AAIB
Air Accidents Investigation Branch

AAIB Bulletin 8/2016

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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.

INCIDENT

Aircraft Type and Registration:	Airbus A320-233, SP-HAI	
No & Type of Engines:	2 IAE V2527-A5 turbofan engines	
Year of Manufacture:	1999 (Serial no: 1007)	
Date & Time (UTC):	21 February 2016 at 1311 hrs	
Location:	Birmingham International Airport	
Type of Flight:	Commercial Air Transport (Passenger)	
Persons on Board:	Crew - 6	Passengers - 99
Injuries:	Crew - None	Passengers - None
Nature of Damage:	None	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	61 years	
Commander's Flying Experience:	13,952 hours (of which approximately 10,000 were on type) Last 90 days - 60 hours Last 28 days - 23 hours	
Information Source:	AAIB Field Investigation	

Synopsis

Shortly after landing at Birmingham Airport, the aircraft failed to negotiate a 90° taxiway turn and ran on to the adjoining grass. The taxiway condition was damp and the aircraft had entered the turn above the maximum speed given in the relevant operating manuals. The nosewheels lost traction and skidded, causing the flight crew to lose full directional control of the aircraft.

History of the flight

The aircraft departed from Katowice in Poland at 0915 hrs on the morning of the incident. It flew without passengers to Paderborn in Germany, where 99 passengers boarded for the flight to Birmingham. The aircraft departed Paderborn on schedule, at 1140 hrs, with the aircraft commander as the handling pilot.

The 1250 hrs meteorological observation at Birmingham Airport gave a surface wind from 260° at 14 kt. It was variable in direction, between 220° and 280°. Visibility was good and there was broken cloud at 1,800 ft. The flight crew flew an ILS approach to Runway 33, later describing the conditions as gusty and turbulent. Because of these conditions, the approach and landing were flown with a reduced flap setting. When the aircraft was given landing clearance, ATC reported the surface wind as being from 260° at 14 kt, gusting to 25 kt.

The aircraft appeared to the ATC Tower controller to touch down in the normal landing zone. As the aircraft slowed and approached the runway exit at Taxiway Bravo, the controller passed taxi instructions, the initial part of which was to turn right onto Taxiway Bravo and then right onto Taxiway Alpha. These were correctly acknowledged by the first officer.

Vacating at Taxiway Bravo (which was routinely used as a runway exit for this category of aircraft) required a 90° right turn. It then only allowed a straight taxi for about 100 m before a further 90° right turn onto Taxiway Alpha, which ran parallel to the runway and back towards the main apron. As the aircraft vacated the runway, the first officer commenced his after-landing actions in order to configure the aircraft for the taxi phase.

The aircraft commenced its right turn onto Taxiway Alpha but failed to negotiate it successfully and ran on to the adjoining grass. The aircraft came to a stop substantially off the taxiway, with only a small part of the outer right-hand mainwheel touching the hard surface. The Tower controller saw what had happened and initiated an Aircraft Ground Incident. The flight crew communicated with the controller to confirm the situation and advise that a passenger evacuation was not intended.

There was some subsequent disruption to airport operations, as the normally used exit at Taxiway Bravo and sections of Taxiway Alpha were rendered unusable for a period.

The passengers were subsequently disembarked via steps placed at the rear right door. The aircraft was then pulled rearwards onto the taxiway and taken to an on-site maintenance facility for a detailed inspection.

Flight crew reports

The flight crew, who were both adequately rested before the flight and familiar with Birmingham Airport, reported that the aircraft was serviceable prior to the incident. Neither pilot recalled any failure or abnormal indications, either prior to or after the event.

The crew thought that the aircraft had skidded in the turn after the steering input had been applied to turn on to Taxiway Alpha. They described having an impression of the aircraft being moved sideways, which they attributed to a combination of the gusting wind, the aircraft's relatively light weight and a slippery surface. The commander, who described the taxiway surface as damp, did not recall what the aircraft's speed was prior to the turn but did not think that it had been excessive or inappropriate (a continuous display of current groundspeed is shown on each pilot's navigation display).

The first officer reported that he had looked to the right in the direction of Taxiway Alpha to check it was clear prior to the final turn, but then he had looked down to continue his after-landing actions. He looked up again when the commander made a brief exclamation, by which time the taxiway excursion was taking place.

Aircraft examination

A detailed inspection of the aircraft by the operator's contracted maintenance company confirmed the flight crew's report that it was serviceable prior to the incident. A number of items relating to the main undercarriage were cleaned or changed and the engines were inspected for foreign object damage, none being found. The aircraft was subsequently returned to service.

Incident site photographs

Photographs taken shortly after the incident confirm the commander's report that the taxiway surfaces were damp. There was a dry strip along the outer edge of Taxiway Alpha, across which could be seen moisture tracks left by the aircraft's mainwheel tyres (Figure 1).

From the distinctive nosewheel skid marks and furrows in the grass, it was clear that the nosewheels had begun to skid very soon after the turn started, and that it adopted, and remained at, a high angle of deflection.

Figure 1

Incident site immediately following excursion.
Note nosewheel skid marks, mainwheel tracks, taxiway condition and nosewheel angle
(*photo courtesy of Birmingham Airport*)

Aircraft operating procedures

The aircraft operator's procedures were based on the Flight Crew Manuals produced by the aircraft manufacturer. These procedures stated that taxi speed should be less than 10 kt for turns of 90° or more.

Recorded data

Flight data recorder

Replay of the aircraft's flight data recorder showed that the aircraft vacated the runway onto Bravo with groundspeed falling to about 17 kt, under light braking. Brakes were then released and groundspeed increased slightly to reach 19 kt whilst on Bravo. Approaching the turn to Alpha, light braking was applied (approximately 500 psi) and speed reduced, but only to 18 kt by the start of the turn. Wheel braking ceased within two seconds of the turn starting, with the speed at 14 kt. There was no further braking and the nosewheel left the paved surface at a groundspeed of 13 kt.

Lateral acceleration for the turn onto Alpha reached 0.13g (compared to 0.16g when the aircraft turned off the runway). Turn rate increased quickly to about 8°/second, and remained nearly constant until the nosewheels left the paved surface.

As the nosewheel left the paved surface, the thrust levers were advanced together to 16.9° (Climb detent is 22.5° and Flex / MCT detent is 33.75°). The thrust levers were retarded to idle four seconds later, after the aircraft had come to a stop.

The flap lever was moved out of the Config 3 position (used for landing) three seconds after the turn on to Alpha started. Nosewheel steering angle and tiller position were not recorded parameters.

Cockpit voice recorder

From replay of the cockpit voice recorder, comments made by the flight crew during the landing roll were consistent with the demanding landing approach they later described. The first officer acknowledged the taxi instructions and there was no further communication between the two pilots until the incident occurred.

A distinctive background noise could be heard for about three seconds before the nose left the paved surface. The noise was consistent with the nosewheel 'scrubbing' (ie at too great an angle for the aircraft's speed, causing it to skid).

After the incident, there was only a brief discussion between the pilots directly relating to the possible cause, when the commander asked "WHAT WAS OUR SPEED?" The first officer replied to the effect that he did not know as he was carrying out his after-landing actions.

Taxiway surface conditions

The Tower controller reported that there had been showers at the airport that morning, but no steady precipitation. The runway had been declared WET earlier, but had quickly dried in the brisk wind. At the time of the incident the runway was declared DRY. The taxiways concerned, which were described by the commander as damp and slippery underfoot when he walked on them after the incident, had been anti-iced earlier in the day.

ATC reported 36 movements that day, all of which except two had vacated Runway 33 at Taxiway Bravo. The most recent was also an A320, only four minutes before the incident. No other crew had reported any difficulty or adverse taxiway conditions. The taxiways in the area concerned were surfaced with asphalt, marked with yellow centreline markings and equipped with taxiway lights.

Taxiway friction measurement

Unlike runways, there is no specific requirement for routine friction testing of taxiways. At AAIB request, a surface friction test was carried out using Continuous Friction Measuring Equipment (CFME). There were some limitations in testing due to the geometry of the taxiways, which meant that test runs were confined to that part of Taxiway Alpha where Taxiway Bravo joined it. The test area was 200 m long (centred on the intersection with Taxiway Bravo) and 9 m either side of Taxiway Alpha centreline.

The test was not carried out in controlled dry conditions, in that there was residual runway de-icing fluid present on the surface. This would have had the effect of depressing the measured friction values.

The test identified a small area of relatively poorer friction values for that part of Alpha where the centreline of Bravo joined it, roughly equating to the path the nosewheels would have initially taken in the incident. However, values beyond the centreline of Taxiway Alpha were comparable to the rest of the measured area. The measured coefficient of friction values in the poorer area were at or above 0.40. For comparison, ICAO Annex 14 Volume 1 equates this value to a braking action of GOOD for an aircraft landing on a snow- or ice-covered runway[1].

Analysis

Although the surface friction test identified a small area of reduced friction values, these were not excessively low. The area concerned had been negotiated successfully by numerous aircraft that morning, including a similar type only four minutes before the incident to SP-HAI. Similarly, although the surface wind was brisk and gusty, it was well within the aircraft's normal operating limits and would not be expected to cause issues with ground manoeuvring.

Footnote

[1] 'GOOD' in this context is a comparative term, intended to mean that aeroplanes should not experience directional control or braking difficulties, especially when landing. It is not meant to equate to conditions that might be found on a clean, dry runway.

The taxiway marks indicated that the nosewheels had started to skid relatively early in the turn and had remained in this state until they left the paved surface. This is supported by the FDR data, which shows that the rate of turn was approximately constant from the initiation of the turn. It was evident from the nosewheel skid pattern and the furrow in the grass that the nosewheels had adopted a high angle of deflection, which was maintained until the aircraft had come to a stop. There was limited wheel braking and no visible evidence of mainwheel skidding.

The aircraft's speed (18 kt) was considerably higher than that given in the aircraft operating procedures (less than 10 kt) for a 90° turn. The procedures do not necessarily take into account degradation in friction qualities such as could be experienced on a damp surface, so it is arguable that an even lower speed might have been prudent. Given the relatively high speed that the turn was entered, it is probable that nosewheel steering angle was increased rapidly to maximum, and that this contributed to the early skid. This is again supported by the FDR data, which shows that the rate of turn was approximately constant throughout the turn.

From the flight crew accounts, the CVR data and the lack of significant wheel braking, it is clear that the flight crew did not appreciate that the aircraft's speed was too high for the 90° turn. The commander did not recall any distractions immediately beforehand, although it is possible that his attention may have been diverted briefly: to refer to a taxi chart, or to monitor the first officer's actions, for example. The first officer's primary role at the time would have been to monitor the aircraft to ensure a safe taxi, and his attention was diverted from this task by performing the after-landing actions at that time. There would have been no particular urgency to these actions, which could have been delayed until the aircraft was safely on Taxiway Alpha.

The difficult approach and landing offers a possible explanation as to why the experienced crew attempted the turn at too high a speed. Landing safely after a period of intense high workload, it is possible that the crew inadvertently but prematurely relaxed their normal level of vigilance.

Conclusion

The aircraft entered a 90° turn on a damp taxiway at a speed that was too high for the conditions and geometry of turn. The nosewheels lost traction and skidded, causing the flight crew to lose full directional control of the aircraft.

ACCIDENT

Aircraft Type and Registration:	Cessna 402B, G-MAPP	
No & Type of Engines:	2 x Continental Motors Corp TSIO-520-EB piston engines	
Year of Manufacture:	1974 (Serial no: 402B-0583)	
Date & Time (UTC):	14 January 2016 at 1214 hrs	
Location:	East Midlands Airport	
Type of Flight:	Training	
Persons on Board:	Crew - 2	Passengers - 1
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Damage to the left main landing gear, left wingtip and aileron, and blade tips of the left propeller. Left engine shock-loaded	
Commander's Licence:	Commercial Pilot's Licence	
Commander's Age:	39 years	
Commander's Flying Experience:	3,900 hours (of which 2,800 were on type) Last 90 days - 38 hours Last 28 days - 11 hours	
Information Source:	AAIB Field Investigation	

Synopsis

During the landing roll the aircraft's left main landing gear collapsed and the aircraft departed the left side of the paved runway. The damaged sustained by the left landing gear components was consistent with the side brace folding as weight was transferred onto the landing gear during the landing. The cause of the landing gear collapse was most probably the incorrect fitment of a set screw in the downlock link. One Safety Recommendation is made.

History of the flight

At 1141 hrs, G-MAPP took off from Runway 27 at East Midlands Airport. On board was an instructor, and two pilots who had recently joined the operator, who were learning to fly this aircraft type. This was the second conversion flight for the new joiners; one was occupying the left pilot's seat, and the other sat in the cabin to observe his colleague. The instructor occupied the right pilot's seat. The weather conditions were good, and the crosswind component of the wind, at 11 kt, was within the company limit of 16 kt for this aircraft type.

The aircraft flew two approaches to overshoot and two touch-and-gos, before taking off again, prior to its fifth approach. For this fifth approach the instructor planned to

demonstrate a flapless approach to a full stop landing. The V_{REF} was calculated as 108 kt and an uneventful approach was flown, with the landing gear confirmed as indicating fully down by all on board, to a landing which was described as smooth. After landing, as the aircraft was slowing down, the left wing began to sink and the left propeller made contact with the ground.

The instructor made a MAYDAY call but was unable to keep the aircraft on the runway, and it came to rest on the grass just to the south of the runway, west of intersection 'S'. The instructor made the aircraft safe and the crew, who were uninjured, evacuated the aircraft. Taxiway 'S' is located close to the fire station and fire crews were quickly on scene, but there was no fire.

