed to be serviceable using a representative fastener and the surrounding structure showed no evidence of damage.

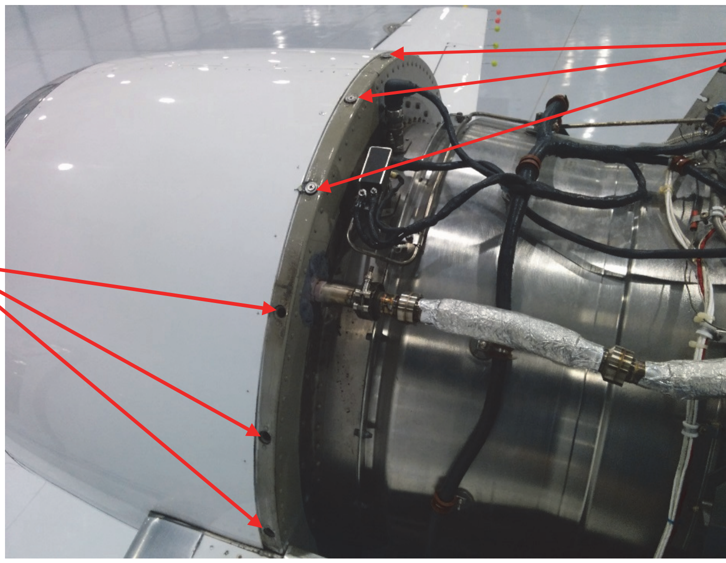

Figure 2

Upper cowling inboard leading edge attachment fasteners

Aircraft history

The aircraft had been leased to the operator six days prior to the occurrence and was on its fourth flight following maintenance. The total flight time since maintenance was approximately five hours.

An investigation carried out by the maintenance organisation established that the engine cowlings had been removed and refitted several times to allow engine troubleshooting. Records showed that the fasteners had been removed from the cowlings as part of a periodic inspection for retention hole wear. No anomalies were identified and the original fasteners were refitted when the check was complete.

Two mechanics installed the cowlings approximately two weeks prior to the occurrence. The cowlings were installed without difficulty and one of the mechanics signed the post maintenance inspection records to confirm '*Engine cowlings closed and attachments tightened'*. The cowlings were not disturbed after the aircraft left the maintenance organisation.

Previous occurrences

In April 2008, Cessna Citation 560XL SE-RCL was flying from Bromma to Geneva when the left engine cowlings detached as the aircraft was on final approach. Investigation identified that the cowlings had not been fastened securely and the maintenance organisation introduced a number of changes to prevent recurrence.

In June 2008, Cessna Citation 560XL G-OROO[1] was on a post-maintenance flight when the crew heard a rumble and felt a 'thud' in the rear of the aircraft. Inspection after landing revealed approximately 75% of the left engine upper cowling had detached in flight, damaging the leading edge of the vertical stabiliser and left elevator. The AAIB concluded that a number of fasteners on the inboard leading edge of the cowling had not been secured and investigation at the maintenance organisation established that the mechanic installing the cowlings had been interrupted and had not completed the task. The maintenance organisation introduced a number of changes to prevent recurrence including enhanced inspections.

The aircraft manufacturer reviewed their service records and advised that the only known occurrences of cowling loss on Cessna Citation 560XL series aircraft were the occurrences highlighted within this report. Furthermore, they analysed data for aircraft in service and confirmed that there was no evidence of any emergent trends relating to the upper cowlings.

Conclusion

It is unlikely that the fasteners were the wrong size or had failed in flight and investigation concluded that the cowling probably detached because a number of fasteners had not been securely fastened during maintenance.

Footnote

[1] https://assets.digital.cabinet-office.gov.uk/media/5422f9fce5274a13170007c7/Cessna_560XL_Citation_XLS__G-OROO_03-09.pdf

Safety action

The maintenance organisation has changed their inspection procedures to ensure that, following installation, the security of engine cowlings is checked by an independent mechanic.

The manufacturer highlighted the three events to their Continued Operational Safety group to assess possible options to minimise occurrences in the future. This includes a proposed video for maintenance agencies to emphasise the importance of ensuring that the quick release fasteners are secure.

ACCIDENT

Aircraft Type and Registration:	Cessna 150F, G-ATKF	
No & Type of Engines:	1 Continental Motors Corp O-200-A piston engine	
Year of Manufacture:	1965 (Serial no: 150-62386)	
Date & Time (UTC):	4 September 2015 at 1110 hrs	
Location:	Hinton-in-the-Hedges Airfield, Northamptonshire	
Type of Flight:	Training	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - 1 (Fatal)	Passengers - N/A
Nature of Damage:	Aircraft destroyed	
Commander's Licence:	None (student)	
Commander's Age:	39 years	
Commander's Flying Experience:	33 hours (of which 33 were on type) Last 90 days - 33 hours Last 28 days - 10 hours	
Information Source:	AAIB Field Investigation	

Synopsis

Following a bounced landing, the student pilot applied power to go around. The aircraft lifted off, adopting a level attitude with a small climb rate. The pilot extended the flaps but did not control the natural tendency for the aircraft to pitch up as a consequence. The aircraft adopted a steep nose-up attitude, stalled and entered a spin to the left from which there was insufficient height to recover. The aircraft struck the ground in a steep nose-down attitude.

History of the flight

The pilot of G-ATKF was a solo student undergoing training for a Private Pilot's Licence (PPL) and, during the morning of the accident, had flown six glide approaches with an instructor. The purpose of the flight was solo consolidation of glide approaches. The wind was from 320° at 7 kt, there was broken cloud at 4,000 ft amsl, visibility of more than 10 km and the temperature was 16°C.

People sitting on a raised platform controlling parachute activity at the aerodrome observed the accident. They often watched G-ATKF making approaches and they reported that on this occasion it had flown two or three circuits using Runway 24 before the approach which led to the accident. One of the witnesses was of the opinion that the aircraft had a small amount of flap extended as it passed his location (Figure 1). He reported that it touched down on its nose landing gear in line with, or just beyond, two cones which were placed one either side of the runway. The aircraft sat back onto its main landing gear, bounced back into the air and, after floating along the runway, touched down again, left main landing gear first, close to the intersection of the taxiways with the runway marked in Figure 1.

The aircraft appeared to settle onto the runway after which power was applied and it lifted off and adopted a level attitude. The witnesses reported that the aircraft appeared to be flying slowly, heading to the left of the runway centreline and climbing gently, when it began to pitch up steadily into a steep nose-up attitude. One of the witnesses, observing through binoculars, stated that he saw flaps extending as the aircraft was pitching up. The aircraft was observed to bank to the left after which the nose attitude decreased rapidly and the aircraft descended and struck the ground.

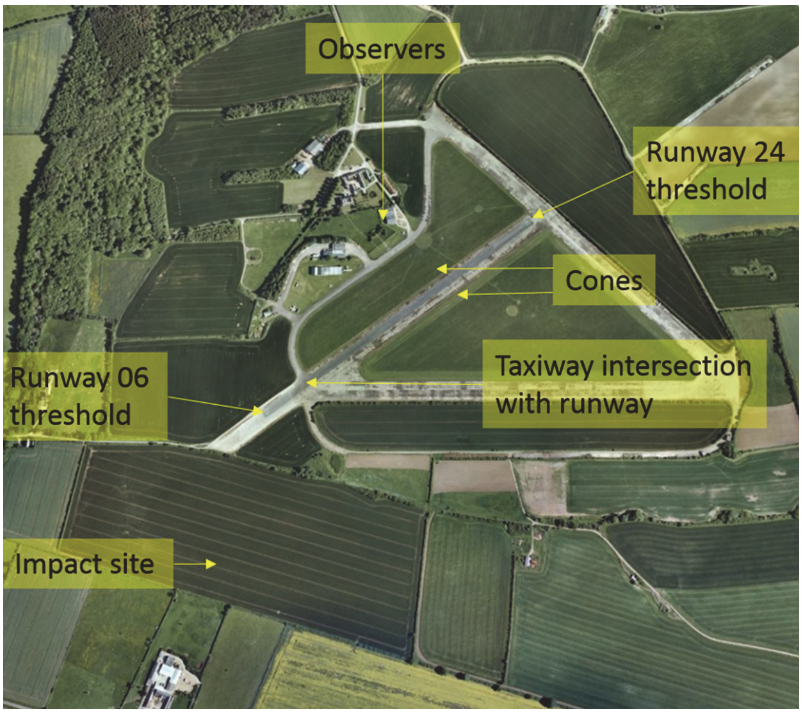

Figure 1

Overhead image of the accident site (Google Earth)

Aircraft description

G-ATKF was an all-metal high wing monoplane powered by a flat four-cylinder Continental Motors piston engine driving a two-blade fixed pitch propeller. It was a two-seater fitted for dual control and was used for general aviation and PPL training.

Flying controls and flaps

The Cessna 150F has conventional flying controls with control yoke and rudder inputs transmitted mechanically to the control surfaces via rods, cables and bell-cranks. The aircraft is fitted with inboard trailing edge flaps which are electrically driven by a motor and screw jack mounted within the wing structure on the right side of the aircraft. The left and right flaps are linked and synchronised by a system of cables and pulleys between the two flaps. The flaps are controlled by a three-position spring-loaded switch in the cockpit. The switch is held up or down against spring pressure to motor the flaps to the desired setting and when released returns to centre whilst the flaps remain in their set position.

Stall warner

The aircraft is fitted with a simple stall warning system which gives an audio indication to the pilot of the onset of wing stall. The stall warner consists of a small orifice in the leading edge of the left wing attached via a tube to a pneumatic device sensitive to vacuum which emits an audible 'whistling' warning tone.

G-ATKF history and records

The aircraft's Certificate of Airworthiness was issued on 29 November 2012 and it had a valid Airworthiness Review Certificate, due to expire on 20 February 2016. At the time of the accident the aircraft had accumulated a total of 12,632 airframe hours and the most recent 50-hour check was carried out at 12,593 hrs, on 18 August 2015. The aircraft had a comprehensive set of technical records which had been kept up to date and there were no deferred defects recorded. The technical log showed that the aircraft had flown regularly in the days leading up to the accident. The aircraft was flown by the pilot and his instructor for 55 minutes immediately prior to the accident flight.

Accident site

The aircraft came down 230 m from the end of the concrete surface in a stubble field with a dry densely packed stony soil surface (Figure 2). It had impacted the ground nose-down at an estimated angle between 10 and 15° from the vertical, leaving a 150 mm deep impression in the soil. The nose landing gear had detached and the aircraft had fallen back to rest upright on its main landing gear which was displaced, twisted and folded underneath the aircraft. One of the propeller blades was curved to the extent that the tip was pointing forwards. The other blade was less damaged, with slight distortion to its tip and deep nicks in the leading edge. The propeller spinner was crushed against the propeller boss leaving impressions of the propeller attachment bolts.

Within the cockpit, the instrument panel and coaming were caved in and a number of the instruments were displaced and severely damaged. Despite this it could be determined that the altimeter was set at 1016 hPa. The fuse panel had bent inwards and the cubby cover panel above the row of fuses had detached from the facia. Two of the fuse holders had been damaged but all the fuses were in place and intact.

The wing had twisted and was no longer perpendicular to the centreline of the fuselage, and both wingtip leading edges were crumpled and distorted. The flaps were down and were rigidly in position. Despite the overall damage there was aileron control system continuity, with slight movement of the ailerons in the correct sense. The rudder and elevator had a full range of movement but were disconnected from the rudder pedals and control yoke due to damage in the cockpit area sustained in the impact.

The engine was generally intact although its bearer frame was severely distorted. There was oil in the sump and showing on the dipstick; however there was a small amount of oil leakage into the engine bay. There was fuel on board the aircraft in both tanks and there was no leakage. The right magneto was still attached and the left was loose due to the mounting flange having broken.

The master switch was off and the ignition key had been removed along with battery disconnection by the first responders to the accident.

The pilot had been sitting in the left seat, wearing the standard three point harness. During the rescue operation the first responders had undone the buckle. However, the short strap and clasp assembly had already detached from the aircraft floor. Damage to the buckle strap mounting bracket bolt showed that it had been pulled out of the anchor nut in the floor. The strap fabric, buckles and clasp were otherwise in good condition.

Figure 2
Accident site and impact mark

Detailed examination

The aircraft was recovered to the AAIB hanger at Farnborough and a more detailed examination carried out.

The stall warner orifice protective gauze was intact and clear of debris. A test was carried out on the stall warning system and it was found to produce normal tone when subjected to a vacuum.

The initial examination at the accident site established a continuity of the flying controls as far as the instrument panel, but they did not appear to be connected to the rudder pedals and control yokes. The yoke shafts had broken at the drive quadrants and were hanging loose, as were the rudder bar linkage assemblies. The elevator trim wheel and its housing had disintegrated and were found loose on the cockpit floor. It was therefore not possible to establish the trim settings prior to the accident.

The flap linkages and drive system were at the same setting each side and by measurement of the screw jack extension were found to be at 38° down. This was corroborated by angular measurement on the wing. The screw jack assembly, motor, wiring and the wing structure surrounding the flaps and drive system were undamaged, although the mainplane displacement had put the flap synchronisation cables under tension, causing them to disengage from their pulleys.

The flap switch and wiring were examined and tested for continuity and found to be serviceable. A 40 amp standard fuse was fitted in the flap circuit although the fuse holder cap had fallen onto the cockpit floor. All the aircraft electrical system fuses are identified by etched and embossed labels on the facia. The flap fuse is normally marked SLO-BLO[1] but, in this case, an alteration had been carried out whereby a 60 amp breaker had been fitted in the SLO-BLO location and labelled ALT, referring to the aircraft alternator. The flap fuse holder had been relocated next to this breaker and relabelled FLAP.

Pathology

The post-mortem examination, which consisted of an external examination and CT scan, did not identify any evidence of natural disease sufficient to have caused or contributed to death. However, medical incapacitation could not be excluded. The examination identified that the deceleration force experienced by the pilot was predominately in the back-to-chest direction and that he died as a result of a head injury.

