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AAIB Special Bulletins / Interim Reports

AAIB Special Bulletins and Interim Reports

This section contains Special Bulletins and Interim Reports that have been published since the last AAIB monthly bulletin.

Aircraft Type and Registration:	AS332 L2 Super Puma, G-WNSB
No & Type of Engines:	2 Turbomeca Makila 1A2 turboshaft engines
Year of Manufacture:	2002 (Serial No: 2582)
Location:	Approximately 1.5 nm west of Sumburgh Airport, Shetland Islands
Date & Time (UTC):	23 August 2013 at 1717 hrs
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 2 Passengers - 16
Injuries:	Crew - 1 (Serious) Passengers - 4 (Fatal)
Nature of Damage:	Helicopter destroyed
Commander's Licence:	Airline Transport Pilot's Licence (Helicopters)
Commander's Age:	51 years
Commander's Flying Experience:	To be advised
Information Source:	AAIB Field Investigation

The investigation

At 1717 hrs UTC on 23 August 2013, an AS332 L2 Super Puma helicopter, with 18 persons on board, crashed into the sea whilst on approach to Sumburgh Airport in the Shetland Islands. Four of the passengers were fatally injured.

The AAIB immediately despatched a team of investigators and support staff to Aberdeen and the Shetland Islands. In accordance with the normal protocols, the AAIB invited representatives from the French accident investigation authority (the Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation civile (BEA)), the helicopter manufacturer, and the engine manufacturer to participate in the investigation. Representatives from the European Aviation Safety Agency (EASA) and the UK Civil Aviation Authority (CAA) were also invited to participate.

History of the flight

The flight, which was the third leg of a four-leg rotation out of Aberdeen, was between the Borgsten Dolphin semi-submersible drilling platform and Sumburgh Airport. As it approached Sumburgh the helicopter was given radar vectors to intercept the final approach course for the LOC/DME/RWY 09 approach (non-precision Localiser and DME approach) to Runway 09 at Sumburgh. The helicopter struck the surface of the sea approximately 1.5 nm west of the airport.

Weather

The weather conditions recorded at Sumburgh Airport at 1720 UTC were: wind from 140° at 17 knots, visibility 2,800 metres in mist, scattered cloud at 200 feet and broken cloud at 300 feet.

Wreckage recovery

The tail boom, containing the Combined Voice and Flight Data Recorder (CVFDR), and other significant parts of wreckage were successfully recovered from the sea. The latter included both engines and the main rotor gearbox, complete with the main rotor head attached. The wreckage was transported to the AAIB's headquarters at Farnborough.

Recorded data

After a period of 48 hours of drying the CVFDR in controlled conditions, the recorded data was successfully downloaded on the evening of 01 September 2013.

Preliminary analysis of the recorded data indicates that the autopilot localizer and vertical speed modes were engaged for the approach.

The recorded data show that at three miles from the runway threshold the helicopter was on the published horizontal and vertical profile of the approach to Runway 09, with the airspeed decreasing steadily. At about two miles from the runway threshold the helicopter was approximately 240 feet below the vertical approach profile, with a rate of descent of about 500 feet per minute, and an airspeed of 68 knots.

The airspeed continued to reduce to below 30 knots and as it did so the helicopter pitched increasingly nose-up. The rate of descent remained constant for a period, before increasing rapidly. Shortly thereafter the helicopter, which was intact, struck the sea in a near level pitch attitude with a slight right bank. Both engines were delivering power until impact.

Summary

To date, no evidence of a causal technical failure has been identified; however, detailed examination of the CVFDR data and the helicopter wreckage is continuing.

Published 5 September 2013

AAIB Field Investigation reports

ACCIDENT

Aircraft Type and Registration:	ATR 42-320, G-DRFC
No & Type of Engines:	2 Pratt & Whitney Canada PW121 turboprop engines
Year of Manufacture:	1986 (Serial no: 7)
Date & Time (UTC):	16 June 2012 at 0723 hrs
Location:	Jersey Airport, Jersey, Channel Islands
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 3 Passengers - 40
Injuries:	Crew - None Passengers - 4 (minor)
Nature of Damage:	Left main landing gear, wingtip, fuselage skin, and left propeller damaged
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	6,106 hours (of which 1,255 were on type) Last 90 days - 103 hours Last 28 days - 49 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft suffered a main landing gear collapse following an uneventful approach to land. It was determined that the left side brace upper arm had suffered a fatigue failure. The failure rendered the side brace ineffective and the unrestrained main trunnion continued to translate outboard, leading to the collapse of the gear. The aluminium brace was found to contain a small metallurgical feature at the crack origin which was consistent with titanium rich particles (TiB_2) particles which are introduced as a grain refiner during casting of the billet prior to forging. The size of the feature was within the defined specifications for AL7010-T74. Analysis of the area surrounding the crack origin revealed an area of static loading before propagating a crack in fatigue, indicating that there may have been a single overload event at some point in the history of the side brace upper arm. The aircraft manufacturer determined that failure of the brace late in a take-off run is hazardous under EASA certification specification (CS) 25.1309.

History of the flight

The crew, comprising a commander, co-pilot and cabin crewmember, reported for duty at 0620 hrs at Guernsey Airport. The commander was conducting line training of the co-pilot, a first officer who had recently joined the company.

The first sector was to be from Guernsey to Jersey. No problems were identified during the pre-flight preparation and the aircraft departed on time at 0705 hrs, with the commander acting as handling pilot.

The short flight was without incident and the weather for landing was reported as good, with the wind from 210° at 16 kt, FEW[1] cloud at 2,000 ft and visibility in excess of 10 km. The commander elected to carry out a visual approach to Runway 27 at Jersey, using a planned approach speed of 107 kt and flap 30 selected for landing. During the approach, the gear was selected down and the flight crew confirmed the three green 'gear safe' indication lights were illuminated, indicating that the gear was locked in the down position. The commander reported that both the approach and touchdown seemed normal, with the crosswind from the left resulting in the left main gear touching first.

Just after touchdown both pilots heard a noise and the commander stated the aircraft appeared to settle slightly differently from usual. This made him believe that a tyre had burst. The cabin crewmember also heard a noise after touchdown which she too thought was from a tyre bursting. The commander selected ground idle and partial reverse pitch and, as the aircraft decelerated through 70 kt, the co-pilot took over control of the ailerons, as per standard procedures, to allow the commander to take control of the steering tiller. The co-pilot reported that despite applying corrective inputs the aircraft continued rolling to the left. A member of ground operations staff, situated at Holding Point E, reported to the tower controller[2] that the left landing gear leg of the aircraft did not appear to be down properly as it passed him.

Footnote

[1] 1-2 oktas (eighths) cloud cover.

[2] The tower controller was also controlling ground movements on the tower frequency as the ground frequency was not in use.

The aircraft continued to quickly roll to the left until the left wingtip and propeller contacted the runway.

The aircraft remained on the runway, rapidly coming to a halt to the left of the centreline, approximately abeam Holding Point D. Both propellers continued to rotate and the commander selected the condition levers to the fuel shutoff position and pulled the fire handles to shut both engines down. The tower controller, seeing the incident, pressed the crash alarm and airfield emergency services were quickly in attendance.

Aircraft evacuation - cabin

As the aircraft begun to roll to the left after touchdown, some of the passengers, concerned about the situation, moved from their seats. In particular, they reported being concerned by a smell of burning. The cabin crewmember quickly instructed them to sit down again but, once the aircraft came to a halt, passengers left their seats and started to move towards the main exit at the rear of the cabin, next to where the cabin crewmember was seated. She realised the aircraft had suffered some kind of accident and that it would be difficult to contact the pilots whilst trying to control the passengers wishing to leave the aircraft. Knowing the engines had stopped she therefore decided to initiate an evacuation.[3] She opened the main door which, due to the angle of the aircraft and the fact the door was hinged at the bottom, could not be opened fully. As the steps are integrated into the door for normal use, this presented an awkward surface for the passengers to negotiate. However, all the passengers were able to vacate the aircraft through the door. One of the passengers had also opened the forward right cabin emergency exit during the evacuation, although it was not used.

Footnote

[3] Operations manual Part E, Section 4.6.3 gives instructions for cabin crew to initiate an evacuation if necessary.

Aircraft evacuation – flight deck

Once the commander had shut down both engines he began to assess the situation, aware that the aircraft had suffered an obvious failure, the exact nature of which was not immediately apparent. He decided to order an evacuation and started to make an announcement on the Passenger Address system. However, as he did so he could see through his side window that passengers were already leaving the aircraft so he did not continue with the message. He returned to ensuring the aircraft had been made safe, assisted by the co-pilot. They reported they did not refer to the Quick Reference Handbook (QRH) as no one checklist seemed immediately appropriate.

There were no signs of fire apparent to the commander. He attempted to contact the fire crew by radio on 121.6 MHz[4] to seek further reassurance and to inform them of the status of the aircraft, but received no response.

Having helped secure the aircraft, the co-pilot left the flight deck to assist the cabin crewmember with the passengers outside. The commander switched off the battery power and walked through the cabin ensuring everyone had left the aircraft before evacuating and joining the passengers on the runway.

The crew and passengers, some of whom had sustained minor injuries, were then transported to the designated emergency reception centre within the terminal building.

Quick Reference Handbook (QRH) Checklist

Page 1.02 of the aircraft QRH contains the actions to be carried out in the event of on-ground severe mechanical damage and emergency evacuation. The boxed items are intended to be carried out from memory. The QRH is available to the pilots on the flight deck and contains a number of normal and emergency checklists. The relevant page is reproduced in Figure 1.

ATR 42 | EMERGENCY | 1.02 | OCT 09 | 001

IN FLIGHT ENG FIRE OR SEVERE MECHANICAL DAMAGE

PL affected side .... FI
CL affected side .... FTR THEN FUEL SO
FIRE HANDLE affected side .... PULL
● **After 10 seconds**
FIRST AGENT affected side .... DISCH
■ **If fire after further 30 seconds**
SECOND AGENT affected side .... DISCH

LAND ASAP
SINGLE ENG OPERATION procedure (2.04) .... APPLY

ON GROUND ENG FIRE OR SEVERE MECHANICAL DAMAGE

PL 1 + 2 .... GI / REVERSE AS RQD
● **When aircraft stopped**
PARKING BRAKE .... ENGAGE
CL 1 + 2 .... FTR THEN FUEL SO
FIRE HANDLE affected side .... PULL
FIRST AGENT affected side .... DISCH
■ **If fire after further 30 seconds**
SECOND AGENT affected side .... DISCH

■ **If evacuation required**
ON GROUND EMER EVACUATION procedure (1.02) .... APPLY

ON GROUND EMERGENCY EVACUATION

AIRCRAFT / PARKING BRAKE .... STOP / ENGAGE
AUTO PRESS .... DUMP
ATC (VHF 1) .... NOTIFY
CL 1 + 2 .... FTR THEN FUEL SO
MIN CAB LIGHT .... ON
CABIN CREW (PA) .... NOTIFY
FIRE HANDLES 1 + 2 .... PULL
AGENTS .... AS RQD
ENG START ROTARY SELECTOR .... OFF / START ABORT
FUEL PUMPS 1 + 2 .... OFF
EVACUATION (PA) .... INITIATE
● **Before leaving aircraft**
BAT .... OFF

Figure 1

Extract from ATR 42 Quick Reference Handbook

Footnote

[4] 121.6 MHz is the UK allocated frequency for use by airport fire services during a declared emergency.

Recorded data

The aircraft was fitted with a tape-based 25-hour Flight Data Recorder (FDR) and a solid state two-hour Cockpit Voice Recorder (CVR); both recorders captured the accident.

The accident occurred during the landing and roll out phase of an 11 minute flight. Figure 2 shows the pertinent FDR parameters during the landing.

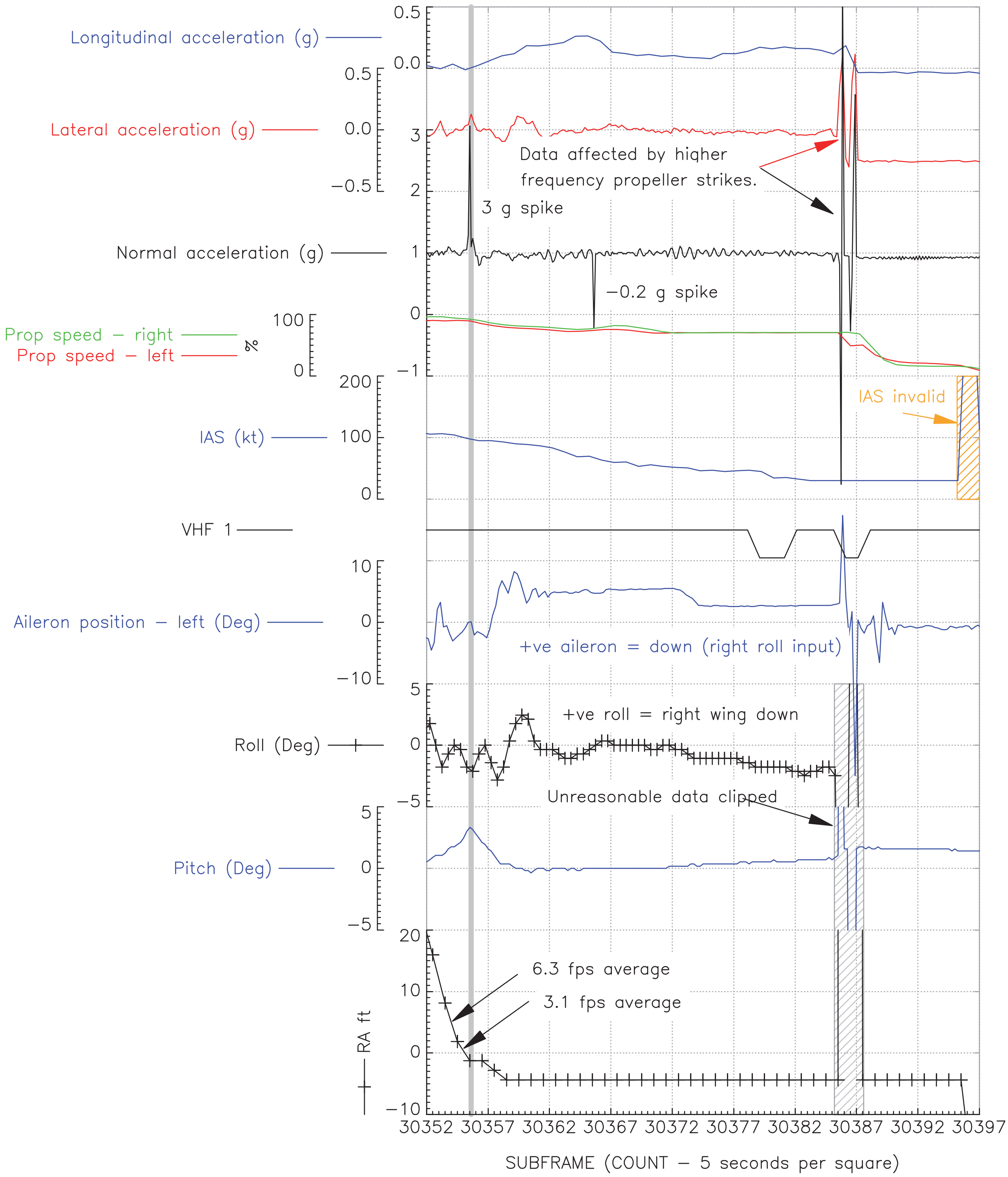

Figure 2

Pertinent FDR parameters

The FDR recorded a 3g normal acceleration spike on touchdown, significantly higher than would be expected during a landing. However, the recorded radio altitude profile indicated a descent rate averaging approximately 3.1 fps over the second just prior to touchdown which was only slightly higher than normal when compared to ten other flights recorded by the FDR. These calculated descent rate figures have limitations due to the low sample rate of once per second; the final height loss may have occurred within a shorter period than the one second between samples.

An isolated -0.2g spike in normal acceleration was recorded approximately 10 seconds after touchdown. No other parameter activity was associated with this spike. Many isolated spikes, that are also similar in value, are present throughout the FDR recording, in flight and on the ground. These are not considered real events. A similar comparison for the 3g spike recorded on landing showed that the other high value spikes were all associated with spikes in other parameters that were not evident during the landing and were likely to be associated with power interrupts. This indicates that the 3g normal acceleration spike is genuine.

Approximately 30 seconds after touchdown many of the parameters became briefly erratic. This is associated with the recorded dip in left propeller speed for a couple of seconds and is likely to be due to the high energy vibrations of the propeller blades striking the runway.

Examination of aircraft

On initial examination, it was found that the left landing-gear had collapsed allowing the wing-tip and rotating propeller to come into contact with the runway surface. A fractured metallic component, identified as part of an attachment lug, was reported to have been found on the runway near the touchdown area.

Landing gear description

Each main landing gear consists of a twin wheel unit mounted on a trailing arm, pivoted on the lower end of a trunnion (Figure 3). The latter is pivoted about an approximately longitudinal axis from a faired structure protruding laterally beyond the profile of the lower fuselage. With the gear retracted, the wheel/axle unit is housed in a recess in the pressure hull below the cabin floor with the axle in a vertical orientation. The trunnion swings through 90° during lowering, to orientate the axle horizontally. Retraction and extension are carried out by means of a double acting hydraulic cylinder connecting the trunnion to the fuselage structure.