Aircraft information

The Cessna 402B is a twin-engined aircraft equipped with a retractable, tricycle landing gear. The aircraft has a maximum certificated landing weight of 6,300 lb and the estimated landing weight at the time of the accident was approximately 5,700 lb, with the centre of gravity within permitted limits.

The landing gear retraction system is powered by an electric motor that drives, via a reduction gearbox, a series of rods, torque-tubes and bellcranks that move the landing gear legs. The main landing gear is held in the 'down and locked' position by a folding side brace. A downlock link, driven by a bellcrank, applies a force to the side brace to keep it in an over-centre position when the landing gear is down, Figure 1.

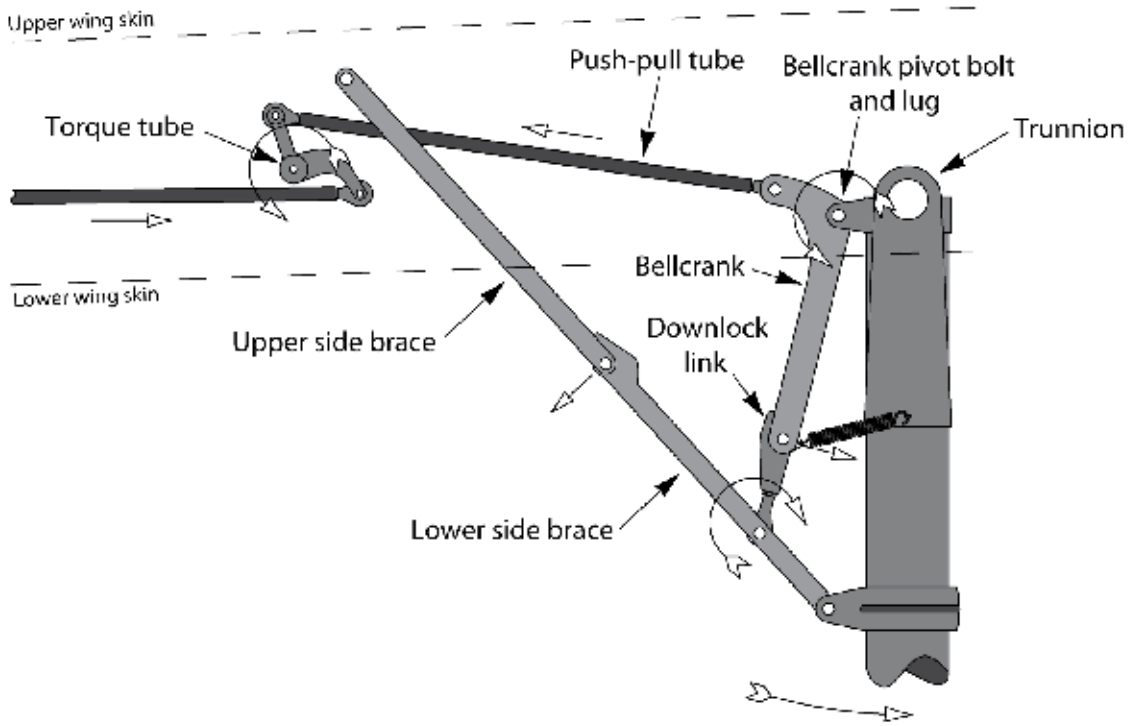

Figure 1

Schematic of the landing gear downlock mechanism

When the main landing gear leg is down and locked, the downlock link and bellcrank should be in an over-centre position, to hold the side brace over-centre and prevent it from folding. A microswitch, mounted on the downlock link, closes when it is over-centre and illuminates the green DOWN instrument panel light for that landing gear leg. The bellcrank is connected to the downlock link by a pin, which is secured in place by a set screw. To ensure that the screw engages in the detent in the pin, an arrow, which is stamped in the end of the downlock pin, must be aligned with the set screw, Figure 2.

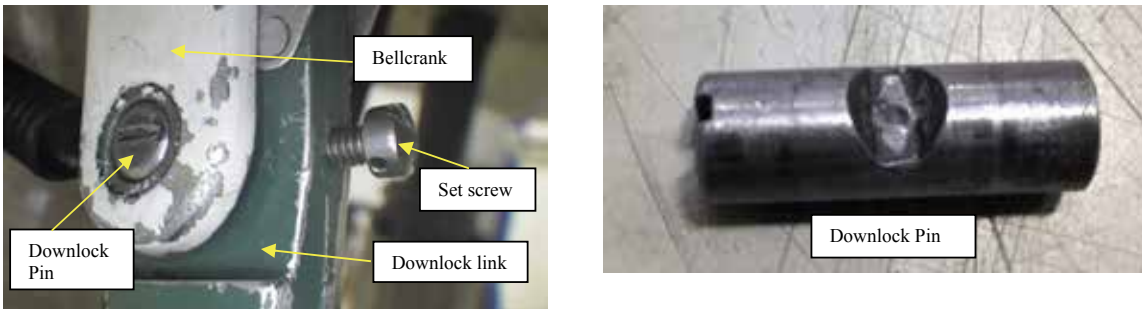

Figure 2

Downlock pin and set screw

Aircraft damage

General

The damage to the left wing and propeller blades was consistent with the left landing gear collapsing and the wing rubbing along the runway. The left landing lamp had been torn out of its mounting and the skin on the lower surface of the wingtip and the outer section of the left aileron had been heavily abraded. All three blade tips on the left propeller had bent rearwards with the outer 20 cm of the blades heavily abraded.

Left landing main landing gear

On the left landing gear, the head of the bellcrank pivot bolt was missing and the remainder of the bolt, which was still attached to the bellcrank, had moved forwards out of the aft mounting lug. The forward mounting lug had fractured across the bolt hole. The Airport Fire Service (AFS) recovered the outer section of the forward lug from the runway, Figure 3.

The downlock pin and its associated bushes were missing. The forward lower lug on the bellcrank had fractured and was recovered from the runway by the AFS. The bolt hole on the rear lower lug, which remained attached to the bellcrank, was damaged. The spring which holds the downlock link in the over-centre position was still attached to the landing gear leg and the downlock link, Figure 4.

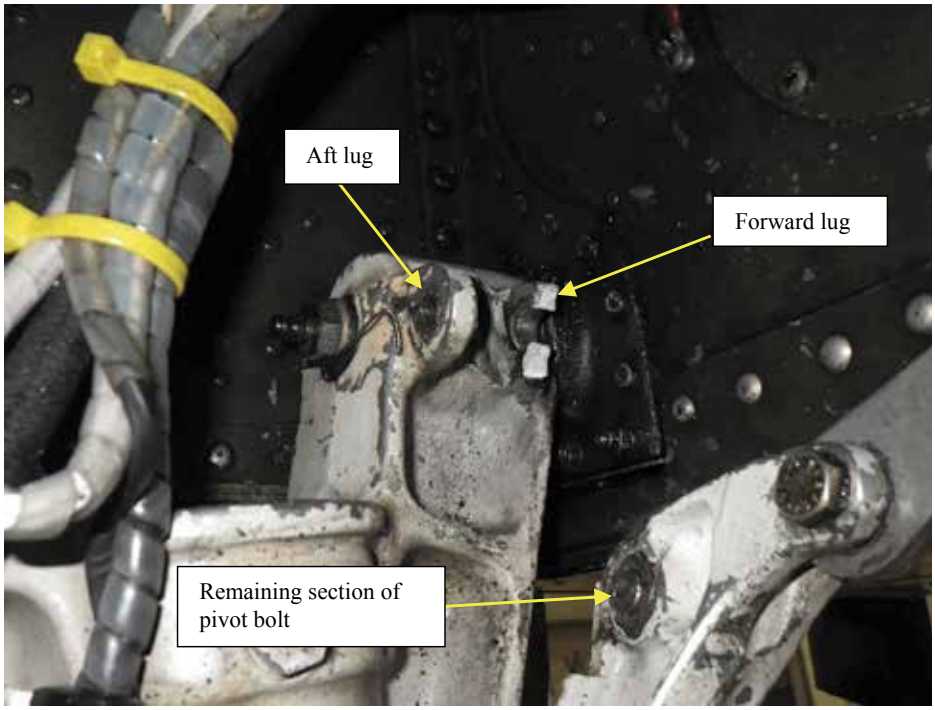

Figure 3
Pivot bolt and mounting lugs

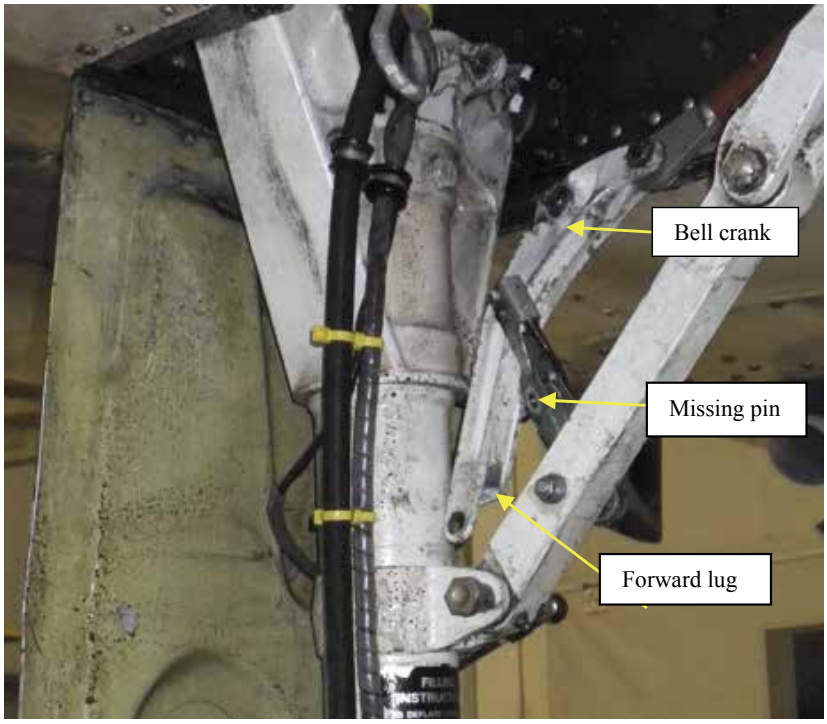

Figure 4
Downlock link

Metallurgical analysis

The fracture surfaces on the pivot bolt and the lugs on the bellcrank and landing gear were inspected by a metallurgist, who advised that the surfaces showed no evidence of a pre-existing crack and had all failed in overload. The lower forward lug had failed as a result of the lug bending forwards.

The part number of the pivot bolt identified it as an aerospace shear bolt with a tensile strength of 160 to 180 ksi, which equates to a Vickers hardness of 352 to 397 HV. A test carried out on the remaining section of the pivot bolt fitted to the left bellcrank on G-MAPP established its hardness as approximately 380 HV. This is within the specified hardness range for the bolt.

Examination of downlock link

Examination of the downlock link revealed that the end fitting that connects to the lower side brace had rotated clockwise by approximately 45º, Figure 5. The set screw was still wire locked to the casting and the head of the screw sat proud of the casting by 4 mm, with approximately five threads showing (Item A). The end of the set screw was flush with the wall of the bore in the casting and did not appear to have entered the hole in the bush. The bush had circumferential damage approximately 4 to 5 mm from the forward face of the downlock. The aft face of the downlock was undamaged, whereas the bore where it exited the forward face of the casting was distorted.

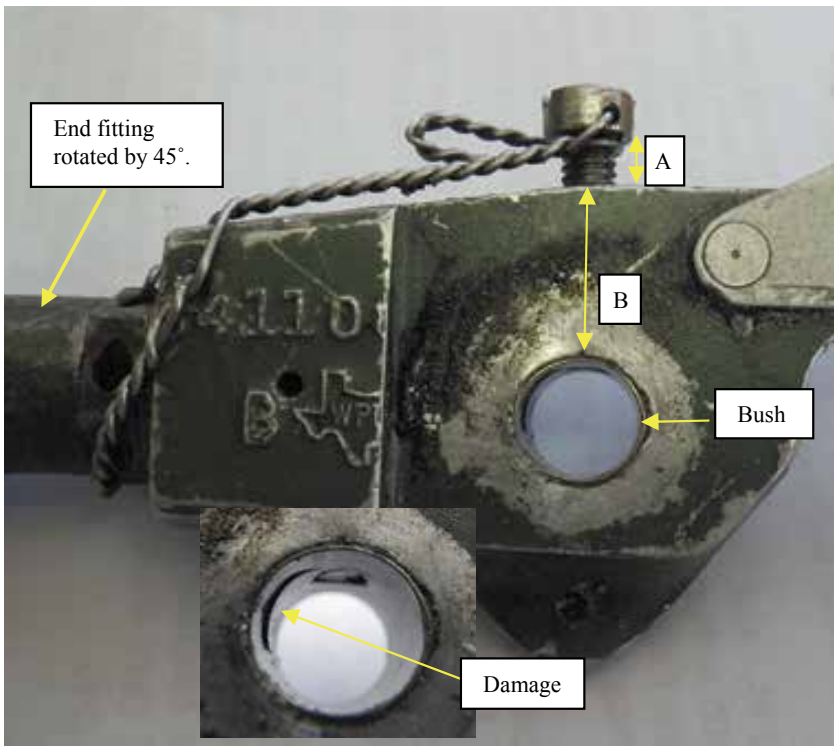

Figure 5
Downlock link

A comparison was made between a number of the key measurements on the left and right downlock links fitted to G-MAPP. Refer to Figure 5 and Table 1.

