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SPECIAL BULLETINS

None

COMMERCIAL AIR TRANSPORT

GENERAL AVIATION

SPORT AVIATION / BALLOONS

ADDENDA and CORRECTIONS

None

(ALL TIMES IN THIS BULLETIN ARE UTC)

INCIDENT

Aircraft Type and Registration:	Boeing 767-300 ER, V8-RBH
No & Type of Engines:	2 Pratt & Whitney 4060 turbofan engines
Year of Manufacture:	1993
Date & Time (UTC):	3 March 2007 at 1630 hrs
Location:	London Heathrow Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 11 Passengers - 189
Injuries:	Crew - None Passengers - None
Nature of Damage:	Failure of No 1 wheel hub
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	56 years
Commander's Flying Experience:	16,635 hours (of which 7,654 were on type) Last 90 days - 162 hours Last 28 days - 60 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot, and metallurgical examination of components

Synopsis

During the takeoff run the aircrew noticed that a BRAKE TEMP warning light was illuminated. The STATUS page showed that the temperature of the No 1 brake was rapidly increasing. The takeoff was rejected at around 90-100 kt and the aircraft was successfully stopped and turned off the runway. The passengers disembarked normally.

The No 1 wheel hub was found to have failed. The heat and mechanical damage to the hub was such that it was not possible to determine the precise cause of the failure.

History of the flight

The aircraft was on its takeoff run on Runway 27L when the BRAKE TEMP warning light was seen to be illuminated. No other warnings or captions were observed. The crew checked the STATUS page and this indicated that the No 1 brake was hot (level 6), and getting hotter (level 7).

Initially the crew thought that there was a binding brake, but as the temperature was high and increasing rapidly, the takeoff was aborted at around 90-100 kt. The aircraft was successfully stopped and turned off the runway on to a taxiway. The No 1 brake temperature subsequently rose from level 7 to level 9. The fire services were requested and, although there was no fire, the wheel was sprayed with water as a precaution.

The passengers disembarked normally and no-one was injured. The No 1 wheel was found severely damaged and was replaced before the aircraft was towed to stand. The aircraft was subsequently ferried to the operator's base station for further maintenance.

In his report the commander noted that there is no EICAS message or aural warning to alert the flight crew of this fault.

Wheel information

The wheel hub is in two parts. The outer hub houses the outer bearing and the inner hub, which is deeper, houses the inner bearing, (see Figure 1).

The inner and outer wheel hubs were both manufactured in 1994. The wheel was last inspected and installed in December 2006, and since then had completed 1145 flying hours and 205 cycles.

Engineering investigation

A large, almost-cylindrical section of the inner hub had become detached (see Figures 2, 3 and 4). The approximate location of the separation of the inner hub into two parts is also shown in Figure 1. The wheel was disassembled into its inner and outer hub parts and subjected to a detailed metallurgical examination. The conclusions from the examination were:

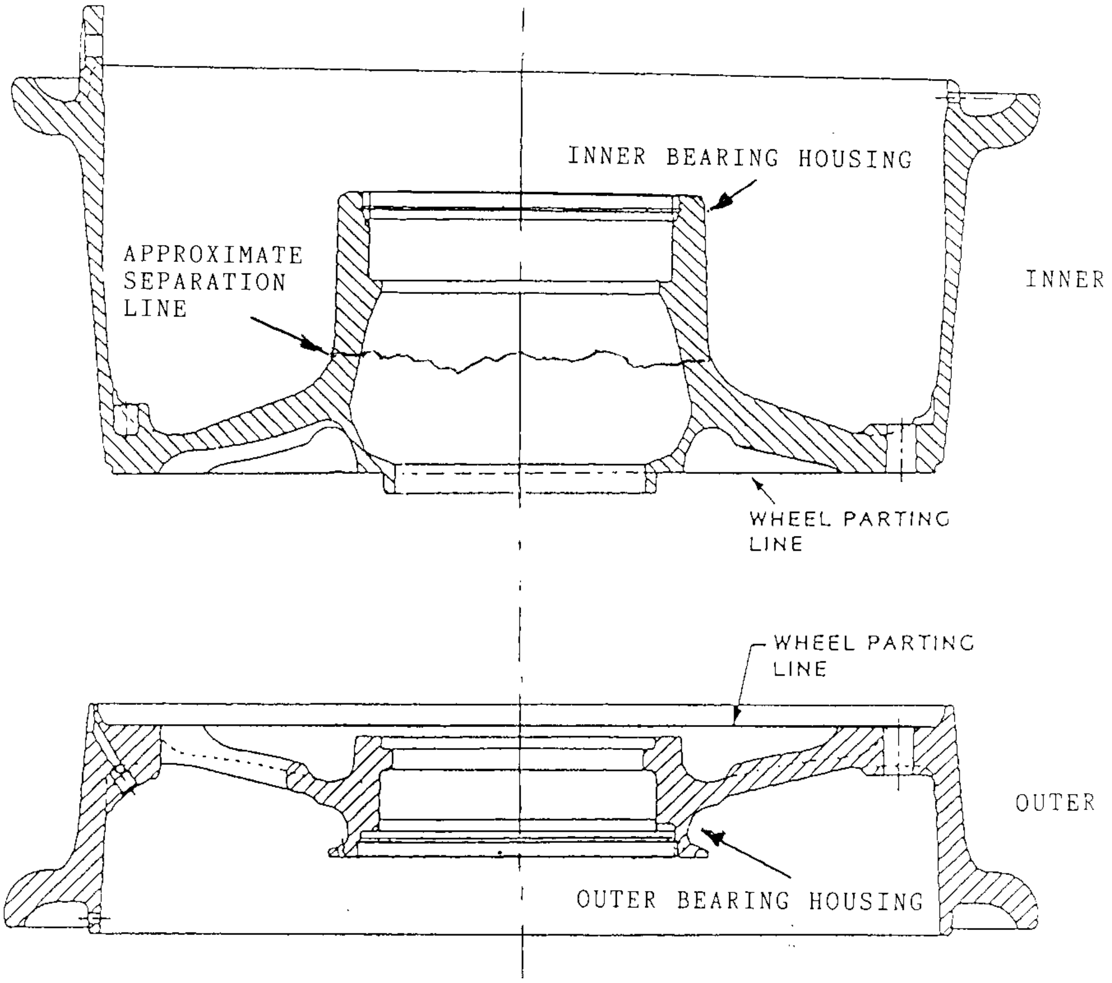
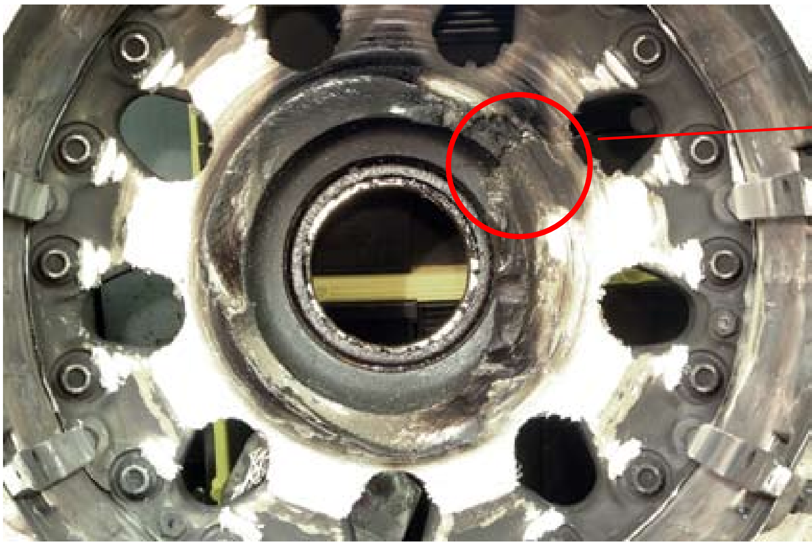


Figure 1

Figure 2

Figure 3



Photos:
Hugh Tyrer Consultants

Figure 4

a) the inner bearing housing had become detached and had severely overheated during contact with the main part of the inner hub. This was likely to have been the cause of the temperature warnings;

b) the initial failure of the inner hub had taken place in the region shown by the in Figure 4;

c) the likely cause of the failure was probably fatigue, or stress corrosion, or a combination of both;

d) a precise assessment of the failure to the hub was impossible due to the extensive heat and mechanical damage. The assessment was also made more difficult by the rapid cooling of the hub that occurred as a result of the water applied by the fire service;

e) There was no evidence of a failure to either the inner or outer bearings.

Comment

Whilst the wheel had been manufactured in 1994 it should not have failed in service. Since the precise cause could not be determined, no safety action or recommendation can be made.

ACCIDENT

Aircraft Type and Registration:	British Aerospace Jetstream 4102, G-MAJZ
No & Type of Engines:	1 Garrett Airesearch TPE331-14GR-807H 1 Garrett Airesearch TPE331-14HR-807H
Year of Manufacture:	1997
Date & Time (UTC):	26 June 2007 at 1745 hrs
Location:	Birmingham Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 3 Passengers - 9
Injuries:	Crew - None Passengers - None
Nature of Damage:	Nose gear collapsed
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	50 years
Commander's Flying Experience:	6,652 hours (of which 434 were on type) Last 90 days - 138 hours Last 28 days - 54 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and AAIB inquiries

Synopsis

After a normal pushback the pushback crew were unable to disconnect the towbar. The aircraft commander decided to return the aircraft to the stand. Headsets had not been used during the pushback and communication was via hand signals. The tug attempted to pull the aircraft back onto stand whilst the aircraft parking brake was still applied, and the nose gear collapsed.

History of the flight

The aircraft was pushed back from Stand 12 at Birmingham Airport onto the centreline of Taxiway W, the parking brake was applied and the nosewheel was chocked. The pushback crew did not wear headsets during the pushback and communication was via hand signals. When the pushback crew attempted to disconnect the towbar from the tug they were unable to do so, despite several attempts. The aircraft was now blocking the taxiway and obstructing another aircraft that was waiting to taxi. The flight crew obtained ATC permission to return to the stand. The commander used hand signals in an attempt to communicate his intentions to the pushback crew. They attempted to reverse the tug towards the stand whilst the parking brake was still applied, and the nose oleo of the aircraft collapsed forward onto the towbar.

Report from aircraft commander

The commander reported "a normal pushback, albeit with hand signals" until the point where the pushback crew attempted to disconnect the towbar from the tug. They were unable to remove the towbar despite several vigorous attempts using a variety of techniques. Meanwhile, another aircraft had pushed back from an adjacent stand and its progress was now obstructed by the Jetstream. The commander was initially reluctant to return to the stand as he was concerned that it would be difficult to communicate that request to the pushback crew without headset communication. Further attempts to remove the towbar were in vain and the commander then made the decision to return to Stand 12. The first officer obtained ATC permission whilst the commander tried to attract the pushback crew's attention. The first officer flashed the aircraft taxi lights and waved his arms to attract the pushback crew's attention, but was unable to do so. Eventually, the commander was able to make eye contact, and he pointed first at the aircraft that was waiting to taxi, then at himself and then in the direction of Stand 12. He believed that this instruction was understood, and when the pushback crew pointed at the stand he gave them "a thumbs up" to confirm that this was his intention. Without any further signals the tug commenced reversing and the nose gear collapsed. The commander called for an immediate shutdown and requested the attendance of the emergency services.

Report from pushback crew

The pushback driver stated that the crew were not using headsets, as they were unserviceable. He also stated: "with these types of aircraft we do find hand signals safer due to the noise factor". The pushback was normal up to the point of disconnecting the towbar from the tug, which would not release from the aircraft, despite repeated attempts. The aircraft commander, using hand signals, gave indications that were understood by the pushback crew to mean the brakes were off and that he wanted to return to Stand 12. The nosewheel chock was removed and the driver reversed the tug. The nose gear of the aircraft then collapsed.

Pushback procedure

The airport operational instruction regarding pushback operations stated:

> *'The person in charge of the operation must be connected to the aircraft's internal communications system, via a headset, to ensure proper communications between the ground crew and the captain of the aircraft.'*

The operator's Ground Operations Manual procedure for towing aircraft required voice communications between the person operating the aircraft brakes, the person approved for the towing operation and the person who operates the tractor. Whilst it is implied that the towing procedures are applicable for a pushback, the Ground Operation's Manual has no specific procedure for pushback.