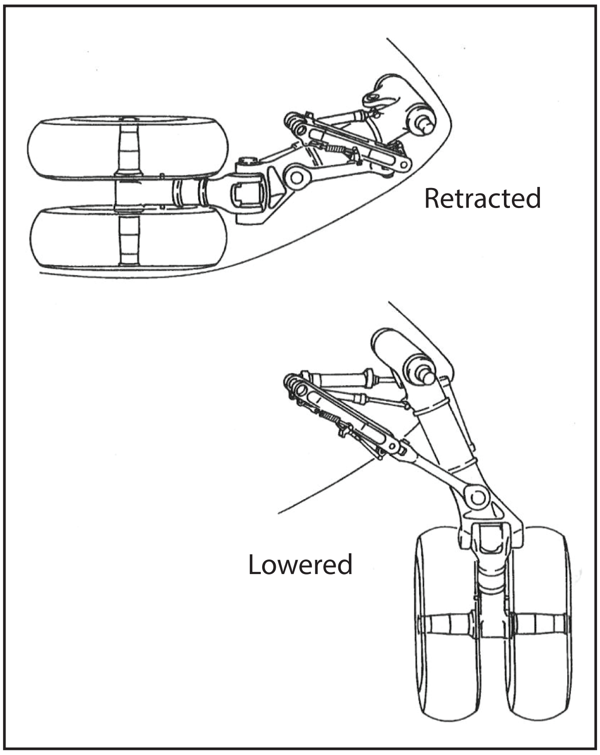

Figure 3
Landing Gear general view looking aft

The side brace is in two parts (Figure 4). The upper arm consists of a forging of 7010-T74 aluminium alloy which terminates at its inboard end in a pair of lugs which are located by an approximately fore and aft orientated pivot pin. This is mounted in a bracket forming a lug system bolted to the fuselage structure. The upper arm and lower arm are joined by a universal joint incorporating the hydraulic downlock and the whole side brace, loaded in tension, acts as the travel limit of the gear at the fully lowered position.

Further examination of the aircraft

It was found that the side brace upper arm of the left main landing gear had suffered a structural failure. This had taken the form of a fracture of both lugs at their attachment to the through bolt in the fuselage-mounted pivot bracket (Figure 5). The failure had rendered the side brace ineffective allowing the main leg to pivot outboard beyond its normal fully deployed position. This had resulted in non-design loading being transferred to the actuating cylinder and overload failure occurring in its attachment bracket to the fuselage structure. The unrestrained main trunnion had thus continued to translate outboard. Part of the lower fuselage had ultimately come into contact with the runway surface. The fractured lug recovered from the runway was found to be the forward of the two lugs of the side brace upper arm.

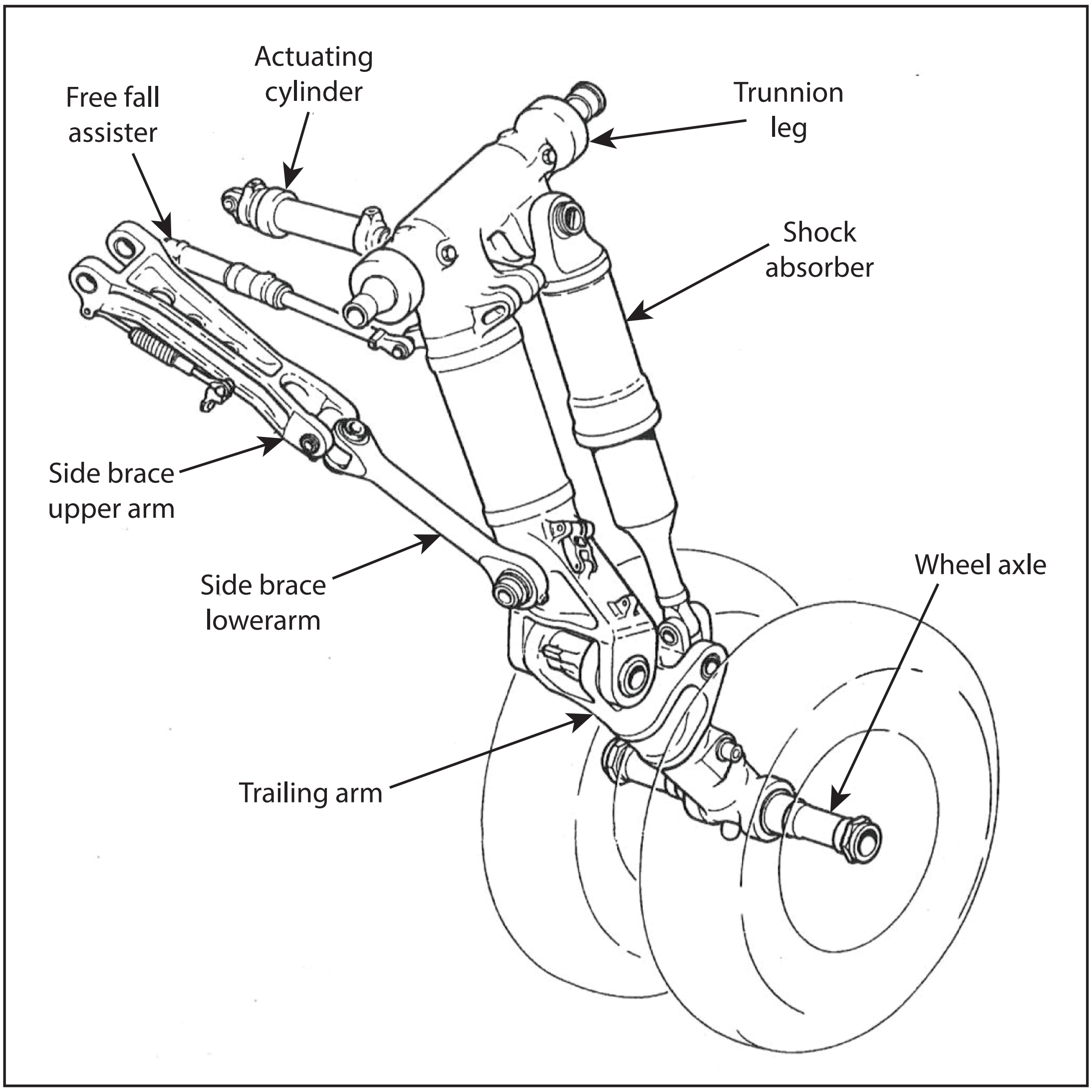

Figure 4

Main landing gear general arrangement

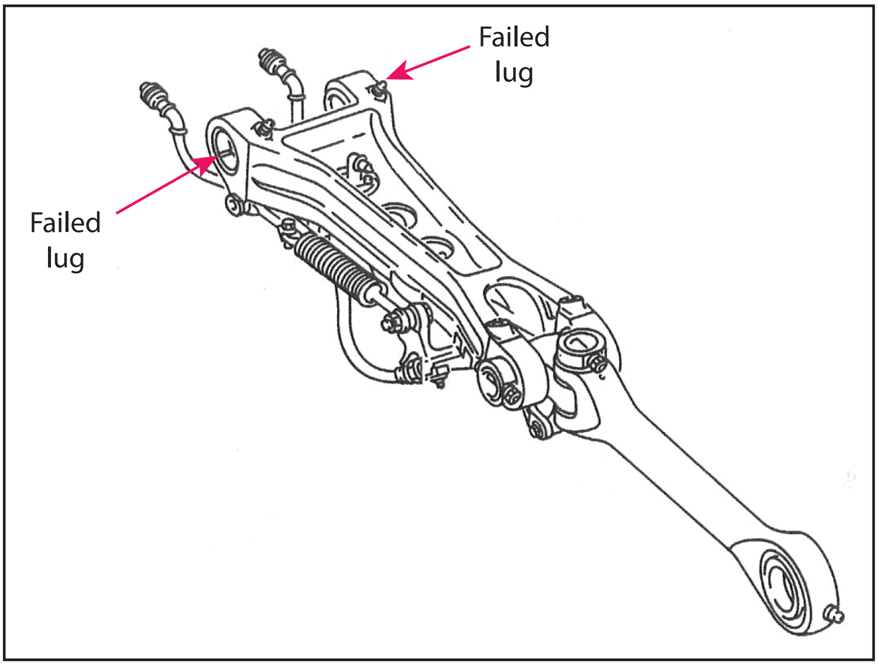

Figure 5

Side brace fracture locations

Following jacking of the aircraft to a wings-level attitude, the complete side brace was removed for detailed examination. During removal, a portion of the second failed lug was extracted from its position, lodged on the pivot bolt where it passed through the aft section of the attachment bracket to the fuselage structure of the aircraft. Removal of the pivot bolt enabled the two pivot bushes to be removed for examination.

History of failed upper arm of side brace

The side brace upper arm was forged to its external profile at a specialist forging company from an eight tonne billet of AL7010 supplied to them by a separate smelting company.

The billet of AL7010 was produced by the smelting company from a melt consisting of various alloying elements. The melt was solidified into a billet using a semi-continuous casting process and grain refiner was then added, which contains titanium rich particles (TiB_2). This was homogenised during a high temperature cycle. The billet was manufactured to specification AIR 9051/A.

The forging company reheated and forged the part, it was then heat-treated to its final temper of T74. Quality control of the part was to specifications MTL-2705 and AMS-STD-2154. The forged part was then passed to a company associated with the landing gear manufacturer for further operations to be carried out, principally the machining of the bores of the lugs. Thereafter, it was forwarded to the landing gear manufacturer for incorporation in a complete main gear assembly.

The complete landing gear assembly was initially installed on another ATR 42 aircraft. The brace was subsequently removed on completion of its specified overhaul life and was overhauled before being returned to service. Following further operation up to its life limit since overhaul, it was again taken from service and overhauled by a manufacturer-approved overhaul company in the USA. Documentation shows that this action was carried out in accordance with the practices mandated by the Original Equipment Manufacturer (OEM). The brace was then installed on G-DRFC. The total number of aircraft on which it was installed during its life is not known but the total life of the component was recorded in its documentation and was within the design fatigue life of the arm. This ultimate life is considerably in excess of the normal component overhaul interval.

The overhaul process included removal of the external components and bushes from the upper arm and comprehensive Non-Destructive Testing (NDT), in accordance with the standard examination methods specified by the OEM. This included the surfaces within the bores of the lugs. This was followed by replacement of the pivot bushes. The latter involves applying a special protective paint to the interior of each bore and the exterior of each corresponding bush.

Laboratory examination of failed components

A general examination of the failed upper arm revealed no other evidence of damage or deformation. Close examination of the eight discrete fracture surfaces (ie both mating faces of each of the two fractures of each of the lugs) created by the overall failure of the lug pair, revealed that the separated lug end recovered from the runway had one of its two fracture faces discoloured over its entire area. This was consistent with it having been in a fractured condition for some time. The mating face on the large portion of the upper arm (part of the forward lug) was similarly discoloured, whilst none of the mating faces of the three other fractures were discoloured and all appeared to have failed recently.

Examination of both mating faces of the discoloured fracture surface (within the forward lug) revealed evidence of fatigue over most of the exposed area. The remaining three fractures, ie that of the other side of the forward lug and both sides of the aft lug, each showed evidence of a small degree of 'thumbnail' fatigue accompanied by a large area of ductile overload fracture.

The characteristics of these small areas of fatigue were consistent with having developed after the loading condition had altered locally following the change in stiffness distribution brought about by the complete progress of initial cracking of the one side of the forward lug (ie the cracking extending from the region of the bore of the lug to the outer profile surface of the forging).

From the discoloured condition of the whole of the two mating fracture faces of one side of the forward lug, this crack was presumed to have progressed over the whole cross-section some time before the final complete failure and separation of both lugs took place.

Examination of the outer surface of the bush and contact face within the associated bore of the forward lug (that containing the initial large area of fatigue cracking) revealed a loss of primer coating consistent with rotation of the bush within the lug having taken place before failure of the latter. This was again consistent with the reduced clamping load resulting from the loss of the semi-interference fit of the bush in the lug permitted by increased flexibility of the latter following propagation of the crack over the whole cross-section of one side.

Preliminary examinations of both mating discoloured fracture faces, using optical microscopy, indicated that the extensive fatigue crack emanated from an origin in the region of the surface of the machined bore of the lug. This finding lead to the initial assumption that surface corrosion had been present in the bore and that this corrosion had lead to the onset of fatigue cracking.

Further examination using Scanning Electron microscopy (SEM) techniques, however, indicated that the origin was actually slightly below the surface of the bore. This origin took the form of an approximately circular region having inter-granular characteristics. Sectioning and further examination of both mating fracture faces at the site of the origin indicated that the feature was approximately spherical in form. Extensive SEM examination and energy dispersive X-ray spectroscopy (EDX) lead to the elimination of most possible causes of the phenomenon noted. One remaining possibility was that the origin took the form of an area of quench cracking, having originated during heat-treatment following forging of the component. The site of this anomaly was close to the most highly tensile loaded plane and location within the lug.

Chemical analysis of samples from the AL7010-T74 billet taken at manufacture, available from the retained documentation of the component, indicated low iron and silicon content, the levels of which were within the specified composition limits but towards the lower end of the specification range. Such low levels are known to be conducive to quench cracking during heat treatment. This tended to support the presence of quench cracking as an explanation. When samples taken from the actual side brace were chemically analysed, however, a higher level of such iron and silicon content was noted. The chemical composition of the aluminiun was within the material specification for AL7010-T74, but the higher levels of iron and silicon were also known to reduce the likelihood of quench cracking.

Thus at this stage, the nature of the origin and the reason for its presence could not be fully identified. As a consequence, a more in-depth study took place, including destructive testing.

Re-evaluation of material characteristics

Progressive polishing down through the origin of the fatigue failure was carried out. A new (very small) discontinuity was found. The void appeared consistent with the presence of inter-granular features although none of the material from within the void was recovered. Further polishing down revealed more regions of inconsistency. However, it is possible that these additional features may have been an artefact of the etching process when polishing down the sample.

Examination of the surface around the origin of the fatigue showed that the feature was surrounded by an area of intergranular cracking of a diameter of about 1.6 mm. Beyond this area was transgranular crack propagation with fatigue striations. The feature had approximate dimensions of 300 µm by 80 µm with a high concentration of titanium (Ti); the smelting company indicated that this may be related to the TiB_2 particles added during grain refining.

The smelting company observed that the intergranular nature of the surrounding 1.6 mm diameter crack surrounding the feature was typical of static failure and was possibly related to a single loading event. They also indicated that that the size of the features observed were smaller than that detectable by ultrasonic or other non-destructive testing means and were within the specification AIR 9051/A[5].

Further analytical work

In order to determine the effect of these observed features on the fatigue life of the component, the laboratories of the landing-gear manufacturer took further samples

Footnote

[5] AIR 9051A no defects of equivalent size greater than or equal to 3.2 mm equivalent flat-bottomed hole, and a maximum limit of five defects per metre tested greater than or equal to 2 mm equivalent flat-bottomed hole.

from the failed side brace of G-DRFC and produced test specimens. These were subjected to a programme of static and tensile fatigue tests to determine the effects on basic sample fatigue life of such material features. One sample experienced fatigue failure after extensive cycling at a high stress level. A further specimen cycled at lower stress levels demonstrated a very high / infinite fatigue life.

The results of these tests indicated that although a number of regions of inter-granular phenomena were present in the side brace; their presence in isolation had not reduced the fatigue life below that of the material specification. Therefore, there should not have had been a measurable effect on the fatigue life of the particular component. It was therefore concluded that at some time during the life of the side brace component it probably suffered excessive loading sufficient to exploit the presence of the origin, creating an initiating crack. Since no evidence of plastic deformation or other damage was visible in the remainder of the upper arm, no intimation that the potential life had been reduced would have been revealed by examination of the component after the excessive loading event.

Status of material batch

It has been established that other ATR 42 components were produced from this batch of AL7010 by the landing gear manufacturer. It was described as Heat #G8165 by the supplier. Other aircraft are also known to have components made from this batch by the same manufacturer as the landing gear of the ATR 42. These include A300, ATR 72 and Dassault types. It is not clear, however, whether that component manufacturer was the only user supplied with material from the batch produced at that time.

Relevant certification and approval processes

The European Air Safety Agency is the body responsible for type approval of the ATR 42 aircraft. The agency does not, however, regulate material suppliers. The holder of the aircraft type certificate is responsible for ensuring and monitoring the quality of such suppliers under their Production Organisations Approval (POA) issued by the National Aviation Authority which, for France, is the Direction Générale de l'Aviation Civile. The quality control includes ensuring the suitability of the material for the specific application. Manufacturing records, which are required to be retained, enable specific batches to be traced back from an aircraft to the original smelter. The certification process does not, however, readily enable utilisation of a batch to be identified when the end user is not specifically known.

Safety significance relating directly to ATR 42

Having reviewed the safety case for the landing gear, the aircraft manufacturer determined that the most severe consequence of a side brace failure would be such an event occurring as a result of the aircraft passing over a runway discontinuity at the high end of the takeoff speed range. This has been classified as hazardous in accordance with EASA certification specification (CS) 25.1309.

Analysis

Evacuation

The passengers' concerns were centred on an apparent lack of announcements during the incident. The decision to order an evacuation from the flight deck is not always an immediate process and the commander arrived at his decision to evacuate after the passengers had already commenced disembarking the aircraft. He had therefore decided any further messages on his part were not required.

The cabin crewmember's decision to initiate the evacuation was in line with the operator's procedures which allow cabin crew to do so once the aircraft has come to a halt and where the situation dictates an evacuation is necessary. The aircraft had indeed stopped, having suffered an obvious accident even if the cause was not immediately apparent. The burning smell evident in the cabin also added to the pressure created by passengers trying to leave the aircraft. Under the circumstances it would have been difficult to both control the passengers and make an announcement and she instead decided to open the main exit and allow the passengers to evacuate the aircraft. All the passengers were able to leave the aircraft in a relatively short time without significant injuries.

Due to the orientation of the aircraft when it came to rest, the design of the main door did not allow easy egress from the aircraft. Despite this, it was still able to be used by everyone leaving the aircraft. Had the angle of the cabin been more severe this might not have been the case but in these circumstances there were emergency exits on the opposite side of the cabin which could have been used instead.

Flight deck actions

Evidence provided by the flight data indicates that the landing was not extraordinary and that it was not considered to have been a contributing factor in the collapse of the landing gear leg. Once the gear had collapsed both pilots were presented with a situation which neither could have expected and there was little either could have done to affect the outcome. When the aircraft had come to a halt the crew faced the difficulty of assessing what had actually occurred in trying to deal with the emergency in the most appropriate manner. The emergency checklists for on ground severe mechanical damage and on ground emergency evacuation covered the necessary actions that should have been taken. Although these checklists were available in the Quick Reference Handbook they were not used. As a result, the operator has stated their intention to reproduce these checklists on the rear cover of the Quick Reference Handbook, allowing quicker and easier access to the checklists in the future.