The toxicology report showed no evidence that the pilot was under the influence of drugs or alcohol at the time of the accident, or that he had been exposed to significant amounts of carbon monoxide.

Pilot information

The student pilot began his flying on 6 June 2015 and first flew solo on 17 August 2015 after 22 hours of instruction. He flew nine flights subsequently which included instruction on flying glide approaches (see next section). Before the accident flight, the student had flown 27 hours with an instructor and three hours solo.

The pilot had been taught low speed handling, with and without flaps extended, earlier in the PPL syllabus as a prelude to being taught about stalling. His training to handle the aircraft with flaps set to 40° had been limited to a demonstration in which he was told that, when applying power, the aircraft attitude was to be held steady and flaps raised to 20° in order to prevent the speed from decreasing. He had been taught not to use 40° of flap to steepen the approach flightpath angle if the aircraft appeared to be high, and his experience of going around had been with 20° or 30° of flap, not 40°.

Footnote

[1] 'Slo-Blo' Fuse – The 'Slo-Blo' nomenclature was used by the manufacturer. It is a fuse which is designed to allow a delay prior to breaking the circuit when its current rating is exceeded.

Training for glide approaches

PPL syllabus

The EASA PPL syllabus is divided into a series of 19 exercise groups. Exercise 13 covers the skills required to fly circuits[2] including: departing and joining the circuit; normal powered approaches to a landing, touch-and-go, or go-around; flapless approaches; and glide approaches (where the approach is made with the throttle at IDLE to simulate an engine malfunction and loss of power). Students fly their first solo flight on Exercise 14 after which they consolidate their learning with a series of dual and solo flights within the circuit area.

In flying glide circuits, students learn how to use flap to control the aircraft's flightpath and touchdown point. At the beginning of a glide approach an 'initial aiming point' (IAP) is chosen approximately one third of the way along the runway to give a target touchdown point. If an aircraft is above the ideal approach angle (and is therefore likely to land beyond the IAP), flap can be extended to steepen the approach and bring the expected touchdown point back towards the IAP. If an aircraft is below the ideal approach angle, it might be able to touch down between the threshold and IAP but, if it is expected to touch down before the threshold is reached, power will be used to complete a normal landing or go-around. A glide approach will have a higher rate of descent than a normal approach and slightly more anticipation is required during the flare before touchdown.

General training at Hinton-in-the-Hedges

Runway 24 at the aerodrome is 700 m long and the operator carried out a risk assessment treating the limited runway length as a hazard. The risks identified were: unstable approach resulting in landing too far into the runway; mishandling resulting in a late go-around at low speed; and mishandling following a go-around. Following the assessment, a rule was introduced to instruct solo students to go around if the aircraft's main wheels were not firmly on the ground by the end of the touchdown zone (TDZ), marked by the cones either side of the runway. Touch-and-go landings are not flown because of the limited runway length and, when practising circuits, the aircraft is brought to a halt after landing and then taxied back along the runway to the takeoff position for the next takeoff.

Glide approach training at Hinton-in-the-Hedges

The student was taught to begin a glide approach on the base leg of the circuit by closing the throttle, flying the aircraft at 65 kt and turning onto the runway centreline. The IAP at the aerodrome is marked by the cones shown in Figure 1 and the student was taught to go around if the aircraft had not touched down by the time it reached the cones. If the aircraft had touched down by the cones, it could be brought to a halt prior to the next takeoff.

Footnote

[2] A circuit is the pattern described by an aircraft taking off and positioning immediately for landing. Aircraft approaching an aerodrome can often join the circuit on different 'legs' of the pattern.

Go around

The student was taught the go-around procedure for approaches flown with 20° or 30° of flap and on one occasion was demonstrated a go-around from an approach with 40° flap. He was taught to apply full power to go around and anticipate the need for right rudder input to counter the slipstream effects of the propeller. He was taught to raise the flaps to 10°, select a level aircraft attitude and hold it to avoid the speed decreasing, and then raise the flaps to 0° once the aircraft reached 65 kt.

Cessna 150F Owner's Manual

The Cessna 150F Owner's Manual states:

> *'Normal and obstacle clearance take-offs are performed with the flaps up. The use of 10° flaps will shorten the ground run … but this advantage is lost in the climb to a 50-foot obstacle. If 10° of flaps are used … it is preferable to leave them extended … in the climb to the obstacle. Flap deflection of 30° and 40° are not recommended at any time for takeoff.'*

Engineering analysis

Although the aircraft was complete and in one piece, the impact had caused substantial damage and disruption to the nose, wing and rear fuselage of the aircraft. The distortion of the nose section and the ground marks were consistent with the aircraft impacting the ground at a steep angle. The nature of the crushing and distortion of the propeller spinner and the damage to the underside of the nose cowling suggested an impact angle approximately 15° from the vertical.

Marks made by the wingtips and associated damage showed that the aircraft hit the ground on its nose, then, as the nose structure deformed, the wing twisted in relation to the fuselage. The wingtip ground marks also implied a slight anti-clockwise rotation of the aircraft as it hit the ground. The attitude of the aircraft at impact and the nature of the wingtip ground marks indicated the aircraft had entered a spin. Witness evidence also suggests that this was the case and the aircraft dropped nose-down near vertical from an estimated height of between 150 and 200 ft. From this height it is estimated that the deceleration forces exerted on the pilot were in excess of 85g during the impact.

The buckle strap floor-mounted bracket and attachment between the seats had detached in the impact. This was as a result of distortion of the cockpit floor folding around the anchor nut such that it became misshapen and released its grip on the mounting bolt, whilst it was under a high tensile load at the moment of impact.

The rudder, aileron and elevator flying control components behind the instrument panel had been severely disrupted; this was wholly attributable to the impact. However, the flying control system and surfaces were found to be correctly assembled and working in the correct sense throughout the rest of the fuselage and wings. There was no evidence to suggest a malfunction of the flying control system prior to the accident.

The examination of the flap system also found no evidence of pre-accident fault or failure and it can be concluded that its electromechanical drive system was operating correctly and responding to the pilot's inputs.

The non-standard modification carried out replacing the alternator fuse with circuit breaker and transposing it with the 'Slo-Blo' fuse holder, fitted with a standard 40 amp fuse, had no effect on the flap system operation and therefore had no bearing on the accident.

The damage to the propeller indicates that one of the blades cut into and drew itself deeply into the soil at the point of impact (Figure 3). The extent of the bend of this blade indicates that it was under high power at this point and the relatively little damage to the other blade shows that the propeller was brought to a stop in one revolution or less. The very steep aircraft angle at impact meant the propeller was presented to the soil almost fully face-on and did not exhibit the multiple progressively increasing tip impacts characteristic of a more shallow impact angle. The propeller effectively tried to 'screw' itself into the ground, causing extreme bending and leading to the conclusion that the engine was at a high power setting.

Figure 3
Propeller damage

The aircraft was well-used and showed signs of wear and tear commensurate with its age, but there was no evidence to suggest the aircraft was unserviceable at the time of the accident. In summary, the aircraft was considered to be airworthy, with systems responding correctly to pilot input prior to the accident. All the disruption and damage to the aircraft was consistent with an impact with the ground at a steep angle.

Operational analysis

Witness evidence suggested that the aircraft lifted off from the runway at a point beyond the taxiway intersection, began to climb gently and turned left. The left turn was consistent with there being insufficient right rudder input to offset the turning effect of the propeller's slipstream at low speed and high power. The turn might also have been due to a small angle of bank to the left, although the witnesses reported that the aircraft began to bank only after it began to pitch up.

The aircraft appeared to be climbing slightly until the flaps began to extend to 38° (the maximum setting is 40°). Extending flap increases lift initially (with a small increase in drag) but, for large flap angles, the drag increases without a proportionate increase in lift. In a high-wing design, such as the Cessna 150, increasing drag by extending flap to its maximum setting tends to cause the aircraft to pitch nose-up and it is likely that, in this accident, this tendency was not controlled by the pilot. With a high nose attitude, there would not have been enough thrust to maintain the airspeed which would have reduced until the wing stalled (observed in this case as the aircraft banking to the left and the nose attitude decreasing rapidly). The aircraft appeared to have entered a spin, adopting a low nose attitude and rotating to the left, until it struck the ground. This was consistent with the physical evidence of the aircraft wreckage.

The limited runway length had been identified as a hazard by the operator and, consequently, students had been instructed to go around if they did not touch down by the time they passed the cones positioned on either side of the runway. It was not determined why the student did not go around after bouncing at a point near the cones. Instead, he applied power once the aircraft settled onto the runway near the taxiway intersection and the aircraft lifted off shortly thereafter.

The flap setting as the aircraft lifted off was not determined, although witnesses reported that the flaps had been extended as the aircraft passed the cones. The aircraft Owner's Manual states that the advantage of using 10° flap (to shorten the takeoff ground roll) is lost during the initial climb, and that takeoffs with flaps set to 30° or 40° are not recommended. The aircraft appeared to have been climbing slightly before it pitched up, which would have been unlikely had the flaps been set to 30° or 40°. On balance, it was likely that the flap was set to approximately 10° as the aircraft lifted off.

The student had been taught that, during a go-around, he should raise the flaps to 10°, select a level aircraft attitude, accelerate to 65 kt and then raise the flaps to 0°. Therefore, the student would have been expected to raise the flaps at about the time they were extended. Given that the flap system was found serviceable, it was concluded that the flaps were operated by the student. The student must have been holding the flap switch while the aircraft was pitching up because, had he released the switch, the flaps would have stopped extending (and they were found almost fully extended). It could not be determined whether he intended to extend the flaps, or whether he intended to raise them but lowered them in error. However, the fact that the pilot was operating the flap switch during the manoeuvre that led to the stall, suggested that he was not medically incapacitated.

Conclusion

Following the bounced landing, the student pilot applied power and the aircraft lifted off and began climbing gently. For reasons that could not be determined, the pilot extended the flaps but did not control the aircraft's natural tendency to pitch up as a consequence.

The airspeed reduced and the aircraft stalled and began to rotate to the left, probably because it was entering a spin. There was insufficient height to recover and the aircraft struck the ground in a steep nose-down attitude.

ACCIDENT

Aircraft Type and Registration:	Rockwell Commander 114B, 2-ROAM
No & Type of Engines:	Lycoming IO-540 piston engine
Year of Manufacture:	1995
Date & Time (UTC):	3 December 2015 at 0911 hrs
Location:	On approach to Blackpool Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Missing) Passengers - N/A
Nature of Damage:	Aircraft lost
Commander's Licence:	Private Pilot's Licence
Commander's Age:	73 years
Commander's Flying Experience:	in excess of 200[1] hours (of which at least 100 were on type) Last 90 days - n/k hours Last 28 days - n/k hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was on a VFR flight from Ronaldsway to Blackpool. A bank of low cloud was moving out to sea, and analysis of the radar track found that, coincident with encountering this cloud, the aircraft descended and its speed reduced until it disappeared from radar. Intensive SAR efforts did not locate the aircraft or pilot.

The available evidence suggests that the aircraft may have stalled at a height from which recovery was not possible.

History of the flight

The aircraft took off from Isle of Man (Ronaldsway) aerodrome at 0836 hrs on a private VFR flight to Blackpool. Radar and RTF recordings were used to establish the history of the flight after departure from Ronaldsway; no other evidence was available[2]. The Blackpool TAF predicted the lowest visibility around the aircraft's time of arrival would be 1,400 m, in heavy rain, with broken cloud 300 ft above the aerodrome.

Footnote

[1] The pilot's log books were not recovered and these are estimates based upon a variety of sources of information.
[2] It was not possible to align the time bases of these recordings, and times recorded on the RTF and radar are not to the same datum.

The pilot established contact with the Blackpool Approach controller (who was providing a procedural service; Blackpool does not have radar) at 0851 hrs:

Station	Spoken words
2-ROAM	ERR BLACKPOOL APPROACH GOOD MORNING TWO ROMEO OSCAR ALPHA MIKE
Blackpool Approach	TWO ROMEO OSCAR ALPHA MIKE BLACKPOOL GOOD DAY TO YOU BASIC SERVICE QNH ONE ZERO ONE SEVEN
2-ROAM	ERR BASIC SERVICE AND QNH IS ONE ZERO ONE SEVEN TWO ROMEO OSCAR ALPHA MIKE
Blackpool Approach	TWO ALPHA MIKE I'LL GIVE YOU THE FULL WEATHER BECAUSE IT'S NOT VERY NICE [brief pause] SURFACE WIND INDICATING ZERO NINER ZERO DEGREES AT FOUR KNOTS [brief pause] VISIBILITY TWO THOUSAND METRES IN SLIGHT RAIN AND MIST [brief pause] CLOUD FEW AT TWO HUNDRED FEET [brief pause] SCATTERED AT ONE THOUSAND SIX HUNDRED FEET [brief pause] BROKEN AT THREE THOUSAND SIX HUNDRED FEET [brief pause] TEMPERATURE PLUS EIGHT
2-ROAM	ERR CAN I FLY THIS [brief pause] CAN I LAND IN THIS
Blackpool Approach	THAT'S ENTIRELY UP TO YOU AND YOUR LICENCE RESTRICTIONS
2-ROAM	OF COURSE IT'S UP TO ME [brief pause] ERR I CAN ALWAYS DIVERT BACK TO THE ISLE OF MAN IF IT'S NOT SUITABLE WHICH RUNWAY IS IN USE PLEASE
Blackpool Approach	RUNWAY ONE ZERO IN USE
2-ROAM	RUNWAY ONE ZERO ERR IF I CAN LAND CAN I TAKE IT ON A LONG FINAL
Blackpool Approach	TWO ALPHA MIKE YOU CAN MAKE A STRAIGHT IN APPROACH FOR RUNWAY ONE ZERO

The aircraft tracked towards Blackpool aerodrome, through a helicopter traffic zone (airspace around oil and gas rigs in Morecambe Bay) in the Irish Sea, and exited the zone at 0858 hrs, at an altitude of 800 ft and a groundspeed of around 115 kt. As the aircraft proceeded eastwards it reached, and then tracked, the extended centreline of Runway 10. At approximately 12 nm from the aerodrome, the aircraft descended to 700 ft.