Despite these requirements, it was not unusual for a pushback to be conducted using hand signals only. However, following this accident ground handling staff have been instructed to use a headset at all times.

The tug, a Schopf F110, has a larger securing pin than other tugs used at the airport, and consequently the connection between the tug's securing pin and towing eye of the Tronair towbar used for the Jetstream was very tight. Both the commander and the pushback crew reported previous incidents where difficulty had been experienced in releasing the towing arm from the Schopf tugs.

The towbar was fitted with a shear pin that was designed to break when excessive turning loads are applied. When an excessive pulling load is applied the shear pin should still break, although it did not do so on this occasion. Had the shear pin broken, its effect would only be to lengthen the towbar marginally and this would not have prevented this accident since no other 'weak link' is in place.

Damage to aircraft

The downlock attachment pin had been pulled from its mounting, with some damage to the surrounding casing. The nose landing gear had collapsed forward onto the towbar. When the aircraft came to rest the rotating propellers were close to striking the ground.

Conclusion

Pushbacks are a routine manoeuvre, normally performed with headset communications between the flight deck and the pushback crew. The airport instructions and the operator's towing procedures make no allowance for aircraft pushbacks without headsets. Nevertheless, it was not unusual for them to be conducted using hand signals only. Ground handling staff have now been instructed to use a headset at all times.

A routine pushback became unusual when it was necessary to return the aircraft to stand. There is no hand signal for 'I would like to return to stand' and the commander had difficulty in conveying his wishes to the pushback crew. The resulting breakdown in communication led to the aircraft being damaged.

ACCIDENT

Aircraft Type and Registration:	Cessna 401, N401JN
No & Type of Engines:	2 Continental TSIO-520-E5B piston engines
Year of Manufacture:	1966
Date & Time (UTC):	21 January 2007 at 1206 hrs
Location:	Blackpool Airport, Lancashire
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Right wing, right landing gear and right propeller damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	58 years
Commander's Flying Experience:	1,091 hours (of which 531 were on type) Last 90 days - 6 hours Last 28 days - 3 hours
Information Source:	AAIB field investigation

Synopsis

During the rollout, following an uneventful flight, the right main landing gear (MLG) collapsed. Subsequent investigation revealed a fatigue failure and overload of the arm attachment holes on the right MLG torque tube. The crack appeared to have been growing since around 2001. A Supplementary Inspection Document (SID) issued by Cessna in 2004 recommended inspections of the arm attachment holes of the torque tube but the inspection had not been carried out on N401JN. This SID is mandatory on aircraft registered in Europe used for commercial air transport, and will be mandatory from September 2008 for those used privately. The SID is not mandatory for US-registered aircraft, such as N401JN. One Safety Recommendation has been made.

History of the flight

Following an uneventful local flight, the aircraft returned to Blackpool for an ILS approach and landing on Runway 28. The wind at the time was from 250° at 24 kt. Prior to landing the pilot carried out the 'before landing' checklist, checking for three green landing gear 'down and locked' lights. Both the pilot and co-pilot cross checked and verified that the lights were illuminated. The subsequent landing was normal and the aircraft then travelled to a point about 100 metres short of taxiway Charlie, where the right main landing gear collapsed. Damage was sustained to the right wing, flaps and right engine propeller. After shutting down the aircraft the pilot and the co-pilot exited normally and were uninjured.

Aircraft description

The electrically-operated landing gear extension and retraction system on the Cessna 401 has an electrical actuator, situated in the middle of the aircraft, which operates a bellcrank. The bellcrank drives push-pull tubes, outboard, to the left and right main landing gear torque tubes respectively, via landing gear door bellcranks. The rod end of the drive push-pull tube fits into an arm assembly of a torque tube and is secured by a nut and bolt through arm attachment holes, (see Figure 1). The torque tube drives a push-pull tube attached to the main landing gear bellcrank, which allows the gear to retract and extend around the main pivot point. To achieve a positive downlock the side brace of the gear is rigged to be over centre when the gear is locked down.

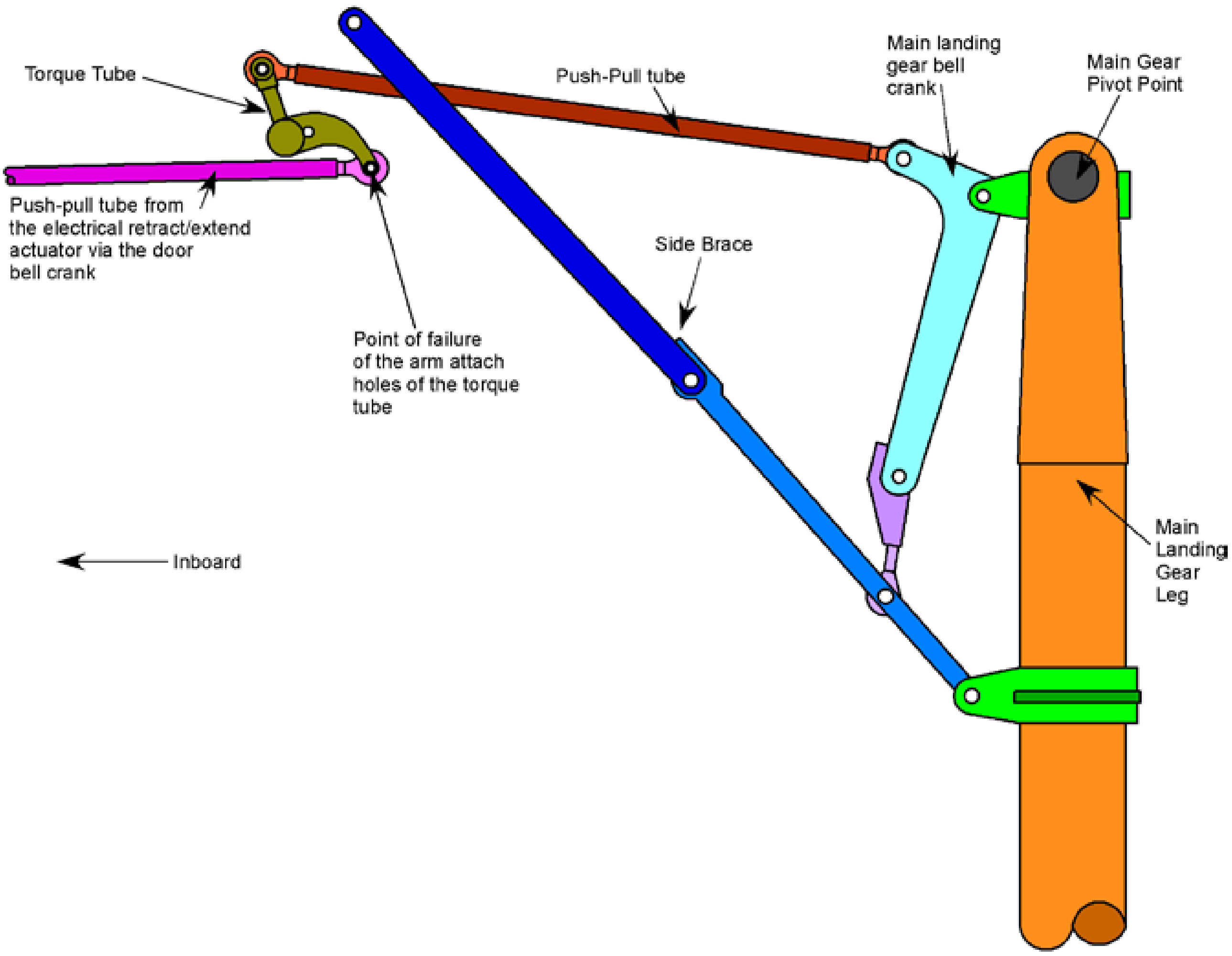


Figure 1

Representative diagram of the right main landing gear extend/retract mechanism

Aircraft examination

The aircraft was recovered from the runway and taken to a local hangar where it was found that the right main landing gear torque attachment holes had failed, (see Figure 2). The failure was such that the pushrod that provided drive to the torque tube from the electrical retract/extend actuator had disconnected.

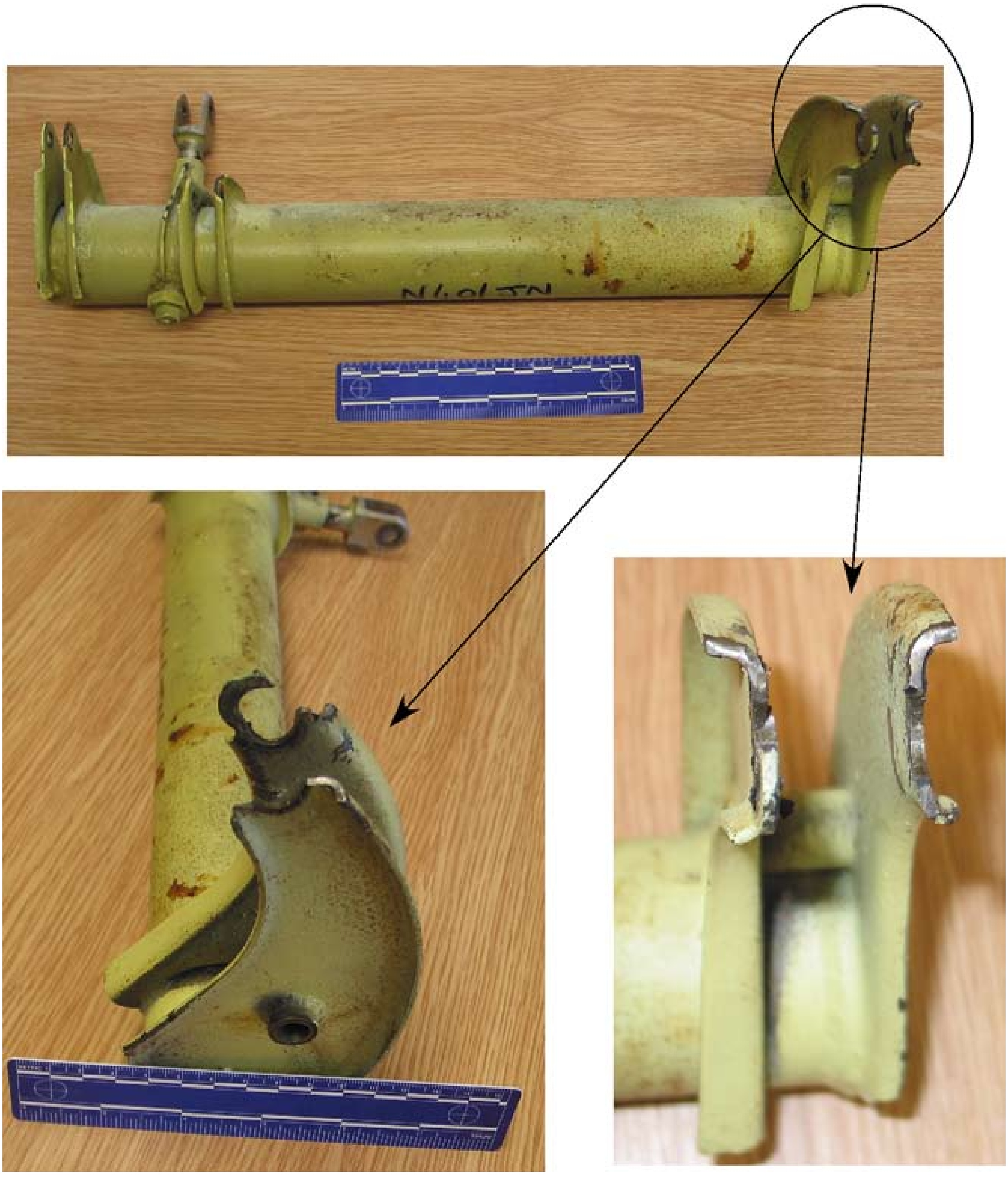


Figure 2

Failed right MLG torque tube removed from N401JN

The torque tube was removed from the aircraft and sent for detailed metallurgic examination. This revealed a slow progressive fatigue failure, followed by a rapid overload, (see Figure 3). The fatigue crack striations indicated that it had suffered up to 250 cycles before the final overload. Each cycle was probably related to an extension/ retraction cycle of the landing gear.