The commander commented that he received no reply in his attempt to contact the fire services by radio on 121.6 MHz. Although this frequency is allocated to the fire services, its use is not automatic and it is for the fire commander to decide whether to use this dedicated frequency or to use only the normal ATC frequencies when dealing with an emergency. If it is decided to use 121.6 MHz then the flight crew of the affected aircraft would always be notified via ATC to switch to this frequency. On this occasion the fire commander had decided to use only the ATC frequency and hence 121.6 MHz was not being monitored when the commander transmitted.

The main landing gear collapse

The recorded data indicates that the rate of descent during the final approach phase was not excessive and remained low through the period of the touchdown. Although the registered vertical acceleration at ground contact was high, this is not consistent with the recorded descent rate and is believed to have been the effect of the close physical proximity of the accelerometer to the location of the fractured side brace. It is reasonable to assume that the release of strain energy during the fracturing process produced an instant shock load recorded as a 3g spike.

The general nature of the failure mechanism precipitating the collapse of the landing gear is clear. A fatigue crack propagated through most of the cross-section of one side of an attachment lug of the left main landing gear side brace upper arm. This continued as a final region of ductile cracking until complete failure occurred. The increased loading, during normal operation, on other elements of the twin lugs, once the initial crack was large or had passed completely through the section, led to overloading in the other section of the forward lug and both sections of the aft lug. This caused rapid onset of three small areas of fatigue damage followed by ductile overload failure of both lugs. The failure rendered the side brace ineffective and the unrestrained main trunnion continued to translate outboard leading to the collapse of the gear.

The aluminium was found to be within the specifications to which it was made. The initial fatigue crack emanated from a feature which was inter-granular and high in titanium content, which was probably a TiB_2 particle introduced during grain refining. This was surrounded by an area consistent with static loading before propagating a crack in fatigue.

Given that there was not a measurable effect on the fatigue life of the material with the feature, and that an area of static overload was evident immediately surrounding the TiB_2 particle, it is therefore concluded that at some time during the life of the side brace component it probably suffered a single loading event sufficient to exploit the presence of the origin, initiating a crack that remained undetectable until failure.

The EASA have been made aware of the findings of this investigation and are reviewing whether there is any safety action required on aircraft that use this material.

Although the immediate safety significance of the failure occurrence on the ATR 42 type on this occasion (landing gear collapse at or shortly after touchdown) is limited, the aircraft manufacturer has further identified the more critical situation of failure at high speed as Hazardous in accordance with CS 25.1309. Adverse runway surface conditions late in a take-off run are thus capable of precipitating failure of a similarly cracked side brace on other aircraft of the type.

ACCIDENT

Aircraft Type and Registration:	Boeing 737-804, G-GDFJ
No & Type of Engines:	2 CFM56-7B26 turbofan engines
Year of Manufacture:	2000 (Serial no: 28229)
Date & Time (UTC):	19 October 2012 at 0638 hrs
Location:	Glasgow Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 187
Injuries:	Crew - None Passengers - 1 (Serious) 15 (Minor)
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	36
Commander's Flying Experience:	7,600 hours (of which 2,200 were on type) Last 90 days - 227 hours Last 28 days - 69 hours
Information Source:	AAIB Field Investigation

Synopsis

As the aircraft commenced its takeoff roll, both pilots commented on a strange smell. A few seconds later, due to what appeared to be smoke in the cabin, the Cabin Service Director (CSD) alerted the flight crew to an emergency situation. The takeoff was abandoned and the aircraft stopped on the runway. Visual inspection by the commander confirmed the appearance of a significant amount of smoke in the cabin. He ordered an immediate evacuation, during which one passenger suffered a serious injury. No source for the smoke was identified but excessive moisture in the air conditioning system was identified as a possible factor. The operator subsequently amended its maintenance procedures.

History of the flight

The flight crew reported for duty at 0515 hrs, for a scheduled departure to Alicante, Spain at 0615 hrs. The pilots had flown together the previous day and it was decided that the commander would be the Pilot Flying (PF) for this outbound sector, with the co-pilot as the Pilot Monitoring (PM).

The aircraft was parked on Stand 25 and, while the commander prepared the flight deck, the co-pilot carried out the pre-flight inspection. The Auxiliary Power Unit (APU) was in operation providing the lighting and heating for the cabin environment. There were no unserviceable items in the technical log and the Daily Inspection (DI) had been carried out. However, there was a 10 minute delay for a passenger. In accordance with their Standard Operating Procedures (SOPs), the crew carried out the takeoff and departure brief, which included the Rejected Takeoff (RTO) procedure.

Once the passengers had boarded and final preparations had been completed, all the doors were closed and clearance to 'push and start' was obtained. Those passengers seated in the rows next to the over-wing emergency exits were given a short briefing on their role in the event of an emergency and asked to study the information in the safety briefing card. The pushback was commenced and both engines were started. The 'Before Taxi' checklist was completed, including turning the engine anti-icing ON. The cabin crew carried out the Safety Briefing and demonstration whilst the aircraft was taxied to Holding Point G1, for a departure from Runway 05. Figures 1 and 2 show Stand 25 and the Holding Point G1, respectively.

The meteorological conditions, as broadcast on the 0556 hrs ATIS, were: Runway 05, wet, wet, wet; surface wind 080°/08 kt; visibility 10 km or more; scattered cloud at 1,200 ft and broken cloud at 1,500 ft; temperature +8°C and dew point +7°C; QNH 1006 hPa.

There was slight drizzle while the aircraft was taxiing and some areas of standing water were present on the surface. Having received the 'cabin secure' notification from the cabin crew, the flight crew carried out the 'Takeoff' checklist and received clearance to takeoff from ATC. The cabin crew dimmed the main cabin lights and some passengers selected their reading lights ON. The commander lined the aircraft up on Runway 05 and set 40% N_1. When both engines were matched and stable, he engaged the Take Off and Go Around (TOGA) mode of the autothrottle (A/T). Both engines accelerated and the pilots became aware of a "strange" smell. The aircraft accelerated normally but, at about 80 kt, the smell intensified and both pilots sensed a slight misting on the flight deck.

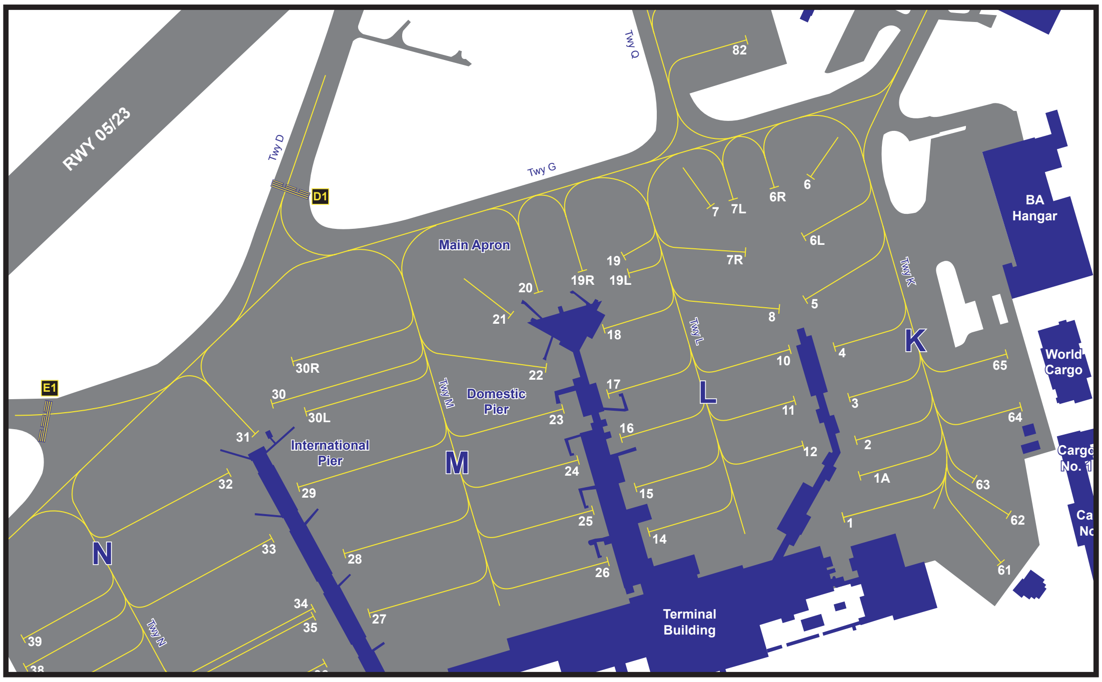

Figure 1

Glasgow Airport parking stands

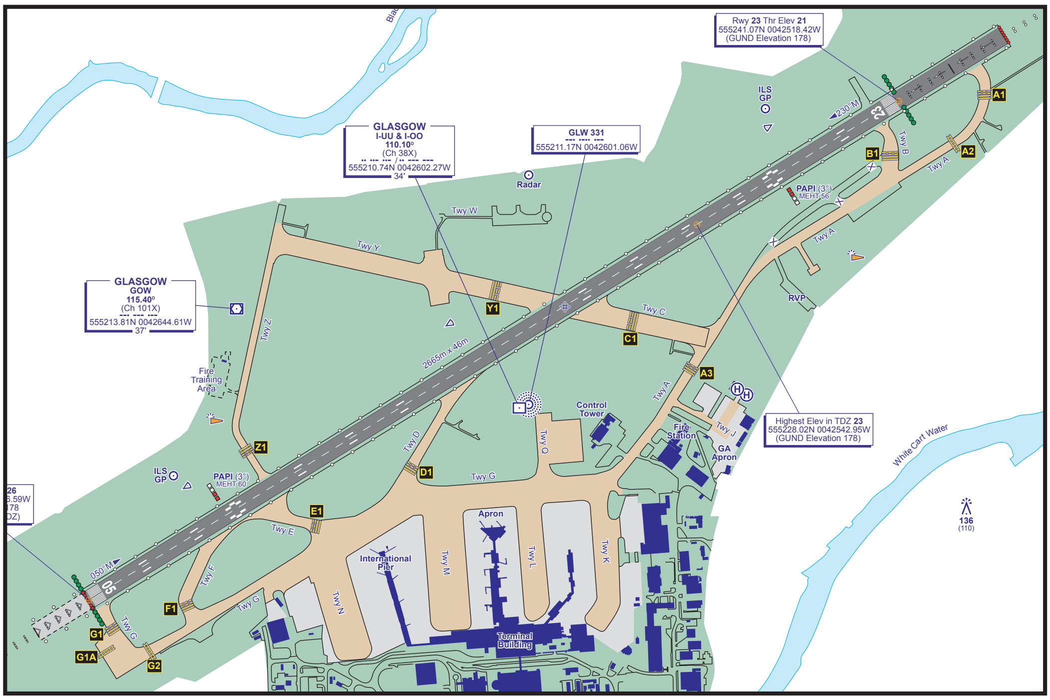

Figure 2

Glasgow Airport map showing Holding Point G1 and the threshold of Runway 05

The cabin crew and passengers were also aware of an unusual smell, which was variously described by the passengers as the smell of hot oil, burning electrics or burning rubber. What appeared to be smoke was coming from the area of the overhead lockers and was seen to be increasing in the beams of the illuminated overhead reading lights. With the deteriorating situation in the passenger cabin, the Cabin Service Director (CSD) repeatedly pressed the flight deck call button on the interphone handset to notify the flight crew that they had an 'urgent' situation in the passenger cabin.

The commander announced the RTO procedure and closed the thrust levers, disconnected the A/T, applied maximum braking, selected the speedbrake fully open and applied reverse thrust. The co-pilot acknowledged the RTO and confirmed that the speedbrake was fully open, that the thrust reversers were unlocked and that braking had been initiated. As the aircraft decelerated through 60 kt, he advised the commander of the speed and moved the flaps from the takeoff position to the 40° (maximum) position, in case of evacuation, and informed ATC that they were stopping on the runway. The aircraft came to a halt and, having applied the parking brake, the commander called the CSD to the flight deck. The CSD briefed the commander on the smell and the smoke in the passenger cabin, which was clearly visible through the open flight deck door. The commander immediately decided to carry out an emergency evacuation on the runway and the flight crew completed the evacuation checklist. The commander then ordered the evacuation and the co-pilot notified ATC.

The cabin crew opened the aircraft doors, the escape slides inflated and passengers opened the over-wing exits. Once all the passengers had evacuated from the aircraft, the cabin crew and, finally, the pilots departed the aircraft; the commander was the last to leave.

The airport Rescue and Fire Fighting Service (RFFS) were alerted by ATC and deployed to the aircraft immediately. They monitored the aircraft in case of fire and, once all those onboard were clear, a team wearing breathing apparatus deflated the forward right emergency evacuation slide and entered the aircraft using a ladder. They found no signs of fire but detected a faint smell of smoke.

Coaches were sent to collect the passengers and crew, to return them to the terminal. Those who were injured were initially treated at the scene, before being transported to hospital.

Evacuation

An AAIB Passenger Questionnaire was sent to each of the 187 passengers onboard the aircraft and 105 completed questionnaires were returned. From the information provided, a detailed picture of the sequence of events was constructed.

After the aircraft was pushed back and the main engines were started, some passengers became aware of an unusual smell but were not concerned enough to mention it to the cabin crew. As the aircraft lined up on the runway and takeoff thrust was set, a large number of passengers became aware of a smell of burning and saw smoke or vapour swirling around in the reading light beams.

Later, as the aircraft decelerated under heavy braking, some passengers described smelling burning rubber. A number of passengers adjacent to the windows reported seeing smoke, sparks or flames on the wings or from the area of the engines. The aircraft came to an abrupt halt and, shortly after, the instruction to evacuate was given. The cabin crew opened the emergency doors and passengers opened the over-wing emergency exits without difficulty. Passengers stood up and started moving towards the exits. Some tried to recover personal items from the overhead lockers, which created restrictions in the flow towards the exits. Passengers climbed onto both wings, which were slippery due to the rain, but were able to see the markings indicating the direction of movement. It was difficult to see the ground in the dark and some passengers were not aware that they should slide down the flap surfaces. Others expected to find an escape slide. On the left wing, some passengers slid down onto the ground and assisted others. On the right wing, fewer people slid down to the ground, while others re-entered the cabin and exited it using door escape slides when it was apparent that there were no visible signs of danger.

Passengers evacuating through the doors jumped onto the slides, as instructed, and, given the wet surface, slid rapidly to the bottom. Some people had difficulty clearing the slides before the next passenger arrived. This caused a number of injuries, as people collided or were knocked over onto the ground.

When all the passengers had cleared the cabin, the cabin crew left the aircraft and tried to gather the passengers together. The aircraft commander walked the length of the cabin and, having ensured all passengers had evacuated, the co-pilot, followed by the commander, exited the aircraft. Figure 3 shows the exits used by those passengers who returned questionnaires.

The airport RFFS arrived during the evacuation and assisted the passengers, as well as recovering a dog from the aircraft cargo hold. Buses were provided by the airport and the passengers boarded them for shelter, before being transported to the terminal building. Injured passengers received treatment at the scene and those requiring hospital treatment were transported there by ambulance. One passenger, aged 77, fractured bones in her neck and chest when she landed badly on

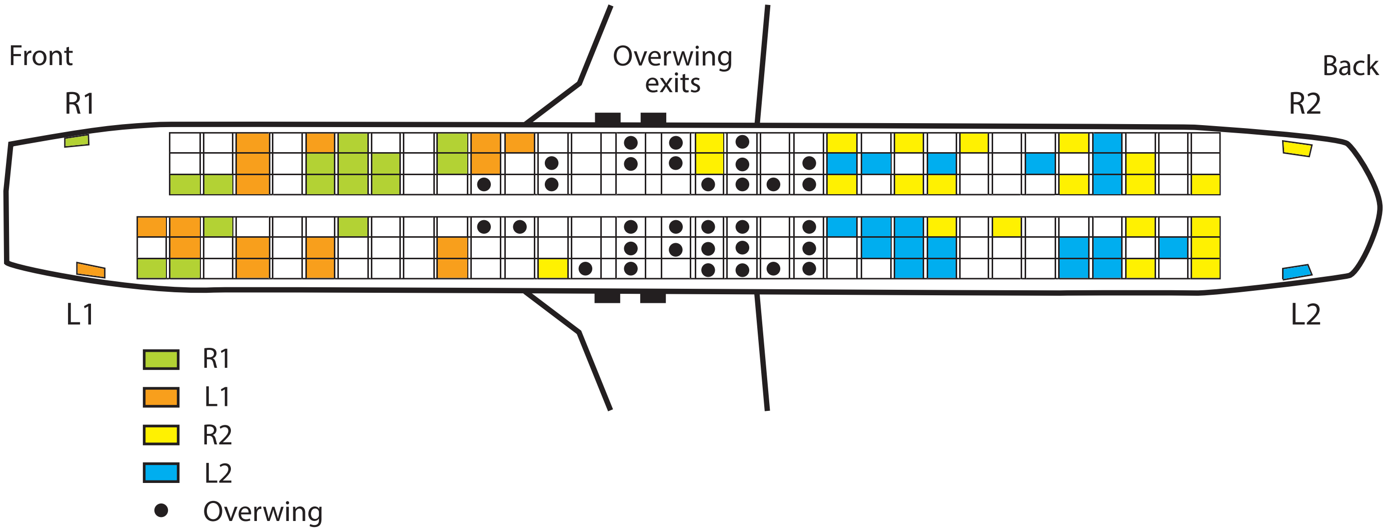

Figure 3

Cabin diagram showing the exits used by passengers

the runway, after descending down a slide. There were 15 minor injuries as a result of passengers sliding into one another at the bottom of slides and being knocked over as they slid off the end.