At 0902 hrs, the pilot reported at "APPROXIMATELY TEN MILES", and was instructed to report when he had the runway in sight. At 0904 the pilot enquired again about the weather:

2-ROAM	TWO ALPHA MIKE WHAT IS THE CLOUDBASE AT THE AIRFIELD
Blackpool Approach	TWO ALPHA MIKE THE ERR CURRENT CLOUDBASE IS ERR FEW AT ONE THOUSAND ONE HUNDRED ERR BUT [indistinct word] IS FEW LOWER AT ABOUT TWO HUNDRED
2-ROAM	OH [brief pause] THANK YOU

When the aircraft was approximately 7 nm from the aerodrome it descended further, to 500 ft, and then at about 5 nm to 400 ft. At 0905 hrs the following exchange took place:

Blackpool Approach	TWO ALPHA MIKE REPORT YOUR RANGE
2-ROAM	ERR APPROXIMATELY FOUR FIVE MILES
Blackpool Approach	TWO ALPHA MIKE ROGER IF YOU DO NOT GET THE AIRFIELD IN SIGHT YOU CAN ERR PROCEED TO THE BRAVO PAPA LIMA AND SEE IF YOU CAN GET VISUAL REFERENCES THEN

The aircraft's groundspeed reduced progressively to less than 60 kt, and its track turned north-easterly at around 4 nm, before turning again towards the centreline, now at 300 ft.

The final RTF exchange took place at 0907 hrs:

Blackpool Approach	TWO ALPHA MIKE REPORT VISUAL WITH THE ERR AERODROME THE ERR LIGHTS ARE ON MAX ERR MAXIMUM
2-ROAM	ERR WILCO [brief pause] I HAVEN'T HAVEN'T GOT IT IN SIGHT YET
Blackpool Approach	TWO ALPHA MIKE ROGER [brief pause] I SAY AGAIN IF YOU WISH YOU CAN PROCEED TO THE BRAVO PAPA LIMA UNTIL YOU GET VISUAL REFERENCES

The lowest groundspeed shown on radar was 48 kt. The final radar return, which was slightly north of the centreline, was recorded on Warton radar at 0907 and showed the aircraft descending at 200 ft and 57 kt.

The RTF recording included two very brief sounds, one at 0908 hrs and one at 0909 hrs, which could have been momentary transmissions from 2-ROAM. In the background of the first was a high-pitched tone, suggestive of the audible stall warning fitted to many light aircraft.

At 0910 hrs, the controller asked the pilot to report his range from Blackpool. No reply was received, and following further unsuccessful attempts to contact the aircraft, the Blackpool controller initiated search and rescue action.

Several helicopters took part in search operations, and their pilots remarked upon the low cloud, poor visibility, and 'fishbowl' effect they encountered over the sea in the search area. The pilot of one, who was a military fixed and rotary-wing pilot current in both disciplines, commented to investigators that it:

> *'was not a day to be out over the sea at low level… there was a significant opportunity for* [the pilot] *to have been disorientated.'*

Aerodrome information

Blackpool Aerodrome is situated on the Lancashire coast immediately inland of a beach, from which it is separated only by dunes and a public road. It has one runway, orientated 10/28, and is equipped with instrument approach aids including a non-directional beacon, with the audio identification BPL, which may be used for approaches to either runway, and an instrument landing system on Runway 28. The aerodrome is not equipped with radar.

Meteorological information

The Met Office provided an aftercast of the conditions prevailing at the time of the accident. The summary stated:

> *The weather conditions at the location of the believed crash were consistent with those to be expected as a warm front moved across the area from the south. The front was bringing large amounts of cloud and outbreaks of rain and drizzle. There was also some mist in the region, so visibilities along the coast in the Blackpool area were in the region of 2000 to 3000M.*
>
> *Broken to overcast amounts of high cloud can be seen in the satellite imagery, which obscured the details of cloud at lower levels, but the surface observations confirm the existence of various layers of cloud at lower levels.*
>
> *The 0850Z METAR at Blackpool (the closest to the crash in spatial and location terms) reported a wind of 090 at 05KT. The visibility was 2000M in light rain and mist. There were 1 to 2 oktas of stratus at 200 feet, 3 to 4 oktas of stratocumulus at 1600 feet, and 5 to 7 oktas at 3600 feet. The temperature and dew point were both plus 8 °C.*
>
> *An examination of the observations in the area confirms they were consistent with the expected forecast conditions from the F215 charts and the TAFs.*

On the *'Forecast Weather below 10,000ft'* chart (Form 215), Blackpool was near the southern edge of an area where conditions the lowest visibility forecast was 200 m over land until 1000 hrs, and the lowest cloud was forecast to be isolated scattered or broken stratus with a base between the surface and 500 ft and tops at 1,000 ft.

The cloud base recording from Blackpool Airport showed a band of low cloud, with base below 200 ft, crossing the aerodrome at about 0820 hrs. In the prevailing wind, this band of cloud would have travelled west approximately three miles, between its passing over the aerodrome and the time of the loss of the aircraft from radar.

The investigation was not able to establish what weather information the pilot had accessed.

The pilot

The pilot held a Private Pilot's Licence with Single Engine Piston rating but no qualification in instrument flying. He had obtained the PPL in late 2014, having trained mostly in 2-ROAM.

Aircraft information

The Rockwell Commander 114B is a four seat, all-metal, low-wing monoplane with retractable tricycle landing gear. It is powered by a Lycoming IO-540 horizontally opposed flat six fuel-injected piston engine fitted with a three-blade variable pitch propeller. The accident aircraft was built in 1995 and held on the Guernsey register. It was kept in the Isle of Man but was maintained by a company based in Guernsey. It had a valid Certificate of Airworthiness and at the time of the accident its airworthiness review was current. The aircraft had a continuous and comprehensive maintenance history and its most recent annual inspection was carried out and certified on 27 April 2015. Although the aircraft was already fitted with a modern avionics suite with a moving map GPS and autopilot, the pilot had made arrangements for an avionics upgrade to be carried out on the aircraft in Guernsey.

The last known uplift of fuel was 133 litres at Ronaldsway on the 15 October 2015 and it is not known what the total fuel contents of 2-ROAM were at takeoff. On his flight plan for the flight, the pilot had stated the aircraft's endurance was 4 hours 36 minutes.

The Rockwell Commander typical cruise speed is between 120 and 130 KIAS and its stall speed is in the range 56 to 64 KIAS, depending upon configuration.

Location and salvage

After the aircraft had been lost from the radar a multi-agency search and rescue operation was initiated under the direction of the Maritime & Coastguard Agency (MCA). During the SAR operation a fuel or light oil slick was identified in the vicinity of the last known radar position of the aircraft. Several very small pieces of wreckage were also found in the same area. These items consisted of a small piece of insulation material and section of rubber or neoprene panel seal which had a distinctive blue paint overspray on its surface. No other items were recovered until the following morning when a member of the public reported finding a small shoulder bag containing various items including an instrument flying text book and non-aviation-related paperwork which linked the bag to the pilot. MCA staff conducted a beach search over the weekend after the accident and recovered a set of lightweight plastic aircraft wheel chocks along with an item which was likely to have been an interior light cover. Other items were also found which may have been associated with the aircraft but were not relevant to the accident.

Several hours after the accident, the regional weather conditions deteriorated into what became a prolonged period of very severe weather throughout the northwest of the UK. This prevented a search for the wreckage on the sea bed until 11 days later when, on the 14 December, a Ministry of Defence team identified an object on the sea bed in approximately 10 metres of water. The weather deteriorated again but on 19 January 2016 a police maritime search unit found an aircraft at this location on the sea bed. Although the very poor sub-sea visibility precluded positive identification or examination, the location, description and colour scheme strongly suggested the aircraft was 2-ROAM.

The aircraft was inverted on the sea bed with the tail fin and cabin area buried in the soft sand, in one piece with its landing gear extended. There appeared to be no debris field. It was not possible to assess flying control and flap positions, or to access the cabin area.

On the 28 January a light aircraft nosewheel with tyre was washed up and handed to Lytham Coastguard. It was heavily corroded, with a deflated tyre still attached. The tyre markings matched those apparent on the aircraft nosewheel as shown on recent pictures of 2-ROAM.

On the 25 February a privately-funded salvage operation was attempted but could not be completed because the aircraft had become full of compacted sand and was firmly lodged within the sea bed. However, the operation did succeed in recovering the engine, propeller and part of the left wing. Immediately after recovery these items were inspected by the AAIB.

Although severe corrosion had set in, the engine showed signs of impact with the sea and had been damaged by the salvage operation. All three propeller blades were bent and twisted and the spinner had been flattened. The ancillary equipment, alternator, vacuum pump, magnetos and plugs were in place but had also suffered impact, corrosion and salvage damage.

Analysis

Engineering

The absence of detached wreckage suggests a low energy impact with the sea. This was confirmed by the police dive team who reported the aircraft was upside down and in one piece. The appearance of the shoulder bag and the chocks shortly after the accident suggest that the cabin and baggage area was compromised during the impact. The only other item of note to be washed up afterwards was the corroded nosewheel and tyre. It is possible the extended nose gear was damaged during the impact and then over time the wheel detached as rapid magnesium alloy corrosion destroyed the structure of the hub and rim.

The distortion of all three propeller blades indicates that the engine was producing power when it came into contact with the sea. The flattening of the spinner also suggests a steep angle of impact but there is not enough evidence to determine whether the aircraft was upright or inverted. Although it is not known how much fuel was on board the aircraft at takeoff, but assuming a minimum of 133 litres, the flight plan endurance, and the high power propeller distortion mean that lack of fuel or its quality are not considered to be factors in this accident.

At the time of writing the fuselage has not been recovered so a full physical inspection of its other systems has not been carried out. The landing gear was extended but the position of the flaps is not known, therefore it cannot be determined if the aircraft was in the landing configuration. However, a technical fault or an external influence, such as a bird-strike, cannot be entirely discounted.

Operations

The meteorological conditions were correctly forecast, and although it was not possible to establish what forecast information the pilot had gathered, his conversation with the other Ronaldsway pilot indicated that he was aware of the possibility of inclement weather. Although he was not inexperienced, he held a PPL without any instrument flying qualification, which would have made a flight in the prevailing conditions challenging.

The weather at Ronaldsway was better than that at Blackpool and, in the course of the flight across the Irish Sea, the aircraft encountered a lowering cloud base and reducing visibility. In particular, the band of low cloud which the cloud base recorder at Blackpool identified at around 0820 hrs would have drifted west by about three miles between that time and the time at which the aircraft disappeared from radar.

The pilot's enquiry to the Blackpool Approach controller, "ERR CAN I FLY THIS [BRIEF PAUSE] CAN I LAND IN THIS" suggests that he was dubious about carrying on and his remark that returning to Ronaldsway was an option suggests that he considered doing so. A prompt reversal of his course, back towards the better weather at Ronaldsway, might have prevented the accident.

The gradual descent and then reduction in speed suggest efforts to remain in visual conditions below lowering cloud, and to reduce speed as visibility became less favourable. The 'fishbowl' effect referred to by helicopter pilots engaged in the search would have made accurate control of the aircraft difficult for a pilot not experienced in instrument flight, and would have made any recovery from a loss of control such as a stall more difficult than usual. These conditions would also have led to increased workload for the pilot, in the context of which the suggestion by the controller, "IF YOU DO NOT GET THE AIRFIELD IN SIGHT YOU CAN ERR PROCEED TO THE BRAVO PAPA LIMA AND SEE IF YOU CAN GET VISUAL REFERENCES THEN", may have added to confusion in his mind about the legitimacy and practicality of continuing.

The ground speed recorded by radar was a result of the aircraft's airspeed less the wind, which was very light and from the east, more or less directly against the aircraft's progress. The lowest recorded ground speed was below the range of stall speeds for the aircraft, and it is possible that the aircraft stalled at a low height from which recovery was not possible. The brief transmission, during which a stall warning may have been sounding, and the steep impact attitude found by the engineering investigation, are consistent with this hypothesis.

Conclusion

The aircraft was operating in weather conditions that would have been challenging for the pilot, who held no instrument flying qualification. The available evidence suggests that the aircraft may have stalled at a height from which recovery was not possible. The engine was producing power at the point of impact with the sea but a technical fault or failure, or some external influence, cannot be entirely discounted.

ACCIDENT

Aircraft Type and Registration:	Silent 2 Electro, G-CIYA
No & Type of Engines:	1 x FES-SIL-M100 22 kW brushless electric motor
Year of Manufacture:	2015 (serial no: 2075)
Date & Time (UTC):	19 October 2015 at 1457 hrs
Location:	Husbands Bosworth Airfield, Leicestershire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	66 years
Commander's Flying Experience:	154 hours (of which none were on type) Last 90 days - 11 hours Last 28 days - 1 hour
Information Source:	AAIB Field Investigation

Synopsis

During the initial climb following a self-launch, the aircraft entered an incipient spin. One wing struck the roof of a farm building, before the other wing and fuselage impacted the ground. The pilot was seriously injured. The investigation did not reveal any malfunction or defect to account for the accident. Although the pilot was experienced and current in light aircraft, gliders and motor-gliders, he had not flown the aircraft type before.

The aircraft was fitted with a ballistic parachute recovery system which had not been activated. The investigation highlighted a number of issues concerning such systems which present a risk to the aircraft occupants and first responders following an accident.

One Safety Recommendation has been made.

History of the flight

The pilot collected the aircraft new from the manufacturer, and transported it by road to Husbands Bosworth. He discussed the launch options for his first flight in the aircraft with other pilots, instructors, and the deputy CFI. He had reportedly concluded that a winch launch, being quite a dynamic exercise, was not appropriate and, because the aircraft only had a belly-hook, an aero-tow was not ideal either (he was used to aero-towing using nose-hooks on other gliders). Therefore, he decided to self-launch using the electric propulsion system. On 18 October 2015, the weather was unsuitable for flight so he rigged the aircraft and only conducted taxi trials using its electric propulsion system.