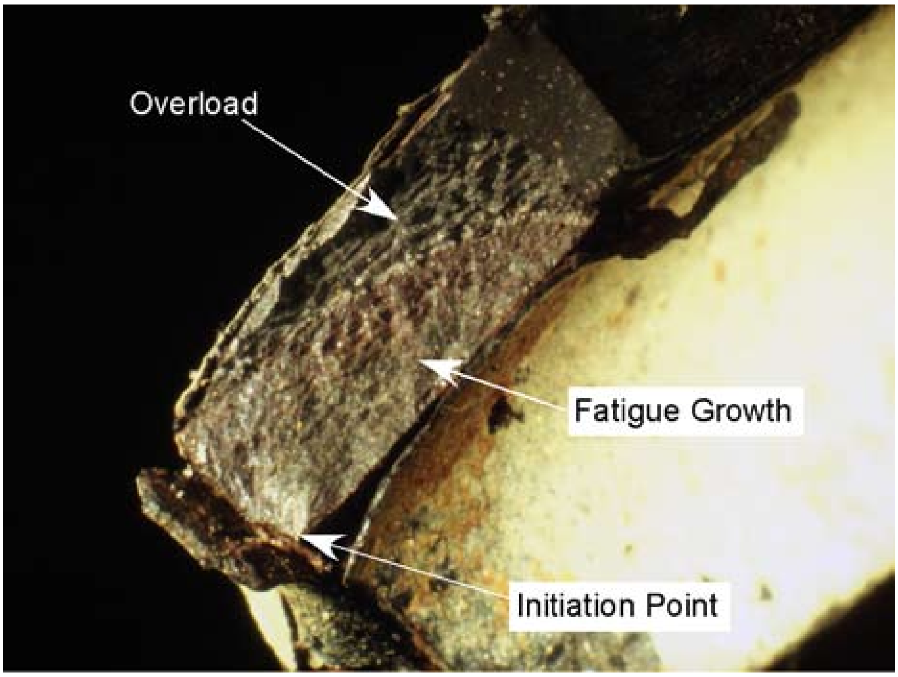


Figure 3

Microscopic image of the initiation and fatigue crack growth

Aircraft history

At the time of the accident the aircraft was 41 years old and had completed 3,450 flying hours. A review of the aircraft and the pilot log books revealed that 250 landings, prior to the accident flight, corresponded to about May 2001. The aircraft had previously been on the UK register, as G-ROAR.

The last disturbance of the right main landing gear was in 2003, although the right main landing gear torque tube was not removed or disturbed at that time. The last maintenance inspection was a 100-hour inspection on 6 October 2006, during which an inspection of the right main landing gear torque tube was not required.

Cessna Supplemental Inspection Document

In August 2004 Cessna issued a Supplemental Inspection Document (SID), 32-10-05, for the main landing gear torque tube assembly. The inspection calls for the removal of the torque tube assembly and a subsequent non-destructive inspection (NDI). One specific area in which the NDI is carried out is on the arm attachment holes that were found fractured on N401JN. The initial inspection of the torque tube should be carried out when the aircraft completes 10,000 landings or after 20 years, with a repeat every 2,000 landings or 4 years. For aircraft that have already exceeded the initial inspection threshold, the SID specifies the inspection should be carried out within 400 landings or by 4 August 2005.

The SID is not mandatory for US-registered aircraft and therefore there was no formal requirement for the inspection to be carried out on N401JN. In Europe, European Commission Regulation EC 2042/2003 Annex 1 (Part-M) Rule M.A.302 requires that all aircraft should accomplish supplemental inspections as part of their maintenance programme. This rule is already applicable to all commercial air transport aircraft and will be applicable to all other aircraft, including those involved in private operations, from September 2008.

Analysis

The gear collapsed due to a failure of the arm attachment holes of the right main landing gear torque tube. The arm attachment holes had failed due to an initial fatigue crack followed by a rapid overload. The fracture caused the pushrod from the electrical extend/retract actuator to disconnect and it is likely that this fracture occurred as the gear was extended for landing. Following the landing, a side load on the right gear caused it to collapse.

It could not be determined what caused the initiation of the crack in the arm attachment holes, although, it had been present and growing for a considerable time. The fatigue striations indicate that the crack had been present over 250 cycles, estimated as being since May 2001. There was no specific mandatory requirement to inspect the torque tube and its location on the aircraft made it difficult to carry out a visual inspection. To detect the crack would have required removal of the torque tube and an NDI.

In 2004 Cessna issued an SID to remove and inspect the torque tube. This was applicable to N401JN and, as the aircraft was over 20 years old, the initial inspection threshold had been exceeded. Thus the inspection would have been carried out by 4 August 2005, had it been mandatory. Had the inspection been carried out it is possible that the crack would have been detected.

In Europe, for aircraft registered in EASA states, the Cessna SID is already mandatory for commercial air transport aircraft, and will be mandatory for all aircraft from September 2008. This date would have applied to this aircraft, had it remained on the UK register. However, N401JN was a US-registered aircraft and the SID would only be mandatory through the issue of an airworthiness directive by the FAA. To reduce the likelihood of further gear collapses, the following recommendation is made:

Safety Recommendation 2007-059

It is recommended that the Federal Aviation Administration mandate Cessna SID 32-10-05 for the Cessna 401/402 main landing gear torque tube, and mandate similar Cessna SIDs relating to main landing torque tubes of similar design.

ACCIDENT

Aircraft Type and Registration:	Cessna T303 Crusader, G-PTWB
No & Type of Engines:	2 Continental Motors Corp TSIO-520-AE piston engines
Year of Manufacture:	1984
Date & Time (UTC):	5 August 2006 at 1810 hrs
Location:	Denham Green, Buckinghamshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 5
Injuries:	Crew - 1 (Serious) Passengers - 5 (Serious)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	1,717 hours (of which 662 hours were on type) Last 90 days - 37 hours Last 28 days - 5 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was completing a day VFR flight from Durham Tees Valley Airport to Denham Airfield. As the pilot turned on to the final approach for Runway 06, the right engine ran down. The pilot attempted to increase power on the left engine but it did not appear to respond. The airspeed decayed and the right wing dropped. The aircraft descended into a wooded area short of the runway, seriously injuring all those on board.

The investigation identified that fuel starvation of both engines was the cause of the accident. One Safety Recommendation is made.

History of the flight

The pilot and five passengers were flying from Denham Airfield on a return day VFR flight to Durham Tees Valley Airport. The purpose of the flight was for all those on board to attend a football match in Newcastle. Having met his passengers at Denham, the pilot carried out the normal daily checks and taxied the aircraft to the refuelling pumps. He checked the fuel gauges and recalled that they indicated approximately 26 to 30 US Gallons (USG) per side. Using the aircraft's Information Manual (referred to in this report for clarity as the Pilot's Operating Handbook or POH), a conversion factor of 1 USG = 6 lbs was used; by this means it was calculated that each wing tank contained 156 to 180 lbs of fuel. With the assistance of one of the passengers reading the fuel delivery meter, he uplifted 70 litres of fuel into each wing tank (one litre of Avgas 100LL of typical density weighs 1.58 lb). This would have taken the total fuel on board the aircraft to between 533 and 581 lbs. After boarding the aircraft, the pilot and passengers secured themselves in their seats and both engines started normally.

The weather for the flight was good with a scattered cloud base between 3,500 ft and 5,000 ft, visibility in excess of 10 km and light winds. The aircraft was taxied to Runway 06, where the power checks were carried out with both engines responding normally. The aircraft departed at 1215 hrs and following a stepped climb, levelled at FL065. During the flight the pilot set the power to 23 inches of Manifold Air Pressure (MAP) with 2,300 rpm and leaned the mixture accordingly. The flight was uneventful and the aircraft landed at Durham Tees Valley Airport at 1332 hrs and taxied without delay to the parking area.

On arrival, the pilot checked the fuel quantity remaining which he recalled as approximately 30 USG per side or 360 lbs total. He noted that there was a slight imbalance between the left and right tanks but he could not recall which tank gauge indicated the lower quantity. From this he calculated that there was sufficient fuel for the return flight with approximately one hour's flying in reserve. The handling agent asked the pilot if he required fuel and the pilot declined.

Having attended the football match, the pilot and his passengers returned to Durham Tees Valley Airport and boarded the aircraft for the flight back to Denham. The pilot carried out his usual pre-flight inspection of the aircraft and once again checked the fuel gauges, confirming sufficient fuel was available for the return flight. The engines started normally and the aircraft was taxied to the holding point for Runway 23. The pre-takeoff and power checks were completed and the aircraft departed at 1656 hrs climbing to a cruising level of FL055. The power was again set at 23 inches MAP with 2,300 rpm and the mixture leaned.

The descent was initiated some 25 minutes prior to the intended landing. It was almost a continuous descent apart from levelling briefly on three occasions. At some point in the latter stages of the flight, the passenger occupying the front right seat noted some instrument indications and the pilot's actions. He saw two rectangular gauges, adjacent to each other with the indicating needles on one gauge just above a red marking and the other in the red marking. He also saw the pilot turn rotary selectors and pull a red 'T' shaped toggle lever out at the base of the inter-seat console.

The pilot, who suffered serious head injuries during the accident, had very poor recollection of some aspects of the flight, particularly just prior to the impact. He could remember operating the fuel crossfeed and thought he may have retarded one of the throttles to idle in order to conserve fuel. He could not recall the fuel quantity indications. He lowered the landing gear, set 10º of flap and turned the aircraft left on to the final approach at approximately 90 kt Indicated Air Speed (IAS). At some point in the left turn the right engine ran down and he advanced what he thought were both throttles, but the left engine did not respond. The passengers described the aircraft rolling to the right and the right engine running down followed by what appears to have been the intermittent sound of the stall warning.

Witnesses on Denham Airfield saw the aircraft execute the left turn on to the final approach at what they described as a slightly steeper than normal bank angle of between 30º and 40º. They could not hear the sound of the engines due to the ambient noise around them. The aircraft rolled to wings level but then continued to roll to its right pausing briefly at a bank angle of approximately 30º before the right wing and nose appeared to drop and the aircraft disappeared behind some trees.

Recorded information

The aircraft was not fitted with a Flight Data or Cockpit Voice recorder, and was not required to be so equipped. National Air Traffic Services, the provider of en-route air traffic control services throughout the UK, provided recorded radar data for both the outbound flight to Teesside and the return flight to Denham. This data included both altitude and position.

From the recorded radar data, the ground track of the aircraft and the vertical profile of the outbound and return flights were established. The ground track distance for the outbound flight was 196 nm and the return ground distance flown was 184 nm. This was a total increase of 24 nm over the planned distance of 178 nm. The flight profiles were plotted and used to estimate the outbound and return flight fuel consumption.