	Left downlock link	Right downlock link
Height of head of set screw above casting (A)	4 mm (approx 5 threads)	4 mm (approx 5 threads)
Length of threaded portion of set screw	16.4 mm	17.2 mm
Depth of casting (B)	12.6 mm	11.9 mm

Table 1

Comparison of key measurements on downlock links

The measurements showed that with the head of the set screw 4 mm above the casting, the right downlock pin would have been locked in place, whereas the left downlock pin would have been free to move. The height of the set screws was checked on one of the operator's Cessna 310R aircraft where the clearance between the head of the screw and the casting was found to be approximately 2 mm (two threads).

It was noticed when refitting the downlock pin into the right downlock link / bellcrank assembly that it was a tight fit and had to be tapped into position with a hammer. The operator's engineers advised that this is quite normal. It was also noted that the set screw was easy to insert into the downlock link until the end of the screw reached the bush, when a significant increase in torque was required to turn the screw as it passed into the bush.

Prior to the removal of the right downlock link, carried out as part of this investigation, the rigging of the right main landing gear was checked and found to be satisfactory.

Manufacturer's instructions on fitting the downlock pin

Aircraft maintenance manual

The installation, rigging and functional testing of the main landing gear is detailed in Chapter 4-18 to Chapter 4-32 of the Cessna 401/402 Service Manual. Chapter 4-26 (c) refers to the set screw and states:

> *'c. Install uplock assembly as follows:*
>
> *1. Assemble side brace lock link (42) to bellcrank (35) with pin (36). On aircraft 401-0001 and On and 402-0001 to 402B1090, secure set screw (41) and stake. Do not stake over existing stakes. On aircraft 402B1090 and On, safety wire set screw to side brace.*
>
> *NOTE*
>
> *Ensure arrow (indicating flat surface) located on end of pin is aligned towards set screw.'*

The 401/402 Service Manual makes no mention of ensuring that that the set screw is inserted a sufficient distance to secure the downlock pin.

Service Letter

On 23 January 1976, the Cessna Aircraft Company issued a Service Letter[1] instructing operators of Cessna 300 and 400 series of aircraft to carry out an inspection within the next 200 hours of operation to ensure that the set screw, which retains the main landing gear downlock link, is properly installed.

While this Service Letter is still available, there is no repeat inspection criteria and it has not been included in Section 02 of the Aircraft Maintenance Manual as a scheduled inspection task to be incorporated in the Aircraft Maintenance Programme. Some of the instructions in the Service Letter are also outdated. The instruction refers to 'staking[2]' the set screw, which on G-MAPP was secured by wire locking, and identifies the set screw as Part Number AN565D8H8, which is different to the Cessna 402B IPC which refers to Part Number MS35265-46.

Significant maintenance

The aircraft had undergone its annual maintenance during May 2015 during which the left main landing gear leg was removed for non-destructive inspections. During this activity the bellcrank pivot bolt, downlock link spring and the bolt securing the lower side brace to the leg were removed. However, neither the set screw nor the downlock pin were disturbed. On assembling the landing gear the left pivot pin was replaced with a new item and rigging and functional checks were carried out by an experienced licensed aircraft engineer in accordance with the relevant chapters of the Aircraft Maintenance Manual[3]. The accident occurred 90 cycles and 117 flying hours after the annual maintenance.

On 22 December 2015, a 50-hour inspection was carried out during which the main landing gear was visually inspected. There were no reports of any faults or maintenance having been carried out on the landing gear. The accident occurred 19 cycles and 13 flying hours later.

It was not possible to establish when the downlock pin on G-MAPP was last disturbed. The operator's records show that since 2011 five downlock pins have been issued to their fleet of seven Cessna 300 and 400 aircraft; however, none had been issued against G-MAPP. The operator stated that downlock pins were normally replaced due to corrosion or play in the linkage.

Footnote

[1] Cessna Aircraft Company Service Letter ME76-4, dated January 23, 1976. Subject: Main landing gear down lock pin and set screw inspection.

[2] Staking is where a centre-punch is used to drive some of the material from the casting into the thread of the set screw to lock it in place.

[3] Cessna 401/402 Service Manual Chapter 4-18 to 4-32.

Analysis

The aircraft was within its maximum landing weight and there was no damage to the airframe to indicate that it had been subject to a hard landing. From the damage to the components on the left main landing gear it is probable that the side brace was not geometrically over centre during the ground roll. An inboard side-load force on the main wheel, such as might have occurred during the crosswind landing, would have caused the side brace to begin to fold, leading to the observed overload failure of the pivot bolt and bellcrank mounting lugs. There are three possible reasons why the left main landing gear side brace may not have been over centre: the landing gear may have been incorrectly rigged; a component may have failed; or the downlock pin was not secured by the set screw.

The landing gear may have been rigged incorrectly during the annual maintenance such that the downlock link, side brace, or both, were not sufficiently over centre. The investigation determined that the right main landing gear had been correctly rigged; moreover the landing gear passed all the functional retraction tests and had operated for over 90 cycles before the accident occurred. It is, therefore, unlikely that the left landing gear had been incorrectly rigged.

Failure of a landing gear component may have caused the landing gear to collapse. The metallurgist advised that the failure of the pivot bolt and mounting lugs was due to overload with no evidence of any pre-existing faults.

The most likely explanation, therefore, is that the set screw had not been inserted a sufficient distance to secure the left downlock pin, which subsequently moved forward out of the aft lower fork on the bellcrank. The force through the retraction linkages would then have been taken by the lower forward fork on the bellcrank, causing it to splay outwards. As the downlock pin continued to migrate forward, damage would have occurred to the inside of the bore and the forward face of the downlock link. The eventual effect of the splaying of the fork would have been to shorten the bellcrank and downlink assembly such that the side brace was no longer over centre. As the left landing gear started to retract during the landing roll, the loads transmitted through the retraction mechanism would have caused the fork, mounting lugs and pivot bolt to fail in overload.

Due to the maintenance documentation previously used by the operator it was not possible to determine when the downlock pin had last been disturbed and it is possible that it might have been fitted by a previous owner. During the last annual maintenance the engineers who fitted the left landing gear leg would have checked that the set screw was in place and wire locked, but would not have known that it had not been screwed a sufficient distance into the downlock link to secure the pin.

It cannot be determined why the set screw had not been inserted a sufficient distance to secure the downlock pin. Small variations in the length of the set screw and the depth of the downlock link casting means that it is not possible to rely on the number of threads showing. It is possible that when the downlock pin was last removed the bush moved, slightly, in the bore such that when the set screw was inserted it caught on the bush

allowing the engineer to believe that it had been fully inserted. A comparison of the left and right downlock links, such as might be carried out during an independent inspection, would have shown that the arrows on the downlock pins were correctly aligned and the same number of threads were showing on both set screws, which were also both correctly wire locked.

Safety actions

Following the accident, the operator carried out a fleet check to ensure that the set screw in the downlock links fitted to their other aircraft had been correctly fitted.

In addition, the operator introduced a new local procedure, following the disturbance of the downlock pin, to ensure that the set screw had been inserted a sufficient distance to lock the pin in place.

'Carry out security check of set screw & pin on LH & RH MLG positions:

1) *Back off set screw.*
2) *Ensure arrowed pin can rotate.*
3) *Ensure arrow (indicating flat surface) located on end of pin is aligned towards set screw.*
4) *Tighten/secure set screw*
5) *Ensure arrowed pin cannot rotate.*
6) *Safety wire set screw to side brace lock link.'*

The most likely cause of this accident is that the set screw had not been inserted a sufficient distance to secure the left downlock pin. The Cessna Service Letter dated 23 January 1976 suggests that the incorrect fitment of the set screw might have occurred before; however, there is no repetitive inspection or warning in the Service Manual or instruction as to how to ensure that the set screw has been fitted correctly. Therefore the following Safety Recommendation is made:

Safety Recommendation 2016-049

It is recommended that Textron Aviation informs operators of Cessna 300 and 400-series aircraft of the actions required to ensure that the set screw, which retains the main gear downlock pin, is properly installed in the side brace downlock link and, in addition, amends the aircraft maintenance manuals to include this information.

ACCIDENT

Aircraft Type and Registration:	Dragon Chaser, G-CHNP
No & Type of Engines:	1 Polini Thor 250 piston engine
Year of Manufacture:	2012 (Serial no: 84)
Date & Time (UTC):	31 October 2015 at 1457 hrs
Location:	Near Pitsford Water, Northamptonshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Aircraft damaged beyond economic repair
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	71 years
Commander's Flying Experience:	242 hours (of which 2 were on type) Last 90 days - 17 hours Last 28 days - 4 hours
Information Source:	Field Investigation

Synopsis

The aircraft, a flex-wing microlight, was flying low near Pitsford Water, a reservoir, in benign weather conditions. It turned and descended, hit the ground and somersaulted, sustaining damage. First aid was administered to the pilot, but he had been fatally injured. Some witnesses recalled hearing the aircraft's engine, and some believed its tone had changed or it had ceased. The investigation identified that the conditions were suitable for carburettor icing to have occurred, and that the field into which the aircraft crashed would have been suitable for a forced landing, but no specific cause of the accident was identified.

History of the flight

The pilot regularly flew flex-wing (solo) and three-axis microlight aircraft (under instruction), and had flown G-CHNP, a flex-wing microlight, on two occasions previously.

The aircraft took off without incident from Northampton/Sywell Aerodrome at 1445 hrs. The weather conditions were benign, with light winds, good visibility and no low cloud. Nothing is known of the flight from shortly after takeoff until a number of witnesses sighted the aircraft in flight close to the accident site. None of them had a lengthy uninterrupted view, but together their accounts provided an impression of the final minutes of the flight.

One witness saw the aircraft, which was flying "lower than aircraft usually do". She saw it make a sharp left turn, onto a south-westerly heading, and descend "quite steeply" before it passed out of her view. A second witness reported that he first saw the aircraft in level flight

at about 100 ft agl, before it gained a little height and then began to descend, turning to the left onto a more southerly track. The descent was at a constant angle for a period until, at about "the height of a house", the descent steepened and the aircraft struck the ground hard. He recalled hearing nothing until the impact with the ground, which he heard quite clearly; this led him to believe that the engine either had not been running or had been running quietly.

The attention of a third witness was first drawn by the sound of the aircraft. She stated that the sound became quieter, probably abruptly, and the aircraft was descending quite steeply before it disappeared from sight behind a tree, after which she heard a "crunch". A fourth witness heard an engine and looked around to see the aircraft, which was "coming down quite steeply" before it hit the ground. It appeared to be under control and he thought the pilot might have been attempting to land.

A fifth witness heard the "loud-ish noise" of the aircraft and saw it "very low" close to the accident site. He described that the engine "feathered" as if the throttle had been closed and the aircraft then "dropped", with the front wheel of the trike impacting and digging into the ground, after which the aircraft somersaulted and then came to rest. Two of the witnesses ran to the aircraft after it crashed and attempted to give first aid but the pilot had been fatally injured.

The pilot

The pilot began training towards a National Private Pilot's Licence on flex-wing aircraft in July 2008 and first flew solo in August 2009, after 46 hours dual training. He passed the skills test for issue of the licence in April 2010, and purchased a Dragonfly microlight, which he flew regularly. In October 2014 he began flying a three-axis microlight with an instructor, but had not flown it solo.

He had accrued a total of 242 hours, of which 105 were under training. He had made a medical declaration, which satisfied the applicable requirement.

Post-mortem examination

A post-mortem examination of the pilot was carried out by a Home Office pathologist. He found that the pilot had died from chest injuries. No evidence of any medical condition likely to be incapacitating was found, and toxicological testing revealed nothing remarkable.

The pathologist reported:

> *'In cases such as this, specific injuries are looked for in order to help answer potential investigative questions. I am not aware of the specific controls of the aircraft concerned in this incident, but the soles of the shoes, feet, legs, arms and hands in this case did not display any damage or injuries that could be considered "control injuries". However, interpretation of the presence or absence of such injuries must be done with caution, and the lack of any such injuries in this case should not be considered evidence that* [the pilot] *was not holding/ operating the controls of the aircraft at the time of impact.'*

Aircraft information

The Dragon Chaser is a single-seat deregulated (SSDR) aircraft which is the combination of the Dragonfly trike and a Chaser 2 sail. G-CHNP had fixed landing gear with spats fitted around both the mainwheels. The aircraft is controlled by weight shift. G-CHNP was fitted with an electrically-driven pitch trim that moves the trike's attachment fore and aft along the keel tube with a total travel of around 5 cm, thus reducing the pilot's pitch control forces.

The wing was of conventional flex-wing construction and had seven battens per side giving the aerodynamic profile.

The engine was a single-cylinder, two-stroke Polini 250 Thor, driving a fixed two-bladed 'pusher' propeller. Fitted to the engine was a reduction gearbox, with an inertial clutch mechanism. The engine speed was controlled using either a hand-lever or a foot-lever, and there was a foot-operated disc brake fitted to the nosewheel. The typical still-air landing distance from a threshold height of 15 m for this aircraft is around 250 m.

The aircraft was fitted with an Aircotec Piccolo electronic variometer, mounted on the control bar.

As the aircraft was operated within a de-regulated environment, there was only a limited requirement to keep technical logs. The owner of the aircraft stated that he was not aware of any problems with the aircraft prior to the flight.

Metrological information and the position of the sun

Reports from local aerodromes, witness evidence, and photographs, showed that the weather was fine and dry around the time of the accident. The METAR for Cranfield Aerodrome, 18 nm south-east of the accident site, stated that the wind was from the south at 4 kt varying in direction between 120° and 210°, visibility was 8 km with no significant cloud, the temperature and dewpoint were 15° and 11°C respectively, and the mean sea level pressure was 1022 hPa.