On the afternoon of 19 October 2015, the weather was benign, with light winds, good visibility, and no low cloud. The pilot went to the gliding club at Husbands Bosworth and rigged the aircraft. He was assisted by another club member who had experience of gliders with electric propulsion systems. This member also ran with the wing during the initial phase of the launch.

The pilot did not subsequently recall events during the flight, and so the recollections of the other club member witness were the only available evidence. The wing-runner reported that the pilot appeared to be methodical in preparing for the flight and was capable of reaching all the controls. The flaps had been set at +1 and the electrical propulsion system appeared to operate normally. He also said that the pilot had a loose seat cushion in the cockpit, but was not sure if he sat on it, or if it was placed behind his back. Either way he did not think that it would have interfered with the takeoff.

The wing-runner described the takeoff, from a straight section of the paved northern taxiway on the airfield, as apparently normal, but stated that at about 20-30 ft agl, the pitch attitude increased to an angle which gave him cause for concern. He reported that this attitude was maintained until "perhaps" around 100 ft agl when the aircraft stalled and its left wing dropped. It then entered what appeared to be an incipient spin and one wing struck the roof of a farm building before the other wing and fuselage impacted the ground. The pilot was seriously injured, and the wing-runner, and then other club members, gave first aid until the emergency services arrived.

Although the aircraft was fitted with a Ballistic Parachute Recovery System, the system had not been activated.

The pilot

The pilot learnt to fly as part of an RAF Flying Scholarship in his younger life[1], and had taken up light aircraft flying and gliding in recent years. He regularly flew in Cessna 152s, Falke motor-gliders, and Schempp-Hirth Discus and SDZ-51 Junior gliders. Within the last 90 days he had flown 5 hours in Self Launched Motor Gliders (SLMG) and 6 hours in gliders.

As the pilot held both motor-glider and glider qualifications, he did not require any additional training to fly the Silent 2 Electro.

Takeoff technique

The Flight and Maintenance Manual contained this instruction concerning flap position for self-launch:

> *'Set the flaps at +1 position.'*

Footnote

[1] No log book of this activity was available and it was not included in the hours quoted for the pilot's experience.

The pilot was provided with a copy of the aircraft's *Flight and Maintenance Manual* and a set of *Flight notes* which, on the topic of self-launching, stated:

- *'Maintain wings level and neutral pitch during the ground run.*
- *The glider will typically lift off when the indicated airspeed of 90~100 kph (48~53kts) is reached. Don't be tempted to pull the glider off the ground prematurely.*
- *Maintain air-speed 90~100kph (48~53kts) for the duration of the climb-out.'*

Aircraft description

General

The Silent 2 Electro is a single-seat, self-launching microlight sailplane that operates in the UK under the Single Seat Deregulation (SSDR) airworthiness exemption to the Air Navigation Order (ANO).

The aircraft is constructed from carbon and glass-fibre, has a 13.5 m wingspan and a 'T' tail configuration. The flying controls, which consist of a speed brake, flaperons, rudder, variable incidence tailplane and elevator, are operated by a system of pulleys, cables and push rods. The aircraft is trimmed in pitch by the tailplane, which is coupled, by a cable, to the flap control. G-CIYA was also equipped with a release hook mounted just in front of the main wheel and was cleared for both winch and aerotow launches.

The pilot's seat, which is not adjustable, is covered with a two-piece cushion joined by a zip fastener, which is attached to the seat base and back by Velcro fasteners. On the accident flight a seat pad (cushion) approximately 380 mm square and 50 mm thick, when compressed, was found in the cockpit. The pilot was secured by a four-point seat harness and the aircraft was equipped with adjustable rudder pedals.

The canopy is attached to the aircraft by a hinge on the forward edge of the canopy frame and is locked in the CLOSED position by two locking pins located on each side of the rear part of the frame. The left locking pin operates a microswitch mounted on the inside of the fuselage that provides a 'canopy-closed' signal to the Controller in the Front Electrical-self-launch System (FES[2]).

Front Electric-self-launch System

The FES consists of two lithium polymer batteries, a controller, a FES Control Unit (FCU), a 22 kW brushless electric motor and two fixed-pitch, folding propeller blades. The electric motor is located in the nose of the aircraft and when it is not operating the propeller blades fold rearwards.

Footnote

[2] FES is also used on other gliders as the acronym for Front Engine Sustainer.

The two lithium polymer batteries are connected in series and are fitted in a compartment behind the cockpit. When fully charged the batteries have a combined capacity of 4.3kWh, at 117v, and can supply sufficient energy for the aircraft to climb for 15 minutes at more than 400 fpm and operate at cruise power for up to 60 minutes. The FCU is located on the instrument panel and provides the pilot with information on the condition of the complete propulsion system, including the batteries. The propeller rpm is set by the throttle/brake control rotary switch located at the bottom of the FCU.

Ballistic Parachute Recovery System

G-CIYA was equipped with the Magnum 300 SSP Ballistic Parachute Recovery System (BPRS). The rocket and parachute were located in a compartment behind the pilot and above the wing spars. The operating handle was located on the right side of the cockpit and had a safety pin to prevent inadvertent operation. A warning placard stating '*Ballistic Parachute Deployment Handle Emergency Use Only*' was attached to the inside of the cockpit adjacent to the operating handle. A second red warning sign stating '*DANGER MAGNUM INSIDE*' was affixed to the BPRS compartment access panel (see Figure 1).

Figure 1
BPRS warning sign

Accident site

The aircraft impacted the roof of a farm building located 20 m north of the northern taxiway at Husbands Bosworth Airfield, (see Figure 2). Ground marks and damage to the building indicate that the aircraft was in a steep nose-down attitude when the outer 4 m section of the right wing hit the roof of the building before the left wing and fuselage impacted the ground.

Figure 2
Accident site

Damage to the aircraft

When the AAIB arrived onsite, the aircraft batteries, which were undamaged, had been disconnected, the electric motor arming switch (key) was in the OFF position and the BPRS safety pin was fitted in the operating handle. In order to assist the pilot, the first responders had to disconnect electrical leads and cut some of the pitot / static pipes in order to remove the instrument panel.

The forward cockpit area and canopy had been destroyed with the electric motor having broken away from the structure. The 'canopy closed' microswitch was broken. The landing gear was in the DOWN position, but due to the damage to the control system it was not possible to establish the position of the flaps, airbrakes or tailplane at the time of the accident. The fuselage in the area of the wing attachment bolts had distorted and the main spar, wing skins and flaperons on the right wing had fractured and broken at the point where the wing struck the end of the building. The tail boom had broken approximately 0.6 m forward of the fin. Both propeller blades had failed close to the attachment bolts and detached from the electric motor. One of the blades had cut deeply into the ground and the second propeller blade was found lying on the ground close to the motor. The pitot / static system had been disrupted in several locations.

A number of the control rods and cables were damaged and had fractured. The BPRS had not been operated.

Detailed examination of the aircraft

A detailed examination of the aircraft was carried out at the AAIB facility at Farnborough where it was assessed that all the damage to the aircraft and control system occurred as a result of the impact. The pilot's harness was intact and the aircraft had been correctly rigged. There was also no evidence of pre-impact damage, or overheating of the FES or electrical systems.

The FCU and the ASI had been damaged in the accident and could not be tested. While the pitot / static system had been damaged, there was no evidence that any of the pipes had become disconnected or damaged prior to the accident.

The battery voltages were each measured as 57 V, giving a combined voltage of 114 V which is close to their maximum charge. The condition of both batteries was also checked using the data leads and test software provided by LZ-Design. This test established that the State of Charge on the batteries was 91.4% and 92.0%. The State of Health[3] was 99.8% and 99.9%.

The examination could identify no mechanical reason why the aircraft departed from controlled flight.

Flight tests

The aircraft had recently been manufactured and prior to being handed over to the pilot at the factory in Italy on 15 October 2015, it underwent two flight tests conducted by the manufacturer's pilots. The first flight test, which lasted 25 minutes, took place on 1 September 2015 using a standard factory instrument panel. The second pre-delivery flight test, which lasted 70 minutes, took place on 8 October 2015 when the aircraft was equipped with the pilot's specified instrument panel and accessories. The accident occurred during the third flight of the aircraft, which was the pilot's first flight on the type.

During the delivery process the pilot was shown and given the opportunity to rig the aircraft.

Weight and balance

A weight and balance report for G-CIYA, dated 5 October 2015, provided the following information:

Empty mass	220.17 Kg
Forward CG limit	357 mm from datum
Rear CG limit	448 mm from datum

Two ballast weights with a mass of 0.74 kg and 0.7 kg were attached to the bulkhead in the nose of the aircraft. The UK agent for the aircraft advised the AAIB that the pilot had informed him during the configuration procedure, prior to delivery, that his weight was 79 kg.

Footnote

[3] The State of Health is a measurement that reflects the general condition of a battery and its ability to deliver the specified performance compared with a fresh battery.

From the weight and balance report it was determined that mass and position of the CG during the accident flight was:

Mass	301 kg
CG	412 mm from the datum (within the CG envelope)

Deregulation of Single Seat Microlight Aeroplanes (SSDR)

On 28 May 2014 the CAA issued General Exemption E3795 to the Air Navigation Order to allow single-seat microlight aircraft to fly in the UK without being subject to the requirement to hold a valid Certificate of Airworthiness or Permit to Fly. However, this exemption does not apply to operations, licensing or medical requirements. Such aircraft are referred to as SSDR.

Ballistic Parachute Recovery System

The aircraft was equipped with a Magnum 300 SSP BPRS installed above the wing spars in the area behind the pilot. This system was fitted and armed at the factory in Italy prior to the pilot taking delivery of the aircraft.

A BPRS presents a risk to third parties who respond to an aircraft accident. This hazard was addressed for small light aircraft by British Civil Airworthiness Requirements (BCAR) Section S, which states:

> *'S 2003 General*
>
> *It must be shown by analysis or test that:*
>
> *a) the airworthiness of the aeroplane, the safety of its occupant(s) and personnel on the ground will not be degraded by the installed parachute recovery system;'*
>
> *S 2041 Markings and placards.*
>
> *d) A warning placard must be placed on the exterior of the aeroplane close to the stored energy device, which is easily distinguishable by ground personnel, warning of the potential hazard.'*

This airworthiness requirement is satisfied by adopting the recommended specification in ASTM F2316 -12[4]. However, along with other SSDR aircraft, G-CIYA was exempt from the requirements of BCAR and the only warning placard on the outside of the aircraft referred to 'Magnum'. It, therefore, may not have been apparent to first responders that a ballistic rocket was fitted to the aircraft. A warning placard, shown at Figure 3, was found in the pilot's documentation, which did appear to conform to the specification in ASTM F2316-12. However, the web site, which was in German, was for a pilot's equipment shop and provided no readily accessible information on how to disarm the BPRS. The telephone numbers were not always answered and the person answering the calls could not always speak English.

Footnote

[4] ASTN F2316 -12, Standard Specification of Airframe Emergency Parachutes.

Figure 3

Warning placard in pilot's documentation

The BPRS on the Silent 2 Electro is installed and armed with the wings removed from the aircraft and it is not possible to make the system safe with the wings fitted. In this accident the wings were damaged and the structure in the area of the BPRS was distorted such that the activating cable was pressed against the side of the fuselage. Due to accessibility it was not initially possible to establish if the trigger in the initiating unit had been partially cocked and it took several hours for the AAIB to disarm the BPRS and safely remove the rocket by cutting a hole in the side of the fuselage.

It was also noticed that there were no warning placards on the trailer that was used to store and transport G-CIYA to alert emergency services, in the event of a road traffic accident, that the aircraft in the trailer had a ballistic rocket fitted.

During an investigation into an accident involving a CZAW SportsCruiser, registration G-EWZZ[5], the AAIB made a number of observations concerning the safety of third parties following an accident involving an aircraft equipped with a BPRS. These observations included placarding, system design and the difficulty in disarming such systems. These observations led to a number of Safety Recommendations being made to the European Aviation Safety Agency[6] and the UK Civil Aviation Authority[7].

Footnote

5 AAIB Report G-EWZZ, reference EW/C2014/08/01.
6 Safety Recommendations: 2015-006; 2015-007; 2015-008.
7 Safety Recommendations: 2015-009; 2015-010; 2015-011; 2015-012.

Analysis

Overview

The witness who helped to launch the aircraft reported that the takeoff initially appeared to be normal, but the aircraft then adopted a steeper than expected pitch attitude before it reached a height of around 100 ft when it appeared to stall and enter an incipient spin to the left. The investigation could not determine why the excessive pitch attitude was maintained.

From the damage to the aircraft, and ground marks, it was established that the aircraft was in a very steep nose-down attitude when it crashed. The initial impact occurred between the outer ⅓ of the right wing and the roof of the farm building. The left wing, followed by the cockpit section, then hit the ground. This sequence reduced the force on the cockpit section, increasing the chance of the pilot surviving the accident.

Possible causes for the excessive pitch attitude

The weather conditions were benign, and the pilot was suitably qualified and experienced on both gliders and SLMG aircraft. Having considered the possible options for his first takeoff in the Silent 2 Electro, he had elected to carry out a self-launch from the paved taxiway at Husbands Bosworth. This was a viable alternative to the more dynamic winch-launch alternative, and suited the fact that he had previously aero-towed only on gliders equipped with nose-hooks.

The aircraft had successfully completed a 70-minute factory flight test eleven days prior to the accident. The pilot had also rigged the aircraft and undertaken a taxi test the day prior to the accident with no reports of any problems. The witness who assisted the pilot on the day of the accident reported that the pilot appeared to be able to reach all the controls and that, in his opinion, the cushion in the cockpit was unlikely to have moved, or deformed, in a manner that would have affected the pilot's ability to control the aircraft.