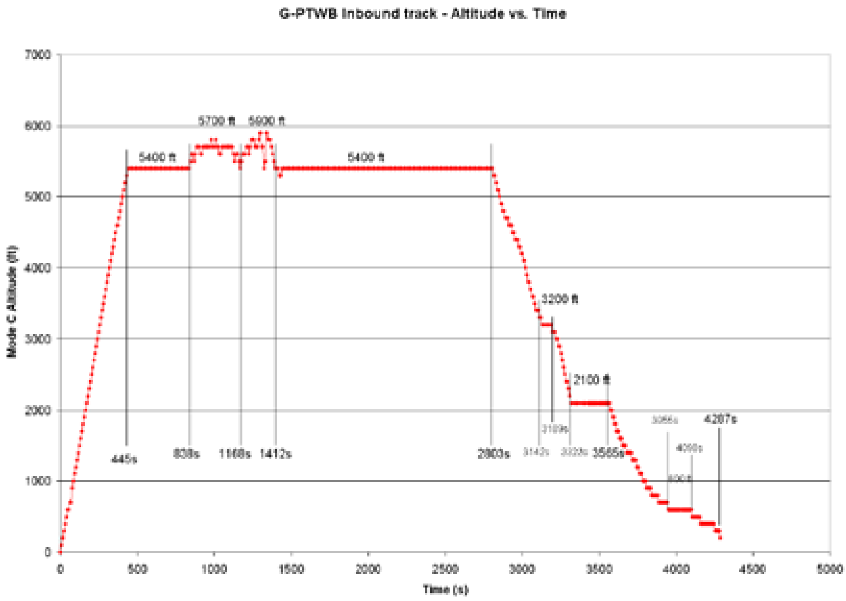


Figure 1

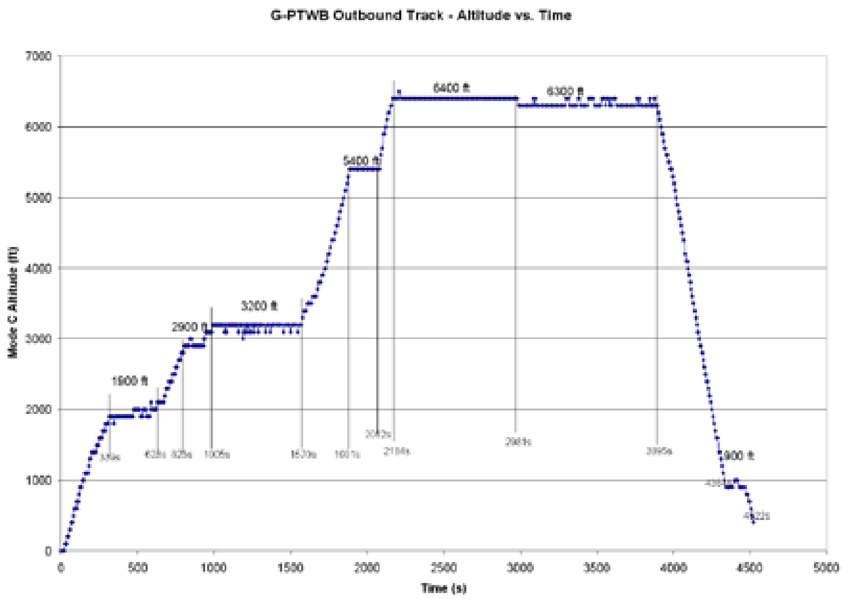


Figure 2

Survivability

The pilot and passengers were all secured in their seats by restraint harnesses. The pilot and front seat passenger had lap and diagonal, upper body restraints. The rear cabin passengers had lap restraints only. The aircraft had passed through the trees before striking the ground in a level attitude with virtually no forward speed. All those on board suffered serious injuries and were incapacitated, experienced different levels of consciousness and were unable to exit the wreckage. The rear cabin door on the left side had burst open during the impact. There was no fire.

The accident was witnessed and reported by a member of the public using his mobile telephone. He was promptly on the scene and provided detailed information to the police control room operator. The call was logged at 1810 hrs. The police initiated their Major Incident procedure and the first police officer was on the scene at 1817 hrs. The Denham Airfield staff, who had also seen the accident, immediately deployed the Airfield Rescue and Fire Fighting Service. Following some difficulty in locating the scene, they supported the police and paramedics in rendering assistance to the injured. The county Fire and Ambulance Services arrived and, following stabilisation and treatment by paramedics, the first casualty was extracted at 1858 hrs, departing for hospital at 1905 hrs. The last casualty was removed by ambulance from the scene at 1951 hrs and all the casualties were taken to hospital.

Training

On 4 August 2006, the day before the accident, the pilot completed his Licence Proficiency Check (LPC) and Instrument Meteorological Conditions (IMC) revalidation test. The person conducting the LPC was an experienced instructor/examiner who had carried out the pilot's initial conversion on to the type and periodical flight checks since he acquired the aircraft. The flight test comprised of simulated instrument flying, visual circuits and upper air work with both engines operating and single engine asymmetric handling. The pilot demonstrated a satisfactory level of flying and passed the LPC.

For the LPC, the aircraft departed Denham at 1206 hrs and landed back there at 1340 hrs giving a total flight time of 1 hour and 34 minutes. The start and taxi to and from the runway was estimated to take approximately 10 minutes. Prior to the flight the aircraft was refuelled to the half full indication on both fuel gauges giving a total fuel of 465 lbs. No weight and balance calculations were recorded but the examiner recalled that following the flight both fuel tank gauges indicated slightly more than one quarter full, which would have been at least 19.3 USG (116 lbs) per side, or 232 lbs total. Fuel used during the training flight would have been 233 lbs, giving a fuel consumption rate of 148 lbs per hour including start and taxi.

Following the flight check, both candidate and examiner seated themselves in the rear of the cabin. The examiner asked the pilot to explain how he would carry out the engine fire drill and the fuel crossfeed drill. The examiner stressed the need not to trust to memory for crossfeed procedures because, in his experience fuel crossfeed labelling was frequently ambiguous. The pilot correctly covered the memory items of the fire drill but stated that he would consult the aircraft checklist for the fuel crossfeed operation. Neither pilot nor examiner could find the crossfeed drill in the checklist and therefore consulted the fuel system description in the aircraft's POH.

From the fuel system diagram and the system description text, they concluded that to crossfeed fuel from the left tank to the right engine, two actions were required. The right engine rotary fuel selector should be turned to the CROSSFEED (yellow sector) position and the crossfeed emergency shutoff control should be pulled out to open the crossfeed fuel line. The use of the crossfeed emergency shutoff control is not clearly explained in the fuel system description. Immediately above the red coloured crossfeed emergency shutoff control, written in white letters on a black background, is the following instruction:

'PULL-EMER FUEL X-FEED SHUT OFF'

In the 'Emergency Procedures' section of the POH, the 'Engine Fire in Flight' and 'Landing Gear Malfunction' procedures clearly state the purpose and operation of the crossfeed emergency shutoff control. For example, in the 'Engine Fire in Flight' non-memory items and in three of the landing gear abnormal procedures, the following action is required:

'Emergency Crossfeed Shutoff - - PULL TO CLOSE'

The examiner and candidate read the text above the shutoff control but did not link the 'Fire Drill' non-memory action shown above. They had no reason to consult the landing gear malfunction procedures when discussing the crossfeed issue and therefore placed an incorrect interpretation on the information contained in the fuel system diagram.

An additional limitation was relevant when using the fuel system crossfeed controls. The crossfeed fuel line pickup in the tank was above the lowest point of the tank. In order to prevent the pilot attempting to crossfeed when the fuel level was lower than the pickup, a minimum fuel level and phase of flight was imposed. This was stated in the fuel system description as follows:

'If single-tank operation is being used when fuel levels are low, the fuel quantity in the tank in use should not be allowed to drop below 60 pounds prior to re-establishing normal single-engine per tank operation; this will avoid the possibility of dual engine stoppage due to fuel starvation.'

A note was also included to emphasise the phase of flight when crossfeeding fuel should not be used:

'The fuel selector valve handles must be turned to the NORMAL FLIGHT, L. TANK, T.O./LDG (green sector)position for the left engine and the NORMAL FLIGHT, R. TANK, T.O./LDG (green sector) position for the right engine for takeoff, landing and all normal operations. Crossfeeding is limited to level flight only.'

The information available to the pilot contained in the aircraft's POH regarding crossfeeding can be summarised as:

1. Only crossfeed during level flight and not during takeoff and landing.
2. Ensure that crossfeeding is stopped before the fuel quantity in the tank being used drops below 60 pounds (10 US gals).
3. The crossfeed emergency shutoff control is pulled to close the valves, not open them, and is not operated when crossfeeding.

Weather

An aftercast provided by the Met Office gave the synoptic situation at 1200 hrs on the 5 August 2006. It showed a ridge of high pressure extending across the British Isles from the south-west with a weak warm front lying north to south across the country. A light north to north-west wind covered the route. By 1800 hrs there was little change in the general conditions and the weather was good for the flight to and from Durham Tees Valley.

There was a possibility of slight rain from a strato-cumulus cloud layer mainly near the Teesside area but the weather was mainly dry throughout the route. The visibility was 20 to 30 km with a Mean Sea Level pressure of 1020 hPa.

In the Denham area at 1200 hrs, the cloud was mainly shallow cumulus base 3,500 to 4,000 ft with small amounts of strato-cumulus and cirrus above. The strato-cumulus layer increased to full cover around the East Midlands/Lincolnshire area, base 4,000 to 6,000 ft. For the return journey, extensive strato-cumulus covered the route from Teesside to the Cranfield area with the base around 3,500 to 5,000 ft. From Cranfield southwards it appears to have improved, with just small amounts of cumulus.

The table below sets out the actual winds for the altitudes given which were recorded from the Nottingham radiosonde ascent for midday on 5 August 2006. It is also a good guide to the winds later in the afternoon for the return journey and throughout the route. (Table 1)

Height AGL	Wind speed and direction
2,000 ft	300º/05 kt
5,000 ft	330º/05-10 kt
10,000 ft	020º/20-25 kt

Table 1

Fuel planning

Article 52 (e), '*Pre-flight action by commander of aircraft*' of the Air Navigation Order (ANO) places the following requirement on the commander:

'In the case of a flying machine or airship, that sufficient fuel, oil and engine coolant (if required) are carried for the intended flight, and a safe margin has been allowed for contingencies.'

The CAA produces Safety Sense Leaflets covering many aspects of aviation. Safety Sense Leaflet number 1e '*Good Airmanship*' contains a section on fuel planning and offers the following advice to private pilots:

'Fuel planning

- *Always plan to land by the time the tank(s) are down to the greater of ¼ tank or 45 minutes cruise flight, but don't rely solely on gauge(s) which may be unreliable. Remember headwinds may be stronger than forecast and frequent use of carb heat will reduce range.*
- *Understand the operation and limitations of the fuel system, gauges, pumps, mixture control, unusable fuel etc and remember to lean the mixture if it is permitted.*
- *Don't assume you can achieve the Handbook/ Manual fuel consumption. As a rule of thumb, due to service and wear, expect to use 20% more fuel than the 'book' figures.'*

From his evidence to the investigation, the power settings generally used by the pilot of G-PTWB in the cruise were 23 inches Manifold Air Pressure (MAP) and 2,300 propeller rpm on both engines. From the performance section of the POH, this equates to approximately 67% power or 143.5 lbs per hour cruise fuel consumption (2.4 lbs per minute). The POH states that a normal rate climb at 5,150 lbs All Up Weight (AUW) to 8,000 ft takes approximately 10 minutes and uses about 33 lbs of fuel (3.3 lbs per minute). Descent from 8,000 ft takes 10 minutes and the fuel required is given as 21 lbs, giving a consumption of 2.1 lbs per minute. Applying these consumption rates to the vertical profile of the radar data indicated that the fuel used on the first sector was 220 lbs and on the return sector was 186 lbs. To this must be added 25 lbs for the start, taxi and takeoff at Denham and Durham Tees Valley, giving an additional total of 50 lbs. Based on this calculation, the total fuel consumption for the 'round trip' flight was approximately 456 lbs.

From previous experience the pilot had derived a planning figure of 100 litres per hour. This was based on 80 litres per hour (126 lbs) consumption, with an additional 20 litres (32 lbs) for contingency or the equivalent of a total 158 lbs per hour. From his experience this provided adequate fuel for the flight he undertook with a reserve which, if not required, would still be available on landing. If payload permitted he would also take additional fuel depending on the weather or nature of the flight being carried out. He had not previously experienced any difficulties with a shortage of fuel.

The pilot used a planning airspeed of 160 kt which, given the light winds at his cruising level, he used as a groundspeed for calculating the time to cover the 178 nm track distance from Denham to Teesside. This gave a flight time of 66 minutes at the 158 lbs per hour rate, requiring 174 lbs for the flight up and 174 lbs for the return flight. To this he added 25 lbs for each sector for start, taxi and climb and one hour reserve giving a total fuel required of 556 lbs.

The POH contains comprehensive tables, graphs and examples covering fuel consumption for all phases of flight in order for a pilot to establish the fuel required for a specific flight. In the introduction to the Performance section, the following statement is made:

'It should be noted that the performance information presented in the range and endurance profile charts allows 45 minutes reserve fuel at the specified cruise power. Fuel flow data for cruise is based on the recommended lean mixture setting. Some indeterminate variables such as mixture leaning technique, fuel metering characteristics, engine and propeller condition and air turbulence may account for variations of 10% or more in range and endurance. Therefore, it is important to utilise all available information to estimate the fuel required for the particular flight.'