At the time of the accident, the sun's elevation was 12° on a bearing of 228°T.

The CAA has published advice on carburettor icing[1], including a graph showing a range of values of temperature and dewpoint and the degree of icing which might be expected. The values reported at Cranfield are shown as red lines on Figure 1, illustrating that the conditions were on the boundary between *'serious icing – any power'* and *'moderate icing – cruise power/serious icing – descent power'*.

Footnote

[1] CAA Safety Sense Leaflet 14 *'Piston Engine Icing'*.

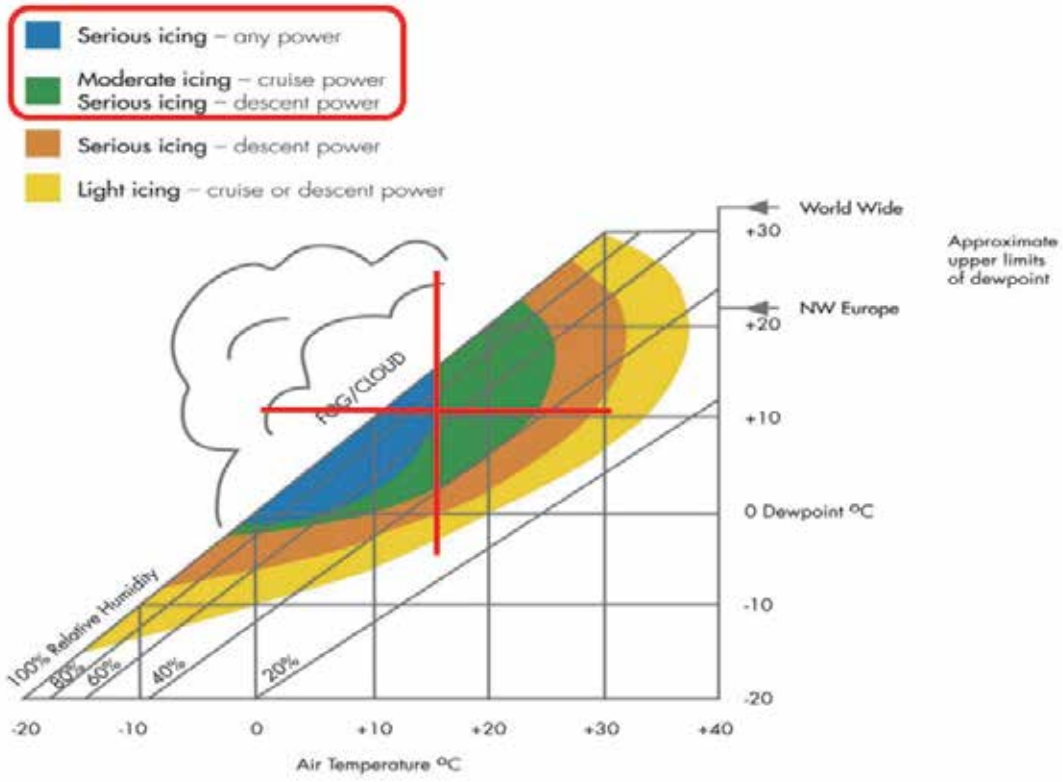

Figure 1

CAA Carburettor Icing chart

(The temperature and dewpoint reported at Cranfield Airport are shown by the two red lines)

Recorded information

Data was recovered from a variometer, which had been mounted on the control bar. This showed peak values of barometric rate, recorded in the 'last flight memory', but it was not possible to establish whether the unit was powered during the accident flight.

Accident site and wreckage

The aircraft crashed in a large field adjacent to Pitsford Water (Figure 2). The field was approximately 400 m long and 100 m wide, and the wreckage was found at the top of a gently sloping knoll. The ground was smooth and there was a grassy crop, approximately 1-2 cm high, growing in the field. The land owner had not been asked for permission to land in the field.

There were several ground marks all located within approximately 16 m from the nose of the aircraft. These marks were consistent with the nose wheel striking the ground heavily in a direction approximately parallel with the hedge running along the edge of the longest side of the field. The aircraft appeared to have performed a 'somersault', which resulted in two holes in the ground being made, first by the apex of the wing and then by the top of the mast, before the aircraft came to rest in an upright position. The ground marks were aligned on a bearing of between 240° and 245°T.

Figure 2

The accident site viewed in approximately the direction of the aircraft's travel

The aircraft structure was inspected and no evidence of a pre-existing structural failure or control problem was found.

Both the propeller blades had failed in a chord-wise direction at approximately half way along their respective lengths. The left landing gear leg had been deformed rearwards which, when inspected in conjunction with the ground marks, was consistent with the left mainwheel striking the ground shortly after the nosewheel. The spat on the left wheel was damaged and had detached. The rearward deformation of the left main gear leg was such that the wheel spat could have entered the propeller disc and caused the blades to fail.

Fuel was found in the carburettor bowl and there was fuel in the damaged fuel tank.

The drive shaft for the electric trim was extended by approximately 5 cm, which equates to a highspeed trim position. The electric trim unit was damaged and was disengaged from the drive screw, hence there was a high degree of confidence that the aircraft was in a high-speed trim position when it struck the ground.

Engineering examination

The wreckage was taken to AAIB headquarters in Farnborough for a more detailed examination.

The battens were removed from the wing and checked against the manufacturer's full scale drawing; nothing significant was found. The engine was taken to the UK distributor where

it was stripped. There was no evidence of any mechanical failure or abnormal running of the engine or the gearbox. The spark plug appeared normal, and a satisfactory spark was observed during testing. It was concluded that the engine was probably producing significant power, because both propeller blades had broken.

Analysis

The pilot was suitably licenced and in current practice, the aircraft was reported to be serviceable, and the weather was suitable for the flight, although the CAA chart showed that there was a risk of carburettor icing.

There was no evidence of the progress of the flight from the takeoff until witnesses saw the aircraft close to the crash site. From the witnesses' recollections, the aircraft appeared to be under control and under power before, from a low height, it entered a descent which steepened and ended with impact with the ground. The accounts of engine noise drawing attention to the aircraft suggest that the engine was running at least until a change in tone was heard; the aircraft was already at a low height when this occurred. The reason for this low height could not be determined; it may have been a consequence of a problem with the aircraft, or intentional on the part of the pilot, or because of some other factor.

Descriptions of the engine note changing or ceasing suggest the engine power may have reduced, either in response to a pilot input or as a consequence of an engine problem. The combination of dew point and temperature indicate that conditions were on the border between those in which *'serious icing'* of the carburettor might occur at any power and *'moderate icing'* at cruise power; *'serious icing'* might occur at descent power, but carburettor icing leaves no evidence and thus no conclusion could be reached in this regard.

The field in which the aircraft crashed was suitable for a landing, either pre-planned or forced; because the land-owner's permission had not been sought, an intentional landing seems unlikely. In either event, any landing could have been challenging because the approach would have been almost directly into a low, setting, sun, and on the knoll before a slightly-down-sloping surface.

Although the post-mortem examination did not identify any evidence of incapacitation in flight, this possibility could not be ruled out.

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.

SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A319-111, G-EZFA
No & Type of Engines:	2 CFM56-5B5/3 turbofan engines
Year of Manufacture:	2009 (Serial no: 3788)
Date & Time (UTC):	16 February 2016 at 1550 hrs
Location:	On departure from Bristol Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 125
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	38 years
Commander's Flying Experience:	9,333 hours (of which 5,702 were on type) Last 90 days - 141 hours Last 28 days - 52 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and Safety Investigation Report produced by the Operator

Synopsis

After lift-off, the co-pilot retracted the flap instead of the landing gear. The commander lowered the nose attitude and selected TOGA thrust but the GPWS Mode 3 aural alert ("DON'T SINK, DON'T SINK") was triggered before the aircraft recovered to climbing flight.

History of the flight

G-EZFA was operating a scheduled Commercial Air Transport (CAT) flight with six crew and 125 passengers on board. The commander was the Pilot Flying (PF). During the takeoff roll there was a "rattle" from the centre console and the co-pilot placed his hand on it, aft of the thrust levers, to reduce the noise. After lift-off, the commander instructed the co-pilot to raise the landing gear but the co-pilot moved the flap lever from position 1 to 0 instead. The aircraft was 46 ft above the runway.

The commander noticed the VLS indication on the PFD increase rapidly (see Note in the next section) but did not realise initially that the flaps were retracting. Seven seconds after the flap lever was moved, the commander lowered the nose attitude of the aircraft and, three seconds later, selected TOGA[1] thrust. The GPWS[2] aural alert "DON'T SINK, DON'T SINK"

Footnote

[1] TOGA: Takeoff/Go-around thrust.
[2] GPWS: Ground Proximity Warning System.

was triggered (by the loss of altitude after takeoff). The aircraft was flying at 194 kt and descending through 393 ft agl with a rate of descent of 1,300 fpm. Two seconds later the commander applied an aft control input with the airspeed at 205 kt and, two seconds after that, the aircraft began to climb. The flight continued to its destination without further incident.

Information from the operator's report

The performance calculation conducted by the pilots determined that the departure would be flown with flaps and slats set to Config 1 + F (18° of slats and 10° of flaps) and with reduced thrust[3].

Flight data

VLS (lowest selectable IAS) is computed by the Flight Augmentation Computer (FAC) and displayed on the PFD as the top of a vertical amber strip along the airspeed scale. VLS corresponds to:

a. 1.13 times the stalling speed during takeoff.

b. 1.28 times the stalling speed in the clean configuration.

When the flap lever was selected to position 0 the aircraft was at 46 ft agl, climbing at 1,300 fpm and 158 kt. The VLS indication on the Primary Flight Display (PFD) increased towards 197 kt, the value corresponding to flaps and slats fully retracted.

Passing through 138 ft agl, the aircraft was climbing at 1,900 fpm and 160 kt and the angle of attack increased to approximately 9.5°. The aircraft is fitted with an Alpha/Speed Lock function which inhibits slat retraction at high angles of attack (above 8.5°) and low speeds (below 148 kt). The protection is not active after the flap lever has been moved to position 0 and did not inhibit slat retraction in this case.

At 308 ft agl, the aircraft was climbing at 1,500 fpm at 167 kt and the commander began to reduce the pitch attitude from 15°. At 418 ft agl, the pitch attitude was 9°, the rate of climb had reduced to 700 fpm and the commander selected TOGA thrust. At 438 ft agl, with the pitch attitude reducing through 8°, the aircraft began to descend and the gear was selected UP. The aircraft descended and accelerated until, at 393 ft agl, the GPWS aural alert, "DON'T SINK, DON'T SINK" was triggered with a rate of descent of 1,300 fpm.

The airspeed increased above VLS with the aircraft at 378 ft agl, the commander began to raise the nose attitude and the aircraft transitioned into a climb.

Aircraft stalling speed

The operator calculated that the stalling speed was 128 kt with the aircraft configured for takeoff and 155 kt with flaps and slats retracted. The aircraft was flying at 158 kt when the

Footnote

[3] In conditions where all applicable performance requirements can be met, a reduced thrust may be used for takeoff. The reduction is entered into aircraft systems using an 'assumed temperature', which Airbus terms a 'flexible' or 'FLEX' temperature.

flap was selected to position 0. At the point where the flaps had retracted fully, the aircraft was accelerating through 183 kt and descending through 440 ft agl with a rate of descent of 1,000 fpm.

Human factors

The operator classified the mis-selection of flap instead of landing gear as a type of '*action-slip*' where:

> *'an out-of-sequence step (the flap selection) was included in a series of routine, well-learnt behaviours (takeoff procedure).'*

In regard to the rattling of the console during the takeoff run, it commented that:

> *'distractions caused by interruptions, can make operators vulnerable to task interference, strong habit intrusion, or mis-ordering tasks.'*

Further:

> *'action slips are hard to detect as the action itself is not under conscious control from a human information-processing perspective.'*

Assessment of cause

The operator assessed that the co-pilot had been distracted by the rattling noise during takeoff which caused him to make an 'action error' in mis-selecting the flap. The operator noted that, in a similar event[4], the pilots re-selected the flap lever to position 1 and the aircraft maintained a positive climb rate and a speed above VLS. In the case of G-EZFA, however, the crew did not fully appreciate what had happened until after TOGA had been selected and, by the time they considered re-selecting flap, the aircraft was recovering to climbing flight.

Footnote

[4] See report Reference EW/G2016/02/11 in AAIB Bulletin 8/2016.

INCIDENT

Aircraft Type and Registration:	Airbus A320-214, G-EZTZ	
No & Type of Engines:	2 CFM56-5B4/3 turbofan engines	
Year of Manufacture:	2011 (Serial no: 4556)	
Date & Time (UTC):	16 February 2016 at 0825 hrs	
Location:	Amsterdam Schiphol Airport	
Type of Flight:	Commercial Air Transport (Passenger)	
Persons on Board:	Crew - 6	Passengers - 167
Injuries:	Crew - None	Passengers - None
Nature of Damage:	None	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	45 years	
Commander's Flying Experience:	13,800 hours (of which 11,100 were on type) Last 90 days - 99 hours Last 28 days - 40 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and Safety Investigation Report produced by the Operator	

Synopsis

After lift-off, the commander retracted the flap instead of the landing gear. Realising his mistake, he immediately returned the flap lever to its previous position and the aircraft continued to climb without further incident.