Examination of the aircraft determined that it had been correctly rigged and, outside the cockpit area, there was no evidence of a mechanical failure or control restriction having occurred prior to the accident. However, due to the damage to the cockpit area and the disruption caused by the rescue operation, the possibility that something in the cockpit had restricted the movement of the control column could not be eliminated.

The Mass and Balance were within the aircraft limitations and the flap setting of +1 was in accordance with the self-launch procedure in the flight manual[8]. The damage to the instruments and pitot / static system made it impossible to determine if the ASI had been reading correctly. However, the ASI had functioned correctly during the test flight carried out 11 days prior to the accident. Although the multi-probe had been removed while the aircraft was transported by road, there had been no disruption to any other part of the pitot / static system, all the connectors were found to be intact and there was no evidence of any pre-impact damage to any of the flexible pipes.

Footnote

8 Flight and Maintenance Manual, Silent 2 Electro, Chapter 4.4.

The witness reported that at the start of the flight the electric propulsion system appeared to be operating normally. From the ground marks it was established that one of the two propeller blades had cut deeply into the ground, indicating that the propeller was rotating under power. The available evidence suggests that the propeller was being driven under power from the electric motor at the time of the accident.

Ballistic Parachute Recovery System

Following an accident involving a SportsCruiser, registration G-EWZZ, the AAIB made a number of Safety Recommendations to the CAA to reduce the risk to third parties responding to an accident involving an aircraft equipped with a BPRS. The Safety Recommendations and the responses from the CAA are as follows:

Safety Recommendation 2015-009

It is recommended that the Civil Aviation Authority review the requirement for the placarding of aircraft referred to in Regulation (EC) 216/2008 Annex II, fitted with a Ballistic Parachute Recovery System so that the warning placards contain information on the location of the rocket launcher and the actuating device, and can be read from a safe distance regardless of the stationary attitude of the aircraft.

The CAA responded:

'The CAA accepts this recommendation and undertakes to review the requirements regarding placarding relative to location of BRS and actuating device fitted.'

And:

Safety Recommendation 2015-010

It is recommended that the Civil Aviation Authority introduce the requirement that, for aircraft referred to in Regulation (EC) 216/2008 Annex II, the rocket launcher in an aircraft Ballistic Parachute Recovery System is fitted in a position where it can be readily disarmed following an accident.

The CAA responded:

'The CAA accepts this recommendation and will compile some Administrative & Guidance Material to BCAR S (Sub-Section K), relating to location and ease of disarming of such systems.'

And:

Safety Recommendation 2015-011

It is recommended that the Civil Aviation Authority introduce an information system, for aircraft operating in the UK that allows first responders and accident investigators to identify if an aircraft is equipped with a Ballistic Parachute Recovery System. This information system should include details of the type of system fitted, the location of the major components, routing of the actuator cable and the actions required to make the system safe.

The CAA responded:

'The CAA accepts this recommendation and will undertake a review to determine the practicality of expanding G-INFO so that owners may add details appropriate to modifications to their specific aircraft.'

And:

Safety Recommendation 2015-012

It is recommended that the Civil Aviation Authority takes action to ensure that information on the risks from Ballistic Parachute Recovery Systems is disseminated to the emergency services operating in the United Kingdom.

The CAA responded:

'The CAA accepts this recommendation. When and if action in response to recommendation 2015-011 is in place, it will undertake to issue an Information Notice to promote awareness.'

BPRS regulatory requirements

Unlike light aircraft that operate in the UK on an EASA Certificate of Airworthiness or a Permit to Fly, aircraft operating under SSDR are not required to conform to aircraft design standards, including those specified in ASTM F2316-12, for BPRS. While owners of SSDR aircraft are required to comply with the Air Navigation Order (ANO), it may not be obvious that Article 38 (2) and (5) of the ANO also apply to a BPRS fitted to SSDR aircraft. These articles state:

'(2) The position of equipment provided for emergency use must be indicated by clear markings in or on the aircraft.

(5) All equipment installed or carried in an aircraft,…….must be installed or stowed and maintained and adjusted so as not to be a source of danger in itself ……'

The potential risk to third parties responding to an accident involving an aircraft equipped with a BPRS is the same irrespective of the requirements under which the aircraft is designed and operated. Therefore with regards to a BPRS, SSDR aircraft should conform to the same requirements as aircraft operating on a UK Permit to Fly. Therefore the following Safety Recommendation is made:

Safety Recommendation 2016-048

It is recommended that the Civil Aviation Authority require that Ballistic Parachute Recovery Systems fitted to Single Seat Deregulated Aircraft comply with Article 38 of the Air Navigation Order and that the installation and placarding meet the same requirements as for aircraft operating on a Permit to Fly.

Safety action taken

The UK agent of the Silent 2 Electro has advised the AAIB that the aircraft manufacturer has taken action to attach the correct BPRS placards to their aircraft and trailers prior to delivery.

The BGA have also stated that they will act on this report to inform the gliding community of the potential dangers from gliders fitted with BPRS that have been involved in an accident.

AAIB Correspondence Reports

These are reports on accidents and incidents which were not subject to a Field Investigation.

They are wholly, or largely, based on information provided by the aircraft commander in an Aircraft Accident Report Form (AARF) and in some cases additional information from other sources.

The accuracy of the information provided cannot be assured.

ACCIDENT

Aircraft Type and Registration:	Boeing 747-400, G-BNLW
No & Type of Engines:	4 x Rolls-Royce RB211-524G2 turbofan engines
Year of Manufacture:	1992 (Serial no: 25432)
Date & Time (UTC):	5 October 2015 at approximately 0830 hrs
Location:	Cape Town International Airport
Type of Flight:	Passenger Transport
Persons on Board:	Crew - N/A Passengers - N/A
Injuries:	Crew - N/A Passengers - N/A
Nature of Damage:	Damage to ground power receptacle
Commander's Licence:	N/A
Commander's Age:	N/A
Commander's Flying Experience:	N/A hours Last 90 days - N/A hours Last 28 days - N/A hours
Information Source:	Investigation by aircraft operator

Synopsis

Shortly after connecting ground power smoke was seen to emanate from the Ground Power Unit (GPU). The aircraft's ground power receptacles and associated wiring sustained heat damage, but there was no degradation of the structural integrity of the aircraft. The most likely cause of the damage was considered to be misalignment of a ground power socket in the aircraft's receptacle during ground power connection.

Description of the event

After arrival at Cape Town a single ground power unit (GPU) was connected by plugging two sockets into the two electrical receptacles on the aircraft, as per the operator's standard procedures. The ground crew experienced difficult in plugging the No. 1 lead into the aircraft and some "wiggling" of the socket was reportedly required. The ground crew then commenced their walk-around inspection. They subsequently observed smoke coming from the GPU, so they disconnected the plugs and noticed they were warm. An avionics engineer inspected both the external receptacle pins on the aircraft and the Electrical and Equipment (E/E) bay inside the aircraft, but found nothing unusual. Another GPU was subsequently connected, but the aircraft would not accept ground power. Later that day the aircraft's electrical power systems were checked and the aircraft was considered to be serviceable. It was dispatched to London Heathrow Airport and the flight was completed without incident.

The GPU was inspected by the ground service provider and nothing significant was found.

Aircraft information

The Boeing 747 has a small access hatch for the E/E bay on the lower surface of the fuselage near the nose gear leg. The two GPU receptacles are mounted on the fuselage skin and are connected to electrical power cables located under the floor of the E/E bay. There are six male electrical pins inside each receptacle. There is a layer of insulation material between the floor and the cables, with a small air gap around the wiring.

Aircraft examination

A more detailed inspection of the aircraft was carried out after arrival at Heathrow. Examination of the E/E bay revealed significant sooting and heat damage to the power cables, and the insulation in the underfloor compartment appeared to have briefly caught fire (Figure 1). The limited volume of air around the wiring might have been a factor in preventing further damage. The aircraft structure was assessed, including eddy current testing, but despite the sooting there was no degradation in the aircraft's structural integrity.

An inspection of both receptacles revealed that the neutral phases were severely overheated, with some evidence of electrical arcing.

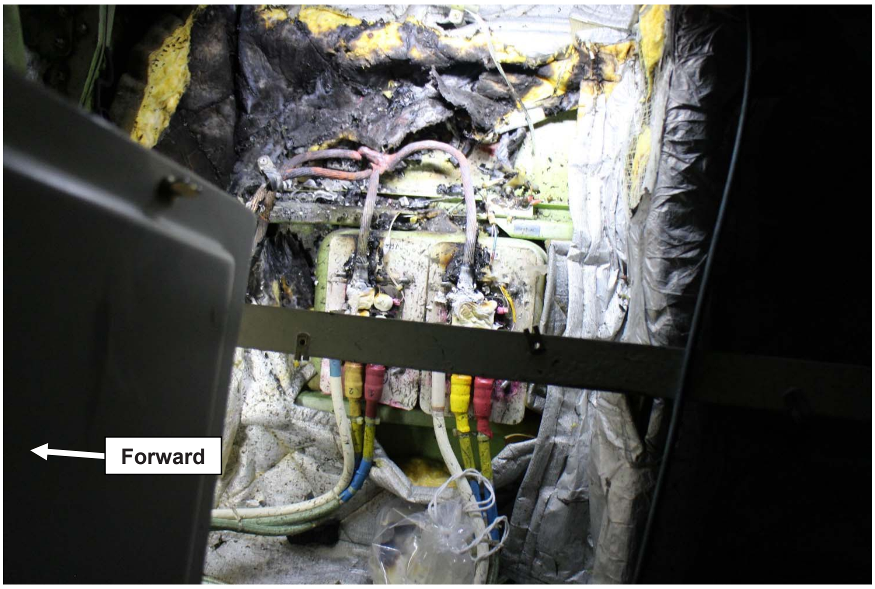

Figure 1

Image of GPU receptacles with the E/E bay floor panel removed showing fire damage

Assessment

It was not possible to be conclusive, but the operator considered that the most likely cause of the damage was misalignment of the GPU socket in the aircraft's ground power receptacle. This could have caused 115V AC power to be supplied to a pin with almost no load, thus resulting in a momentary power surge and electrical arcing.

Safety action

The operator has since notified ground staff to be on the lookout for signs of heat damage to the aircraft receptacles and GPU sockets, and to ensure that connectors are correctly aligned when plugging in ground power.

ACCIDENT

Aircraft Type and Registration:	Embraer EMB-145MP, G-CGWV
No & Type of Engines:	2 Allison AE 3007A1 turbofan engines
Year of Manufacture:	2000 (Serial no: 145362)
Date & Time (UTC):	5 December 2015 at 2019 hrs
Location:	Newcastle Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 19
Injuries:	Crew - None Passengers - None
Nature of Damage:	Left wingtip and aileron scraped
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	36 years
Commander's Flying Experience:	5,002 hours (of which 1,234 were on type) Last 90 days - 96 hours Last 28 days - 34 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

The aircraft's left wing touched the runway surface during a night landing in strong, gusty wind conditions. Just before touchdown, the aircraft rolled rapidly left, probably as a result of a sudden wind shift. The pilot tried to counter this with a control wheel input to the right but the left wing made contact with the runway. An air traffic controller saw a spark from the aircraft's vicinity when it landed and damage to the left wingtip and aileron was found after the flight. Scrape marks were also found on the runway. The accident was not notified immediately to the AAIB and no action was taken to preserve the data on the CVR. The aerodrome operator and aircraft operator have amended their procedures to provide better guidance for the actions to be taken in the event of an accident or serious incident.

History of the flight

The commander was Pilot Flying (PF) for a commercial flight from Stansted Airport to Newcastle Airport. The forecast surface wind at Newcastle was from 230º at 28 kt, gusting to 38 kt, with a 40% probability that the strength could temporarily increase to 38 kt, with gusts to 55 kt.

This night-time flight proceeded normally and the aircraft was established on an ILS approach for Newcastle's Runway 25. The runway was reported as damp, with the surface wind from 240º at 30 kt, gusting to 43 kt when landing clearance was given. ATC provided further surface wind checks of 240º at 37 kt and then of 240º at 27 kt, two minutes and one minute before touchdown, respectively. The pilots reported that the approach felt bumpy but not unduly turbulent, and they were satisfied that neither the operator's maximum crosswind limit of 30 kt nor the maximum operating wind speed of 50 kt were likely to be exceeded.

The aircraft was configured with the flaps set to 22º for landing, and the target approach speed (V_{APP}) was 139 kt, 15 kt greater than the calculated reference speed (V_{REF}) to allow for the wind (see *Landing performance*). The pilots recalled the wings were kept almost level until the flare commenced, with the aircraft's nose pointing slightly left of the runway centreline, to compensate for the crosswind. Just before touchdown, the aircraft rolled left rapidly. The PF turned the control wheel right, to counteract what he and the co-pilot both perceived to be a sudden gust from the right, and they thought that the aircraft subsequently touched down smoothly. Neither of the pilots heard any aural warnings and they proceeded to a parking area where the aircraft was shut down and the passengers were disembarked.

An ATC controller thought he saw a spark from the vicinity of the aircraft when it landed and asked an airfield operations officer to investigate. A technician, working abeam the touchdown zone, told the operations officer that the aircraft had seemed to roll to one side while landing. The operations officer inspected the runway and found witness marks, which started approximately 270 m from the displaced threshold and 1 m to the left of the runway centreline (Figure 1). The operations officer passed this information to ATC and visited the parked aircraft, where the crew had discovered scuff marks and abrasions to paintwork on the left wingtip.

Figure 1

Witness marks on Runway 25, viewed looking east towards the landing threshold

Aircraft damage

Following the accident, surface abrasions were noted to the left wingtip fairing and the left aileron (Figure 2). Subsequent examination proved that the wingtip fairing could be repaired but the aileron was damaged beyond acceptable limits and was replaced.

Figure 2

Damage to the left wingtip and aileron of G-CGWV
(photographs courtesy of Newcastle Airport)

Flight data

Due to the elapsed time between the accident and notification to the AAIB on 5 January 2016, evidence from the Flight Data Recorder (FDR) and CVR was not available.