In the performance section, specific 'Fuel and Time Required' graphs were provided for 50%, 60% and 70% power. The graphs permit the pilot to calculate the fuel required for a specific distance, wind conditions, altitude and power setting. This includes the fuel used for engine start, taxi, takeoff, normal climb, descent and 45 minutes reserve. By entering the 50% power graph with a distance of 178 nm and nil wind, a fuel required of 265 lbs is obtained. By adding the 10% contingency from the note above, a fuel required of 291.5 lbs is obtained.

The manufacturers were provided with time versus altitude data for the flights and asked to calculate the fuel used during the round trip including ground taxiing. They concluded that, based on the Cruise Performance chart, with a flight time in radar contact of 2 hours and 27 minutes the aircraft used 377 lbs of fuel. Adding 25 lbs of fuel for start, taxi and climb at Denham and Teesside gave a total consumption of 427 lbs for the round trip flight.

If the Fuel and Time Required chart was used and the 45 minute reserve of 104 lbs subtracted the figure increased to 455 lbs. The difference was accounted for by the Fuel and Time Required chart including an allowance for start, taxi, climb and descent, whilst the cruise chart does not.

The AAIB calculation was based on the minute/lb burn rates set out above with 25 lb start, taxi and takeoff allowance at Denham and Teesside, and produced a figure of 444 lbs based on the performance at a maximum AUW of 5,150 lbs.

From the different methods of calculating the POH fuel consumption, the 'round trip' fuel consumption was estimated at between 427 lbs and 456 lbs.

Weight and balance

No written record of the weight and balance calculations carried out by the pilot was available to the investigation. The weights of the pilot and passengers are their actual weights at the time of the accident, subsequently provided to the investigation. The calculation set out below is based on the examiner's recollection of the fuel remaining on board the aircraft following the training flight, that is, approximately ¼ full. The addition of 70 litres per side on the morning of the accident has been added to that amount. (Table 2)

Using the pilot's recollection of the tanks being between 26 and 30 USG per side before refuelling at Denham, for the lower figure an additional 80 lbs should be added to the total fuel weight. At 30 USG per side, an additional 128 lbs should be added to the 453 lbs shown in Table 2.

The Maximum permitted TakeOff Weight (MTOW) for the aircraft was 5,150 lbs. The aircraft CG envelope at 3,300 lb was from the forward limit at 146.5 in to the aft limit of 157.2 in aft of the CG datum. The forward limit is constant to 3,800 lb and then reduces in a linear fashion to 151.2 in at the MTOW of 5,150 lb. The aft CG limit remains constant at 157.2 in up to the MTOW.

Item	Weight (lbs)	Arm (in)	Moment
Aircraft basic weight	3,696		559,083
Pilot	191	138	26,358
Front passenger	112	138	15,456
Middle seat passengers (2)	476	178	84,728
Rear seat passengers (2)	353	216	76,248
Cargo	25	250	6,250
Fuel	453		73,000
Departure Denham	**5,306**	**158.5**	**841,123**
Flight fuel burn	*220		
Landing Teesside	**5,086**	**158.37**	**805,489**
Flight fuel burn	*186		
At impact	**4,900**	**158.4**	**776,223**

*AAIB calculated leg consumption, no inclusion of 25 lbs for taxi and takeoff.

Table 2

From the weights provided and the estimate of fuel carried and consumed, the aircraft was operated initially 156 lb above the MTOW during the departure from Denham. This would increase to 284 lbs if the higher fuel quantity was carried. The CG was calculated initially at 158.5 in aft of the CG datum reducing to 158.4 in aft of the datum as fuel was consumed. This was beyond the aft CG limit for the aircraft throughout the flight.

When loading the aircraft, the pilot had placed the heavier passengers and baggage at the rear. By re-seating the heavier passengers at the front and lighter passengers at the rear, as well as placing the baggage in the forward baggage hold, the CG could have been brought forward of the aft limit. The aircraft could also have been operated within the MTOW of 5,150 lbs, if fuel for the outbound flight only had been carried, as set out below, although it would have been necessary to refuel for the return flight. (Table 3)

Medical

After the accident, the pilot was admitted to hospital and a sample of his blood was taken for hospital purposes. During the course of the day, the pilot had been seen to consume alcoholic beverage and analysis of the blood by the hospital indicated the presence of alcohol. The amount detected was not considered to be a major contributory factor in the accident but the exact effect on the pilot's performance could not be established.

Performance

The aircraft was observed by ground witnesses in a left turn with an angle of bank of 30º to 40º before rolling through the wings level attitude to approximately 30º right bank. At this point the right wing dropped. The stall speeds with 10º of flap set with an aft CG and the angle of bank flown are reproduced below, showing both indicated and calibrated airspeeds (KIAS and KCAS). (Table 4)

Item	Weight (lbs)	Arm (in)	Moment
Basic weight	3,696		559,083
Pilot	191	138	26,358
Front passenger	245	138	33,810
Middle passengers	418	178	74,404
Rear passengers	280	216	60,480
Forward baggage bay	25	82	2,050
Fuel	295*		48,800
Weight and CG at Takeoff	**5,150**	**156.31**	804,985
Weight and CG at Landing	**4,950**	**155.72**	

* The fuel required of 295 lbs would have been sufficient to operate the aircraft on the sector to Durham Tees Valley with 45 minutes reserves and 10% contingency, using 50% power settings.

Table 3

Angle of Bank	0°	0°	30°	30°	45°	45°	60°	60°
Weight (lb)	KIAS	KCAS	KIAS	KCAS	KIAS	KCAS	KIAS	KCAS
5150	57	62	61	67	68	74	81	88
4650	53	59	57	63	63	70	75	83

Table 4

A note states that:

> *'Altitude loss during an engine inoperative stall recovery may be 300 feet with a pitch below the horizon of 30°.'*

As an indication of the aircraft's performance with one engine inoperative at 4,800 lbs at sea level, the rate of climb at 97 kt (V_y) with the failed engine propeller feathered, landing gear and flap retracted and maximum power set on the operating engine is 270 ft per min. The following decrements must be subtracted from that rate of climb to calculate the aircraft climb/descent performance. (Table 5)

Configuration	Decrement
Landing gear extended	-350 ft/min
Flaps extended 10º	-50 ft/min
Flaps extended fully	-450 ft/min
Inoperative propeller windmilling	-250 ft/min

Table 5

With landing gear lowered, flap set to 10° and the right propeller windmilling, a net rate of descent of 380 ft/min would result. If power was not available from the left engine, the drag from both propellers windmilling and the aircraft configuration would have resulted in a rapid loss of airspeed had a positive nose-down attitude not been adopted.

Significant Aircraft Features

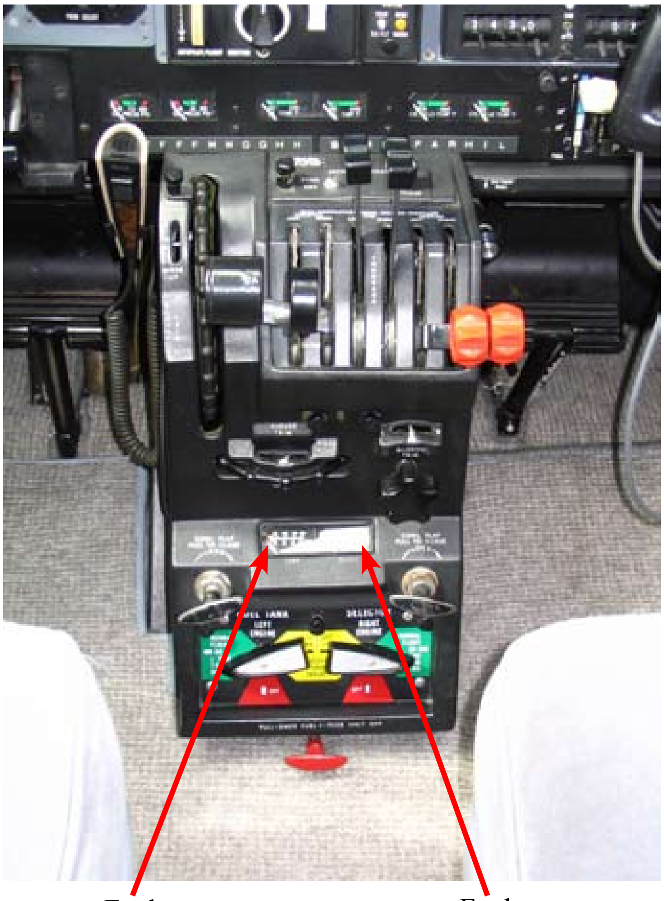
The aircraft type is equipped with two integral fuel tanks. These are positioned in the outer wings and are formed by the upper and lower skins and the front and rear wing spars. They are bounded at their inboard ends by closure ribs, approximately co-incident with the outboard sides of the engine nacelles, and extend outboard from there to stations close to the wing tips. The fillers are at the outboard ends of the tanks and since the wing has significant dihedral, the tanks can contain a large proportion of their capacity before any fuel can be seen via the filler orifices.

The fuel pick-up points are positioned at the forward and aft ends of manifolds sited at the extreme inboard ends of each tank. Each pick up point is positioned close to the plane of the lower wing skin and is closed by an individual float valve. Thus, when fuel is present at the pick-up point, the valve admits it to the manifold, but when it is absent, closure of the valve prevents air from flowing into the manifold. The POH states that each tank has a maximum capacity of 77.5 USG, whilst the total unusable fuel is quoted as 2.0 USG.

The fuel system supplies the engines via fuel selector valves positioned in the wings, just inboard of the tanks. These are controlled, via sliding cables within conduits, by means of handles mounted on a console between the two front seats, just above the cabin floor. The relevant tank contents gauges are to be found above the fuel selector handles. Each of these is annotated with white markings on a black background at 10, 30, 50, and 70 USG levels. These numerical indications are positioned below a horizontal white line. Above the line, fuel quantities are annotations in lbs. Those graduations indicated are at the 100, 200, 300 and 400 lbs levels. The section which appears to fall between the empty and 10 USG graduations on each gauge is coloured yellow and white, whilst a narrow red line graduation is positioned approximately at the empty position.

Each selector can be turned to the 'OFF', 'ON' or 'CROSSFEED' position. With the selector set to the 'ON' position, the relevant engine is supplied by the tank on the same side of the aircraft. When the 'CROSSFEED' setting is selected, the engine on the same side as that selector receives fuel from the tank on the other side of the aircraft, via crossfeed pipes which pass beneath the cabin. To prevent leakage of fuel, should one or both crossfeed pipes become damaged, crossfeed shutoff valves are provided. These are fitted close to the tanks. They ensure that only the fuel volume within the pipes, and no fuel from either tank, can be lost through any crossfeed pipe leakage once the shutoff valves are moved to the 'OFF' position. Both shutoff valves are operated via cables within conduits from a singe T-handle below the fuel selector valve console. If the handle is pulled when both fuel selectors are in the 'ON' position, engine operation is not affected. If, however, it is pulled when a fuel selector is set to 'CROSSFEED', the supply to the engine on the side of the selector with that setting will be interrupted and the engine will not continue to operate. The cross-feed shut off valve control handle is painted red, signifying its emergency control status.

The crossfeed pipes have open pick-up points positioned on the inboard closure ribs of the fuel tanks, significantly above the plane of the lower wing skins. Air can thus be drawn into the crossfeed system and thereby interrupt the fuel supply to the engine selected to crossfeed, if the fuel in the tank in question is below the level of the orifice of the crossfeed pick-up.



Fuel gauge Fuel gauge

Figure 3

Fuel system controls and gauges

The fuel divider units on the engines each incorporate a spring-loaded valve. This shuts off the fuel supply to the injectors positively when the fuel pressure to the relevant divider drops below a threshold. Loss of fuel supply to an engine fuel/air control unit thus results in closure of the valve and engine stoppage. A volume of fuel, however, remains in the engine fuel system upstream of the flow divider, following such engine fuel starvation.