Evacuation certification requirements

The Boeing 737-800 was required to meet the requirements of Federal Aviation Requirements (FAR) Part 25.803 and demonstrate an emergency evacuation in accordance with the following:

> *'For airplanes having a seating capacity of more than 44 passengers, it must be shown that the maximum seating capacity, including the number of crew members required by the operating rules for which certification is requested, can be evacuated from the airplane to the ground under simulated emergency conditions within 90 seconds. Compliance with this requirement must be shown by actual demonstration using the test criteria outlined in appendix J of this part unless the Administrator finds that a combination of analysis and testing will provide data equivalent to that which would be obtained by actual demonstration.'*

FAR 25.803 required, amongst other things, that the demonstration must be conducted under the following conditions:

> *'1) It must be conducted during the dark of night or during the daylight with the dark of night simulated, utilising only the emergency lighting system.*
>
> *5) A representative passenger load of persons in normal health must be used as follows:*
>
> *(i) At least 30% must be female*
> *(ii) Approximately 5% must be over 60 years of age with a proportionate number of females.*
> *(iii) At least 5% but no more than 10% must be children under 12 years of age, prorated through that age group.'*

This demonstration was satisfactorily carried out.

The age group requirements for the demonstration, by percentage, are shown in Figure 4. They are compared with the actual age distribution in the accident, obtained from the 105 questionnaires returned.

Evacuation guidance for pilots and cabin crew

The operator provides advice to its pilots in the Boeing Flight Crew Training Manual. Section 8.4, states:

> *'For persistent smoke or fire which cannot be confirmed to be completely extinguished, the safest course of action typically requires the earliest possible descent, landing and evacuation.'*

An Operational Staff Instruction (OSI) 11/222 for the Boeing 737-300/800 fleet, for the takeoff phase of a flight, also advised:

> *'If the decision is made to reject the take-off the Captain is to call 'STOP' and carry out the manoeuvre as prescribed in the QRH. It is to be the 737 Fleet policy that a Passenger Evacuation is to be ordered for every RTO that has involved a fire, even if that fire has been extinguished.'*

Cabin Crew alert to the Captain

The Cabin Safety Manual contains instructions for Cabin Crew on how to alert the Captain of an emergency in the cabin. These are:

> *'4.1.1 'Alerting Captain to an Emergency in the Cabin*
>
> *Should the Cabin Crew be aware of an emergency situation in the cabin, e.g. fire, and need the immediate attention of the Captain. They should use the interphone system and press the Captain button 5 or more times.'*

Escape slide requirements

Aircraft doors which are used for emergency evacuation are required to be fitted with escape slides which must meet set criteria. In the case of over-wing exits, no slide is required providing the escape route utilises the flap surface and the height to the ground from the trailing edge of the flap is less than six feet. The height from the trailing edge of the flap to the ground during the certification of the Boeing 737-800 was measured to be 70 inches. The

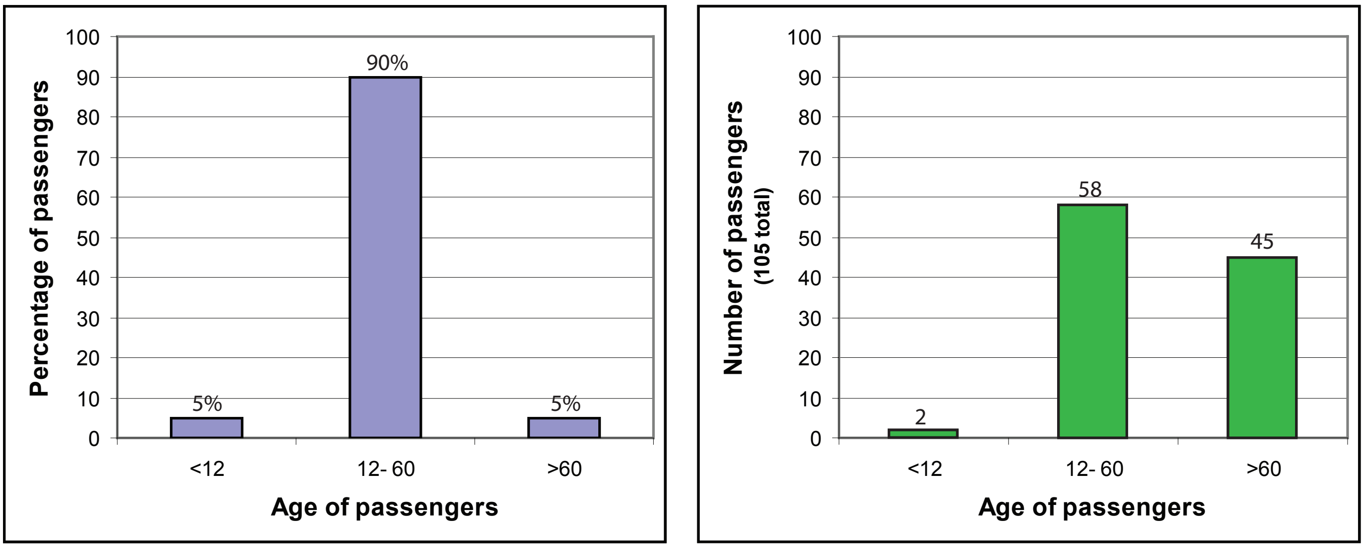

Figure 4

Certification and accident age distribution

Figure 5

Showing the flaps in the fully lowered position.

height of the lowest part of the flap trailing edge with the flap fully lowered (see Figure 5) is 42 inches.

Recorded data

The aircraft was fitted with a CVR and an FDR which were downloaded. The aircraft was also fitted with a Quick Access Recorder (QAR) but this did not record any additional parameters. Some parameters and recordings from the rejected takeoff are shown in Figure 6.

ATC, RTF and Surface Movement Radar (SMR) recordings were made available to the investigation. The RTF recordings covered communications on the Tower, Ground and Fire frequencies and the OMNICRASH communications system. The SMR provided a timeline for vehicles attending the aircraft.

Recordings from three CCTV cameras were provided to the AAIB. The CCTV cameras were not initially directed at the aircraft but panned to the aircraft at various times after the evacuation had started. There was no view of the left side of the aircraft and recording quality was poor, due to low light conditions, limited resolution and very low frame rates. However, they yielded useful information.

The various sources of the recordings used slightly different time stamps. For the purposes of this report, the times were adjusted to align with the ATC recordings. Table 1 is a time line of the pertinent times, events and communications.

Detailed observations

The CVR recording captured the end of the previous flight. Wipers were used during that approach and, after landing, the crew commented on the amount of standing water on the ground. The CVR also recorded that the aircraft's departure before the RTO was delayed for one passenger, waiting for wheelchair assistance.

The recordings show that the pilots identified a "STRANGE SMELL" approximately five seconds after the engines reached their takeoff power. The flight crew did not make reference to any visual signs in the cockpit. Eleven seconds after the flight crew first commented on the smell, the cabin crew alerted the flight crew to a problem in the cabin. This was identified as smoke. There was no reference to heat or breathing problems.

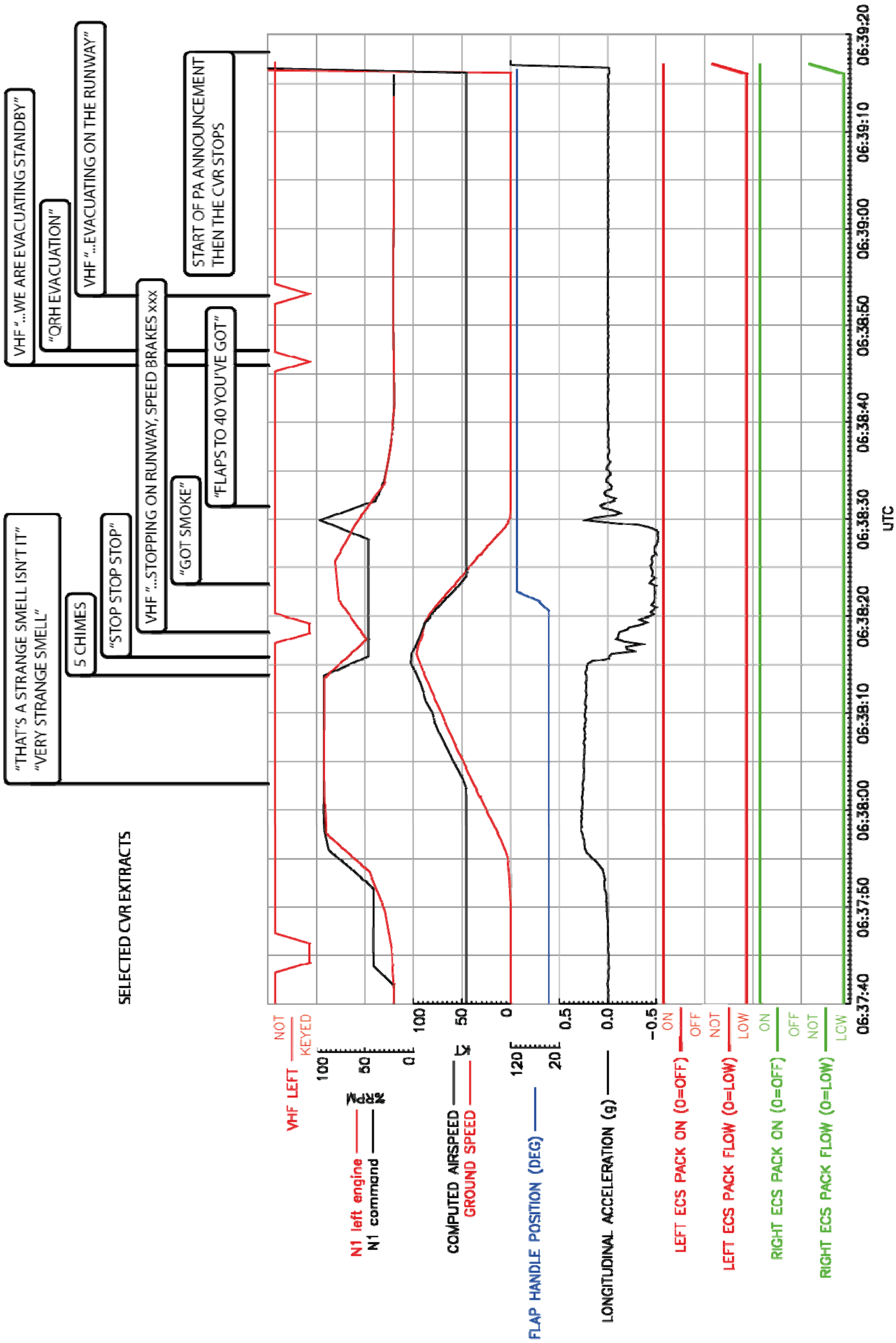

Figure 6

Pertinent FDR parameters and CVR extracts

UTC	Recording source	Observation
06:26:50	CVR	First engine start.
06:31:15	FDR	The ECS packs were switched ON with LOW flow.
06:37:40	RTF / CVR	ATC provided takeoff clearance.
06:37:58	FDR	The engines reached takeoff power.
06:38:03	CVR	"THAT'S A STRANGE SMELL ISN'T IT" reply "VERY STRANGE SMELL".
06:38:10	CVR	"EIGHTY KNOTS".
06:38:14	CVR	Five chimes.
06:38:16	CVR	"STOP STOP STOP".
06:38:19	RTF / CVR	Radio "...STOPPING ON RUNWAY, SPEED BRAKES", CVR had additional un-transmitted "UP" at the end of the sentence.
06:38:23	CVR	"GOT SMOKE".
06:38:30	SMR	Aircraft appears stationary.
06:38:31	CVR	"FLAPS TO 40 YOU'VE GOT".
06:38:37	CVR	"CABIN CREW AT STATIONS, SENIOR TO THE FLIGHT DECK".
06:38:46	RTF / CVR	Aircraft to tower: "…WE ARE EVACUATING STANDBY".
06:38:48	CVR	"QRH EVACUATION".
06:38:53	RTF / CVR	Aircraft to tower "...EVACUATING ON THE RUNWAY".
06:39:08	OMNICRASH	Passed a message regarding a ground incident specifiying aircraft type and location.
06:39:18	CVR	PA "THIS IS THE CAPTAIN…" then the recording stopped.
06:39:26	OMNICRASH	Passed information regarding an evacuating onto the runway and a speed brake problem.
06:39:52	RTF	Tower asked for confirmation of a speedbrake problem.
06:39:55	RTF	Aircraft to tower: "...FIRE IN THE CABIN…"
06:40:01	SMR	First sign of vehicles emerging from the fire building.
06:40:01	RTF	Aircraft to tower: "SMOKE IN THE CABIN SIR".
06:41:19	CAM9	The camera panned to the aircraft and showed that the slides were deployed and people were on both sides of the runway.
06:41:28	SMR	First vehicle stopped in front of the aircraft, shortly followed by two others.
06:41:45	CAM9	The last time a person came down the right rear slide (note 1).
06:42:56	CAM9	The last time a person came down the right front slide (note 1).

Note 1 - the CAM9 (CCTV) recording was only at one frame per second and with poor image quality in the low light, so it is possible that more people came down the slides but it was not apparent in the recording. There were no recordings available that viewed the left side of the aircraft.

Table 1.

A timeline of selected extracts from the CVR, FDR, ATC RTF recordings, CCTV cameras and the SMR

Previous flights

The FDR data covered eight flights; a limited sample. Compared to the previous flights, this flight included the second shortest period between the Environmental Control System (ECS) packs being selected ON, in accordance with the standard operating procedures, and takeoff power being applied, which came after the longest period with the engines running and the ECS packs OFF. This followed an earlier short engine ground run, approximately an hour and a half before the engines were started.

Cabin air supply

During normal operation, bleed air is taken from the engine compressors and passed through an air conditioning system to provide a supply of temperature controlled fresh air to the cabin and cockpit. The air supply can also be provided by the APU or a ground source via an external connection, if required.

Each engine supplies a separate air conditioning pack and the output of conditioned air from both of these packs is fed into a single mix manifold, where it is mixed with recirculated cabin air before being distributed to the two cabin zones, forward and aft. The cockpit air supply is taken from an outlet between the left pack and the mix manifold. The air temperature for each zone is independently controlled by mixing hot unconditioned air with the conditioned air supply to that zone. This unconditioned air supply is a combined single supply of hot air which is taken from points just downstream of the flow control valves.

During taxi, the engines mostly operate at ground idle and the bleed air from the engine compressors is at relatively low pressure. The pneumatic system uses pressure regulation to extract air for use by the air conditioning packs. Therefore, when engine pressures are low, less air is extracted. This low airflow means that during ground operations it takes longer for the air conditioning system to adjust the cabin air temperature to the desired value. Safeguards that limit the coldest air temperature from a pack are built into the system to prevent the pack from freezing. Conditioned air is mixed with recirculated cabin air in the mix manifold and typically air is delivered to the cabin at around 15°C.

During takeoff, the pressures in the engine compressors rise and more air is available to the air conditioning packs. The packs can now supply more conditioned air at colder temperatures, down to the safeguard limit. Therefore, during takeoff, the air conditioning system provides larger volumes of air to the cabin and could, if demanded, provide air to the cabin at temperatures down to 1.7°C.

Examination of the aircraft

During the previous night a borescope inspection had been carried out on the No 2 engine as part of maintenance actions following an earlier birdstike. No damage or bird remains were found and a short engine run was carried at ground idle to confirm there were no leaks following the inspection.

After the evacuation, the aircraft was inspected by the operator's maintenance personnel under the supervision of the AAIB. The aircraft had not had any hydraulic fluid uplifts immediately prior to the flight and it had not been de-iced. Both engine oil levels had been replenished before the flight but they were found to be within the normal operating range. An initial visual inspection of the aircraft was carried out and no anomalies were noted.

Inspections were then carried out in accordance with the manufacturer's Fault Isolation Manual (FIM),

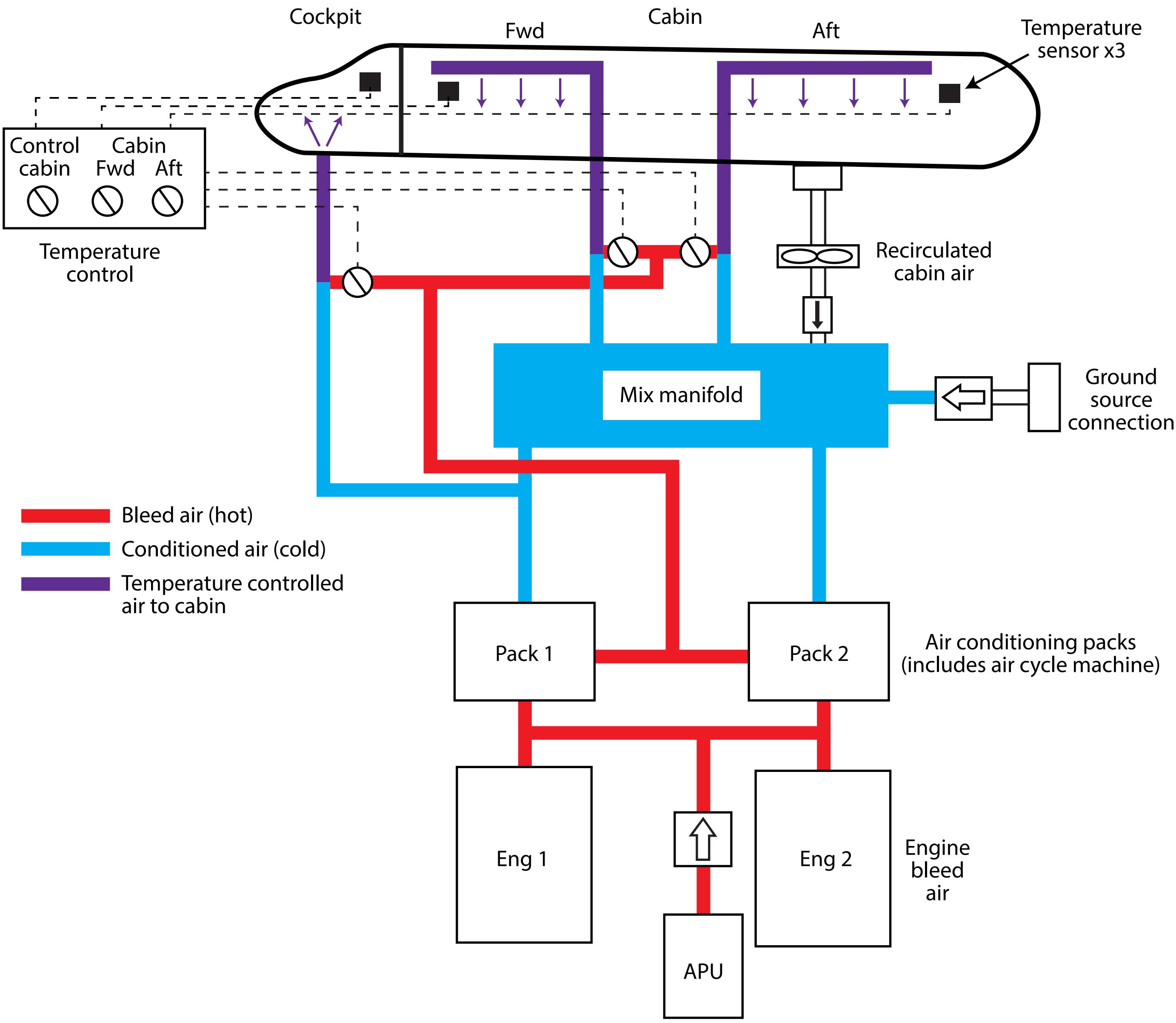

Figure 7

Simplified Schematic of Air Conditioning System

Task 21-00-806 Smoke or Fumes in the Cabin, Source Unknown and Task 71-05-807 Smoke or Fumes in Cabin, Pneumatic Power Supplied by Engine. These tasks included a borescope inspection of both engine's compressors and a thorough inspection of the aircraft bleed air and air conditioning systems, including the inside of ducting. No anomalies or evidence of contamination were found.