However, the operator was able to provide recorded flight data from their Flight Data Monitoring (FDM) program, which recorded a copy of the FDR data (Figure 3).

As the aircraft descended through 50 ft agl, the Computed Airspeed (CAS), which was sampled every second, was increasing between 137 and 148 kt. At the same time, the recorded groundspeed was 100 kt, magnetic heading was 244° and the roll attitude was (-)2.9°[1] to the left. Left and right aileron and rudder surface positions were not recorded, nor were they required to be. The exact touchdown point could not be established but at a radio altitude of 4 ft, the recorded localiser deviation showed the aircraft deviating to the right of the runway centreline, with its heading decreasing to 236°M. It rolled to a

Footnote

1 The minus sign (-) denotes a roll to the left.

maximum of (-)12.8° to the left, with a nose-up pitch attitude of approximately 5º. At the same time, the CAS reduced to 126 kt and the groundspeed to 97 kt. Full control wheel (40º) was applied to the right to counter the roll to the left, together with 7° of right rudder pedal[2].

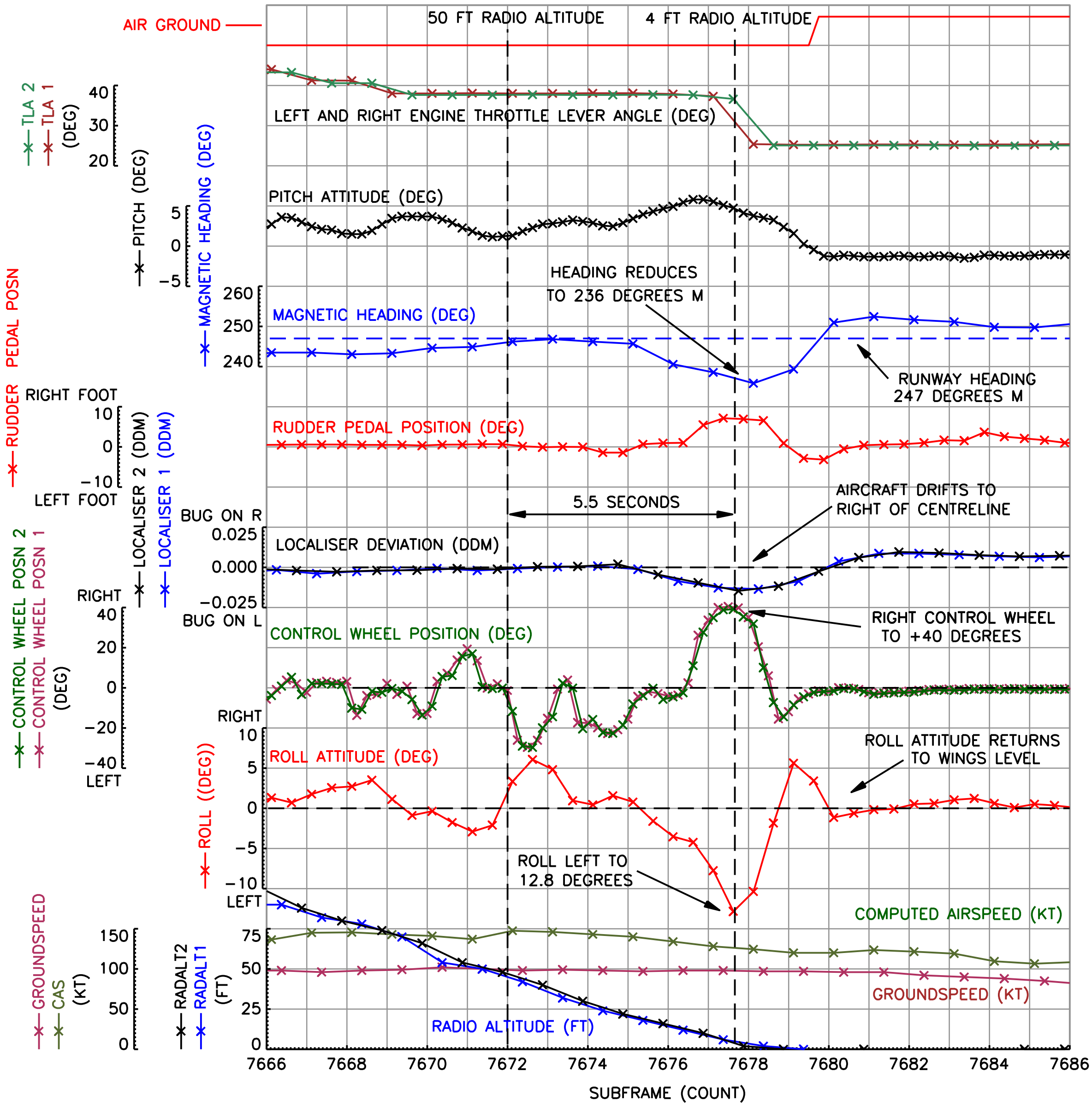

Figure 3

G-CGWV FDM data

The EGPWS in the Embraer 145 produces an aural ‘*Bank Angle*’ warning when a high angle of bank is detected close to the ground. From 30 ft to 5 ft agl, an angle of bank of

Footnote

[2] Maximum rudder pedal travel is +8.8º and -9.03º.

±10º initiates the warning but it is de-activated below 5 ft agl. Due to the sampling rate, the exact roll attitude at 5 ft agl could not be established but the recorded roll to the left was increasing from (-)7.7° to (-)12.8°.

Surface wind data

The relevant wind data was taken from an anemometer situated south of the Runway 25 touchdown zone. The aerodrome authority is unaware of any obstacles or local effects that may cause a south-westerly wind to veer or gust in the vicinity of the touchdown zone.

Between 2010 hrs and 2020 hrs, the average recorded wind was from 230º at 30 kt, varying in direction between 200º and 256º, and between 16 and 51 kt. Between 1950 hrs and 2050 hrs, the recorded wind did not veer beyond 262º. The Met Office studied the Newcastle area weather reports but found no evidence of a sudden, strong gust from an angle more than 20º right of the centreline.

Aircraft information

The aircraft manufacturer has calculated that an angle of bank of 16.4º is needed for the left wingtip of an Embraer 145 to make ground contact, when the left wheel is in ground contact, without the oleo compressed and the aircraft in a 5º nose-up attitude. The manufacturer's calculation does not account for wing flexing due to aerodynamic loads and assumes a level surface.

The aircraft touched down to the right of the centreline, on a runway which slopes away from the centreline for drainage purposes. The wingtip touched the runway 1 m left of the centreline in a position where the elevation was higher than that at which the left wheel made contact. Therefore, it was possible for ground contact to be made by the wingtip with an angle of bank of less than 16.4º.

Landing performance

Either Flap 22 or Flap 45 can be used for normal landings of the Embraer 145. The manufacturer recommends the use of Flap 22 in windshear conditions and the operator advocates this flap setting when strong winds are reported, subject to runway performance considerations. The manufacturer states that V_{APP} is to be calculated by adding a minimum wind correction of 5 kt[3] and a maximum wind correction of 20 kt (Flap 22) or 15 kt (Flap 45) to V_{REF}. Cards were provided on the flight deck by the operator to help the crew to calculate V_{REF} and V_{APP} but these only stated a maximum wind correction of 15 kt. The appropriate V_{REF} for this approach was 124 kt and the V_{APP} was 144 kt.

Landing performance calculations assume aircraft are at a 50 ft screen height and at V_{REF} when passing the runway threshold. The manufacturer's Standard Operating Procedures Manual states a 10 kt increase in V_{REF} increases the required landing distance by approximately 16%. The operator's policy is for airspeed to be reduced below V_{APP} in the

Footnote

[3] The wind correction is calculated by taking half the reported surface wind and adding all of any reported gust factor.

latter stages of the approach, in order to cross the threshold at V_{REF}. From the recorded data, the aircraft's airspeed was approximately V_{REF} + 20 kt at the 50 ft screen height and this reduced to V_{REF} +2 kt at 4ft. On this occasion, the declared landing distance available on Runway 25 was not limiting.

Notification and preservation of evidence

The commander immediately contacted the operator and was told the operator would inform the AAIB the following day. However, this action was subsequently overlooked and no action was taken to preserve CVR data. An occurrence report was submitted to the CAA on 7 December 2015 but this made no mention of damage to the aileron.

The UK Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996 state that when an accident or serious incident occurs in the UK, or to a UK registered aircraft, the commander is responsible for informing the AAIB. However, the operator's Operations Manual (OM) states that the operator's management will notify the AAIB when an accident occurs in the UK.

The OM also states that if there is doubt about the classification of an occurrence it is to be treated as an accident and that '*Accidents must be notified to the Company and the Authority via the quickest means.*'

EU Commission Regulation No 965/2012 (Air Operations Regulations section CAT.GEN. MPA.105 '*Responsibilities of the commander*' section 10) states that the commander shall:

(10) ensure that flight recorders:

(i) are not disabled or switched off during flight; and

(ii) in the event of an accident or an incident that is subject to mandatory reporting:

(A) are not intentionally erased;

(B) are deactivated immediately after the flight is completed; and

(C) are reactivated only with the agreement of the investigating authority;

The operator's OM provided guidance to commanders on the isolation of a CVR following an accident but not after a serious incident.

The UK Regulations also require the aerodrome authority to inform the AAIB of any accident or serious incident that takes place on or adjacent to an aerodrome, by the quickest means of communication available.

Discussion

The pilot's impression was that there was a sudden, large gust of wind from the right while flaring to land. Recorded data suggested the aircraft's roll to the left during the flare was more likely caused by a sudden slackening of the strong gusty wind, from slightly left of the runway centreline.

The maximum angle of bank recorded was 12.8º at 4 ft radio altitude; less than the angle calculated by the manufacturer for a wingtip strike with the left wheel touching the ground. However, this calculation does not allow for aerodynamic loads and does not account for the runway sloping away from the centreline.

The AAIB was not informed of the accident until a month later. Meanwhile, the CVR had not been preserved but flight data was available from the operator's FDM programme.

Safety actions

The aerodrome operator has reviewed its guidance to try to ensure any future serious incident which is suspected to have occurred on or adjacent to Newcastle Airport, will be notified to the AAIB without delay.

The aircraft operator has updated its guidance concerning serious incidents and has clarified company procedures in the event of an accident or suspected serious incident. The guidance provided to assist crews to calculate their approach speed has been amended.

Following this accident the aircraft operator intends to include appropriate go-around practice during pilots' recurrent simulator training.

ACCIDENT

Aircraft Type and Registration:	Aerotechnik EV-97 Eurostar SL, G-CGTT
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2011 (Serial no: LAA 315B-14985)
Date & Time (UTC):	8 May 2016 at 1154 hrs
Location:	Deanland Airfield, East Sussex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Wing skins and leading edges, right aileron, rear spar attachment and propeller
Commander's Licence:	Light Aircraft Pilot's Licence
Commander's Age:	71 years
Commander's Flying Experience:	963 hours (of which 252 were on type) Last 90 days - 13 hours Last 28 days - 13 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Deanland Airfield has a single grass runway orientated 06/24 with a LDA of 457 m; the runway condition was dry at the time of the accident. The pilot decided to land on Runway 24 having observed the airfield's windsocks and, a few minutes earlier, hearing a radio transmission from a departing aircraft. This decision was also influenced by the runway profile, which slopes upwards towards its end. The pilot reported that the touchdown occurred at a higher speed and further down the runway than expected but, with about 80 m of stopping distance still remaining, he considered that the aircraft had slowed sufficiently under braking to safely exit the runway. Whilst applying back pressure on the control stick, the pilot turned the aircraft to the right using the steerable nosewheel with the intent of then making a 180° left turn. However directional control was lost at this point and the right wingtip struck a fence post bordering the runway, causing the aircraft to yaw into a wire fence where it came to a stop. The aircraft sustained substantial damage but both occupants were uninjured.

A post-accident review of the airfield's recorded weather station data indicated that, at the time of the landing, the wind was from 112° at 4 kt; this equates to a tailwind of about 3 kt.

The pilot assessed the cause of the accident to be the choice of Runway 24, with a faster and deeper landing than expected followed by degraded effectiveness of the steerable nosewheel with back pressure on the control stick.

ACCIDENT

Aircraft Type and Registration:	CZAW SportCruiser, G-OCRZ
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2008 (Serial no: PFA 338-14668)
Date & Time (UTC):	13 April 2016 at 1225 hrs
Location:	Firs Farm, Newbury, Berkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nose leg detached, left main landing gear damaged and propeller destroyed
Commander's Licence:	Light Aircraft Pilot's Licence
Commander's Age:	76 years
Commander's Flying Experience:	518 hours (of which 102 were on type) Last 90 days - 2 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The pilot misidentified the runway and flew an approach to an adjacent, visually distinct but uncultivated strip of rough ground. He realised his mistake on touchdown, when the nose leg collapsed and the propeller struck the ground. The aircraft came to a halt nose-down and left wing low but the pilot vacated without difficulty.

History of the flight

The pilot returned to land at his home airstrip after a short, middle-of-the-day flight. He was very familiar with this airstrip, having operated from it for six years. Visibility was good and there was a light south-westerly breeze as he joined the circuit, intending to land on grass Runway 23. He lined-up his final approach on a yellowish coloured strip of land, which he identified as the runway, and touched down in an apparently "perfect" manner. However, the landing was made on a rough, uncultivated strip of ground adjacent to the south side of the runway which the pilot had mistaken for Runway 23.

The nose leg immediately collapsed and detached, and the propeller struck the ground. As the aircraft slowed, the left main landing gear collapsed and the aircraft came to a halt with its nose and left wing resting on the ground (Figure 1). The pilot turned the master switch OFF and vacated the aircraft without difficulty.

Figure 1

G-OCRZ after the landing accident

Pilot's comments

The pilot was amazed that he had misidentified the runway in good weather and without any distraction. He noted the runway was a similar colour to the adjacent green crop on the north side, while the rough strip on the south side was a contrasting, yellowish colour, shaped like a runway. At first sight it looked like a runway, so, even though he had prior knowledge of its existence, he accepted it was the runway. During the circuit and approach the pilot concentrated on making a smooth landing and had no reason to query the strip for which he was aiming. He did not spot the real runway to the right of his approach path because he was not expecting to see it there; an error which he later recognised as confirmation bias[1].