History of the flight

G-EZTZ was operating a scheduled Commercial Air Transport (CAT) flight with six crew and 167 passengers on board. The co-pilot was the Pilot Flying (PF). The crew reported that the takeoff was normal but when, after lift-off, the PF asked the Pilot Monitoring (PM) to select the landing gear to UP, he moved the flap lever to position 0 instead. The PM realised his error immediately, returned the lever to position 1 and told the PF what he had done. The PF reduced the nose attitude of the aircraft, maintained a positive rate of climb and the airspeed did not decrease below VLS (the lowest selectable IAS). The aircraft continued to its destination without further incident.

VLS is computed by the Flight Augmentation Computer (FAC) and displayed on the PFD as the top of a vertical amber strip along the airspeed scale. VLS corresponds to:

a. 1.13 times the stalling speed during takeoff.

b. 1.28 times the stalling speed in the clean configuration.

Flap system logic

The departure was flown with flaps and slats set to Config 1 + F (18° of slats and 10° of flaps). After takeoff, when the flap lever was moved to position 0, the flaps began to retract but the slats remained in position 1 initially. The slats would have retracted subsequently but, because the PM immediately moved the flap lever back to position 1, they remained extended. In flight, moving the flap lever from position 0 to 1 extends the slats but does not normally extend the flaps ie Config 1 is commanded rather than Config 1 + F. In this case, although the PM moved the flap lever back to position 1, the flaps continued to retract.

Human factors

The operator classified the mis-selection of flap rather than landing gear as an *'action slip'*. The PM intended to carry out the correct action but, during the execution phase, did something different. The report stated:

> *'Tasks which are highly practiced, routine and largely physical actions are more vulnerable to action slips than more cognitively demanding tasks. These well-practiced tasks are linked with automatic processing where* [we can do the task] *'without thinking'. Our ability … to automate our processing* [allows] *us to develop expertise and create the cognitive capacity to process more complex tasks. However, it can also leave us vulnerable to making errors in relatively simple tasks'.*

The operator noted that this was not an isolated event[1], which confirmed that flight crew, in general, are vulnerable to this type of slip.

Footnote

[1] See report Reference EW/G2016/02/10 in AAIB Bulletin 8/2016.

INCIDENT

Aircraft Type and Registration:	Airbus A320-214, G-EZTE
No & Type of Engines:	2 CFM CFM56-5B4/3 turbofan engines
Year of Manufacture:	2009 (Serial no: 3913)
Date & Time (UTC):	7 January 2015 at 1523 hrs
Location:	On approach to Paphos Airport, Cyprus
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 157
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	39 years
Commander's Flying Experience:	4,500 hours (of which 4,200 were on type) Last 90 days - 173 hours Last 28 days - 94 hours
Information Source:	Air Safety Report and investigation report submitted by the operator, and further enquiries by the AAIB

Synopsis

During a visual approach to Runway 29 at Paphos, Cyprus, the airspeed reduced below the target speed and the ALPHA FLOOR autothrust (A/THR) protection activated. The flight crew took recovery action and, during the subsequent go-around, a TCAS RA was generated as the aircraft came into potential conflict with an aircraft at a higher altitude.

History of the flight

The commander and co-pilot were operating a scheduled flight from London Luton Airport to Paphos, Cyprus. The forecast weather conditions at Paphos were clear, with a wind from the north-west. After reviewing the flight planning paperwork, the co-pilot was designated as the pilot flying (PF) for the sector.

En route, the crew checked the latest weather information for Paphos Airport (elevation 41 ft amsl), which showed that conditions could be suitable for a visual approach to Runway 29. The 1430 hrs Paphos METAR reported: surface wind from 310° at 19 kt, with gusts to 29 kt, visibility more than 10 km, few cumulonimbus clouds at 2,500 ft, few towering cumulus clouds at 3,500 ft and scattered cloud at 5,000 ft, temperature 10°C and QNH 1010 hPa. The crew planned for both an instrument and a visual approach, to cover the two options.

During the approach briefing, which was conducted before the descent started, the crew consulted the Operations Manuals (OM) to review the visual approach procedures. The commander then sketched out a plan of how these procedures would apply to an approach at Paphos in the prevailing conditions. The briefing included a discussion of threat and error management. A number of potential threats at Paphos were identified, including the effects of the wind on the timing for the downwind leg and the crosswind on final approach. A modification was made to the information on the navigation display, at the co-pilot's suggestion, with the creation of a 4 nm range ring centred on the Runway 29 threshold. This was to depict the protected area for a circling approach, a technique that the co-pilot had been shown on his last simulator check but was not a standard operating procedure (SOP).

During the descent, the flight crew made visual contact with Paphos Airport and requested a visual approach from Paphos ATC. This was approved, with an initial cleared altitude of 4,000 ft amsl. Accordingly, the co-pilot flew a left-hand circuit pattern, joining the downwind leg at that altitude. The TRK/FPA (track/flight path angle) pushbutton was then pressed to select the flight path vector (FPV) ('the bird') on the PFD (Primary Flight Display), which also replaced the FD bars with the flight path director (FPD). The airspeed was reduced and Flap 2 was selected.

On receiving clearance from ATC, a further descent was initiated to the circuit altitude of 1,500 ft amsl, using the Thrust Idle (THR IDLE) and Open Descent (OP DES)[1] modes, with the autopilot engaged. Both crew considered that the aircraft was now above the desired profile. The landing gear was selected DOWN and the aircraft passed abeam the Runway 29 threshold at an altitude of 3,500 ft amsl. About 42 seconds later, while still within the 4 nm range ring, the co-pilot disconnected the autopilot and started the base turn, with the aircraft descending through an altitude of 3,100 ft amsl at an airspeed of 165 kt. The associated SOP call *'autopilot OFF'* and instruction *'flight directors OFF'* were omitted and the FPD remained ON[2]. At the same time, ATC issued revised go-around instructions, advising the aircraft to maintain runway heading and level at an altitude of 2,000 ft amsl, in such an event. This was acknowledged by the commander.

As the aircraft turned onto base leg, the co-pilot announced "speed decaying". The commander, whose attention was directed outside the aircraft to provide position information during the base turn, thought this was the intention and asked the co-pilot if he required Flap 3. On receiving the latter's confirmation, Flap 3 was selected. The aircraft descended through 2,860 ft amsl, with a speed of V_{LS}[3] +5 kt, a high angle of attack and a pitch attitude of 12° nose-up. The speed continued to decay and at V_{LS} -2 kt the FD automatically disengaged[4].

Footnote

[1] With OP DES engaged, autopilot pitch control maintained the target speed. Further description on this mode is provided under 'Aircraft information'.

[2] The commander commented that, with the FPV (the bird) active and the FPD replacing the FD bars on the PFD, the FPD symbol would have been less obvious than the FD bars.

[3] Lowest selectable speed. The aircraft manufacturer states: '*VLS represents the lowest selectable speed providing an appropriate margin to the stall speed*.'

[4] A feature of the speed protection system.

Concerned about the reduction in airspeed, the co-pilot focused his attention on the airspeed indication. In the turn, the pitch attitude increased and the rate of descent decreased, leading to a further reduction in airspeed. ALPHA FLOOR[5] then activated and Takeoff/Go-Around (TOGA) thrust was set automatically by the A/THR. The co-pilot announced "ALPHA FLOOR" and after a few seconds, realising he was losing his situational awareness, handed control to the commander. At that point, the aircraft had a nose-up pitch attitude of 10.5° and was climbing through an altitude of 2,900 ft amsl.

The commander, whose attention had been redirected outside the aircraft and had been "startled" by the co-pilot's announcement, turned the aircraft away from the coastline and terrain, announcing "GO-AROUND, FLAP". TOGA thrust was selected on the thrust levers, to match the lever position with thrust, the co-pilot selected Flap 2 and an initial nose-down pitch input was followed by a nose-up pitch input. As the aircraft continued to climb, the Speed Reference System engaged (target speed V_{APP}) and the FD bars re-appeared. The speed increased, the flaps were retracted to Flap 1, A/THR was selected OFF and the thrust levers were moved out of the TOGA detent, to regain control of the thrust. Meanwhile, the landing gear remained DOWN.

As the aircraft climbed through 3,900 ft amsl, a TCAS RA "LEVEL OFF, LEVEL OFF" aural alert was triggered. The aircraft was levelled, then descended and passing 3,860 ft amsl the TCAS alert "CLEAR OF CONFLICT" was announced. The aircraft continued to descend to 3,380 ft, with the FD remaining ON, at which point ATC cleared the aircraft to climb to an altitude of 4,000 ft. Having levelled at 4,000 ft amsl, the autopilot and A/THR were re-engaged. Thereafter, an uneventful ILS approach and landing on Runway 29 was carried out.

The minimum speed recorded during the ALPHA FLOOR event was V_{LS} -7 kt.

Aircraft information

Warning and protection systems

The aircraft's Flight Augmentation Computer (FAC) computes the aircraft energy level and issues an aural 'low-energy' alert, 'SPEED SPEED SPEED', repeated every five seconds, to warn the pilot when the aircraft's 'energy level' becomes low. It is available with Flap 2, 3 and FULL, when the aircraft is below a height of 2,000 ft on the radio altimeter. During aircraft deceleration, the low energy alert is normally triggered before ALPHA FLOOR is activated.

A speed protection function is provided in some flight modes when FD orders are not followed by the flight crew. With the FD engaged (no AP) in OP DES mode and the speed at or below V_{LS} -2 kt, the FD bars disappear and the A/THR, if active, engages in SPEED mode. Thrust is increased to recover the speed target and a triple click aural warning sounds.

ALPHA FLOOR is a protection which becomes active with a high angle of attack, commanding TOGA thrust, regardless of thrust lever position. It is available throughout the flight, from

Footnote

[5] A description of ALPHA FLOOR is provided under 'Aircraft information'.

lift-off until the aircraft has descended to a height of 100 ft RA on final approach. When ALPHA FLOOR activates, TOGA thrust is locked until it is disconnected by the flight crew. The Flight Crew Training Manual (FCTM) recommends that the flight crew cancel the mode by disconnecting the A/THR, using the 'instinctive' disconnect pushbutton on either thrust lever, as soon as a safe speed has been achieved.

Traffic Collision Avoidance System

When a RA is detected, the TCAS issues one of a number of aural alert messages and an associated visual command on the Primary Flight Display (PFD) vertical speed scale. The required initial crew actions are to select the autopilot OFF, if engaged, and both Flight Directors OFF. Then, the aircraft's pitch attitude should be adjusted smoothly, as required, to achieve a rate of climb/descent in the green band on the vertical speed scale and/or avoid the red band.

Automation modes

The active A/THR mode is displayed on the FMA at the top of the PFD. When the autopilot/flight director (AP/FD) is off and the A/THR is engaged, the A/THR is in SPEED/MACH mode (MANAGED or SELECTED) and the thrust is varied to maintain the target speed. When the A/THR and AP/FD are both engaged, the A/THR modes '*are selected automatically in conjunction with the AP/FD modes'*. In THRUST mode, the A/THR maintains a fixed thrust, either CLB or IDLE.

OP DES is an AP/FD 'vertical' mode. Speed, MANAGED or SELECTED, is maintained with the autopilot pitch mode and the A/THR maintains IDLE thrust. When the autopilot is disconnected, the flight directors provide pitch commands for the PF to maintain the target speed/Mach number, and the A/THR continues to command IDLE thrust. When the flight directors are selected OFF, the A/THR reverts to speed mode, varying the thrust to maintain the target speed/Mach number.

Visual approach guidance

The operator's Operations Manual (OM), Part B, provides procedures for flying a visual approach. It states:

> *'Method*
> - *The autopilot is not used,*
> - *Both FDs are off,*
> - *FPV is recommended,*
> - *A/THR use is recommended with managed speed'*

It is suggested that the FMS flight plan may include the downwind leg as a useful indication of aircraft position but notes that visual references must be used. A diagram of the circuit pattern is also provided, basing the timings and positional guidance on a circuit height of 1,500 ft aal.

In the section entitled '*Use of the flight management and guidance system',* the following information is provided: *'When flying a visual approach the Flight Directors should be deselected'.* The normal sequence of actions during a visual approach, with associated standard calls, are: *'autopilot OFF, flight directors OFF, and 'Bird'[6] ON'*.

Flight Crew Operating Manual

The Flight Crew Operating Manual (FCOM) also provides guidance on flying a visual circuit (see Figure 1).