An extensive ground run test was then carried out using the APU and the engines as the pneumatic source. The bleed air and air conditioning system were configured in various combinations and temperature selections to try and reproduce the fault. These systems operated normally and nothing unusual was observed. No signs of any smoke or fumes were noted by any of the people onboard during these tests.

Subsequent to this testing the right air cycle machine and its pack valve were replaced due to an intermittent reluctance to operate. The air cycle machine was taken to the manufacturer's workshop where it was dismantled and inspected under supervision of the AAIB. The unit had been manufactured in 1999 and remained fitted to the aircraft ever since. The inspection found the unit to be in a condition commensurate with its age and no defects were identified that could have led to smoke or fumes being present in the cabin.

In order to identify the nature of the fumes seen in the cabin, the two cabin temperature sensor filters were removed for testing. These filters are located, one forward and one aft, in the underside of the hat racks and they filter cabin air before it is drawn across the temperature senor. Another set of filters were removed from a similar aircraft to use as a comparison. The filters were sent to a specialist laboratory for testing, using Gas Chromatography with a Mass Selective Detector. The laboratory summarised its findings as:

> *'The materials trapped by the all the filters are consistent with general dirt and dust.*
>
> *The amounts of materials trapped by the filters from both aircraft are comparable.*
>
> *The natures of the organic materials in the incident and control aircraft are the same.*
>
> *The organic materials which could not be characterised are not present in Mobil Jet II or Skydrol.'*

The laboratory concluded,

> *'the analyses carried out have not identified any significant differences between the contents of the filters from the incident aircraft when compared with those of the control aircraft. There are no identified materials in the filters from the control aircraft that could be linked to the reported fumes/smoke.'*

The aircraft was operated to another base without passengers onboard, to confirm satisfactory operation before being returned to service. The positioning flight and subsequent commercial flights were normal and there was no recurrence of the smoke / fumes in the either the cockpit or cabin.

Information from the aircraft manufacturer

In December 2009, the manufacturer issued Service Letter 737-SL-00-023-B, a Smoke and Burning Odour (SBO) Event Summary. This provided an analysis of SBO events reported to the manufacturer. The predominant causes that had been identified were listed along with potential corrective or preventive actions for each. These were reviewed by the operator and all were ruled out as the potential cause of this event. The Service Letter notes that events where a root cause was not identified were excluded from the analysis.

Other similar events

The CAA was asked to conduct a search of their Mandatory Occurrence Reporting (MOR) database for similar events on this type of aircraft over the last five years. Of the twenty two events recorded, nine relate to smoke from ovens, caused by things such as stray paper or grease; four to technical defects such as hydraulic fluid leaking onto hot brakes and six were due to contamination of the air conditioning system, such as ingestion of de-icing fluid into air intakes or over servicing of the engine oil system. Three reports related to unidentified mist or fumes inside the aircraft, one was in the cruise and resulted in a diversion and one was during boarding which was temporarily suspended. The third occurred shortly after takeoff and was reported as 'greyish' smoke in the flight deck, with no odour, and misting and a 'rubbery' odour present in the front of the cabin. The misting or smoke cleared and the flight continued. No cause was found during subsequent inspections.

Analysis

No defects were identified on the aircraft that could have led to the smoke or fumes that were seen and smelt. Laboratory analysis of the cabin temperature sensor air filters, exposed to cabin air, showed that there were no unusual substances or residues of oil or hydraulic fluid present.

At the beginning of the flight, the air conditioning packs were selected ON after engine start, in accordance with the standard operating procedures, but later than on the other flights sampled. This, combined with the short taxi time, may have meant that the cabin was slightly warmer than usual by the time the takeoff commenced. The ambient conditions on the day meant the air was humid, with the temperature and dew point only one degree apart. As engine power was increased for takeoff, more air was available for air conditioning and the air conditioning system was able to supply colder air to the cabin to achieve the selected temperature. As the cabin was warm and humid, this sudden influx of cold air, potentially down to 1.7°C, could have caused the formation of mist or fog in the cabin which, in the low lighting conditions, could have given the appearance of smoke or fumes.

No reason for the acrid burning smell could be found and it did not recur at any time during ground tests or subsequent flights. There was no residual smell in the cabin or on people's clothing and none of the aircraft occupants reported any negative effects. It is possible that this smell may have been due to excessive moisture in the pneumatic system, vaporising from the ducting as it heated up to its normal operating temperature.

Some passengers in window seats reported seeing sparks outside the aircraft as it was decelerating on the runway. Nothing outside the aircraft was found that could have caused the apparent sparking. Given the wet runway conditions and low levels of light, these 'sparks' were most likely the aircraft and runway lights reflecting off the spray thrown up from the runway by the use of full reverse thrust on the engines.

Evacuation

When the flight crew set the takeoff thrust, they were aware of a "strange smell". As the takeoff run progressed, passengers and cabin crew both noticed increasing amounts of smoke or vapour in the cabin, visible in the beams of the reading lights. Prompt action by the CSD, in alerting the flight crew, assisted the commander in making a timely decision to abandon the takeoff and stop the aircraft.

When the CSD entered the flight deck, the commander was clearly able to see the smoke or vapour in the cabin. This visual picture, the strong smell of burning and the CSD's assessment were the triggers for an immediate emergency evacuation, which the commander initiated. The crew then followed the procedures for evacuating the passengers. Those passengers at the over-wing exits opened them, as briefed earlier.

The evacuation took an estimated 3 minutes and 38 seconds. Passengers attempting to recover property from the overhead lockers delayed movement towards the exits, and the age or infirmity of some of the passengers may have extended the evacuation time. Several passenger decided to re-enter the cabin through the over-wing exits, rather than slide down the extended flaps, as they considered it would be safer to use an escape slide. Also, the time taken for the commander to walk the length of the cabin, to ensure all on board had left, further extended the total evacuation time.

The injuries suffered were as a result of the evacuation, due to passengers bumping into each other on the slides or being knocked to the ground. In the case of the over-wing exits, sliding six feet to the ground off a wet flap can be a daunting experience but the aim is to escape from the aircraft and, as such, carries a degree of risk.

The effects of fire and smoke are well documented and the procedures and guidance provided to crews reflect the need to take prompt decisions and action when fire and/or smoke are encountered in an aircraft.

Subsequent action

Excessive moisture in the air conditioning ducting was a possible factor in this event. Consequently, the operator has directed its maintenance personnel, by Quality Notice 118A, to take additional action following all engine ground runs after maintenance. It states:

> *'The following shall be carried out for all engine runs after maintenance. In addition to the minimum idle of 5 minutes without load (as per AMM task 71-00-00), both air conditioning packs shall be run using engine bleed (as per AMM task 21-00-00) with cabin temperature selectors in the mid position for a further 5 minutes prior to engine shut down.'*

In addition, the operator has re-issued the on-board Safety Card to reflect the need for passengers, evacuating via the overwing exits, to slide down the trailing edge of the wing. Also, the verbal briefing given to passengers occupying seats adjacent to the overwing exits has been amended to stress the requirement to turn aft, immediately after evacuating through the exit, and to slide down the trailing edge of the wing.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-161 Cadet, G-TLET
No & Type of Engines:	1 Thielert TAE 125-02-99 diesel engine
Year of Manufacture:	1989 (Serial no: 2841259)
Date & Time (UTC):	21 July 2012 at 1458 hrs
Location:	Field south of Shoreham Airport, West Sussex
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to propeller, landing gear, and wing spar
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	26 years
Commander's Flying Experience:	840 hours (of which 642 were on type) Last 90 days - 158 hours Last 28 days - 47 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

At about 200 ft aal after takeoff the engine suffered a sudden loss of power and the pilot initiated a forced landing. The aircraft touched down in a field at the end of the runway but then it hit a fence, a hedge and a large mound, which caused significant damage to the aircraft. The loss of power was caused by failure of a clamp between the turbocharger compressor outlet and the turbo pipe assembly. This clamp had failed due to a fatigue crack that had initiated at multiple sites on the inner diameter and then propagated through the thickness of the sidewall. Following the accident the maintenance organisation discovered another cracked clamp, which had not yet failed, on another aircraft fitted with the same engine type. Three Safety Recommendations are made.

History of the flight

The instructor pilot was carrying out circuit training with a student and they had successfully completed two 'touch-and-go' departures from Runway 20. During the climb-out from the third touch-and-go, at about 200 ft aal, there was a sudden and significant loss of engine power and the aircraft began to sink. The instructor exercised the throttle lever and, with no response from the engine, decided to land in the nearest safe area and made a MAYDAY call. The aircraft touched down in a field to the south of the runway and the railway track, just outside the airport perimeter, then hit a hedge and fence and continued over a large mound of earth that ran along the length of the field. The impact with the mound caused the landing gear to collapse and all three wheels to separate from the aircraft. The instructor followed the shut-down procedures to secure the aircraft and exited, with the student, through the main door.

Engine recorded data

The aircraft was fitted with a Thielert TAE 125-02-99 turbo-charged diesel engine, also known as the Centurion 2.0. This engine has a Full Authority Digital Engine Control (FADEC) unit which records some engine parameters. A download of this data revealed that shortly after takeoff the propeller rpm reduced from 2,300 rpm to 1,940 rpm and the manifold pressure reduced from 2,024 mb to 1,010 mb, representing a 50% loss of power, while the throttle lever remained at 100%. The throttle lever was subsequently reduced from 100% to 60% and returned to 100% with no effect on the engine power.

Engine examination

The aircraft was recovered by a maintenance organisation and examination of the engine revealed that there was a clamp missing between the turbocharger compressor outlet and the turbo pipe assembly. This clamp, referred to as a Wiggins clamp, was later found in a field at the southern end of the runway, close to the extended runway centreline. The clamp had fractured and broken apart (Figure 1). A loss of this clamp in flight would result in a loss of compressed air from the turbocharger compressor to the intake manifold and a significant reduction in power.

The maintenance organisation decided to carry out an inspection of their fleet of aircraft fitted with Thielert engines to check for cracks in the Wiggins clamps. They found that on another Piper PA-28-161(G-BZLH) the Wiggins clamp had started to crack in a similar location to the failed clamp from G-TLET (Figure 2).

Metallurgical examination of the clamps

Both the failed clamp from G-TLET and the cracked clamp from G-BZLH were sent for metallurgical examination. The clamps (Thielert P/N NM-0000-0024701) were manufactured from aluminium alloy (2024-T4 or T351) and qualified to specification Mil-C-22263.

Figure 1

Failed Wiggins clamp from G-TLET

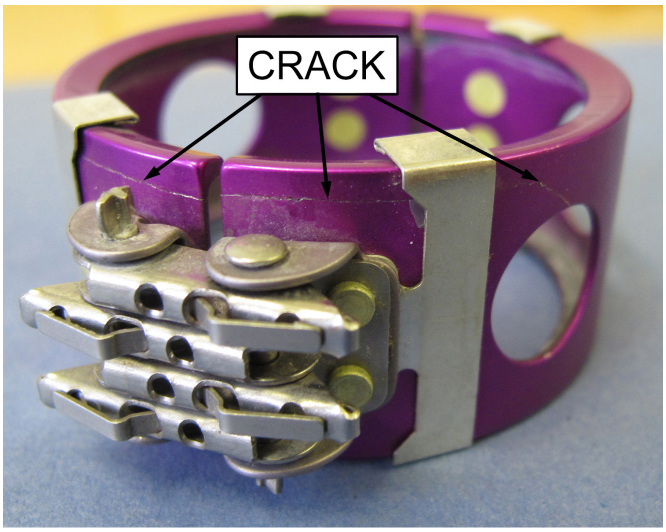

Figure 2

Cracked Wiggins clamp from another PA-28-161 with TAE 125-02-99 engine (G-BZLH)

The clamp from G-BZLH was sectioned to reveal the fracture surfaces of the cracks. Microscopic examination of the fracture surfaces from both clamps revealed that the cracks had initiated at multiple sites on the inner surface and had propagated in fatigue through the thickness of the sidewall toward the outer surface (Figure 3). As they did so, these minor fatigue crack fronts coalesced, resulting in the formation and circumferential expansion of the fracture plane. It was concluded that the crack on the G-BZLH clamp, if it had gone undetected, would have eventually caused the clamp to fail in the same manner as the clamp from G-TLET.

No pre-existing material defects were identified associated with the initiation of the cracks. The clamp wall thickness was measured as between 0.864 mm and 0.889 mm, which was within specification. There was evidence of significant fretting on the inner surface of the G-TLET clamp (Figure 4). There was also fretting wear on the inner surface of the G-BZLH clamp (Figure 5), although less extensive than on G-TLET. This indicated that both clamps had been subject to vibrations during operation.

The metallurgist concluded that the clamp from G-TLET had separated due to fatigue fracture under the influence of engine vibrations. It was not possible to estimate the duration of the fatigue crack growth.

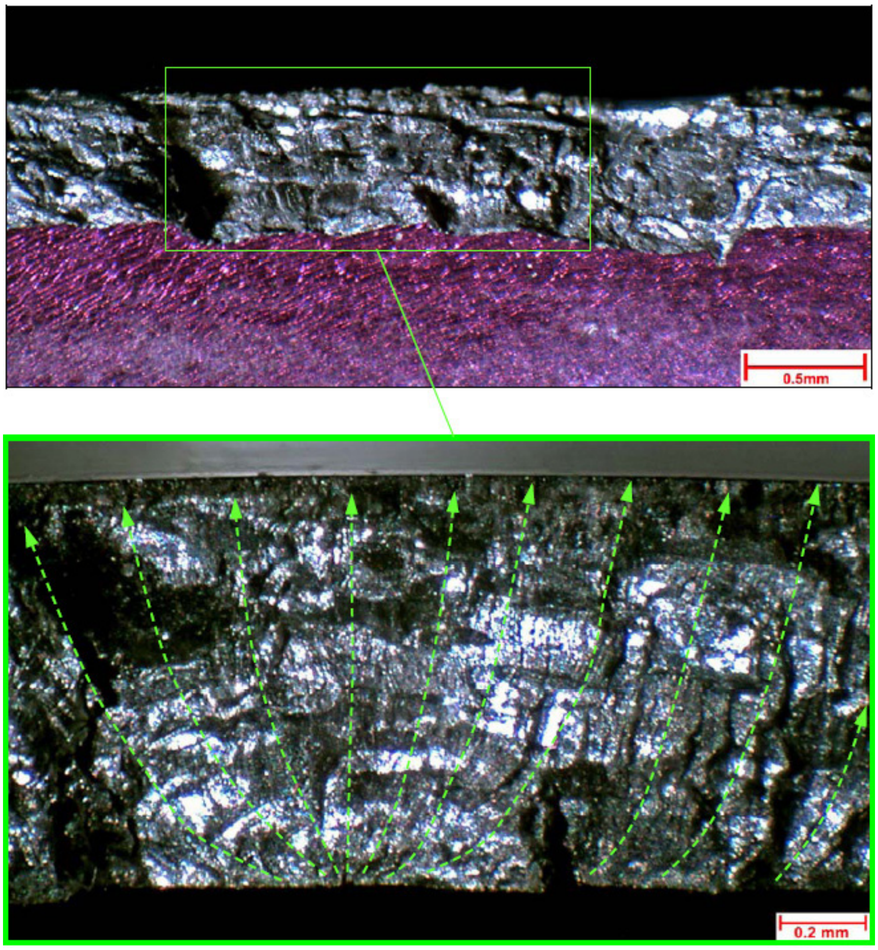

Figure 3

Radial outward fatigue crack growth on the main fracture plane of the failed clamp from G-TLET

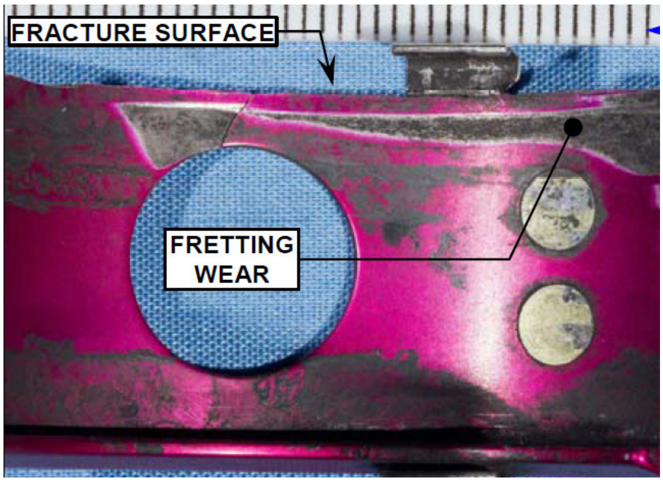

Figure 4

Fretting wear on the inner diameter of clamp from G-TLET

Type Certificate (TC) and Supplemental Type Certificate (STC) holder details

Thielert Aircraft Engines GmbH (TAE) is the Type Certificate (TC) holder of the TAE 125 series of engines. TAE is also the Supplemental Type Certificate (STC) holder for the installation of the TAE 125 on the Piper PA-28[1], Cessna 172 and Robin DR400 aircraft. This means that TAE are responsible for defining the engine maintenance requirements for the Piper PA-28, Cessna 172 and Robin DR400 aircraft. The TAE 125 engines are also fitted to the Diamond DA40 and Diamond DA42 aircraft for which the aircraft manufacturer Diamond Aircraft Industries GmbH is responsible for the maintenance requirements. However, TAE is responsible for providing maintenance recommendations to Diamond, which are provided in the engine Operation and Maintenance Manual for the TAE 125-02-99/Centurion 2.0 (OM-02-02).