Safety action

White markers are now in place to make the runway outline more obvious to approaching aircraft.

Similar accidents

On 18 June 2015 an Auster J5F, G-AMZT, had an accident when it landed in a yellowish coloured crop adjacent to the runway at Bolt Head Airfield, Devon. Shortly afterwards, on 1 July 2015, a Europa, G-TAGR, did likewise at the same airfield. The accident report for G-TAGR contains a photograph showing how the cultivated strip to the right of the runway

Footnote

[1] Confirmation bias is the selective processing of information to confirm a person's pre-existing beliefs. Hence, once the 'runway' was visually identified, the pilot subconsciously viewed the scene in a way that fitted this initial assumption and his tendency would have been to ignore, or not look for, any contradictory evidence.

created a stronger visual impression of being a landing surface than the runway itself. The AAIB reports for both accidents are on the AAIB's website. The URL for G-TAGR's report is: https://assets.digital.cabinet-office.gov.uk/media/5616293ced915d39b9000009/Europa_G-TAGR_10-15.pdf

ACCIDENT

Aircraft Type and Registration:	Europa, G-OURO	
No & Type of Engines:	1 Rotax 912 ULS piston engine	
Year of Manufacture:	1995 (Serial no: PFA 247-12522)	
Date & Time (UTC):	31 March 2016 at 1400 hrs	
Location:	Holmbeck Airfield, Buckinghamshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - None	Passengers - 1 (Minor)
Nature of Damage:	Nose landing gear collapsed, damage to propeller and engine cowl	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	70 years	
Commander's Flying Experience:	281 hours (of which 85 were on type) Last 90 days - 1 hour Last 28 days - 1 hour	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The pilot of G-OURO was preparing to take off in order to demonstrate the aircraft to a potential buyer. He taxied to grass Runway 29 which is 517 m long, and the wind was reported to be from 350° at 5 kt. He performed the power checks, briefed his passenger and selected half flap before applying full power for takeoff.

The first 50 m of the runway had an upslope but after this the aircraft accelerated normally and the pilot rotated at 50 kt, by which time they were about 400 m down the runway. The aircraft lifted off to a height of approximately 15 ft but then the right wing and nose dropped, causing the aircraft to strike the ground. It slid for about 10 m and slewed to the right before coming to a halt with the nose landing gear collapsed.

The pilot is unsure whether he had set the pitch trim incorrectly or had applied too much rearward movement of the control column.

ACCIDENT

Aircraft Type and Registration:	Gardan GY80-160 Horizon, G-TIMY
No & Type of Engines:	1 Lycoming O-320-B3B piston engine
Year of Manufacture:	1964 (Serial no: 36)
Date & Time (UTC):	11 March 2016 at 1730 hrs
Location:	2 miles east of Coventry Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Propeller, landing gear, engine and lower fuselage
Commander's Licence:	Private Pilot's Licence
Commander's Age:	21 years
Commander's Flying Experience:	97 hours (of which 42 were on type) Last 90 days - 8 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reported that while conducting pre-flight checks, the fuel drain sample contained water, which he described as a common occurrence for this aircraft. He drained the fuel until he obtained a clear sample. He took further samples, including after refuelling, until satisfied that the fuel tanks were free from water contamination.

The aircraft took off from Runway 23 at Coventry Airport, with the pilot reporting the pre-takeoff engine power checks and after takeoff checks being normal. After climbing to 2,000 ft, the engine began to run rough. The pilot turned on the fuel pump and informed ATC he would be returning to Coventry, but the rpm continued to reduce and the engine subsequently stopped. He selected a different fuel tank and restarted the engine, but the aircraft could not maintain height. He chose a field in which to land, electing to keep the undercarriage retracted due to the ground conditions and to maximise the glide range[1]. The forced landing was successful and both occupants exited the aircraft without assistance.

The pilot considered that the engine failure may have been caused by water contamination in the fuel, carbon build-up on the spark plugs, or some other problem.

Footnote

1 On this aircraft type the flaps extend fully when the landing gear is lowered.

ACCIDENT

Aircraft Type and Registration:	Jodel D120A, G-BYBE
No & Type of Engines:	1 Continental Motors Corp C90-14F piston engine
Year of Manufacture:	1964 (Serial no: 269)
Date & Time (UTC):	10 February 2016 at 1310 hrs
Location:	Shobdon Airfield, Herefordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Tailwheel detached and damage to right mainwheel attachment
Commander's Licence:	Private Pilot's Licence
Commander's Age:	66 years
Commander's Flying Experience:	1,150 hours (of which 2 were on type) Last 90 days - 11 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft was lined up for a departure from Runway 27 (paved) with the wind from the north-west at 10 to 12 kt. The takeoff weight was 624 kg and the maximum takeoff weight was 650 kg. The pilot applied full throttle and the aircraft accelerated normally. He raised the tail and although he did not note the airspeed or engine rpm, all appeared normal to him from previous training flights. The pilot reported that the aircraft lifted off as normal and he kept it low to increase airspeed. About one-third along the runway the aircraft "wobbled" and the left wing dipped, which he raised with aileron and rudder control inputs. The pilot's impression was that he was slow and he recalled trying to push the throttle hard forward but finding it already hard forward. The left wing dipped again, so at between 5 and 10 ft above the runway with the aircraft drifting to the left, he decided to abort the takeoff. The aircraft landed heavily in a three-point attitude and departed the left side of the runway. The aircraft continued across a rough tarmac surface, where the tailwheel was later found, traversed a grass microlight strip and then entered a field of kale where it came to rest. The pilot shut down the aircraft and both he and his passenger exited via the left and right doors respectively.

The pilot assessed the accident was caused by insufficient airspeed, a quartering crosswind and a stall.

ACCIDENT

Aircraft Type and Registration:	Pitts Super Stinker 11-260 (Modified), G-IIIV
No & Type of Engines:	1 Lycoming AEIO-540-D4A5 piston engine
Year of Manufacture:	2002 (Serial no: PFA 273-13005)
Date & Time (UTC):	30 July 2015 at 1700 hrs
Location:	Field adjacent to Leicester Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Engine, propeller, landing gear, top wing and rudder
Commander's Licence:	Private Pilot's Licence
Commander's Age:	47 years
Commander's Flying Experience:	1,300 hours (of which 200 were on type) Last 90 days - 33 hours Last 28 days - 14 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

During a local flight to practise aerobatics, the pilot reported that shortly after he commenced his routine the engine began to run roughly and the available power "dropped off". The pilot selected the mixture to RICH and the electric fuel pump ON, but there was no improvement in the engine's performance. He carried out a forced landing in the only available field, which had a 30° upslope and contained sheep. The aircraft was substantially damaged but the pilot, who was uninjured, was able to vacate normally.

The constructor and maintainer of the aircraft commented that an initial inspection of the engine did not reveal any defects. He considered it was possible that, during the aerobatic manoeuvring, air may have been ingested into the fuel supply system and, due to the length of pipework on this particular model, it may have taken time to clear.

Further work is planned to inspect and fault-find the engine and fuel system. If there are any relevant findings they will be reported in a future AAIB Bulletin.

ACCIDENT

Aircraft Type and Registration:	Reims Cessna FRA150L Aerobat, G-BAEV
No & Type of Engines:	1 Continental Motors Corp O-240-A piston engine
Year of Manufacture:	1972 (Serial no: 173)
Date & Time (UTC):	26 September 2015 at 0950 hrs
Location:	Beverley Airfield, Yorkshire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Significant structural damage to the noseleg, propeller, fuselage and wings
Commander's Licence:	Student
Commander's Age:	24 years
Commander's Flying Experience:	38 hours (of which 38 were on type) Last 90 days - 2 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The student pilot had completed 3 hours solo in the circuit and 55 minutes of solo cross-country. This flight was a triangular solo cross-country exercise from Beverley to overhead Carnaby, to overhead Elvington, and then back to Beverley.

The student pilot was approximately half way between Elvington and Beverley on the last leg when she started to feel dizzy and found concentration difficult. She continued towards Beverley and joined downwind, recalling that her height had dropped to around 600 ft. She turned onto final at approximately 300 ft, and recalled that she was struggling to concentrate and manage the aircraft's height. The aircraft struck some tall grass close to the runway threshold and landed heavily on the nosewheel, causing extensive damage to the nose gear, forward fuselage and left wing. The student suffered minor injuries and was assisted by an instructor who was first on the scene.

INCIDENT

Aircraft Type and Registration:	Titan T-51 Mustang, G-TSIM
No & Type of Engines:	1 Suzuki V6 Mini Merlin piston engine
Year of Manufacture:	2012 (Serial no: LAA 355-14964)
Date & Time (UTC):	14 May 2016 at 1045 hrs
Location:	Shobdon Airfield, Herefordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Tailwheel link failed and slight damage to rudder
Commander's Licence:	Light Aircraft Pilot Licence
Commander's Age:	54 years
Commander's Flying Experience:	890 hours (of which 323 were on type) Last 90 days - 18 hours Last 28 days - 15 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

During taxi the tailwheel collapsed due to failure of a supporting link.

History of the flight

The aircraft was being taxied along a rough grass taxiway to Runway 09 when the pilot felt a small 'bump'. The pilot stopped the aircraft and exited to discover that the tailwheel had collapsed due to failure of a supporting link.

Aircraft information

The Titan T-51 Mustang is a three-quarter scale replica of the P-51 Mustang (Figure 1). It is a two-seat homebuilt aircraft of steel frame and aluminium skin construction, with a retractable main landing gear and tailwheel. The tailwheel is attached to an aluminium spring (Figure 2) which serves as a shock absorber. This spring is supported by a rod with two adjustable rose joints, called the 'link' (Figure 2).

Earlier in the year the owner discovered that the aluminium tailwheel spring had bent. He discussed this problem with the kit manufacturer and thought the kit manufacturer had advised re-installing the spring upside down. The owner installed the spring upside down and after landing on 8 April 2016 the spring failed. The owner obtained a new spring and installed it in the aircraft. He carried out an uneventful flight on 16 April 2016. The subsequent flight was the incident flight on 14 May 2016 when the link failed at a rose joint.

Figure 1

Titan T-51 Mustang (G-TSIM)

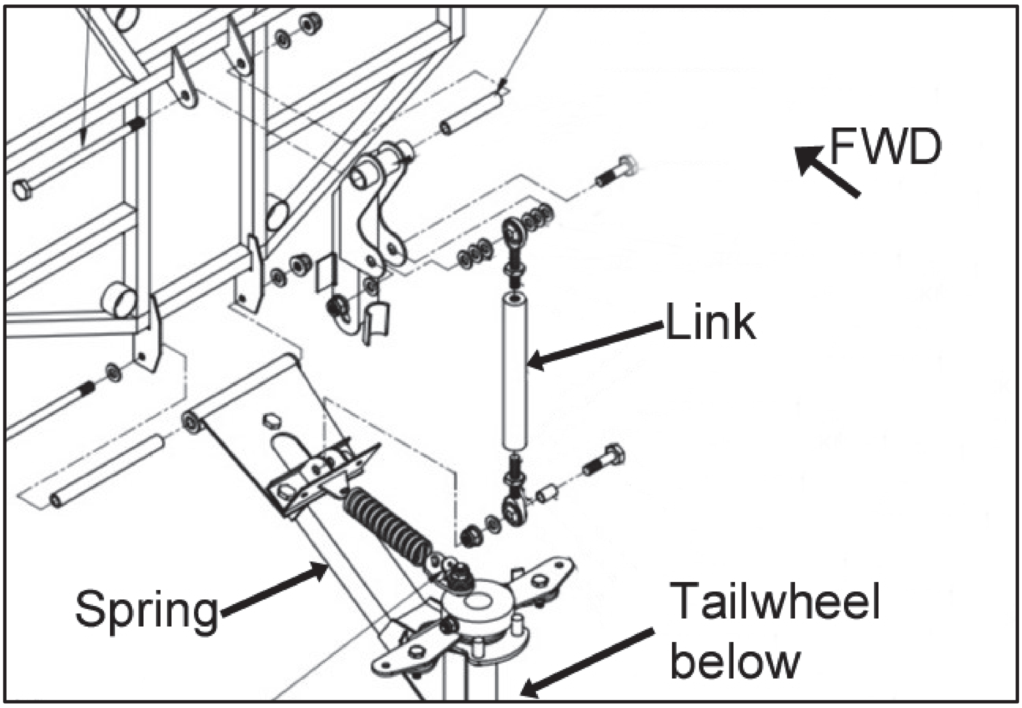

Figure 2

Tailwheel installation showing spring and link location

Comments by the owner of the aircraft

The owner stated that his belief that the kit manufacturer had advised re-installing the spring upside down was probably due to a miscommunication. Although he inspected the link when he installed the new spring he did not detect any cracks. He thinks it subsequently failed due to fatigue. The owner, who is also the UK dealer for the aircraft, manufactured a replacement link of solid forged steel without adjustable rose joint ends. The rose joints are intended to make length adjustments to adjust the height of the tailwheel and to adjust the over-centre retraction linkage. Once this length is determined a bespoke solid link for the length required can be made. The Light Aircraft Association has approved the modified link. As part of this modification, the owner has also obtained approval from the Light Aircraft Association to install a modified spring made of steel to reduce the chance of it bending.

ACCIDENT

Aircraft Type and Registration:	Aerotechnik EV-97 Eurostar, G-CGOG
No & Type of Engines:	1 Rotax 912UL piston engine
Year of Manufacture:	2010 (Serial no: LAA 315A-14980)
Date & Time (UTC):	7 May 2016 at 1335 hrs
Location:	Whittles Farm Airstrip, Oxfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nosewheel collapsed, propeller and firewall damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	78 years
Commander's Flying Experience:	1,120 hours (of which 43 were on type) Last 90 days - 13 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reported whilst returning to his home base at Whittles Farm Airstrip he made a "fairly fast" final approach to Runway 11. During the flare the aircraft was caught by a gust and this resulted in the aircraft making "significant" contact with the runway whilst still travelling quickly. The nose landing gear collapsed and the aircraft slid to a halt approximately two-thirds of the way along the 380 m long grass runway. The pilot was not injured.