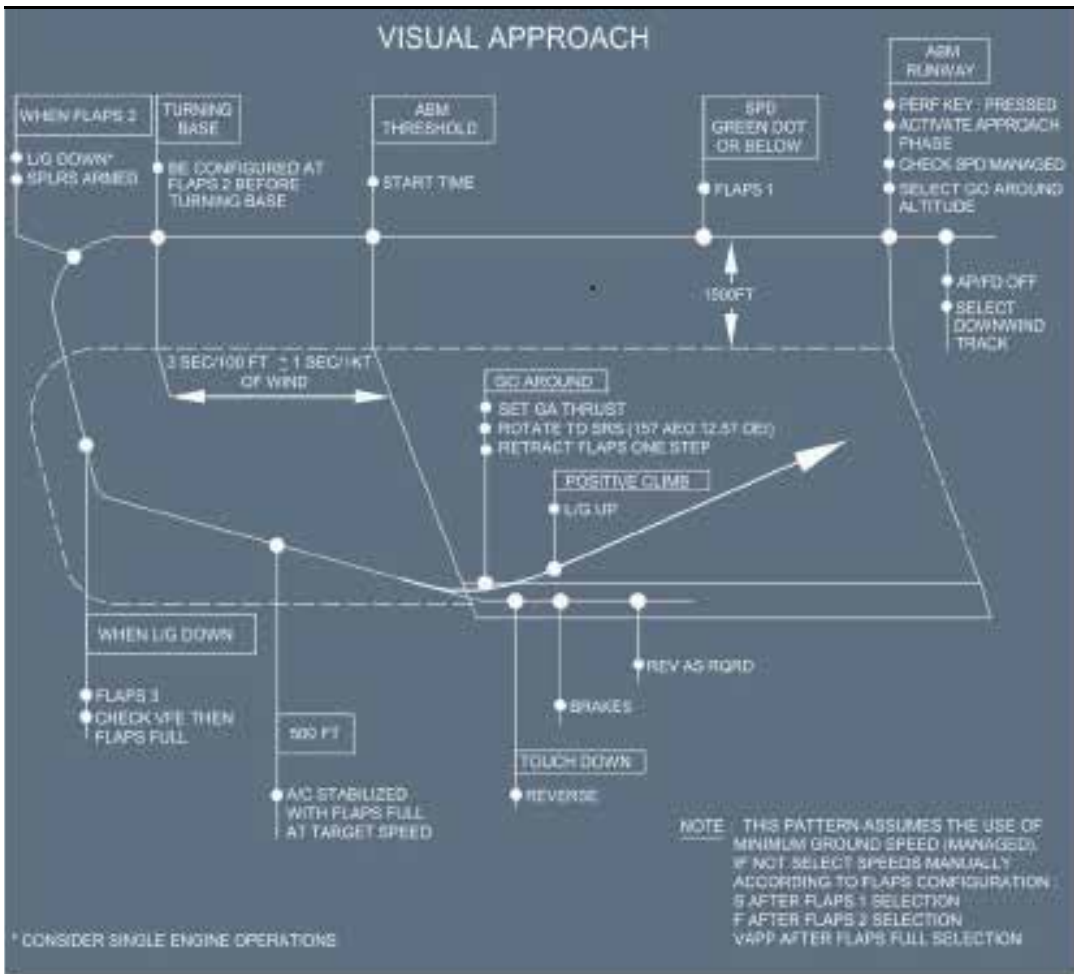

Figure 1

Visual approach pattern

Flight Crew Training Manual (FCTM)

The aircraft manufacturer's FCTM includes a section entitled '*Preventing Identified Risks',* the purpose of which is to increase awareness and management of some of the risks likely to be encountered by flight crew. One of the risks highlighted is ALPHA FLOOR activation

Footnote

[6] Flight Path Vector.

with no subsequent disconnection of autothrust, with TOGA thrust being maintained and the possibility of an overspeed. However, the FCTM does not include information about the risk associated with disconnection of the autopilot, without deselecting the flight directors, when operating in OP DES mode, and the A/THR continuing to command IDLE thrust.

Flight crew information

The co-pilot had 2,800 hours of experience on Airbus A320 series aircraft, and both he and the commander had carried out the operator's previous recurrent simulator programme, which included specific training on the automation modes and more complicated circling manoeuvres. The simulator programme, active at the time of the incident, included a specific element of A/THR awareness training, in which the risks associated with OP DES mode were highlighted. The co-pilot had completed this training.

Recorded flight data

As a result of the TCAS RA 'LEVEL OFF, LEVEL OFF' aural alert, a TCAS download was performed by the operator and supplied to the AAIB. This indicated that a minimum vertical separation of 1,000 ft was maintained.

Previous similar events

In December 2013, the French Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (BEA) published a Serious Incident Report entitled *'Aircraft Airbus A320-214 registered F-HEPE, 3 April 2012 at 12 56 hrs, Deviation below manoeuvring airspeed on final, go-around, triggering of ALPHA FLOOR protection.*[7]*'*

The investigation reported on an incident which occurred during visual manoeuvring, as part of an RNAV Visual Approach, while an aircraft was turning onto final approach. The autopilot was disconnected but the flight directors remained engaged in OP DES mode, with the A/THR in IDLE thrust. The PF made an aft sidestick input during the turn, contrary to the flight director indication, and the speed reduced to V_{APP} -16 kt. ALPHA FLOOR activated and the low speed situation was recovered. The report found that:

> *'Both pilots indicated that they thought that the A/THR would adjust the thrust to maintain speed. The PF's pitch-up input without intervention from the PNF showed that the crew had not identified the risk associated with not following the FD in OPEN DESCENT mode.'*

In the report it was also noted that, on 8 April 2012,

> *'a similar event occurred on the same approach with the Airbus A320 registered F-GKXO and a different crew from the same airline. During this second event, the crew reacted as soon as the SPEED, SPEED, SPEED alarm sounded: the crew adjusted the thrust and continued the approach without the ALPHA FLOOR protection mode engaging.'*

Footnote

[7] http://www.bea.aero/docspa/2012/f-pe120403.en/pdf/f-pe120403.en.pdf [accessed 10 March 2015]

As a result of this investigation, the BEA made the following Safety Recommendation:

> *'EASA[8], in partnership with national civil aviation authorities, ensure that training and recurrent training programmes include instruction on the risks associated with the use of OPEN DESCENT mode on approach. [Recommendation FRAN-2013-86]'*

In response to this Safety Recommendation, on 10 June 2014 EASA issued Safety Information Bulletin (SIB) No: 2014-17, *Aeroplane Mode Awareness During Final Approach,* to encourage operators and training organisations to provide training to:

> *'enhance pilots' understanding of automated flight modes, with particular emphasis on: vertical modes commanding the thrust to idle and speed/energy protections....'*

Since the two events reported on by the BEA, Airbus has introduced a revision to the FCOM, providing guidance on the procedure for flying an RNAV Visual Approach.

Discussion

The flight crew briefed thoroughly before the approach and had a plan they both understood. The visual circuit for Runway 29 involved a left-hand pattern. Therefore, the co-pilot, who was PF, would not be able to see the runway, from the downwind position and would have to rely on the commander for information on the visual aspect. However, the detail in the briefing suggested that, in practice, the co-pilot relied more on timing and the map display than the visual aspect. In addition, the briefing and proposed plan did not prepare the crew for the delayed clearance to descend to the circuit altitude.

The aircraft was in OP DES mode when the co-pilot initiated the base turn, while at an altitude of 3,100 ft amsl (3,059 ft aal) and just inside 4 nm from the Runway 29 threshold. From this position there were 7 track miles (nm) to the threshold, leaving the aircraft above the desired profile. The 4 nm range ring, which had been drawn on the navigation display and intended to be the limit for a circling approach, may have been misinterpreted as a limit for the visual approach, thereby constraining the circuit pattern. As the turn started, the co-pilot disconnected the autopilot but at that moment the commander was responding to a radio call from ATC, concerning revised go-around instructions. This was a possible distraction, diverting the commander's attention from monitoring the flight path and inhibiting the co-pilot from immediately announcing the autopilot disconnect SOP calls. Thus, the action to select the FD OFF was overlooked.

The co-pilot was aware that the speed was decaying but made an inappropriate aft stick input, suggesting that his situational awareness was reduced, possibly as a result of an increasing workload.

Footnote

[8] European Aviation Safety Agency.

The activation of the ALPHA FLOOR protection mode and handover of control by the co-pilot startled the commander, who had to evaluate the unexpected situation and take corrective action. The aircraft was already above the revised go-around altitude of 2,000 ft and TOGA thrust had activated. While regaining the required airspeed and climbing, the aircraft approached another aircraft. A TCAS RA was generated and complied with, maintaining a minimum vertical separation of 1,000 ft.

Automation modes

On the A320 series, when the autopilot is disconnected in OP DES mode, the FD remains engaged in thrust mode, commanding IDLE thrust, and provides pitch commands for the PF to maintain the target speed. Thrust will not increase when the pitch commands are not followed and there is a decay in speed, until the low speed protections activate. To revert to SPEED mode and resume variable thrust, the flight director must be switched OFF. Flight crew are accustomed to the speed protections afforded by the A/THR system and the two events reported on by the BEA demonstrate that, if misunderstood, there can be an expectation that the A/THR will vary the thrust to maintain the target speed.

EASA's SIB No: 2014-17, *Aeroplane Mode Awareness During Final Approach,* encourages operators and training organisations to provide training to:

> *'enhance pilots' understanding of automated flight modes, with particular emphasis on: vertical modes commanding the thrust to idle and speed/energy protections....'*

The crew had received the associated specific training on the automation modes and the co-pilot had recently undergone training in autothrust awareness, in which the risks associated with OP DES mode were highlighted. However, although the crew knew of the potential risks associated with the mode, a breakdown in procedures and lack of appropriate reaction to the reducing airspeed led to a high angle of attack and activation of ALPHA FLOOR.

Safety action

Following a review of the circumstances of this event the operator provided a programme of additional ground and simulator training for the commander and co-pilot. This training addressed non-technical skills, including threat and error management, technical aspects of the flight guidance systems and handling of the aircraft after activation of flight envelope protection systems.

The operator had earlier introduced a specific program of automated flight mode awareness simulator training, before this event. Since the occurrence, an additional procedure has been introduced, which requires the PF to announce the active A/THR mode whenever flight directors are selected OFF.

SERIOUS INCIDENT

Aircraft Type and Registration:	Boeing 737-86N, EI-FHG
No & Type of Engines:	2 CFM56-7B26/3 turbofan engines
Year of Manufacture:	2010 (Serial no: 37884)
Date & Time (UTC):	8 January 2016 at 2210 hrs
Location:	On approach to London Gatwick Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 78
Injuries:	Crew - None Passengers - None
Nature of Damage:	None reported
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	50 years
Commander's Flying Experience:	13,385 hours (of which 9,985 were on type) Last 90 days - 182 hours Last 28 days - 67 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and inquiries made by the AAIB

Synopsis

The aircraft was on approach to London Gatwick when the crew was presented with erroneous airspeed and altitude information on one of the two cockpit display systems. The crew took appropriate 'IAS Disagree, ALT Disagree and Airspeed Unreliable' actions in accordance with the Quick Reference Handbook (QRH). In the final stage of the approach the airspeed and altitude returned to normal and the aircraft landed without further incident.

Subsequent diagnosis found the right (first officer's) pitot probe to have a fault with its ice and rain protection heating element. Ordinarily this would not have affected the operation of the probe but the aircraft had encountered light icing conditions during its descent. Without the protection afforded by the pitot heater, it is likely that an ice restriction developed within the tube, corrupting pitot pressure data fed into the aircraft system.

A similar event, to a Boeing 737-8AS, EI-DWS, is included in this AAIB Bulletin.

History of flight

During descent and approach to Gatwick (LGW) in light icing conditions the crew observed that the right-side airspeed indications dropped from 250 kt to 115 kt and the altitude differed from the left-side indication by 200 ft. This was immediately followed by an 'IAS and ALT disagree' master caution. The crew initiated 'IAS Disagree, ALT Disagree and Airspeed Unreliable' checklist actions and confirmed the left to be correct and the right

to be at fault. The commander elected not to disconnect the autopilot as he was content with the aircraft attitude and system parameters. The crew continued their descent from FL130 into a normal approach. At FL70 the crew noted that the autothrust was not getting 'N_1 limiting' values and was using degraded N_1 thrust limits from the Flight Management Computer. After selecting FLAP 1 the stick shaker activated, with attitude and N_1 within limits. The GPS ground speed and airspeed corroborated so no recovery action was taken. However, during the final stage of the approach, the first officer's airspeed indicator rose to 220 kt and altitude rose to 300 ft in agreement with the indications on the left-side displays. At this point the 'IAS and ALT disagree' caution disappeared. The crew continued to land the aircraft without further incident except that the Electronic Engine Control (EEC) ALTN[1] caution illuminated after landing but required no action. There was no cockpit indication of pitot system malfunction throughout the incident.

System description

The Boeing 737 NG series are fitted with pitot probes mounted on the left and right of the fuselage just aft of the radome. The aircraft are also fitted with an auxiliary probe on the right side of the forward fuselage and two 'elevator pitot probes' on the fin. The probes incorporate heating elements which are part of the aircraft ice and rain protection systems. The probe assembly fitted to the left side of the aircraft is referred to as the commander's probe. The probe fitted on the right side is referred to as the first officer's probe. In addition there is a static plate fitted with separate orifices for the commander's and first officer's air data systems.

Analysis

About the time of the incident the commander noted they had entered light icing conditions observing the effect on the windscreen. When the 'IAS and ALT disagree' caution illuminated he concluded the cause to be a frozen pitot probe or static port. The aircraft responses to the various actions taken by the crew confirmed that a blockage within the first officer's pitot probe was the probable cause. Although the airspeed and altitude information was unreliable, there was not a complete loss of information which suggests only a partial blockage of the probe which alleviated as the aircraft continued its descent.

The operator carried out fault diagnosis on the pitot-static system and found the first officer's pitot heater resistance to be out of limits. The probe, Part No 0851HT, had accrued 20,232 hours and 11,526 cycles.

During this incident, as with previous similar events, there was no indication of pitot probe malfunction on the window/pitot heat panel. The aircraft manufacturer had issued Service Bulletin (SB) 737-30-1070 in April 2014 which introduced a minor modification to the pitot probe heater wiring. The modification ensures that in the event of a pitot heater malfunction, a master caution will appear in the cockpit. The Service Bulletin compliance is at the Operator's discretion and in this case the modification is under consideration.

Footnote

[1] The ALTN caption indicates that the engine EEC is in alternate thrust setting mode, in this case due to invalid light condition data.

Conclusion

The erroneous airspeed and altitude indications were likely to have been caused by partial and transient ice blockage of the first officer's pitot probe whilst in light icing conditions. This was as a result of the failure of pitot probe heating element. The partial icing conclusion is supported by the fact that the blockage alleviated itself during the final approach when the IAS and ALT information returned to normal.