Footnote

[1] The installation of the TAE 125 engine on the Piper PA-28-161 was approved as a major modification by EASA under STC EASA.A.S.01632.

Figure 5

Fretting wear (dark areas) below crack line on clamp from G-BZLH

Maintenance requirements

The maintenance requirements for the TAE 125-02-99/ Centurion 2.0 fitted to the PA-28-161 are in a supplement to the PA-28 aircraft maintenance manual (document no. AMM-40-02 version 2/0) which is authored by the engine manufacturer as the STC holder. This document refers to the Wiggins clamp as the 'clampshell coupling' (see Figure 6 for its location). It states that this clampshell coupling should be inspected every 300 hours in accordance with section 71.60, which states:

> *'(1) Remove clampshell coupling. (2) Check coupling and O-rings for damage, wear and tear. (3) Replace part if necessary. (4) Install clampshell coupling. Note: Check if the clamp can be moved easily. Tension at the clamp can lead to deformation or damage.'*

It also states that the clampshell coupling should be replaced every 1,200 hours and that every 100 hours or at the annual inspection, whichever comes first, further maintenance action should be carried out in accordance with the engine Operation and Maintenance Manual OM-02-02. This document (version 2/9) states under '*every 100 operating hours*':

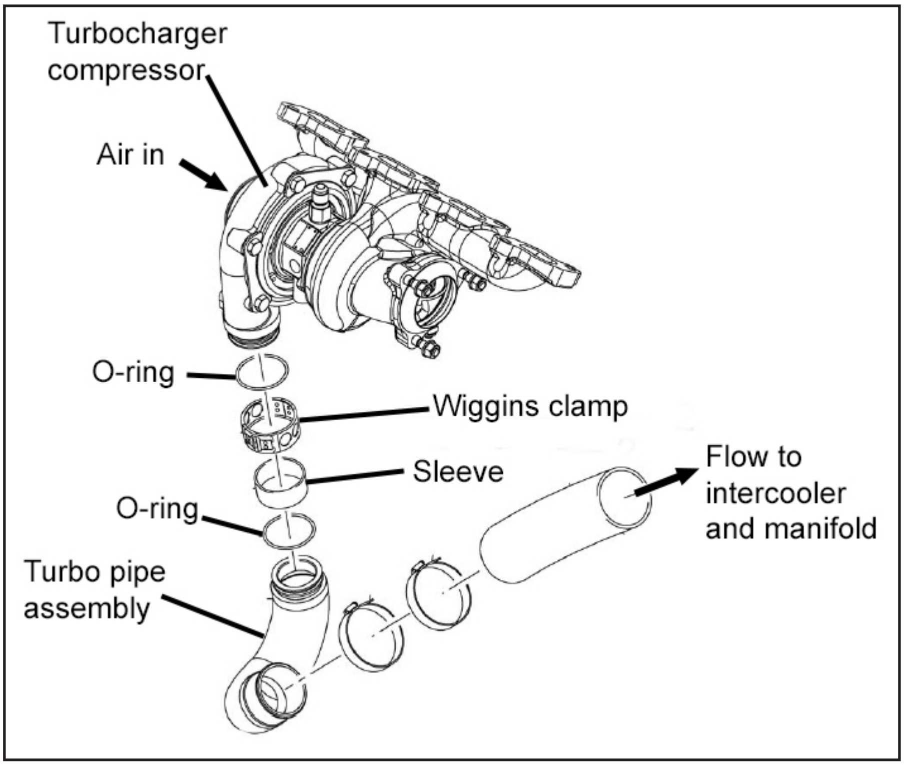

Figure 6

Location of Wiggins clamp

> *'Visual inspection of the Wiggins clamp on the turbocharger'*

The OM-02-02 manual contains no further detail on this inspection requirement, but according to the engine manufacturer this visual inspection does not require removal of the clamp.

The TAE 125-02-99/Centurion 2.0 engine can also be retro-fitted to the Cessna 172 and Robin DR400 aircraft, and comes factory fitted to the Diamond DA40 D aircraft. The installation of the Wiggins clamp is the same on all three aircraft, but the maintenance requirements are different. The maintenance manual supplement for the Robin DR400 states that the Wiggins clamps should be inspected every 100 hours in accordance with section 71.62:

> *'(1) Remove the wiggins clamp. (2) Inspect the wiggins clamps for wear marks caused by friction and metal scoring.' Inspect elbow for wear marks and if wear marks present replace intercooler. 'If not, reinstall the wiggins clamp, and check that it is installed stress free by rotating the clamp. It must rotate free.'*

There is no requirement to replace the clamp at 1,200 hours in the DR400 manual.

The maintenance requirements for the Wiggins clamp on the Cessna 172 are the same as on the Piper PA-28, namely a 100-hour in-situ inspection, 300-hour removal inspection and 1200-hour replacement.

In the Diamond DA 40 maintenance manual (which is the responsibility of the aircraft manufacturer and not the engine manufacturer) it states that every 100 hours

'*Look specially at these items:' '-Wiggins clamp and O-rings.*' This mirrors the requirement in the engine manufacturer's OM-02-02 manual which only requires an in-situ visual inspection every 100 hours. There is no requirement to remove and inspect the clamp at 100 hours, 300 hours or a requirement to replace the clamp at 1,200 hours on the DA40.

These differing requirements are summarised in Table 1. The engine manufacturer stated that the reason for the differences was that the manuals were written by different people at different times.

Maintenance history

When the maintenance organisation first took responsibility for the maintenance of G-TLET the engine had accumulated 854 hours – at this time the engine fitted was the older Centurion 1.7[2]. The hours on the Wiggins clamp had not been recorded. The maintenance organisation subsequently replaced the Centurion 1.7 engine with a Centurion 2.0 engine while re-using the Wiggins clamp. At the time of failure, the combined hours recorded on the Centurion 1.7 and 2.0 engines was 1,647 hours, of which 793 hours were under the responsibility of that maintenance organisation. It was not possible to determine if the previous maintenance organisation had replaced the Wiggins clamp, so it could only be established that the clamp had logged at least 793 hours of operation, but possibly as many as 1,647 hours – 447 hours in excess of the replacement requirement. The maintenance organisation was unaware of the Thielert PA-28 maintenance manual supplement and therefore was unaware of the 300-hour clamp removal and inspection requirement and the 1,200-hour replacement requirement. They had been maintaining the engine in accordance with the Thielert engine maintenance manual (OM-02-02) which only called for a 100-hour in-situ inspection of the clamp.

The last maintenance check on G-TLET, a 150-hour check, was completed two days before the accident but it did not include the 100-hour clamp inspection. The last 100-hour engine check which included the clamp inspection was carried out on 26 June 2012, 50.6 hours before the accident.

	100 hr in-situ inspection	100 hr removal inspection	300 hr removal inspection	1200 hr replacement
TAE 125 OM-02-02	X			
PA-28-161 AMM	(X)(1)		X	X
Cessna 172 AMM	(X)(1)		X	X
Robin DR400 AMM		X		
Diamond DA40 AMM	X			

Note (1) The 100 hr in-situ inspection is not directly stated in the PA-28-161 and Cessna 172 AMMs, but is required because these AMMs make reference to carrying out additional maintenance action as per OM-02-02 every 100 hours.

Table 1

Summary of the different Wiggins Clamp maintenance requirements

Footnote

2 The Centurion 1.7, also known as the TAE 125-01, was the predecessor to the TAE 125-02-99/Centurion 2.0 engine.

The clamp on G-BZLH had been installed new when the aircraft was fitted with a Centurion 2.0 engine on 27 October 2011. On 3 August 2012, after the G-TLET accident, the Wiggins clamp was specially removed from G-BZLH during a 200-hour engine inspection. The crack was detected and at this time the engine and clamp had accumulated 195 hours since installation. The previous clamp inspection, which did not include removal, was carried out 96 hours earlier on 11 May 2012.

History of clamp failures

The engine manufacturer was aware of only one previous failure of a Wiggins clamp on a Centurion engine and that was on a Cessna 172R, registration SX-CCA, in 2010. During this incident the aircraft suffered a loss of power during the climb, but was able to turn back and land at the airfield. The clamp on SX-CCA was found to have cracked perpendicular to the main cracks found on the G-TLET and G-BZLH clamps (Figure 7). There was evidence of dark-coloured fretting damage on the inside of the clamp similar to G-TLET and G-BZLH. The engine manufacturer carried out an examination of the engine and noted that the mating section of the turbo charger compressor had a partially broken lip where the O-ring was fitted. Because the fracture surface was dirty they concluded that it was older than the clean fracture surface on the clamp. Loss of this mating section would result in tilting of the two interconnecting pipes which would result in a high load being transferred to the clamp and could cause it to fail. The manufacturer concluded that the clamp failure was caused by the mating surface failure, which may have been caused by use of improper tooling, based on surface damage witness marks near the failure. No metallurgical examination of the fracture surfaces was carried out.

Figure 7

Failed Wiggins clamp from Cessna 172R (SX-CCA) fitted with Centurion 2.0 engine

Details of previous clamp type

The TAE 125/Centurion engines were originally designed with a different type of clamp, part number 14C02-24A. An example of this clamp type is shown in Figure 8 – this clamp was removed from a Diamond DA40 D in 2012 due to excessive wear at the hinge. There was also evidence of fretting on the inner surface. This type of clamp is still in use today. The new clamp (P/N NM-0000-0024701), which was fitted to G-TLET, was approved in October 2003 and introduced into the field sometime thereafter but there was no requirement to retrofit, and therefore the total hours in service of the new clamp are not known. The engine manufacturer reported that the new clamp was introduced because of problems with excessive wear at the hinge of the old clamp and due to issues with its split-pin being out of position. There were, however, no reported occurrences of cracks and failures of the old clamp type. The wall thickness of the old clamp shown in Figure 8 was measured at 1.032 mm in the centre, with a region of thicker material at the edges of between 1.67 and 1.83 mm. This compares to a thickness of 0.864 to 0.889 mm for the newer clamp fitted to G-TLET.

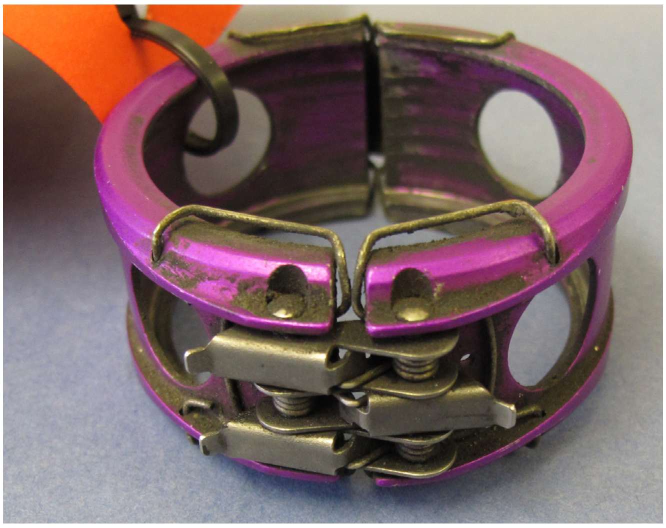

Figure 8

Older style clamp (P/N 14C02-24A) which was removed from a Diamond DA40 D in 2012 due to excessive hinge wear

Maintenance organisation comments

The maintenance organisation commented that the location of the clamp meant that it was difficult to detect a crack in the clamp without removing it. However, they also considered that repeatedly removing the clamp to inspect it could introduce other problems so they recommended that the clamp should be made stronger such that it was less susceptible to cracking. Since the G-TLET accident they have revised their 100-hour engine check schedule to call for a removal and inspection of the Wiggins clamp and they have initiated a 1,200-hour clamp replacement requirement for all aircraft types, in accordance with the PA-28 AMM supplement.

Analysis

At the time of the accident, and during the investigation, the engine manufacturer was known as Thielert Aircraft Engines GmbH. In July 2013, however, the diesel aircraft engine and manufacturing assets of this company changed ownership and were added to the Continental Motors Group as Technify Motors GmbH. The Safety Recommendations in this report are, therefore, addressed to Technify Motors GmbH.

The loss of power in G-TLET was caused by failure of the Wiggins clamp between the turbocharger compressor outlet and the turbo pipe assembly. The clamp had failed due to a fatigue crack that had initiated at multiple sites on the inner surface and then propagated through the thickness of the sidewall. No pre-existing material defects were identified and the clamp wall thickness was within specification. There was significant fretting wear on the inner surface so it was possible that loads due to vibration initiated the fatigue crack. These vibratory loads would have been superimposed on any loads from the compressed air passing through the angled turbo pipe assembly. It is also possible that a misalignment of the pipes during installation could have induced an additional pre-load on the clamp. It was not possible to determine when the crack had formed but the clamp had been in use for at least 793 hours and possibly as many as 1,647 hours – 447 hours in excess of the replacement requirement. The maintenance organisation had been unaware of both the 1,200-hour replacement requirement and the 300-hour 'remove and inspect' requirement. Had the clamp been removed for an inspection at the last 300–hour check the crack might have been detected, unless it had initiated after that inspection.

The evidence from the clamp from G-BZLH indicates that cracking can initiate in under 300 hours. This clamp had only accumulated 195 hours and it had started to crack in fatigue in the same manner as the clamp on G-TLET. If the crack had gone undetected the clamp probably would have failed with consequent loss of power. The maintenance organisation stated that they had detected the crack on the G-BZLH clamp only because they had removed it following the accident to G-TLET. There was no requirement to remove it because only an in-situ inspection was required every 100 hours. G-BZLH had undergone a 100-hour engine check 96 hours before the crack was detected and during this in-situ clamp inspection no crack was detected. Similarly, on G-TLET a maintenance check involving an in-situ clamp inspection was carried out 50.6 hours before the accident and no crack was detected. Since the crack initiates on the inside of the clamp and propagates outwards the only way to catch the crack early is to remove it and inspect the inside.

Although this clamp was introduced in 2003, there was no requirement to retrofit; therefore, the in-service hours of the new clamp and the failure rate are not known.

The old-style clamp, which is still in use, has not suffered any reported cracks or failures. It is possible that this is due to its thicker sidewall or it could be due to vibration loads being absorbed by the hinge, which results in a 'worn hinge' problem but alleviates stress that might otherwise initiate a crack.

The TAE 125/Centurion engines can be fitted to the Piper PA-28, the Cessna 172, the Robin DR400 and the Diamond DA40 but the maintenance requirements for the clamp are not consistent. One only requires a 100-hour in-situ inspection, one requires a 100-hour removal inspection, some require a 300-hour removal inspection and some require a 1,200-hour replacement. The engine manufacturer could not provide a reason for the different requirements, except to comment that they were drafted by different people; the engine manufacturer was not able to state which inspection requirements were the most appropriate.

Because of the hazard associated with the loss of power following the failure of the Wiggins clamp, the following three Safety Recommendations are made.

Safety Recommendation 2013-018

It is recommended that Technify Motors GmbH, as the STC holder, informs operators of Piper PA-28, Cessna 172 and Robin DR400 aircraft fitted with TAE 125-01 and 125-02 engines that the Wiggins clamp (P/N NM-0000-0024701) is susceptible to cracking, which can lead to clamp failure and significant power loss. Furthermore, as TC holder they should inform Diamond Aircraft Industries of the same.

Safety Recommendation 2013-019

It is recommended that Technify Motors GmbH establishes a consistent and suitable inspection and/or replacement interval for Wiggins clamp (P/N NM-0000-0024701) to be specified in the engine maintenance manuals and the aircraft maintenance manuals for which it holds the Supplemental Type Certificate, to maximise the likelihood that cracks in the clamp are detected before they propagate to failure.

Safety Recommendation 2013-020

It is recommended that Technify Motors GmbH re-assesses the vibration and loading conditions at the clamp and selects an alternate clamp design if necessary to ensure that it is not susceptible to cracking and failure during normal operations.

AAIB correspondence reports

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

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

The accuracy of the information provided cannot be assured.

ACCIDENT

Aircraft Type and Registration:	Cessna 210D Centurion, G-OWAN
No & Type of Engines:	1 Continental Motors Corp IO-520-A piston engine
Year of Manufacture:	1964 (Serial no: 210-58321)
Date & Time (UTC):	20 July 2013 at 1200 hrs
Location:	Pendle View Farm, North Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to propeller and fuselage underside
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	66 years
Commander's Flying Experience:	5,806 hours (of which 80 were on type) Last 90 days - 176 hours Last 28 days - 28 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft had taken off from a farm strip but returned when oil was seen to be leaking from the engine compartment and onto the left side of the windscreen. On short finals, the pilot handling in the left seat asked the pilot in the right seat to perform the landing because his visibility was impaired. In so doing, they omitted to extend the landing gear and the aircraft landed wheels-up.