SECTION 7
AIRPLANE & SYSTEMS DESCRIPTIONS

CESSNA
MODEL T303

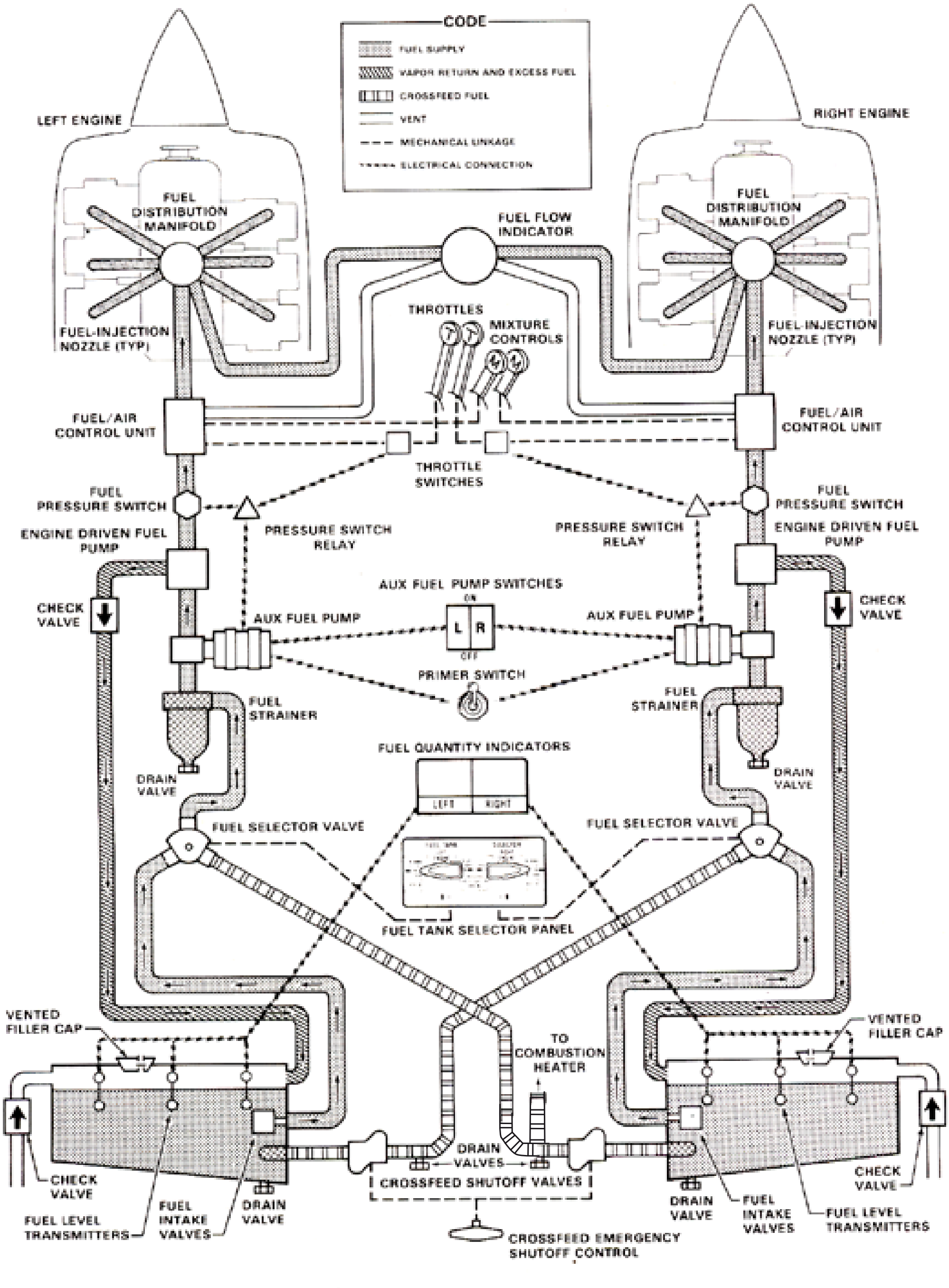


Figure 4

Fuel system diagram

The accident site

The aircraft came to rest in a wings-level attitude on an upward sloping surface in dense woodland, at a point having no significant ground vegetation. The slope formed the upper part of a railway embankment. Examination of the damaged trees revealed that the aircraft had struck and demolished one, but had inflicted little damage to adjacent trees. It had come to rest while moving laterally to the right, as indicated by the vertical trunk of a small tree which had penetrated the wing tip and travelled inboard for approximately ½ metre. A substantial branch had passed vertically between the elevator and the horizontal stabilizer. Both engine nacelles were deformed into a pronounced 'hogging' (ie down at the extremities) shape. Extensive damage had been inflicted to the nose of the aircraft forward of the windscreen although no significant longitudinal compression damage was evident. The fuselage was reduced in depth and the tail unit, complete with fuselage tailcone, was separated from the aft end of the fuselage. The seatback of one of the rear row of forward facing seats had collapsed backwards.

Both propellers were in the normal operating range and the lower two blades of both were embedded in soft soil. Neither propeller exhibited any evidence of rotation at impact. A number of tree boughs were found to have been chopped in an orientation approximately perpendicular to the branch axes. It was known, however, that sawing equipment had been used to cut away timber to gain access to the forward end of the cabin during rescue operations. This created significant quantities of cut timber of similar appearance to tree boughs having suffered blade strikes from fast rotating propellers.

The aircraft had the landing gear extended and one stage of flap (10º) was set.

On entering the aircraft cabin it could be seen that the right fuel selector was in the crossfeed position whilst the left selector was in the normal tank to engine position. The crossfeed shutoff control was in the shutoff position.

After initial examination, the aircraft was dragged approximately four metres forward on to level ground, using strops attached to the main landing gears, in order to ensure there was no danger of it sliding down the embankment and descending through trees on to the adjacent railway track. It was subsequently noted that the interior of the right tank at its inboard end could be seen through a hole in the upper wing surface. No fuel was present. The lower surfaces of the tank appeared to be undamaged so it was postulated that the tank may have been empty at impact. When a quantity of water was poured into the tank filler, however, a rupture was identified where the lower edge of the rear spar had deformed close to the inboard end of the tank. A hole deliberately created in the top skin of the left tank revealed that it was also empty and introduction of water revealed a correspondingly positioned rupture to that identified in the right tank. Samples of the water introduced into the tanks were then recovered in a transparent beaker and examined. Only a scarcely detectable layer of hydrocarbon appeared to be present on the surface of the water from each tank.

It was reported that rescue of the occupants initially required access to both sides of the aircraft from the rear, involving rescuers passing behind the points of tank rupture. With the aircraft on a steep slope this required personnel to pass below the points from which any fuel present would have drained immediately after the impact. None of the personnel on the scene immediately after the impact reported seeing or smelling any fuel or noticing any dampness of the otherwise very dry soil. The absence of surface vegetation precluded the examination for discolouration which often reveals the presence of Avgas residue.

Detailed examination

The aircraft was cut into a number of sections for removal from the woods before being transported to the AAIB headquarters where a detailed examination was carried out. Prior to separation of structural elements, all piping requiring cutting was crushed flat using special equipment, thus sealing the ends against loss of fuel or ingress of other substances. The crushed areas were then cut at mid length, preserving, as far as possible, the sealing effect of the crushing on both sides of the cut.

During subsequent examination, the settings of the two fuel selector valves and the crossfeed shutoff valves were established by determining the presence or absence of flow resulting from application of air pressure to various fuel lines following cutting away of the crushed sections. It was thereby established that all four valves were set to the same position as their cockpit selectors indicated. Both crossfeed pipes were found to contain fuel.

The powerplants were removed from the firewalls and examined in the presence of the AAIB and a specialist provided by the engine manufacturer. All the engine fuel system components were rig tested in accordance with their manufacturer's specifications. All were found to contain varying amounts of fuel and to function correctly, with the exception of one variable fuel valve mounted co-axially with its throttle butterfly. This valve exhibited a small volume leak. Examination of the local area revealed no evidence of discolouration from pre-accident leakage in this area, however. Examination of the seals on the shaft in the region of the leakage did not reveal any excessive wear, deterioration or damage. The possibility that slight bending of the shaft had occurred during the impact resulting in reduced performance of the seal could not be ruled out.

Strip examination of both engine carcases revealed no evidence of pre-crash failure.

Discussion

From the evidence at the accident site, it could be deduced that the aircraft had struck the top of a tree in an approximately erect attitude with very little forward speed but significant vertical speed. The restriction of major damage to one tree in a wood of closely spaced trees all of similar height was a particularly positive indication of this. It was further concluded that the presence of the tree had reduced the final descent rate. The ground impact force on the main landing gear appeared, however, to have been sufficient to produce the deformation of the nacelles and contributed to the flattening of the cabin. Some backward motion during the impact sequence was evident from the backward collapse of one of the seatbacks. Damage inflicted to the right wing tip and to the elevator / horizontal stabiliser junction was indicative of, respectively, lateral and vertical motion through the trees, whilst absence of wing leading edge damage confirmed an absence of significant forward motion.

The impact with, and subsequent destruction of, the one tree had left no positive evidence as to the pitch and roll attitude at initial contact. The lack of leading edge impact damage and the failure of the aircraft to impact nose-down between trees tended to confirm the view that tree-top impact occurred in an attitude not grossly different from that of normal flight. It indicated significant downward rather than forward motion.

The propellers exhibited no evidence of rotation, although the soft ground and lack of forward speed constitute conditions which frequently leave no evidence even when significant power is known to have been produced at impact.

There are two possible reasons for the absence of fuel visible through holes in the upper skins at the inboard ends of both tanks:

(1) The tanks were empty at the time of the accident, or

(2) At the time of the impact the remaining tank contents all drained through the ruptured rear spar joints at the inboard ends of the tanks.

The latter event is a possibility since the aircraft initially came to rest on a slope in a nose-up attitude causing the ruptures to be positioned close to the lowest points in the tanks. The wreckage was only subsequently dragged to a level surface where much of the examination took place. It is surprising, however, that a small residue of fuel from the extreme low point of the tanks did not remain when the tanks were examined.

Although some fuel was found in components of the engine-mounted fuel systems and pipe-work, one component was damaged by the impact and had allowed some leakage to take place. It was thus not possible to compare usefully quantities of fuel in the two engine systems. It should be noted that the flow divider unit incorporates a spring-loaded shutoff valve so that when air enters the engine system leading to a loss of delivery pressure, the valve will shut off. This causes power loss even though a significant volume of fuel remains in the components and pipe-work. The presence of fuel in these areas, therefore, does not necessarily indicate that fuel was still being supplied from either tank at the time of the impact.

The use of a cable and conduit system for controlling the fuel tank selector and crossfeed shutoff valves makes it unlikely that either the valves or their controls moved from their immediate pre-impact positions. This is despite the considerable impact distortion of the fuselage relative to the wing structure.

The settings of the valves, as determined from tests using air pressure, confirm that the left fuel valve was in the normal position, the right valve was in the crossfeed position and both crossfeed shutoff valves were in the closed position. These all corresponded with their cockpit selections as found during the site examination and this is presumed to have been the situation at the time of ground impact.

The signs of a lack of forward motion through the trees, the relatively intact, although severely damaged state of the aircraft and the survival of the occupants indicate relatively low energy at the time the aircraft struck the trees. These factors are consistent with both a low forward speed and low height at the time control was lost. Although the engine power at impact could not be determined, it appears that the impact was consistent with a stall rather than the consequences an asymmetric power induced control loss during the approach.

No failure or defect within the aircraft or its propulsion system was identified.

Fuel starvation was probably the main causal factor of the accident, although fuel exhaustion could not be ruled out. The lack of a record of the aircraft fuel state prior to the departure from Denham or Durham Tees Valley meant accurate departure fuel quantities could not be established. There were two different recollections of the fuel quantity remaining onboard the aircraft after the training carried out on the day before the accident. The examiner recalled slightly more than ¼ full or 19.5 USG per side and the pilot thought there was 26-30 USG per side. With the addition of 140 litres of fuel prior to departure from Denham the quantity onboard was between 453 lbs by the examiner's recollection, and up to 581 lbs from the pilot's.

No precise quantity of fuel consumed on the 'round trip' flight could be established but using fuel consumption data from the POH, between 427 lbs and 455 lbs was considered a reasonable estimate.