SERIOUS INCIDENT

Aircraft Type and Registration:	Boeing 737-8AS, EI-DWS	
No & Type of Engines:	2 CFM56-7B26 turbofan engines	
Year of Manufacture:	2008 (Serial no: 33625)	
Date & Time (UTC):	9 January 2016 at 1630 hrs	
Location:	During descent into Liverpool Airport	
Type of Flight:	Commercial Air Transport (Passenger)	
Persons on Board:	Crew - 6	Passengers - 173
Injuries:	Crew - None	Passengers - None
Nature of Damage:	None reported	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	41 years	
Commander's Flying Experience:	12,000 hours (of which 8,700 were on type) Last 90 days - 178 hours Last 28 days - 70 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and inquiries made by the AAIB	

Synopsis

The aircraft was descending towards Liverpool Airport when the crew was presented with erroneous airspeed and altitude information on one of the two cockpit display systems. The crew took appropriate 'Airspeed and Altitude Unreliable' actions in accordance with the Quick Reference Handbook (QRH). In the later stages of the descent the airspeed and altitude returned to normal and the aircraft landed without further incident.

Subsequent diagnosis found the left (commander's) pitot probe to have a fault with its ice and rain protection heating element. Ordinarily this would not have affected the operation of the probe but the aircraft had encountered light to moderate icing conditions during its descent. Without the protection afforded by the pitot heater, it is likely that an ice restriction developed within the tube thus corrupting pitot pressure data fed into the aircraft system.

A similar event, to a Boeing 737-86N, EI-FHG, is included in this AAIB Bulletin.

History of flight

After an uneventful flight from Alicante the aircraft had commenced its descent into Liverpool. At FL110 the commander's indicated airspeed (IAS) and altitude (ALT) indications became erratic followed by an ALTN[1] caption on the electronic engine control

Footnote

[1] The ALTN caption indicates that the engine EEC is in alternate thrust setting mode in this case due to invalid flight condition data.

(EEC). The first officer's and the standby instruments were unaffected and appeared normal. The aircraft was in light to moderate icing conditions, in IMC, with a Total Air Temperature (TAT) of +8ºC. At the time the first officer was the handling pilot and autopilot B was engaged. The erroneous indications had no effect on the aircraft flight path. The crew observed that shortly after the ALTN caption illuminated the autothrust made erratic thrust commands so they disengaged the autothrust and flew manual thrust for the remainder of the flight. The QRH checklist for 'Airspeed Unreliable' and EEC ALTN was actioned and it was confirmed that the first officer's and standby instruments were reliable data sources. The aircraft continued its descent and took up a hold at FL70 where two circuits were flown before radar vectors to the ILS Runway 09 (LPL) were resumed. Shortly after leaving the hold as the aircraft descended, the commander's airspeed and altitude indications returned to normal and there were no further erroneous readings during the approach and landing. There was no cockpit indication of a pitot system malfunction throughout the incident.

System description

The Boeing 737 NG series are fitted with pitot probes mounted on the left and right of the fuselage just aft of the radome. The aircraft are also fitted with an auxiliary probe on the right side of the forward fuselage and two 'elevator pitot probes' on the fin. The probes incorporate heating elements which are part of the aircraft ice and rain protection systems. The probe assembly fitted to the left side of the aircraft is referred to as the commander's probe. The probe fitted on the right side is referred to as the first officer's probe. In addition there is a static plate fitted with separate orifices for the commander's and first officer's air data systems.

Analysis

During the incident the commander noted that the symptoms appeared to indicate some form of blockage or restriction to his pitot probe thereby corrupting pitot information into the air data system. Icing was considered the plausible cause given the atmospheric conditions. Although the airspeed and altitude information was unreliable, there was not a complete loss of information which suggests only a partial blockage of the probe which alleviated as the aircraft continued its descent.

Subsequent fault diagnosis carried out by the operator found that the commander's (left side) pitot probe heater element had shorted to its casing. The item was replaced and the aircraft returned to service. The probe, Part No 0851HT, had accrued 17,864 hours and 10,385 cycles.

During this incident, as with previous similar events, there was no indication of pitot probe malfunction on the window/pitot heat panel. The aircraft manufacturer had issued Service Bulletin (SB) 737-30-1070 in April 2014 which introduced a minor modification to the pitot probe heater wiring. The modification ensures that in the event of a pitot heater malfunction, a master caution will appear in the cockpit. The SB compliance is at the Operator's discretion and in this case the Operator had scheduled it for this aircraft's next deep maintenance package.

Conclusion

The erroneous airspeed and altitude indication was likely to have been caused by partial and transient ice blockage of the commander's pitot probe whilst in light to moderate icing conditions. This was as a result of the failure of the pitot probe heating element. The partial icing conclusion is supported by the fact that the blockage alleviated itself in the descent when the IAS and ALT information returned to normal.

ACCIDENT

Aircraft Type and Registration:	CZAW SportCruiser, G-FELX	
No & Type of Engines:	1 Rotax 912ULS piston engine	
Year of Manufacture:	2007 (Serial no: PFA 338-14661)	
Date & Time (UTC):	29 February 2016 at 1100 hrs	
Location:	Crowfield Airfield, Suffolk	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Propeller, nose gear and one main gear	
Commander's Licence:	Light Aircraft Pilot's Licence	
Commander's Age:	73 years	
Commander's Flying Experience:	438 hours (of which 245 were on type) Last 90 days - 6 hours Last 28 days - 3 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The pilot was intending to take off from the grass Runway 02 near the Runway 02/13 intersection. After taxiing on the grass along the side of Runway 13, the pilot positioned the aircraft just before the Runway 02/13 intersection for the power checks. Once complete, the pilot taxied onto Runway 02 just forward of the numbers; however, he found it difficult to establish the precise edge of the runway on the grass and so taxied beyond the edge of the runway before turning left onto Runway 13/30. After crossing Runway 13/30, the aircraft taxied onto soft ground to the side of Runway 02 where the nosewheel dug in and the nose leg broke, allowing the propeller to contact the ground. On reflection, the pilot realised that it would have been better to have turned right onto Runway 02 following the power checks to start the takeoff from the numbers.

ACCIDENT

Aircraft Type and Registration:	Falco F.8L, G-BWYO	
No & Type of Engines:	1 Lycoming O-320-E2A piston engine	
Year of Manufacture:	1998 (Serial no: PFA 100-10920)	
Date & Time (UTC):	22 August 2015 at 1700 hrs	
Location:	Pitlands Farm, Up Marden, Sussex	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Nosewheel sheared and propeller damaged	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	38 years	
Commander's Flying Experience:	Not known Last 90 days - not known Last 28 days - not known	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The pilot stated that "after arriving overhead to visually inspect the [farm landing] field I positioned downwind. After an uneventful final approach, the landing was a hard one causing the nosewheel to shear and the aircraft to slide some 50 to 100 m [before coming] to a stop. The aircraft was made safe and evacuated in a normal way".

ACCIDENT

Aircraft Type and Registration:	Pietenpol Air Camper, G-OFFA
No & Type of Engines:	1 Lycoming O-235-L2C piston engine
Year of Manufacture:	2005 (Serial no: PFA 047-13181)
Date & Time (UTC):	19 April 2016 at 1245 hrs
Location:	Turweston Aerodrome, Northamptonshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to the propeller, engine shock-loaded, damage to the left wing tip, left landing gear leg, and additional airframe damage
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	25 years
Commander's Flying Experience:	926 hours (of which 20 were on type) Last 90 days - 134 hours Last 28 days - 53 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

After an uneventful flight from Bicester, the aircraft landed on Runway 27 at Turweston. A sudden gust of wind from the right caused the aircraft to weathercock and the right wing to lift. This resulted in the aircraft turning to the right, leaving the runway and imposing a lateral load on the left landing gear, which collapsed.

History of the flight

On completing a 50-minute flight from Bicester to Turweston the pilot made a straight-in approach to land on Runway 27. On initiation of the flare the pilot noted turbulent wind conditions. After a normal touchdown on the runway, with no 'crabbing', the aircraft slowed down on all three landing gears. As the airspeed reduced below 30 kt, a gust of wind from the right caused the aircraft to weathercock; despite the application of full rudder this could not be arrested due to an apparent lack of control authority. The aircraft turned through 45° to the right as the upwind (right) wing lifted. This caused the aircraft to skid to the left, imposing a lateral loading on the left landing gear leg, which subsequently collapsed at a speed of approximately 10 kt; the aircraft came to a halt approximately 5 m right of the runway.

Other information

The pilot reported that, prior to departing Bicester, he had obtained the latest ATIS information from Kidlington, which gave the wind as 360°/9 kt. During the flight he obtained an update that led him to expect a wind speed of 5 kt at Turweston.

Conclusion

The wind at Turweston was at 90° to the landing direction at a higher speed than the pilot was expecting. The pilot assessed that a sudden gust caused the aircraft to turn into wind and the right wing to lift, thus precipitating the event.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28RT-201T Turbo Cherokee Arrow IV, G-LZZY
No & Type of Engines:	1 Continental Motors Corp TSIO-360-FB piston engine
Year of Manufacture:	1979 (Serial no: 28R-8031001)
Date & Time (UTC):	20 May 2016 at 1826 hrs
Location:	Shoreham Airport, West Sussex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Right main landing gear door cracked and damage to right flap
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	55 years
Commander's Flying Experience:	16,243 hours (of which 94 were on type) Last 90 days - 38 hours Last 28 days - 0 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries made by the AAIB

On approach to Shoreham Airport the pilot selected the landing gear DOWN and, although green lights illuminated to indicate the nose and left main landing gear were locked down, the green light for the right main landing gear did not illuminate.

The pilot requested a visual inspection from the ground and, once this was completed, he was informed that the landing gear "appeared ok". However, in preparation for the aircraft's arrival, air traffic control initiated a full emergency and the pilot, now holding to the west of the airport, waited for the airport's RFFS to deploy. During this time, the pilot recycled the landing gear and completed the *'Emergency Landing Gear Extension'* checklist which included a step to lower the landing gear using the backup gear extender. In addition, he swapped the bulb in the right main landing gear indicator with one that was known to be working, but the indicator remained unlit. Once the RFFS were in place, the pilot made an approach to Runway 25, stopping the engine after touchdown but, as the aircraft settled, the right main landing gear collapsed. The uninjured pilot turned the fuel and electrics off and vacated the aircraft. He attributed the cause of the accident to the right main landing gear downlock failing to engage.

ACCIDENT

Aircraft Type and Registration:	Piper PA-32R-301T Saratoga II TC, G-MAIE	
No & Type of Engines:	1 Lycoming TIO-540-AH1A piston engine	
Year of Manufacture:	1998 (Serial no: 3257046)	
Date & Time (UTC):	12 April 2016 at 1300 hrs	
Location:	Daedalus Airfield, Hampshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Nose gear collapse, damage to propeller, engine, engine cowling and nosewheel gear doors	
Commander's Licence:	Commercial Pilot's Licence	
Commander's Age:	54 years	
Commander's Flying Experience:	4,061 hours (of which 35 were on type) Last 90 days - 78 hours Last 28 days - 31 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries made by the AAIB	

Synopsis

During a flight from Bournemouth Airport to Daedalus Airfield, the aircraft suffered a rough running engine. The pilot elected to cross Solent Waters to continue the flight to Daedalus. However, the final approach to Daedalus was aborted as a glider was occupying the runway and, during the subsequent attempted go-around, the engine failed to respond and the pilot was forced to land in a grass field short of Runway 23. The aircraft suffered substantial damage.

History of the flight

Having spent 30 minutes on the ground at Bournemouth Airport the pilot took off in G-MAIE to return to Daedalus Airfield, from where he had departed earlier in the day. After levelling at 1,800 ft amsl, the pilot selected cruise power and turned the electric fuel pump off. Shortly afterwards, the engine began to run roughly, so the pilot selected the electric fuel pump back on and changed fuel tanks. These actions had no effect on the rough running engine so the pilot leaned the fuel mixture, also to no effect, before returning the mixture to fully rich.

As the aircraft was now halfway to Daedalus Airfield he elected to continue the flight, crossing Solent Waters, for a downwind join for Runway 23. No PAN call was transmitted. When downwind, the pilot saw a glider and tug aircraft operating on the airfield and made a radio call to announce his position. In response he was informed that the glider launch

would be expedited but, on finals at 300 ft agl, the glider had yet to begin its takeoff roll, and the pilot applied power to go-around. However, the engine did not respond and the aircraft was forced to land in a grass field short of Runway 23.

The aircraft sustained substantial damage but the uninjured pilot was able to vacate the aircraft after turning off the fuel and electrics. A total of 50 US gallons of fuel were found onboard the aircraft and testing showed that no water or other contaminants were present. The engine and ancillaries were also removed and sent for overhaul, but, despite extensive examination, no fault was identified.

ACCIDENT

Aircraft Type and Registration:	Vans RV-6A, G-TOGO	
No & Type of Engines:	1 Lycoming IO-320-D1A piston engine	
Year of Manufacture:	2003 (Serial no: PFA 181A-13447)	
Date & Time (UTC):	8 May 2016 at 1300 hrs	
Location:	Andrewsfield Airfield, Essex	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Damage to nose landing gear and associated fairings	
Commander's Licence:	Light Aircraft Pilot's Licence	
Commander's Age:	68 years	
Commander's Flying Experience:	18,500 hours (of which 598 were on type) Last 90 days - 3 hours Last 28 days - 3 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and verbal report by the aerodrome authority	

The pilot reported that the aircraft had just commenced its takeoff from the grass Runway 09 Right when it encountered an unseen obstruction. The nose of the aircraft pitched down and then up as the aircraft passed the obstruction. The aircraft was accelerating and handling normally, so the pilot elected to continue the takeoff. After landing, the nose landing gear fairings were found to be damaged, with grass and earth lodged in the torn fibreglass structures. Further examination showed the nose gear leg had been bent. The pilot thought that the aircraft may have encountered a shallow gulley or rabbit hole.