The weather conditions were reported by the pilot as: light south-easterly breeze, good visibility and scattered cloud.

The CAA Safety Sense Leaflet 12, '*Strip Sense*', provides useful advice and guidance. It includes the comment: *'...you must know and fly the correct speeds for your aeroplane and remember the importance of using appropriate techniques, keeping the weight off the nosewheel…'*

The full Strip Sense leaflet can be downloaded from the CAA website[1].

Footnote

1 http://publicapps.caa.co.uk/docs/33/20130121SSL12.pdf

ACCIDENT

Aircraft Type and Registration:	Cyclone AX2000, G-BYJM
No & Type of Engines:	1 HKS 700E piston engine
Year of Manufacture:	1998 (Serial no: 7523)
Date & Time (UTC):	8 September 2015 at 1535 hrs
Location:	Manton, near Marlborough, Wiltshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Minor) Passengers - 1 (Minor)
Nature of Damage:	Fuselage tube snapped, landing gear collapsed, forward compression strut snapped, and deformation of cockpit tube frame
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	48 years
Commander's Flying Experience:	214 hours (of which 39 were on type) Last 90 days - 33 hours Last 28 days - 16 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During the outbound flight from Clench Common, the pilot felt that the aircraft was unable to maintain altitude and he performed a precautionary landing at a nearby airfield to investigate. Following checks of the airframe and engine, he took the aircraft for a solo circuit, during which it performed normally. He decided to return to the departure airfield with his passenger but, shortly after takeoff, the engine power again appeared to be insufficient to maintain altitude. The pilot decided to force-land in a field, during which the aircraft was badly damaged. No reason was found why the engine might not have been able to deliver full power.

History of the flight

The pilot and his passenger had taken off from Clench Common airfield on a local flight, having performed the usual pre-flight inspections including a check for water in the fuel; none was found. As they passed Manton Airfield at an indicated height of 1,100 ft, the pilot felt that the aircraft was struggling to maintain height, although all other aspects of the flight seemed normal. He suspected he had encountered an area of sink and applied full power, finding that this was just sufficient to maintain height; however he decided to land at Manton as a precaution. After landing he performed an external check of the aircraft, finding nothing untoward so he decided to do a solo circuit. This, including the pre-flight checks, was normal and he concluded that his earlier suspicion of encountering an area of sink was probably correct.

He therefore decided to return to Clench Common with his passenger. During takeoff and climbout, at 50 kt and using full throttle, the aircraft performed normally until about 200 ft agl, when it again appeared to stop climbing and indicated airspeed decayed. The pilot decided to abandon the journey and considered a forced-landing in a field, finding that a recently harvested wheat field to the right of the runway extended centreline seemed suitable. However, as he turned towards it, the right wing dropped sharply, probably due to a stall or partial stall. Upon recovery, he found that they were now heading roughly at 90° to the centreline, so he decided to continue the turn in order to land downwind on a grass field to the south of the runway.

As the aircraft neared the ground, the pilot was aware that the terrain was rising towards them, so he closed the throttle to avoid "powering into the ground" even though he was having to maintain airspeed by pushing forward on the control column. He was also aware that the groundspeed was quite high as they were landing downwind and he tried to flare into the rising ground. His recollection of events at this point was partial, but he believes that the sense of speed and rapid closure with the ground caused him to pull back too far on the column, leading to a stall. The aircraft struck the ground and came to rest some 5 to 8 m further on.

The two occupants suffered only minor injuries and were able to evacuate the aircraft unaided, although photographs suggest that the nose and forward fuselage were badly disrupted. Although the pilot felt that engine performance may have been degraded, it was only a vague perception at the time and he did not look at the rpm gauge during the flight to ascertain whether or not full power was being developed.

ACCIDENT

Aircraft Type and Registration:	EV-97 Teameurostar UK Eurostar, G-CDNG
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2005 (Serial no: 2319)
Date & Time (UTC):	14 March 2016 at 1310 hrs
Location:	Cotswold Airport, Gloucestershire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to landing gear, landing gear fixing points and fuselage floor
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	71 years
Commander's Flying Experience:	138 hours (of which 122 were on type) Last 90 days - 6 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

At the end of a flight from Shobdon Airfield to Cotswold Airport in clear but gusty conditions, the pilot landed heavily on Runway 08 after stalling in the flare. A cockpit video showed that no additional margin was added to the approach and landing speeds to allow for the gusting conditions. However, it is not conclusive that this was causal. The landing runway was wider than the runways familiar to the pilot which may have led to an illusion that the aircraft was lower than it actually was, resulting in the pilot flaring too high. Continued pitch input led to a stall resulting in the heavy landing.

The damage caused by the heavy landing did not prevent the aircraft being taxied clear. No injuries were sustained.

The pilot stated that he misjudged the flare and assessed that possible factors were the strong and gusting headwind and landing at an unfamiliar runway with an upslope.

History of the flight

The aircraft departed Shobdon Airfield at approximately 1200 hrs and flew to Cotswold Airport, an airfield unfamiliar to the pilot. During the landing on Runway 08, in clear but gusty conditions, the pilot reported that he flared too early and, with continued pitch-up input, stalled the aircraft, resulting in a heavy landing. The pilot was not injured and the aircraft damage did not prevent him from taxiing off the runway. The right landing gear had deformed resulting in damage to its fixing points and penetration of the fuselage floor.

Gusting conditions

A cockpit video recording provided by the pilot indicated airspeeds for the approach, flare and touchdown were approximately 60 mph, 43 mph and 30 mph (post-stall) respectively. The METAR for RAF Fairford, 18km to the east, approximately 10 minutes earlier, reported the wind as, from 80° at 14 kt gusting 22 kt; a gusty headwind for Runway 08. CAA Safety Sense Leaflet 1e *'Good Airmanship',* section 26 '*Speed Control*' states:

> *'b) When landing, aim for the flight handbook speed (or 1.3 times the stall speed with flap if none is published) over the threshold, and reduce speed in the round-out. If the head-wind is turbulent or gusty, add a margin of, say, 5 kt or half the gust factor, whichever is the greater.'*

No margin above the speeds in the pilot handbook was used for the accident landing, but the video is inconclusive that this was a causal factor.

Unfamiliar airfield

The pilot had recently flown at Shobdon Airfield with an instructor to refresh his crosswind skills after a period without flying. Cotswold Airport Runway 08/26 is more than twice the width of Shobdon Airfield. Visual cues when landing on a runway that is wider than the pilot is familiar with can create the illusion that the aircraft is closer to the ground than it actually is. This can result in the pilot initiating the flare with too much height.

CAA Safety Sense Leaflet 1e *'Good Airmanship',* section 29 '*Circuit Procedure*' states:

> *'f) Be aware of optical illusions at unfamiliar aerodromes with sloping runway or terrain, or with very long, or very wide, runways.'*

Conclusion

The pilot flared too early during the landing and stalled the aircraft. Gusty conditions and/or illusions associated with an unfamiliar size of runway may have been a factor. The CAA Safety Sense Leaflet 1e '*Good Airmanship*' provides guidance on both these topics.

Miscellaneous

This section contains Addenda, Corrections and a list of the ten most recent Aircraft Accident ('Formal') Reports published by the AAIB.

The complete reports can be downloaded from the AAIB website (www.aaib.gov.uk).

BULLETIN CORRECTION

Aircraft Type and Registration:	Alpi (Cavaciuti) Pioneer 400, G-CGVO
Date & Time (UTC):	3 January 2015 at 1528 hrs
Location:	Near Popham Airfield, Hampshire
Information Source:	AAIB Field Investigation

AAIB Bulletin No 3/2016, page 24 refers

The report published in March 2016 contained two typographical errors.

Under Meteorological information, the report stated that the 'Met Office aftercast agreed with the forecast chart (F215) for weather below 1,000 ft between 0800 hrs and 1700 hrs.' The report should have stated '…weather below **10,000 ft**…'

Additionally, the file reference quoted on the page header for this report was incorrect and should have read '**EW/C2015/01/02**' not 'EW/C2015/01/02/02 as originally shown.

The online version of the report was corrected on 9 June 2016.

TEN MOST RECENTLY PUBLISHED FORMAL REPORTS ISSUED BY THE AIR ACCIDENTS INVESTIGATION BRANCH

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

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.

1/2014 Airbus A330-343, G-VSXY at London Gatwick Airport on 16 April 2012.
Published February 2014.

2/2014 Eurocopter EC225 LP Super Puma G-REDW, 34 nm east of Aberdeen, Scotland on 10 May 2012 and G-CHCN, 32 nm south-west of Sumburgh, Shetland Islands on 22 October 2012.
Published June 2014.

3/2014 Agusta A109E, G-CRST Near Vauxhall Bridge, Central London on 16 January 2013.
Published September 2014.

1/2015 Airbus A319-131, G-EUOE London Heathrow Airport on 24 May 2013.
Published July 2015.

2/2015 Boeing B787-8, ET-AOP London Heathrow Airport on 12 July 2013.
Published August 2015.

3/2015 Eurocopter (Deutschland) EC135 T2+, G-SPAO Glasgow City Centre, Scotland on 29 November 2013.
Published October 2015.

1/2016 AS332 L2 Super Puma, G-WNSB on approach to Sumburgh Airport on 23 August 2013.
Published March 2016.

Unabridged versions of all AAIB Formal Reports, published back to and including 1971, are available in full on the AAIB Website

http://www.aaib.gov.uk

GLOSSARY OF ABBREVIATIONS

aal	above airfield level
ACAS	Airborne Collision Avoidance System
ACARS	Automatic Communications And Reporting System
ADF	Automatic Direction Finding equipment
AFIS(O)	Aerodrome Flight Information Service (Officer)
agl	above ground level
AIC	Aeronautical Information Circular
amsl	above mean sea level
AOM	Aerodrome Operating Minima
APU	Auxiliary Power Unit
ASI	airspeed indicator
ATC(C)(O)	Air Traffic Control (Centre)(Officer)
ATIS	Automatic Terminal Information System
ATPL	Airline Transport Pilot's Licence
BMAA	British Microlight Aircraft Association
BGA	British Gliding Association
BBAC	British Balloon and Airship Club
BHPA	British Hang Gliding & Paragliding Association
CAA	Civil Aviation Authority
CAVOK	Ceiling And Visibility OK (for VFR flight)
CAS	calibrated airspeed
cc	cubic centimetres
CG	Centre of Gravity
cm	centimetre(s)
CPL	Commercial Pilot's Licence
°C,F,M,T	Celsius, Fahrenheit, magnetic, true
CVR	Cockpit Voice Recorder
DME	Distance Measuring Equipment
EAS	equivalent airspeed
EASA	European Aviation Safety Agency
ECAM	Electronic Centralised Aircraft Monitoring
EGPWS	Enhanced GPWS
EGT	Exhaust Gas Temperature
EICAS	Engine Indication and Crew Alerting System
EPR	Engine Pressure Ratio
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
FAA	Federal Aviation Administration (USA)
FDR	Flight Data Recorder
FIR	Flight Information Region
FL	Flight Level
ft	feet
ft/min	feet per minute
g	acceleration due to Earth's gravity
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
hrs	hours (clock time as in 1200 hrs)
HP	high pressure
hPa	hectopascal (equivalent unit to mb)
IAS	indicated airspeed
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
IP	Intermediate Pressure
IR	Instrument Rating
ISA	International Standard Atmosphere
kg	kilogram(s)
KCAS	knots calibrated airspeed
KIAS	knots indicated airspeed
KTAS	knots true airspeed
km	kilometre(s)
kt	knot(s)
lb	pound(s)
LP	low pressure
LAA	Light Aircraft Association
LDA	Landing Distance Available
LPC	Licence Proficiency Check
m	metre(s)
mb	millibar(s)
MDA	Minimum Descent Altitude
METAR	a timed aerodrome meteorological report
min	minutes
mm	millimetre(s)
mph	miles per hour
MTWA	Maximum Total Weight Authorised
N	Newtons
N_R	Main rotor rotation speed (rotorcraft)
N_g	Gas generator rotation speed (rotorcraft)
N_1	engine fan or LP compressor speed
NDB	Non-Directional radio Beacon
nm	nautical mile(s)
NOTAM	Notice to Airmen
OAT	Outside Air Temperature
OPC	Operator Proficiency Check
PAPI	Precision Approach Path Indicator
PF	Pilot Flying
PIC	Pilot in Command
PNF	Pilot Not Flying
POH	Pilot's Operating Handbook
PPL	Private Pilot's Licence
psi	pounds per square inch
QFE	altimeter pressure setting to indicate height above aerodrome
QNH	altimeter pressure setting to indicate elevation amsl
RA	Resolution Advisory
RFFS	Rescue and Fire Fighting Service
rpm	revolutions per minute
RTF	radiotelephony
RVR	Runway Visual Range
SAR	Search and Rescue
SB	Service Bulletin
SSR	Secondary Surveillance Radar
TA	Traffic Advisory
TAF	Terminal Aerodrome Forecast
TAS	true airspeed
TAWS	Terrain Awareness and Warning System
TCAS	Traffic Collision Avoidance System
TGT	Turbine Gas Temperature
TODA	Takeoff Distance Available
UHF	Ultra High Frequency
USG	US gallons
UTC	Co-ordinated Universal Time (GMT)
V	Volt(s)
V_1	Takeoff decision speed
V_2	Takeoff safety speed
V_R	Rotation speed
V_{REF}	Reference airspeed (approach)
V_{NE}	Never Exceed airspeed
VASI	Visual Approach Slope Indicator
VFR	Visual Flight Rules
VHF	Very High Frequency
VMC	Visual Meteorological Conditions
VOR	VHF Omnidirectional radio Range

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