The two gauges, one alongside the other, which were observed by the front right seat passenger, were probably the fuel gauges. The needle on one gauge was just above the red and the other was in the red. Whilst he could not remember exactly at what point he saw them, from his description it was just prior to the approach to Denham. The red line indicates the tank is almost empty and therefore suggests that the fuel in the tank with the needle in the red was about to run out. The other tank contained a small amount of fuel. The pilot also recalled seeing an imbalance but could not recall the indications.

These indications were consistent with the pilot reducing power on the engine on the side with the tank with the lowest fuel contents, and attempting to crossfeed from the other tank, which had slightly more fuel remaining. From the position of the crossfeed selector and valve, the right tank was the tank which contained least fuel, and was nearly empty. Opening the crossfeed, however, would not draw fuel from the left tank as the level was below its crossfeed fuel pick-up. If sufficient fuel had been available to crossfeed, the effect of pulling the crossfeed emergency shutoff would have been to prevent the right engine drawing fuel from the left tank. However, this was not relevant at such a low fuel state since crossfeeding was not possible. The right engine therefore ran down and with the propeller not feathered the aircraft would have yawed to the right.

The information contained in the POH (Information Manual) and the crossfeed labelling was not clearly understood by either the pilot or the LPC examiner, and so the following Safety Recommendation is made:

Safety Recommendation 2007-086

The Federal Aviation Administration should review the Cessna T303 Crusader Information Manual and Checklists to ensure that clear and unambiguous information is provided for the operation of the fuel crossfeed system.

If the left tank fuel was also exhausted, then the left engine would also have run down. If, however, useable fuel remained in the left tank, it is possible that in the 30º- 40º left bank, with the aircraft yawing to the right, the fuel migrated towards the left wing tip and uncovered or partially uncovered the normal fuel pick-up. Again, the left engine would suffer a reduction in power, or stop.

With the left engine not responding and the right engine propeller not feathered, airspeed would have decayed rapidly from the 90 kt approach speed. The stall speed is given as 60 to 65 KCAS depending on the angle of bank. If the nose was not lowered positively the aircraft would stall and possibly drop a wing. This was the behaviour described by the witnesses on the ground.

There was no evidence of fuel on the ground, and none was reported escaping by those first on the scene. Although a small spillage might not have been obvious, larger amounts should have been evident from smell and visible leaks. From this, it is probable that the fuel on board on departure from Denham was closer to the lower estimate of 453 lbs than the higher estimate of 581 lbs.

The pilot had not carried out a full weight and balance calculation to determine the AUW and balance of the aircraft. Had he done so the limited amount of fuel that could be carried and the CG position outside the permitted envelope should have been apparent. With the weight of the aircraft, the pilot, passengers and baggage, only 297 lb of fuel could be carried in order to remain below the 5,150 lbs MTOW. By re-arranging the passenger seating and baggage, the CG could have been moved forward to within the permitted envelope.

With only 297 lbs of fuel available, the aircraft could have operated the Denham/Durham Tees Valley sector with 45 minutes reserves and 10% contingency at 50% power. This would not have met the Safety Sense leaflet recommendation of 20%. Refuelling at Durham Tees Valley would have been necessary for the return flight.

Conclusions

The pilot was properly licensed and qualified to conduct the flight. The aircraft was fully serviceable and the weather was suitable for the flight and was not a factor in the accident.

From the evidence provided, the loading of the aircraft was such that it was operated initially above the MTOW of 5,150 lbs and throughout the flight the aircraft was operated outside the aft CG limit of 157.2 inches aft of datum.

With the payload being carried, the aircraft was not capable of safely completing the 'round trip' flight and remaining within the permitted weight and balance envelope without refuelling at Durham Tees Valley. Insufficient fuel was carried for adequate reserves and contingency fuel to complete the flight.

The pilot had consumed alcoholic beverage during the day but the effect on his decision making and aircraft handling ability is not known.

During the approach, the fuel crossfeed was used, which was not permitted. The selection of crossfeed from the left tank to the right engine was probably the cause of the right engine running down. This was due to insufficient fuel contents being available to allow fuel to be drawn from the left tank by the crossfeed pick-up. Pulling the crossfeed emergency shutoff control therefore did not contribute to the accident.

The accident was caused by fuel starvation of both engines with the right engine ceasing to produce power and the left engine operating at reduced power or stopping. Control was then lost when the airspeed decayed and the aircraft stalled, dropping the right wing.

INCIDENT

Aircraft Type and Registration:	Fairchild SA227 AC Metro III, EC-JCU
No & Type of Engines:	2 TPE331-11U-612G turboprop engines
Year of Manufacture:	1987
Date & Time (UTC):	10 October 2006 at 1510 hrs
Location:	Lasham Airfield, Hampshire
Type of Flight:	Commercial Air Transport (Cargo)
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Tyre damage, and all four brakes replaced due to overheating
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	33 years
Commander's Flying Experience:	2,150 hours (of which 1,915 were on type) Last 90 days - 210 hours Last 28 days - 70 hours
Information Source:	AAIB Field Investigation

Synopsis

The lightly loaded aircraft commenced the takeoff with its centre of gravity towards the forward end of the permitted range; the co-pilot was the handling pilot. The aircraft did not respond as expected when he attempted to rotate the aircraft and he handed control to the commander. The commander aborted the takeoff and the aircraft overran the paved surface of the runway on to an area of grass stubble.

The investigation found no technical fault that could have contributed to the apparent control problem. Experience had shown that, for this type of aircraft, a large aft control column movement is required during rotation when the centre of gravity is close to the forward limit. Although there was nothing in either pilots' training records that could have had a bearing on this event, the crew was relatively inexperienced and it was considered that this was a factor in the incident. The aircraft has subsequently carried out a number of uneventful takeoffs and responded normally to control inputs.

One Safety Recommendation is made with regards to the flight data recording system.

History of the flight

EC-JCU had positioned from Coventry to Lasham with the two pilots and their personal bags on board. The aircraft had departed from Coventry with a calculated takeoff weight (TOW) of 12,972 lbs and a calculated centre of gravity (CG) 262 inches aft of the datum, close to the forward limit. The commander was the pilot flying (PF) and the flight was completed without incident. After landing on Runway 09 at Lasham, the commander re-trimmed the horizontal stabiliser to the middle of the takeoff range during the after-landing checks, in accordance with normal procedure. This operation was confirmed by a recording of the aural warning associated with horizontal stabiliser trim operation, as detected by the Cockpit Voice Recorder's (CVR) area microphone on the flight deck.

During the turn around, the aircraft was refuelled to a total of 4,300 lbs of fuel and loaded with 44 lbs of cargo, which was placed in the forward (No 1) cargo bay in the cabin. The crew calculated a TOW of 14,492 lbs for their departure; the maximum TOW was 16,000 lbs. Their calculation was based on an assumed cargo load of 220 lbs in the centre (No 2) cargo bay and 100 lbs of baggage in the aft baggage compartment. They calculated the CG to be 264.5 inches aft of the datum, further aft than for the departure from Coventry, but still within the forward portion of the CG range.

The co-pilot was the PF for the departure from Runway 09 and initiated a rolling takeoff from the runway 'numbers', just ahead of the threshold markings, by setting an intermediate power setting with the brakes off. With the PF monitoring the position of the power levers, the pilot not flying (PNF) trimmed the levers to a takeoff power setting of 87.3% torque. The PNF made the standard operating procedure (SOP) calls at 60 kt and 80 kt, which were confirmed by the PF, and called "V_1" and "ROTATE" at 109 kt and 112 kt respectively. On hearing the commander call "ROTATE", the co-pilot pulled back the control column "a bit". He reported that the aircraft did not respond, so he pulled back the control column "a bit more". The aircraft still did not respond, so the PF returned the control column to its forward position before making another attempt. He reported that he then pulled the control column back half to three-quarters of its full travel. The nose of the aircraft pitched up a small amount but no further. He advised the commander of the problem. The commander took control and, after trying to rotate the aircraft himself, without success, he rejected the takeoff by applying reverse thrust and maximum braking. EC-JCU departed the end of the paved surface and ran on to an area of grass stubble. The commander advised Lasham Air/Ground radio that they and the aircraft were safe, before shutting the engines down. Neither pilot was injured.

The crew of one of the airfield's fire vehicles, which was positioned at a holding point on the north side at the upwind end of the runway, had followed the aircraft when they saw it pass them, at speed but still on the ground. They too reported the aircraft's predicament to the airfield's Flight Information Safety Officer (FISO), who was in the airfield's control tower, near the downwind end of the runway; he had not seen the incident because of the convex nature of the airfield surface.

Although the brakes were hot there was no fire, and the crew exited the aircraft normally. Before leaving the aircraft, the pilots carried out a 'full and free' check of the flying controls and confirmed that the elevator responded normally to flying control inputs initiated from the flight deck. They also confirmed that the horizontal stabiliser was in the middle of the takeoff range, as indicated on the instrument panel.

Damage to the aircraft

There was a deep cut approximately 10 cm long on the No 3 tyre. (The No 3 wheel is the inboard of the two wheels fitted to the right main gear leg.) Following a subsequent inspection at the aircraft's base maintenance organisation all four brakes were replaced due to wear and suspected overheating.

Personnel information

The commander had flown a total of 2,150 hrs on all types of aeroplane. He had flown 1,915 hrs in the SA227, and 250 hrs of these were as commander.

The co-pilot had flown a total of 585 hrs on all types of aeroplanes; 295 hrs of these were in the SA227. He had completed his training in March 2006.

The pilots had flown together once before, and the investigation revealed nothing in either pilots' training records that related to the handling of the flying controls during the takeoff.

Aircraft information

The Fairchild SA227 AC Metro III is powered by two turboprop engines and is certified for single pilot operation in the cargo configuration.

The elevator is actuated via a closed loop cable system that is connected to the control columns in the cockpit at one end, and to the elevator quadrant, mounted in the fin, at the other. The cables are guided under the floor of the fuselage and through the tail by a series of pulleys. There is no option to disconnect one of the control columns from the cable system manually, as is the case on some aircraft.

The aircraft is trimmed in pitch by an all-moving horizontal tailplane, which is operated through a three-position thumb switch on each control yoke; when either of these switches is moved from its neutral, central position, the pitch trim actuator, in the fin, moves the horizontal tailplane either nose-up or nose-down. In addition, there is a central console-mounted backup switch. An electronic horn sounds intermittently during operation of the pitch trim actuator. The middle 45% of the operating range of the tailplane incidence is the valid range for takeoff. There is a dial in the cockpit which indicates the amount of nose-up or nose-down trim that has been applied. The manufacturer's Before Taxi checklist includes an item on checking the stabiliser trim system before takeoff. Explanatory material advises the crew that:

> *'All takeoffs should be made with the stabilizer trimmed within the takeoff band marked on the trim indicator. When the airplane is loaded to a forward center of gravity configuration, the stabilizer should be trimmed to the nose up end of the takeoff band; for aft center of gravity configurations, the stabilizer should be trimmed to the nose down end of the takeoff band.'*

If the horizontal tailplane is not within the valid range during the takeoff run, a loud continuous electronic alarm sounds. The logic for this alarm requires the pitch trim to be out of the central range, the power levers to be advanced and for weight to be on the wheels.

The aircraft has two systems that provide retardation. The primary method is to select reverse thrust on the engine power levers which changes the pitch angles of the propeller blades. Additional braking is provided by four brakes, one mounted in each of the four main wheels. The brakes on EC-JCU did not have an anti-skid system fitted.

Weight and CG

The TOW and CG position were recalculated using the actual weights and locations of the load. This consisted of 44 lbs of cargo in the No 1 cargo bay; 31 lbs of manuals and wheel chocks in the nose baggage compartment, and replacing the allowance for 100 lbs of equipment in the aft baggage compartment with the actual figure of 28 lbs for personal bags. The remainder of the equipment had been included in the aircraft's Operating Weight Empty (OWE) and its associated CG index. This gave a TOW of 14,275 lbs and a CG 262 inches aft of the datum; the same CG position that had been calculated for the departure from Coventry. The permitted CG range at that weight is from 260.4 inches to 277 inches aft of the datum.