The aerodrome authority reported that a full runway inspection had been carried out after the pilot reported the incident, but that no surface irregularities had been found. Several other aircraft had used the area in question, both before and after G-TOGO had taken off, and no other adverse reports had been received.

ACCIDENT

Aircraft Type and Registration:	Evektor EV-97 EuroStar, G-CDAC
No & Type of Engines:	1 Rotax 912UL piston engine
Year of Manufacture:	2004 (Serial no: 2116)
Date & Time (UTC):	7 May 2016 at 1030 hrs
Location:	Cromer (Northrepps) Aerodrome, Norfolk
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Displaced engine mounting, firewall damage and damage to pedals, floor plate, left wing and scratches to propeller
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	66 years
Commander's Flying Experience:	230 hours (of which 200 were on type) Last 90 days - 4 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Following an overhead join, the pilot judged his approach to land to be high and fast so decided to go around. The second approach was also high and fast; however, the pilot made the decision to land. The aircraft touched down late but could not be brought to a stop before the end of the runway. Before running out of runway and colliding head on with the airfield boundary hedge beyond, the pilot turned the aircraft right but was unable to prevent colliding with the hedge (in front of which was a shallow ditch). The pilot, who was wearing a full harness, was unhurt and exited the aircraft unaided.

ACCIDENT

Aircraft Type and Registration:	Ikarus C42 FB100, G-CFIT	
No & Type of Engines:	1 Rotax 912ULS piston engine	
Year of Manufacture:	2008 (Serial no: 0804-6966)	
Date & Time (UTC):	23 March 2016 at 1155 hrs	
Location:	Clench Common Airfield, Wiltshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Nose landing gear collapsed, damage to propeller and possible damage to right wing	
Commander's Licence:	Private Pilot's Licence (Microlight)	
Commander's Age:	61 years	
Commander's Flying Experience:	205 hours (of which 90 were on type) Last 90 days - 8 hours Last 28 days - 4 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The pilot reported that during his approach to Runway 08 the aircraft was faster than he intended. The aircraft landed long on the slightly down-sloping, damp grass surface and the pilot recognised that it was unlikely to stop on the runway. However, he decided that there was insufficient space to take off again and safely clear trees located in the next field. The pilot was unable to stop the aircraft before it overran the runway onto a ploughed area, during which the nose landing gear collapsed.

CAA Safety Sense Leaflet 12 titled '*Strip Flying*' offers advice for operating from unlicensed aerodromes and private strips.

ACCIDENT

Aircraft Type and Registration:	Mainair Blade 912, G-CBRE
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2002 (Serial no: 1330-0602-7-W1125)
Date & Time (UTC):	22 May 2016 at 1330 hrs
Location:	Long Marston Airfield, Warwickshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Major damage to wing. Damage to left wheel spat, gel coat damage to right side, monopole twisted
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	44 years
Commander's Flying Experience:	74 hours (of which 74 were on type) Last 90 days - 20 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reported that he flew the aircraft from Pound Green to Long Marston. Whilst overhead the field at 2,000 ft QFE, he observed the windsock and judged the wind to be 240° at 10 kt. He then flew the short distance to Stratford, orbited and returned to Long Marston. He joined the circuit at 600 ft QFE and observed that the wind direction had altered to 300°. Consequently, the wind was blowing almost directly across Runway 22. The pilot abandoned the first landing attempt owing to the high level of turbulence and the crosswind.

He re-joined the circuit and carried out a long final approach in anticipation of turbulence and the crosswind. He lined up on the centreline and was expecting to touch down about one-third of the way along the runway. A few feet before touchdown the aircraft encountered a gust, turned to the left and landed on rough ground to the side of the runway. It overturned and came to rest on its left side.

ACCIDENT

Aircraft Type and Registration:	Pegasus Quik, G-GBEE	
No & Type of Engines:	1 Rotax 912ULS piston engine	
Year of Manufacture:	2004 (Serial no: 8039)	
Date & Time (UTC):	23 March 2016 at 1243 hrs	
Location:	Redland Airfield, Swindon, Wiltshire	
Type of Flight:	Training	
Persons on Board:	Crew - 2	Passengers - None
Injuries:	Crew - 1 (Minor)	Passengers - N/A
Nature of Damage:	Extensive damage to trike pod and control frame	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	60 years	
Commander's Flying Experience:	3,408 hours (of which 82 were on type) Last 90 days - 17 hours Last 28 days - 13 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and additional enquiries by the AAIB	

Synopsis

During takeoff roll for a dual instructional flight the Pilot under Training (Pu/t), whose flying recency had lapsed for many years, decided to abort the takeoff but then attempted to take off again to avoid overrunning the runway. However, he then attempted to stop again but inadvertently kept his foot on the throttle at the same time. The instructor shut down the engine but was unable to prevent the aircraft from running into a hedge.

History of the flight

The purpose of the flight was to provide refresher training for a pilot who held a UK Private Pilot's Licence but had not flown weight-shift microlights for 14 years and wished to renew his microlight rating. He also wanted to be tutored on the differences between his newly-purchased Quik and the Mainair Flash on which most of his previous flying experience had been gained.

Whilst his instructor felt that his Pu/t's general handling was good, he had made some observations about him which included his takeoff technique. The instructor commented that the Pu/t tended to use to the technique he had used on the Flash, which was to push the control bar fully forward and apply full power until the aircraft became airborne. The Pu/t had been advised that this was not the correct technique when flying the Quik. His instructor had shown him, and he had demonstrated, that the correct technique was to

commence the takeoff roll with the control bar held in 'neutral' and, once sufficient speed had been achieved, to exert forward pressure on the bar to lift off.

On the day of the accident, the instructor briefed that they would practise circuits on Runway 06N at Redlands Airfield, having departed from Runway 06S (06S being shorter than 06N). As the aircraft was relatively heavy, the instructor felt that using the shorter runway would provide an opportunity to demonstrate the takeoff run required when the correct technique was employed.

The Pu/t taxied the aircraft to the runway and applied full power, holding the control bar in the neutral position as instructed. As airspeed built towards the figure which the instructor judged was appropriate to rotate the bar forwards, the Pu/t suddenly took the decision to abandon the takeoff. He closed the throttle, pulled back on the bar and applied the brakes. Although the instructor felt that this had been unnecessary, he was not concerned because he felt there was plenty of room to stop before the end of the runway, despite the fact that the mainwheels were skidding.

However, the Pu/t opened the throttle again, initially pushing forward on the bar in an attempt to lift off to prevent the aircraft overrunning the end the runway, beyond which was a boundary hedge. He then pulled fully back on the bar but still kept his foot on the throttle. The instructor, realising that contact with the hedge was now inevitable, turned off the magneto switches to kill the engine, which was rotating under full power; the aircraft struck the hedge before coming to an abrupt halt. With the help of other pilots at the airfield, both occupants freed themselves from the wreckage. The Pu/t was uninjured but the instructor had suffered a broken metatarsal in his right foot.

The Pu/t reported that in his view the aircraft would not have become safely airborne during the initial takeoff attempt. He felt that, even with stronger headwinds, his previous takeoffs on the longer Runway 06N had used the equivalent length of the shorter Runway 06S. He also added that the control bar had not felt as though liftoff was imminent during the takeoff roll.

ACCIDENT

Aircraft Type and Registration:	Rans S5 Coyote, G-MZGD
No & Type of Engines:	1 Rotax 447 piston engine
Year of Manufacture:	1999 (Serial no: PFA 193-13096)
Date & Time (UTC):	13 March 2016 at 0830 hrs
Location:	Welshpool Airport, Powys
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Nature of Damage:	Right main and nose landing gears collapsed, damage to propeller and engine mounts
Commander's Licence:	Private Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	880 hours (of which 168 were on type) Last 90 days - 18 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The pilot was conducting an impromptu investigation of the aircraft's minimum unstick speed. However, as he abandoned the takeoff, he was unable to prevent a turn to the right and the aircraft landed heavily in a ploughed field to the right of the runway.

History of the flight

The pilot arrived at Welshpool Airport to find that the lengthy flight he had planned would not be possible due to low cloud. The aircraft had been fully refuelled the day before in anticipation of the intended flight and he states that he decided to perform a 'test flight' to investigate the minimum unstick speed in this slightly heavier-than-normal condition. Having done this, he would continue to fly a circuit to reassess the weather conditions; the wind was calm.

As he was about halfway along the Runway 22 during the takeoff roll, using somewhat less than full power and balancing the aircraft on its mainwheels only, he became unhappy with the restricted forward visibility due to the extremely nose-high attitude. Fearing that he might run off the right side of the runway and potentially strike an edge light, he applied full power to clear the lights but was now faced with a dilemma – if he cut the power and abandoned the takeoff, he would probably overrun into the boundary hedge. The pilot instead chose to remain airborne under full power in the hope that he would clear the hedge, although he now realised that the aircraft was travelling nearly at right angles to the runway over a ploughed field with the right wing very close to stalled. Any attempt to straighten up using

left rudder would now leave it flying towards power cables, so he initially chose to accept the turn to the right and continue under full power. However, when he realised that this could make matters worse, he throttled back and accepted a very heavy landing in the ploughed field which collapsed the right and nose landing gear legs.

ACCIDENT

Aircraft Type and Registration:	Stemme S10-V, G-BXGZ	
No & Type of Engines:	1 Limbach L 2400-EB1AD piston engine	
Year of Manufacture:	1995 (Serial no: 14-023)	
Date & Time (UTC):	2 April 2016 at 1300 hrs	
Location:	Lasham Airfield, Hampshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Broken propeller and damaged nose cone	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	50 years	
Commander's Flying Experience:	530 hours (of which 254 were on type) Last 90 days - 13 hours Last 28 days - 5 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The aircraft had initially planned to take off on the tarmac Runway 09 but was asked by the Launch Point Controller to use the grass by the side of Runway 16. The pilot repositioned the aircraft to the right of Runway 16 and began his takeoff roll. The aircraft accelerated as usual up to the point when it was about to become airborne. At this point, the wheels hit a "boggy / very soft area of grass" leading to a rapid deceleration, causing the aircraft to pitch down and for the nose and propeller to strike the ground.

Both the pilot and passenger were wearing full harnesses and escaped uninjured. The pilot was not aware of the condition of the grass before takeoff and the reported wind conditions were 10-15 kt from 160°.

ACCIDENT

Aircraft Type and Registration:	Thruster TST Mk1, G-MTKA	
No & Type of Engines:	1 Rotax 503 piston engine	
Year of Manufacture:	1987 (Serial no: 867-TST-021)	
Date & Time (UTC):	14 May 2016 at 1328 hrs	
Location:	Manchester/Barton Aerodrome	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Wing spar distorted, left mainwheel detached and propeller damaged	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	63 years	
Commander's Flying Experience:	567 hours (of which 16 were on type) Last 90 days - 2 hours Last 28 days - 1 hour	
Information Source:	Aircraft Accident Report Form submitted by the pilot and information from the airport operator	

When commencing takeoff on grass Runway 26L, the pilot believed there was a moderate crosswind from his right. As he reached flying speed, his rudder and aileron control inputs suddenly seemed ineffective. The right wing lifted and the aircraft (Figure 1) yawed quickly to the right through 90º. The left wheel dug into the ground and detached and the left wing then struck the runway. This caused the aircraft to yaw left, while pitching nose-down until the propeller made ground contact. The aircraft then fell back onto its tailwheel and right mainwheel and the two occupants vacated, without assistance.

Figure 1

Thruster TST Mk1, G-MTKA

Airport records indicated the wind direction that afternoon was predominantly northerly, at 10 kt or less but with occasional gusts of up to 15 kt. Approximately six minutes before the accident, it veered east of north and, before takeoff, the pilot was informed that the wind was from 030º at 7 kt. However, he recalled seeing no downwind component for Runway 26L on the windsock situated nearest the threshold. Immediately after the accident, he sensed the wind was extremely variable and suspected a sudden wind shift caused the loss of control.

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:	Cessna 172S Skyhawk, G-ENNK
Date & Time (UTC):	31 March 2016 at 606 hrs
Location:	Sherlowe Airstrip, Shropshire
Information Source:	Aircraft Accident Report Form submitted by the pilot

AAIB Bulletin No 6/2016, page 62 refers

The above Correspondence Report was published in the AAIB Bulletin and was based on information supplied by the pilot. The report, however, gave incorrect information in relation to the runway length at Sherlowe airstrip. Runway 15 at Sherlowe is shown in *Pooley's Flight Guide* as being 240 m in length as opposed to the 318 m stated in the Bulletin.

So the first paragraph should now read:

> The pilot was attempting to take off from Sherlowe airstrip, using grass Runway 15 which is approximately 240 m long.

The following paragraph should be added after the second paragraph:

> The Cessna 172S Pilot's Operating Handbook (POH) shows that, for a short-field takeoff, the minimum ground roll required to lift off from a flat, level and dry paved surface is 186 m at 0ºC ambient temperature and 2,200 lb All-Up Weight. The POH notes that 15% should be added to the ground roll when operating from a dry grass runway which means that the minimum calculated ground roll is 214 m. There was thus a margin of 12% to offset against the soft, damp runway conditions.

The online version of the report was amended on 14 July 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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