History of the flight

The aircraft had undergone a pre-flight check which included a top-up of the engine oil. On boarding the aircraft the owner, who held a Private Pilot's Licence, sat in the front left seat and another pilot, who held a Commercial Pilot's Licence, sat in the right seat. A passenger also took his place in the rear left seat.

The pre-flight and power checks were carried out as normal and the aircraft took off with the left seat pilot handling. During the climb out, he noticed oil seeping from the cowling and flowing onto the windscreen and decided to return. However, on short finals to land, his forward vision was becoming obscured by the oil and he asked that the pilot in the right seat perform the landing. This the latter did but, as the aircraft touched down gently and slid to a halt along the grass on its belly, they realised that they had forgotten to extend the landing gear.

The cause of the oil leakage was found to be an improperly secured filler cap. The right seat pilot stated that, given that he was asked to take control at a very late stage, the fact that the flaps were already lowered meant he had assumed the aircraft was fully configured for landing. He notes that the gear warning horn did not sound, which should occur if the throttle is set close to idle without the landing gear extended. At the time of preparation of this report, the reason why the warning did not sound had not been determined.

ACCIDENT

Aircraft Type and Registration:	Fournier RF4D, G-AVNZ
No & Type of Engines:	1 Rectimo 4AR-1200 piston engine
Year of Manufacture:	1967 (Serial no: 4030)
Date & Time (UTC):	1 August 2013 at 1750 hrs
Location:	Private airstrip near Bristol
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Propeller destroyed and possible shock loading to engine
Commander's Licence:	Private Pilot's Licence
Commander's Age:	53 years
Commander's Flying Experience:	1,075 hours (of which 145 were on type) Last 90 days - 3.5 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot was landing at a grass strip in fine weather conditions. The landing was entirely normal until after about 40 or 50 m of ground roll the single main landing gear collapsed, causing damage to the propeller when it struck the ground. On inspection, it was apparent that the main landing gear had become unlocked. The precise reason for this had not been determined at the time of reporting, but the pilot suspected that age and wear of landing gear components may have been factors.

ACCIDENT

Aircraft Type and Registration:	Laser Z200 (Modified), G-VILL
No & Type of Engines:	1 Lycoming AEIO-360-A1E piston engine
Year of Manufacture:	1988 (Serial no: 10)
Date & Time (UTC):	31 May 2013 at 1555 hrs
Location:	Swanborough Farm, Lewes, Sussex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Aircraft damaged beyond economic repair
Commander's Licence:	Private Pilot's Licence
Commander's Age:	50 years
Commander's Flying Experience:	852 hours (of which 46 were on type) Last 90 days - 12 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft was returning to Swanborough Farm Airstrip following about 30 minutes of aerobatic practice. On touching down on Runway 24, the aircraft immediately pitched forward, yawed to the right and cartwheeled before coming to rest only 30 yards from the touchdown point. The pilot evacuated the aircraft normally via the opening canopy and immediately saw that the right mainwheel was missing and that the landing gear leg had 'dug in' to the grass.

The missing wheel and brake assembly was found some considerable distance to the left of Runway 24. The pilot had taken off from Runway 06 and he was of the opinion that the distribution of the components showed that the wheel had departed on takeoff, although the presence of the wheel spat close to the touchdown point suggested that it had probably detached on landing.

On examination it was found that the threads of all four bolts securing the wheel and brake mechanism to the landing gear strut had stripped. At the time of preparation of this report, no reason for this condition has been established, although the Light Aircraft Association (LAA) has requested the parts for examination.

ACCIDENT

Aircraft Type and Registration:	Piper PA-32R-301 Saratoga SP, G-BJCW
No & Type of Engines:	1 Lycoming IO-540-K1G5D piston engine
Year of Manufacture:	1981 (Serial no: 32R-8113094)
Date & Time (UTC):	6 June 2013 at 1701 hrs
Location:	Humberside Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 3
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to left wing
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	671 hours (of which 300 were on type) Last 90 days - 10 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot, occurrence reports submitted by the pilot and Aerodrome Controller; additional information from Humberside ATC

Synopsis

The pilot received ATC taxi instructions from his parking position in the light aircraft parking area. However, the route the controller intended the aircraft to take was not the same as that understood by the pilot, who taxied the aircraft onto a vehicle access road where it collided with a signpost.

Description of the event

The pilot prepared the aircraft for a flight with three passengers from Humberside to Southend. It was daylight and the weather conditions were good. The aircraft was parked facing about 020° on a grass area designated as the light aircraft parking area (Figure 1). It was the pilot's first visit to Humberside, so he requested detailed taxi instructions from ATC. He was initially given instructions to join the grass taxiway towards Runway 08, but the controller subsequently decided there may be insufficient room for the aircraft to taxi safely along that route. The controller amended his instructions, intending to route the aircraft to Runway 08 via hard taxiways. He informed the pilot of his revised intentions and asked "CAN YOU SEE THE CONCRETE STRIP ON YOUR LEFT HAND SIDE". The pilot replied that he could, so the controller instructed the pilot to take it, and then Taxiway Delta. The pilot replied "OK, I GUESS. IT'S A BIT NARROW BUT I'LL HAVE A GO". From his position in the ATC tower, some 800 m away, the controller became aware that the aircraft was not exactly where he first thought, so warned the pilot "THE CONCRETE IS A BIT FURTHER ALONG THAN THAT" to which the pilot responded "AH YES I CAN SEE IT NOW".

The pilot taxied the aircraft onto a concrete roadway to his left. However, this section of concrete was the fire station access road and was not for use by aircraft. The controller had intended to direct the pilot to Taxiway Delta via the concrete ramp which joined the access road further along, this being the normal access from the parking area to the hard taxiway. The boundary between the parking area and the access road that the aircraft crossed was marked by seven low-level signboards with arrows pointing towards the access ramp. There were also triangular black-and-white striped 'bad ground' markers between the signs, warning pilots not to join the hard surface in that area.

A post-mounted sign next to the fire station access road warned drivers of vehicles that they were approaching an aircraft manoeuvring area. The pilot saw this, but as he was already in receipt of an ATC clearance, he continued to taxi and the aircraft's left wing struck the signpost.

Local safety actions

A Unit Investigation at Humberside made two recommendations intended to prevent reoccurrence. These covered the provision of enhanced taxiing information to pilots using the light aircraft parking area and options to reduce the hazard posed by the signpost in case other aircraft inadvertently taxied onto the roadway.

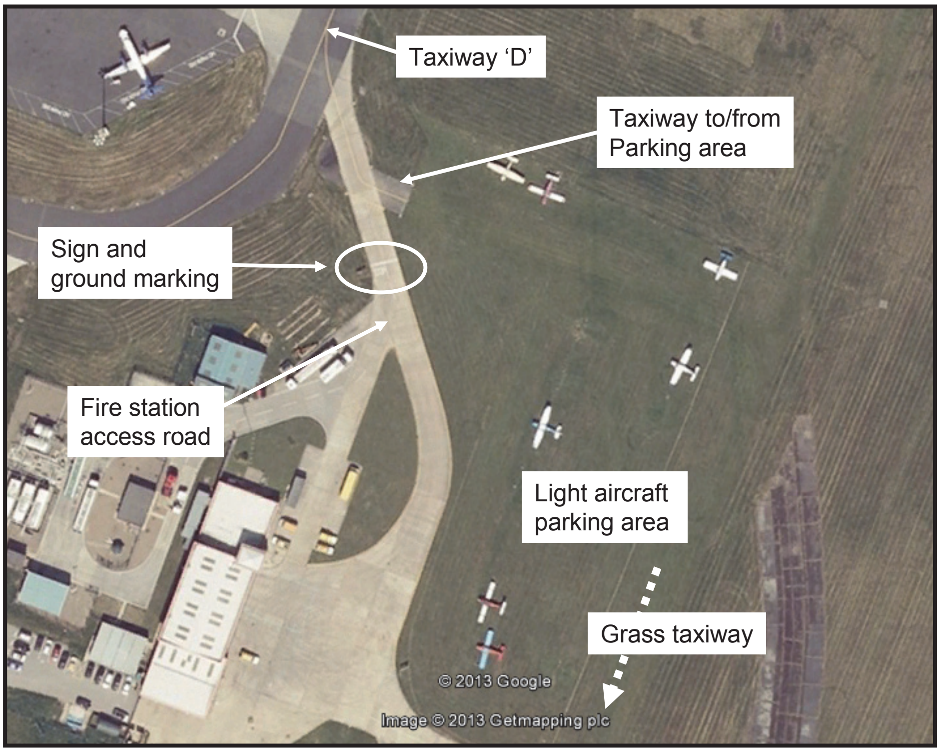

Figure 1
Light aircraft parking area with surrounding roads and taxiways

ACCIDENT

Aircraft Type and Registration:	Pitts S-2B, G-IIII
No & Type of Engines:	1 Lycoming AEIO-540-D4A5 piston engine
Year of Manufacture:	1983 (Serial no: 5010)
Date & Time (UTC):	25 May 2013 at 1030 hrs
Location:	Lashenden (Headcorn) Aerodrome, Kent
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Minor damage to left wing and aileron, left wheel fairing and left side of fuselage
Commander's Licence:	Private Pilot's Licence
Commander's Age:	52 years
Commander's Flying Experience:	1,333 hours (of which 104 were on type) Last 90 days - 10 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft hit a runway edge marker after it bounced and drifted left during a landing on the grass runway at Lashenden. The pilot, who was undertaking a refresher flight in this two-seat Pitts, reported that the drift was caused by a crosswind, combined with a lapse in his spatial awareness. He subsequently regained control and completed the landing safely.

History of the flight

The handling pilot had not flown a Pitts for around six months and was undertaking a refresher flight. The aircraft re-joined the circuit after some handling practice away from the airfield. On the third circuit, the aircraft touched down close to the unmarked centreline of grass Runway 29 but bounced up two or three feet. Due to the restricted forward field of view in the landing attitude, the pilot was using the right hand runway edge markers as prime points of visual reference. The bounce coincided with a gap of around 40 m between two edge markers, so his spatial awareness was degraded and he did not notice that the aircraft was drifting left. The pilot reported that the initial cause of the drift was a crosswind from the right. The surface wind was reported as being from 340° at 15 kt.

The aircraft collided with one of the 45 cm high, left hand runway edge markers. The left wheel spat struck first, followed by the left aileron spade, which detached. The impact of the spade snatched the control column from the pilot's grasp and caused the aileron to initiate a left wing down input. The handling pilot quickly regained control without any input by the other pilot. He was then able to manoeuvre back over the runway, complete the landing and taxi back to the hangar area. The damage to the fuselage was believed to have been caused by debris from the broken marker board.

ACCIDENT

Aircraft Type and Registration:	Porterfield CP50 Collegiate, G-AFZL
No & Type of Engines:	1 Continental Motors Corp A50-5(Modified) piston engine
Year of Manufacture:	1939 (Serial no: 581)
Date & Time (UTC):	30 June 2013 at 1000 hrs
Location:	White Waltham Airfield, Berkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Propeller destroyed, damage to engine cowlings, cockpit transparencies, wings, fuselage and tail fin
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	1,383 hours (of which 1,037 were on type) Last 90 days - 11 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft appeared to be caught by a gust of wind while manoeuvring downwind at the holding point prior to takeoff. The aircraft pitched nose-down and inverted. The pilot, who was uninjured, vacated the aircraft without difficulty.

Description of the event

After refuelling at the fuel pumps, the pilot taxied the aircraft to Runway 25 in preparation for a solo flight. The weather was generally fine, with a surface wind from 240° at 10 to 15 kt. The pilot, who had flown the aircraft (a tailwheel type) for thirty years in varying conditions, had not experienced any difficulty in taxiing the aircraft both crosswind and downwind. Being very familiar with the aircraft's behaviour taxiing in adverse wind conditions, he considered the wind at the time to be fairly benign.

After carrying out his pre-takeoff power checks into wind, the pilot observed the windsock and saw no change in strength or direction. In accordance with local procedures, he then turned the aircraft left across the wind to face downwind in order to observe the final approach path before lining up on the runway.

With the approach clear, and another aircraft approaching from his right, the pilot applied some differential braking to turn left towards the runway, while applying moderate power. As the aircraft was directly downwind, a gust of wind appeared to catch and lift the tail. The aircraft continued to pitch down and, in what seemed quite a gentle and slow movement, inverted and came to rest facing directly into wind. The engine had stopped as the propeller struck the ground, and the aircraft settled approximately wings level.

The pilot, who was uninjured, released himself from his harness and vacated the aircraft immediately and without difficulty, mindful of the full fuel tank and potential for significant spillage. The airfield emergency services arrived on scene soon afterwards. At this stage the pilot thought the wind may have been a little gustier than it had been earlier when the aircraft was at the fuel pumps.

The pilot considered the event to be a classic light taildragger/tailwind accident. With no passenger and a full fuel tank, the aircraft's centre of gravity was at a relatively forward position. He thought this may have exacerbated the situation, which was probably initiated by the combination of differential braking and a gust of wind. Although the pilot could not be sure, he thought he had been holding some or full forward elevator as the aircraft turned downwind, as he recalled instinctively pulling back on the control column as the aircraft pitched forward through the level position. While this could have aggravated the situation, the pilot felt that a full inversion was inevitable at that point.

ACCIDENT

Aircraft Type and Registration:	Replica Fokker DR1, G-FOKK
No & Type of Engines:	1 piston engine
Year of Manufacture:	2008 (Serial no: PFA 238-14253)
Date & Time (UTC):	10 June 2013 at 1500 hrs
Location:	Podington Airstrip, Northamptonshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - NONE
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to wing, fuselage, cowling and propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	476 hours (of which 100 were on type) Last 90 days - 4 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot had landed at the private grass strip earlier in the day in a Tiger Moth in preparation for a later flight, this time in G-FOKK. He was familiar with the strip as he had previously owned an aircraft which he had based there for several years. He had noticed that smoke from a bonfire to the north of the strip was rising almost vertically, indicating little or no wind.

On the later flight in G-FOKK, he made a low pass over the strip to check the ground and weather conditions. He observed that the bonfire smoke was still rising almost vertically and that trees adjacent to the runway were still. Following a standard left-hand circuit, the approach and touchdown to Runway 26 were uneventful. He closed the throttle and the tail lowered gently to the ground. Shortly afterwards, the aircraft began a turn to the left which the pilot was unable to correct with right rudder. The aircraft collided with a steel gate on the perimeter track and pitched over onto its nose and upper wing. The pilot, who was uninjured, made the aircraft safe before vacating. He later estimated that the wind had been between 5 and 10 kt from the south-west.

ACCIDENT

Aircraft Type and Registration:	Slingsby T67A Firefly, G-BIOW
No & Type of Engines:	1 Lycoming O-235-L2A piston engine
Year of Manufacture:	1981 (Serial no: 1988)
Date & Time (UTC):	26 May 2013 at 1810 hrs
Location:	Sherburn in Elmet Airfield, North Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nose landing gear, propeller.
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	306 hours (of which 97 were on type) Last 90 days - 4 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

During takeoff from Runway 29 at Sherburn in Elmet Airfield, the nose landing gear oleo and nosewheel detached from the aircraft. The pilot reported that the takeoff was normal, except that he had felt a minor "bump" through the rudder pedals at rotation. After discussions with the Chief Flying Instructor on the VHF radio, a decision to divert to Humberside Airport was made. After making a practice approach the pilot selected the engine, fuel and battery OFF on short final and landed on the foam covered runway at Humberside. The aircraft remained upright and the pilot and passenger, who were uninjured, were able to vacate the aircraft normally.

The pilot reported that the upper part of the torque link appeared to have failed and that the lower part of the link was found still attached to the lower oleo assembly. The maintenance organisation confirmed that the circlip which located the oleo into the leg was found with the detached oleo and it appeared hat the failed torque link had allowed the oleo drop out as the aircraft became airborne. The reason for the upper torque link failure had not been identified.

ACCIDENT

Aircraft Type and Registration:	1) Tecnam P92-EM Echo, G-CBDM 2) AT-16 Harvard IIB, G-AZBN
No & Type of Engines:	1) 1 Jabiru 2200A piston engine 2) 1 Pratt & Whitney R-1340-AN-1 piston engine
Year of Manufacture:	1) 2003 (Serial no: PFA 318-13756) 2) 1942 (Serial no: 14A-1431)
Date & Time (UTC):	8 June 2013 at 1455 hrs
Location:	Deanland Airfield, Sussex
Type of Flight:	1) Private 2) Private
Persons on Board:	1) Crew - 1 Passengers - None 2) Crew - 1 Passengers - None
Injuries:	1) Crew - None Passengers - N/A 2) Crew - None Passengers - N/A
Nature of Damage:	1) Damage to left wing tip and landing gear 2) None
Commander's Licence:	1) Private Pilot's Licence 2) Private Pilot's Licence
Commander's Age:	1) 60 years 2) 52 years
Commander's Flying Experience:	1) 886 hours (of which 768 were on type) Last 90 days - 15 hours Last 28 days - 7 hours 2) 1,291 hours (of which 68 were on type) Last 90 days - 26 hours Last 28 days - 13 hours
Information Source:	Aircraft Accident Report Forms submitted by the pilots and eyewitness accounts

Synopsis

While taxiing towards the runway for departure, the microlight aircraft passed behind a Harvard that was carrying out propeller checks. The propeller wash from the Harvard caused the microlight to be blown onto its left side, damaging its left wing tip and landing gear.

Report by pilot of Tecnam P92-EM Echo, G-CBDM

Towards the end of a 'fly-in' day at Deanland Airfield, the pilot of the three-axis Tecnam Echo microlight, G-CBDM, taxied for departure from Runway 06. In accordance with local flying orders published for the event, the pilot broadcast his intention to taxi on the local Air/Ground radio frequency. He subsequently brought his aircraft to a stop on the grass taxiway before the runway, with an aircraft ahead carrying out pre-takeoff engine checks. The pilot became aware of a Harvard parked to his right which was starting up. Being behind the Harvard, the pilot was concerned about propeller wash. There was insufficient space to turn around and the taxiway ahead was largely blocked by the other aircraft, although the pilot attempted to manoeuvre forward towards a gap beside it. However, the microlight was then blown onto its left side by the propeller wash from the Harvard.

The microlight pilot, who was uninjured, vacated his aircraft and approached the Harvard in order to alert its pilot to the accident. The Harvard pilot shut down his engine and there was an exchange between them before the Harvard pilot started his engine again and departed. In his report, the Echo pilot noted that he had received no marshalling assistance, nor been warned by marshals of the potential hazard area behind the Harvard.

Report by pilot of AT-16 Harvard IIB, G-AZBN

The pilot of the Harvard reported that he had been in discussion with the 'fly-in' event organisers before the day, on issues including taxiing and parking. It was agreed that he would follow directions for parking on his arrival, and this is what occurred. The pilot also reported that, because of the confined nature of the airfield, he asked one of the event organisers before departing about where he should perform pre-takeoff power checks. The organiser told the pilot that he could do these where the aircraft was parked, and arranged for another lightweight aircraft parked behind to be moved.

The pilot spoke to the leader of a group of Air Cadets who were providing marshalling assistance, with a view to ensuring the area behind his aircraft was clear. He agreed hand signals to be used to denote engine starting and power increase for pre-takeoff checks. Having given the signal for start, the pilot received a confirmatory nod and started the engine. After about 5 minutes of warming time, the pilot checked behind and gave a hand signal, which was again acknowledged. The pilot increased engine rpm and commenced propeller checks. On the third propeller cycle, the pilot was given a signal to reduce power, after which he learnt that an aircraft had taxied behind and been blown on to its side. Following the exchange with the pilot of G-CBDM, the Harvard pilot re-started and departed without further incident.

Witness accounts

Two eyewitnesses gave their accounts. Both confirmed that the Harvard engine had been running for some time before the Echo taxied behind, and that the Harvard pilot had just commenced his propeller check. One witness observed that the ground over which the Echo was taxiing sloped, and thought this may have made the aircraft more likely to tip when it encountered the propeller wash. Both witnesses reported that only limited marshalling assistance was being provided because the marshals were not formally trained in this role.

ACCIDENT

Aircraft Type and Registration:	Vans RV-9A, G-CGXR
No & Type of Engines:	1 Lycoming O-320-H2AD piston engine
Year of Manufacture:	2013 (Serial no: PFA 320-14371)
Date & Time (UTC):	24 July 2013 at 1245 hrs
Location:	Carlisle Airport, Cumbria
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damaged nose landing gear, propeller and engine mount
Commander's Licence:	Private Pilot's Licence
Commander's Age:	73 years
Commander's Flying Experience:	320 hours (of which 6 were on type) Last 90 days - 7 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft was landing on Runway 25 at Carlisle when the accident occurred. The weather was generally fine, with a very light westerly wind. The pilot reported that he flew a normal approach, but flared the aircraft too high. It landed heavily and bounced before touching down again, nosewheel first. This caused the nose landing gear to collapse. The pilot brought the aircraft to a stop on the runway. Neither occupant was injured, and both were able to vacate the aircraft in the normal manner.

ACCIDENT

Aircraft Type and Registration:	Aero AT-3 R100, G-SACW
No & Type of Engines:	1 Rotax 912-S2 piston engine
Year of Manufacture:	2010 (Serial no: At3-058)
Date & Time (UTC):	24 July 2013 at 1055 hrs
Location:	Sherburn in Elmet Airfield, North Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Propeller destroyed, nose leg sheared off and cockpit floor ruptured
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	63 years
Commander's Flying Experience:	125 hours (of which 47 were on type) Last 90 days - 4 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft bounced on landing following a normal approach in fine conditions. When it touched down again the nose leg collapsed and the propeller struck the ground. The aircraft came to rest on the runway.

History of the flight

The pilot returned to the airfield after a local flight and carried out a normal approach to Runway 24. The weather conditions were good, with a surface wind from about 240° at 5 kt. The pilot flared the aircraft for landing and was expecting a smooth touchdown. However, it landed heavily and bounced, which took the pilot by surprise. The second contact with the runway was also heavy and not in a controlled attitude, causing the nose leg to shear off. The propeller shattered as the nose pitched down. The aircraft came to a stop about halfway along the 793 m grass runway.

The pilot thought that the heavy landing had resulted from him flaring the aircraft slightly too early. He considered that his correct course of action at that stage would have been to apply power and go around.

Previous occurrences

Since November 2007, the AAIB has reported on 12 accidents involving the Aero AT-3 R100 (including this report). Of these, five[1] involved heavy or bounced landings which caused damage to the nose leg. In four of the cases the nose leg was sheared off. In each of these accidents, the approaches seemed normal to the pilots, with difficulties being encountered at or about the point of flare.

Footnote

[1] G-SACX, 30 April 2009; G-SBRK, 15 August 2009; G-SYEL, 24 September 2009; G-SACY, 5 September 2012; G-SACW, 24 July 2013.

ACCIDENT

Aircraft Type and Registration:	BFC Challenger II, G-MZAC
No & Type of Engines:	1 Rotax 503-2V piston engine
Year of Manufacture:	1995 (Serial no: PFA 177A-12716)
Date & Time (UTC):	24 July 2013 at 1200 hrs
Location:	Private airstrip near Warminster, Wiltshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nose landing gear damaged
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	63 years
Commander's Flying Experience:	188 hours (of which 12 were on type) Last 90 days - 13 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

After a local flight in fine conditions, the pilot flew a glide approach to the 500 m grass airstrip, which was orientated 09/27. The surface wind was southerly at 8 kt, with gusts to 14 kt, and the pilot approached in a westerly direction. At the flare, the aircraft "ballooned" 3 or 4 ft above the ground and the pilot decided to fly a go-around. However, before he could do so, the aircraft dropped to the ground in a flat attitude, still in a crabbed condition due to the crosswind. The pilot established directional control through the rudder pedals and completed the landing roll. However, whilst taxiing back along the airstrip, the aircraft stopped responding to rudder pedal inputs and veered to the right (a southerly direction) onto unprepared ground beside the runway. The aircraft was subsequently found to have suffered a fractured nose leg and bent nosewheel steering rods.

The pilot thought that his delay in executing a go-around had been a contributory factor. He attributed this to his concern over possible adverse pitch effects from the high-mounted pusher engine and a lack of practice on go-around manoeuvres in this aircraft type.

SERIOUS INCIDENT

Aircraft Type and Registration:	Cameron Z-275 balloon, G-VBFT
No & Type of Engines:	None
Year of Manufacture:	2009 (Serial no: 11215)
Date & Time (UTC):	19 July 2013 at 0640 hrs
Location:	Near, Lanark, South Lanarkshire
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 1 Passengers - 10
Injuries:	Crew - 1 (Minor) Passengers - 7 (Minor)
Nature of Damage:	Damage to basket frame and fence wire
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	58 years
Commander's Flying Experience:	408 hours (of which 228 were on type) Last 90 days - 32 hours Last 28 days - 11 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The pilot was unable to arrest an unexpected descent as the balloon was in the final stages of its approach to landing. The basket struck two fences, causing some damage to its frame, before coming to rest in the chosen landing field.

History of the flight

The balloon launched in fine weather and calm conditions at 0640 hrs with the pilot and ten passengers on board. It climbed to about 3,500 ft for a time before descending again, moving in a generally west to south-west direction. After nearly an hour, the pilot identified a landing site in a field, just beyond a railway line and a line of trees. It was also just beyond a minor road, although this was on an embankment and not visible initially. The pilot instructed the passengers to adopt their landing positions.

The balloon passed over the line of trees at 50 ft and 10 kt, but the speed soon increased to 13 kt and the balloon started to descend. Despite the pilot's efforts to maintain height, the balloon struck a fence before crossing the road and striking another fence on the far side. Both fences were on the embankments, the second being higher than the first. Contact with a solid post in the second fence line damaged the balloon basket frame.

The balloon came to a stop about 30 m into the chosen field. The pilot checked the passengers individually before supervising their exit from the basket. Some were complaining of knocks and bruises and the pilot decided to call an ambulance. She reported that the passengers who went to hospital were later discharged.

INCIDENT

Aircraft Type and Registration:	Jabiru UL, G-BZEN
No & Type of Engines:	1 Jabiru Aircraft Pty 2200A piston engine
Year of Manufacture:	2000 (Serial no: PFA 274A-13272)
Date & Time (UTC):	2 May 2013 at 1800 hrs
Location:	Wickenby Aerodrome, Lincolnshire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Left landing gear partially detached and scuffed elevator
Commander's Licence:	Private Pilot's Licence
Commander's Age:	27 years
Commander's Flying Experience:	873 hours (of which 30 were on type) Last 90 days - 24 hours Last 28 days - 11 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and additional enquiries by the AAIB and LAA

Synopsis

As the aircraft touched down after completing a training flight the left landing gear leg collapsed and, despite the pilot's attempts to maintain heading, the aircraft veered off the runway onto the grass. It came to rest with its left landing cantilever spring leg partially detached from the surrounding structure, twisted forwards and underneath the fuselage. This was caused by the failure of its three mounting bolts. It was found that the aircraft was fitted with the original design 5/16 inch diameter landing gear mounting bolts rather than the recommended 3/8 inch diameter bolts detailed in Jabiru Service Bulletin (JSB) 008-1.

History of the flight

As the aircraft touched down after a training flight the pilot heard a loud bang and felt the left wing drop. Assuming a tyre had burst the pilot applied right stick to lift the weight off the suspect left mainwheel tyre. The nose of the aircraft began to pitch upwards and the left wing dropped. The pilot then realised this to be more than just a tyre burst and made various control inputs in an effort to maintain directional control of the aircraft. As the airspeed decayed the wing began to drop again and, so as not to damage the propeller and shock-load the engine, he shut the engine down. He was unable to maintain heading and the aircraft veered off the runway and gradually came to stop. The pilot and passenger were uninjured and vacated the aircraft. The aircraft had come to rest canted over to the left with its nose and right wheel in contact with the ground. The left landing gear leg had collapsed and twisted forward underneath the fuselage.

Aircraft description

The Jabiru UL-430 is a high-wing two-seat microlight aircraft equipped with a fixed tricycle landing gear. The nose landing gear is mounted onto the fibreglass structure bolted to the engine bulkhead. The Main Landing Gear (MLG) consists of separate left and right cantilever spring legs each of which is secured to the underside of the fuselage by one inboard and two outboard attachment bolts.

Engineering findings and corrective action

An examination of the collapsed landing gear found that all three $^{5}/_{16}$ inch diameter (AN5[1]) mounting bolts of the left cantilever spring leg had failed. The inner bolt had bent whilst the outer bolts had fractured and bent. As well as the damage sustained at the point of failure, the remains of all three bolts were in a generally worn and distressed condition. It is probable that one of the outboard bolts failed first resulting in overload and distortion of the remaining two bolts.

Jabiru had responded to previous incidents of a similar nature by issuing Service Bulletin 008-1 on 31 March 2005. This recommended the introduction of larger diameter landing gear mounting bolts, 3/8 inch (AN6) rather than the 5/16 inch (AN5) originally specified, using a proprietary Jabiru modification kit. In addition, on 7 May 2009, Jabiru issued Service Bulletin 052-2 which advised the introduction of a 500-hour life for the 3/8 inch landing gear bolts. It appears that G-BZEN had not had JSB 008-1 or JSB 052-5 applied. It was noted that these JSBs were not mandatory at the time of the incident. As result of this and a recent previous incident (See AAIB Bulletin 3/2013) action is now being taken by the Light Aircraft Association to mandate both JSBs with the publication of an Airworthiness Information Leaflet.

Footnote

[1] Prefix to designation codes of US military hardware denoting "Army-Navy"; now rare, although the codes remain in use for aircraft general spares. For example; a bolt designated AN5-20 is one of $^{5}/_{16}$ inch diameter and $2^{3}/_{32}$ inches long.

ACCIDENT

Aircraft Type and Registration:	Jabiru UL-450, G-ODGS
No & Type of Engines:	1 Jabiru Aircraft Pty 2200A piston engine
Year of Manufacture:	2003 (Serial no: PFA 274A-13472)
Date & Time (UTC):	18 July 2013 at 1650 hrs
Location:	Manchester Barton Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damaged propeller and nose landing gear
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	54 years
Commander's Flying Experience:	175 hours (of which 145 were on type) Last 90 days - 8 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft took off from Runway 27R, a 518 m grass runway. Immediately after lifting off, the engine started to misfire. The pilot concentrated on avoiding close-in obstacles and managed to climb the aircraft to a maximum height of about 300 ft agl. He made a radio call to notify the AFISO and was advised that Runway 20 (a 532 m grass runway) was available. With the engine continuing to misfire, the pilot flew an abbreviated approach to the runway. The aircraft arrived at the runway with excess speed and bounced on landing. The nose landing gear was torn from the aircraft, which came to rest on its main wheels and lower engine cowling.

The pilot, who was uninjured, reported that the aircraft had stood all day in warm, calm conditions (the temperature at Manchester International Airport reached a maximum 28°C that day). He suspected that vapour lock had occurred in the fuel system, disrupting the flow of fuel to the engine. A subsequent engine examination by a maintenance organisation revealed no abnormalities other than those attributable to the sudden engine stoppage which occurred when the propeller struck the ground on landing.

ACCIDENT

Aircraft Type and Registration:	P and M Aviation Quik GTR, G-RSAM
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2012 (Serial no: 8638)
Date & Time (UTC):	30 June 2013 at 1329 hrs
Location:	Wingland Airfield, Lincolnshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Extensive damage
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	38 years
Commander's Flying Experience:	311 hours (of which all were on type) Last 90 days - 47 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The microlight was landing at Wingland after a flight from Great Oakley Airfield. The weather was generally fine but the wind, which was estimated at 15 kt, was slightly turbulent and gusty. On arrival overhead Wingland, the pilot found the windsock to be indistinct. Based on his observation of nearby wind turbines, he decided the wind direction favoured grass Runway 20 and made an approach accordingly. The microlight became high on the approach, so the pilot flew a go-around, during which he noted that the windsock was indicating that Runway 13 was more suitable. He therefore flew an approach to grass Runway 13, a new runway which is about 240 m in length. Just above the surface, the microlight encountered unexpected sink and bounced, before settling on the runway. The pilot commenced braking but it soon became apparent that the microlight would not stop in the available distance remaining, which, by that time, was also insufficient for a safe go-around. The microlight overran the prepared surface and ran into a dyke, suffering extensive damage. The pilot, who was uninjured, later assessed the actual surface wind as being from 220° at 15 kt.

ACCIDENT

Aircraft Type and Registration:	Pegasus Quik, G-CBZT
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2003 (Serial no: 7936)
Date & Time (UTC):	6 July 2013 at 1130 hrs
Location:	Eshott Airfield, Northumberland
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to the propeller, nose landing gear and wing
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	50 years
Commander's Flying Experience:	600 hours (of which 298 were on type) Last 90 days - 14 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The pilot was making his third approach to land following two previous approaches which had been abandoned due to turbulence. At a height of 10 to 15 ft, the aircraft stalled and struck the ground left wing first. The pilot was uninjured.

History of the flight

The pilot departed from Runway 01 at Eshott Airfield and carried out a flight along the coast of Northumberland, initially to the north, before returning to Eshott. On departure, the wind was light and variable from the northwest, with the visibility in excess of 10 km and some high cumulus cloud. The northbound flight was uneventful but on the return to the airfield the pilot noticed an increasing tailwind, with significant turbulence. On arrival at Eshott, the pilot assessed the surface wind as being from the west-north-west at 10 mph, gusting 23 mph, and carried out an overhead rejoin for Runway 26. On the final approach, at a height of between 50 ft and 200 ft, there was severe turbulence and the pilot carried out a go-around. He made a second approach from which he also had to go around again, because of difficulty controlling the aircraft in the turbulence. He then decided to use a cropped area on the northeast side of the old, disused part of the airfield as this allowed him to land into the wind. The pilot made his approach at 65 to 75 mph but, at a height of 10 to 15 ft, he thought the aircraft stalled and the left wing struck the ground. He was uninjured and was able to vacate the aircraft unassisted.

The pilot considered that the wind had increased significantly and unexpectedly during his 80-minute flight, with turbulence being created by the Cheviot Hills to the northwest. This made control of this flex-wing aircraft more demanding on final approach and the eventual loss of airspeed resulted in a stall.

ACCIDENT

Aircraft Type and Registration:	Savannah Jabiru(5), G-CSUE
No & Type of Engines:	1 Jabiru Aircraft Pty 2200 piston engine
Year of Manufacture:	2006 (Serial no: BMAA/HB/517)
Date & Time (UTC):	7 July 2013 at 1800 hrs
Location:	Menaglaze, Bodmin Moor, Cornwall
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Both wings, propeller, landing gear, firewall
Commander's Licence:	Private Pilot's Licence
Commander's Age:	73 years
Commander's Flying Experience:	222 hours (of which 110 were on type) Last 90 days - 4 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot had departed from a grass field and had carried out a short local flight before returning to land. The field was roughly rectangular in shape, with some poplar saplings on its southern boundary, and measured 90 m in the northerly landing direction. The weather was good, with a light surface wind from the north at about 10 kt. The estimated landing roll was approximately 50 m and the aircraft needed to touch down at a specific point, which was critical when operating into the site.

The final approach was made at 50 mph with the first of two stages of flap selected. As the aircraft passed over the southern boundary of the field with the airspeed reducing to 40 mph, the pilot felt the right wing impact the top of a poplar tree. The aircraft landed heavily and the landing gear collapsed. The pilot isolated the fuel and the electrical systems before exiting the aircraft uninjured.

He considered that the cause of the accident was operating into a marginal site and becoming too low and slow on the approach.

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).

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

1/2010 Boeing 777-236ER, G-YMMM
at London Heathrow Airport
on 17 January 2008.

Published February 2010.

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

Published May 2010.

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

Published May 2010.

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

Published September 2010.

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

Published September 2010.

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

Published November 2010.

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

Published November 2010.

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

Published December 2010.

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.

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