Aircraft handling characteristics

During the investigation, the manufacturer and another operator of the SA227 were contacted regarding the handling characteristics of the aircraft during takeoff. They confirmed that with a forward CG the handling pilot would be required to pull the control column back a large amount in order to rotate the aircraft and complete the takeoff.

Meteorological information

The weather conditions at the time of the incident were good. The surface wind was from 160º at 5 kt, there was scattered cloud at 1,500 ft agl, the visibility was greater than 10 km, the temperature was 18ºC and the QNH pressure setting was 1014 hPa. Lasham Airfield lies at an elevation of 618 ft amsl.

Performance

Runway 09 at Lasham Airfield is 1,797 m in length and has an asphalt surface. It is unlicensed and, on the basis of balanced field constraints, the values for the Take Off Distance Available (TODA) and Accelerate Stop Distance Available are both 1,797 m.

At the correct weight of the aircraft, and in the ambient conditions, V_1 and V_R were confirmed as 109 kt and 112 kt respectively. The Take Off Distance Required was approximately 500 m less than the TODA.

The commander initiated the rejected takeoff procedure nine seconds after calling "V_1". In nine seconds, at that speed, the aircraft would have travelled a further 498 m beyond the point of the V_1 call. However, since the aircraft was accelerating during this time the distance it travelled after V_1, and before the takeoff was rejected, would have been greater.

Flight recorders

The aircraft was fitted with a 30-minute duration CVR and a 25-hour duration Flight Data Recorder[1] (FDR) that recorded five parameters[2]; these did not include aircraft attitude, pitch trim, control surface or column positions.

Both recorders were removed and replayed at the AAIB. The abandoned takeoff and overrun had been recorded on the CVR and, in addition, the previous approach and landing were also available. The FDR contained the previous 13 flights, plus the abandoned takeoff, but it was found that the recording of airspeed was defective. This is discussed in detail later.

Recorded data

On the previous flight the pitch trim activation tone could be heard during the final approach and landing. After the landing the tone was activated for a further 4 seconds. No further activation was recorded.

During the attempted takeoff from Lasham the Commander called "60 kt", "80 kt", "V_1" and "ROTATE". About 4 seconds after the commander had made the last call the co-pilot advised the commander that the aircraft

Footnote

1 The FDR was manufactured by L-3 Communications; part number 17M900-274, serial number 729.

2 Altitude, airspeed, heading, normal acceleration and radio keying.

would not rotate. Three seconds later the engines could be heard to enter the reverse range, eight seconds later the aircraft overran the end of the runway, finally coming to a stop after a further six seconds. About 40 seconds had elapsed from the start of the takeoff roll to the commander calling V_1. At the start of the roll, engine power was initially set at about 80% of the takeoff power setting, before being increased to takeoff power about 8 seconds after the roll had commenced (about 32 seconds before the commander had made the V_1 call).

Due to a fault with the FDR, the airspeed parameter had remained at zero knots during the entire takeoff roll.

FDR airspeed parameter

Analysis of the thirteen previous flights indicated that the recorded airspeeds at takeoff were significantly lower than expected and that, during a number of approaches, the recorded airspeed had reduced to zero before the aircraft had landed. During all of the takeoffs the airspeed was observed to increase suddenly from zero to about 65 kt, always occurring shortly before the takeoff point. The airspeed value then gradually increased during the climb and then stabilised prior to the descent and landing. No airspeed values lower than 65 kt, other than zero, had been recorded at any time.

The FDR was located in the rear section of the aircraft, just forward of the empennage. The FDR obtained both airspeed and altitude parameters by means of pneumatic lines which were connected to the co-pilot's airspeed indicator (pitot) and altimeter (static) lines. Both inputs were connected to the FDR, and internal transducers then converted the pneumatic information to electrical signals, prior to being processed for recording onto the FDR tape. The relationship between pneumatic pressure and electrical output signal is not linear across the transducers' operational range. At speeds below the normal flight envelope of the aircraft, about 100 kt, the transducer is not required to be as sensitive to pressure changes when compared to that at higher airspeeds.

The FDR was taken for testing to an approved repair agency, where it was confirmed that the FDR airspeed parameter was defective. Under ideal test conditions the FDR started to record an airspeed value of about 30 kt when the actual airspeed reached about 100 kt. At a recorded value of about 65 kt the actual airspeed was about 117 kt. As the airspeed increased the error gradually reduced to a minimum of about 20 kt below that of the actual airspeed.

The altitude parameter was tested and found to be serviceable and a leak test was performed on both the FDR airspeed and altitude transducers, which were both found to be within manufacturer's specifications.

A serviceable unit of the same type was then tested to confirm when it would start to record airspeed. Recording commenced at about 10 kt. Historical records of other similar aircraft installations were assessed and it was found that airspeed recording typically started at about 12 to 14 kt, consistent with the results of the serviceable unit.

Built In Test Equipment

The unit's Built In Test Equipment (BITE) was not capable of detecting a fault of this type, and thus no failure warning would have been indicated by the FDR. To determine a fault of this type, a readout would have been required, followed by appropriate analysis of the recorded data.

FDR annual replay requirement

To determine how long the FDR airspeed recording defect may have been present the operator was asked if they held records of any previous readouts from the FDR. The operator advised that they had never performed an FDR readout for EC-JCU. Discussions with the Spanish Aviation Authorities highlighted that there was no requirement for an operator to perform a readout of the FDR under JAR-OPS 1 and that no supplemental requirement existed in Spain.

UK legislation has included a requirement to perform a routine readout of the FDR for many years. UK operators are required to preserve a record of one representative flight made within the last 12 months from the FDR and must ensure that the recording system, and those parameters recorded by it, are serviceable. To assist operators in complying with this requirement, the CAA has provided instructions in document CAP 731 "*Approval, Operational Serviceability and Readout of Flight Data Recorder Systems*".

ICAO Annex 6 Part I states that an annual readout of the FDR should be performed and that a complete flight from the FDR should be examined, in engineering units, to evaluate the validity of all recorded parameters. JAR-OPS 1 provides for the preservation of recordings but it does not include a requirement to perform a routine readout of the FDR. This however differs from JAR-OPS 3 (Helicopters) which does include a requirement to readout the FDR within the last 12 months. Neither JAR-OPS 1 nor JAR-OPS 3 includes a requirement to evaluate the validity of all recorded parameters.

Incident site information

The aircraft had come to a stop in the grass overrun area on a heading of 110°, the nose landing gear was 34 m from the end of Runway 09 and 13.5 m to the right of the runway centre line. There were tyre marks on the runway leading to where all four main wheels went onto the grass. The longest of the tyre marks were over 200 m long, and became progressively less noticeable further back along the runway; it is therefore probable that that the brakes were applied before the marks become visible.

Aircraft inspection

The elevator travelled through its full range, without any hindrance, when operated from either pilot's seat; this concurred with the checks made by the pilots immediately after the incident. The elevator control runs from the control columns to the elevator quadrant in the fin were inspected and no control restriction or evidence of a foreign object was found.

The elevator control system is fitted with a bob-weight to enhance pitch stability and a damper to dampen any sudden movement to the elevators. The damper was found to have leaked slightly and this was removed for inspection. The inspection revealed nothing of significance.

The pitch trim actuator system was inspected and functionally checked. The pitch trim actuator system, including the actuator indication in the cockpit, was found to operate satisfactorily. During subsequent high speed taxi tests the aircraft responded normally to the elevator commands and no restrictions were encountered.

The Air Speed Indicator (ASI) system was checked with calibrated portable test equipment. A leak was detected in the right pitot system and the right ASI under-read the actual speed. However, during the subsequent high speed taxi tests all the ASIs gave consistent readings.

Estimation of speed during the takeoff run

With no valid speed data recorded by the FDR, the speed reached during the takeoff roll was estimated. Three estimates were made, and all used the simple principle that the distance travelled is the area under a speed versus time curve. The length of the runway, the approximate position of the aircraft at the start of the takeoff roll, and the distance travelled beyond the runway were all known. The times for the initial advance of the power levers, the further advance of the power levers, the calls made by the commander for "60 kt", "80 kt", "V_1" and "ROTATE", and the times when the aircraft went onto the grass and stopped, were derived from the CVR.

All three estimates assumed that the deceleration over the grass was linear, and hence the aircraft's speed was estimated to be 23 kt when it left the runway and entered the grass run-off area.

The three estimates were as follows:

a) Pessimistic estimate
If a linear acceleration and deceleration are assumed and the liner acceleration is assumed to start when the power levers are first advanced (thus maximising the assumed acceleration phase), then the estimated maximum speed during the takeoff roll is 114 kt.

b) Optimistic estimate
If a linear acceleration and deceleration are assumed and, the liner acceleration is assumed to start when takeoff power is set (thus reducing the assumed acceleration phase) then the estimated maximum speed during the takeoff roll is 134 kt.

c) More realistic estimate
In reality, the acceleration was probably not linear since the aircraft was already rolling when the power levers were fully advanced. Also, as the speed increases, the rate of acceleration starts to decrease, mainly due to the total drag on the aircraft increasing non-linearly with speed. Hence in reality the speed versus time curve is a gentle S shape, with the acceleration being greatest at approximately half the rotation speed.

The speed versus time curve was taken from a similarly sized turbo-prop and both axes were scaled so that a good fit with the speeds and times from the pilots' calls on the CVR was obtained. This resulted in the estimate for the maximum speed being around 125 kt.

Analysis

No fault was found with the aircraft that could have contributed to the co-pilot's perception of the aircraft's lack of response to aft control column movement or to the commander's concern for a possible control malfunction. The aircraft began the takeoff roll from a point close to the start of the runway. The pitch trim was set in the middle of the takeoff range but the aircraft's CG was close to the forward limit; this would have exaggerated the need for a large aft movement of the control column during rotation, in order to complete the takeoff. The co-pilot, who was relatively inexperienced, did not achieve the response from the aircraft that he was expecting when he initially pulled back on the control column.

On taking over control, the commander was presented with a possible control malfunction and little time in which to make a decision as the end of the runway was approaching rapidly. After a short time assessing the situation, he rejected the takeoff. However, due to the acceleration of the aircraft after the "V_1" call, the aircraft would have travelled approximately 535 m beyond the point on the runway at which that call had been made.

That, and the need to stop from a speed in excess of V_1, resulted in the aircraft overrunning the paved surface of the runway by 34 m.

A slight leak was detected in the right pitot system and the right ASI under-read the actual speed. However, during the subsequent high speed taxi tests all the ASIs gave consistent readings. It was thought that the lack of an under-read during the taxi tests, and presumably during the incident takeoff attempt, was due to a greater volume of air being available which was not available with the test equipment. In this incident, any under-reading of the ASI is unlikely to be a factor since the elevator would appear to be more effective than the reading on the instrument would imply since the aerodynamic force increases with the square of the speed.

Estimates of the speed indicated that the maximum speed achieved during the rejected takeoff was approximately 125 kt. No airspeed value greater than zero was recorded by the FDR during the incident; however, whilst reviewing previous takeoffs it was noted that the recorded value jumped from zero to about 65 kt, at which point the actual airspeed was about 117 kt. It can, therefore, be inferred that the maximum airspeed achieved during the rejected takeoff was probably less than 117 kt.

Following an extensive technical examination the aircraft was released for a test flight; it completed an uneventful takeoff and reacted appropriately to flight control inputs, and has continued to operate normally since.

Reliable FDRs are an essential component of effective accident investigation and in order to address the anomalies found in JAR-OPS, the following Safety Recommendation is made:

Safety Recommendation 2007-060

It is recommended that the European Aviation Safety Agency require operators to conduct an annual operational check and evaluation of recordings from FDRs to ensure the continued serviceability of the system. The annual check should require, as a minimum, a readout of the FDR and an evaluation of the data, in engineering units, in order to establish compliance with recording duration, error rates and validity of all recorded parameters.

INCIDENT

Aircraft Type and Registration:	SD3-60 Variant 100, G-CLAS
No & Type of Engines:	2 Pratt and Whitney Canada PT6A-65AR Turboprop engines
Year of Manufacture:	1984
Date & Time (UTC):	11 May 2007 at 0002 hrs
Location:	2 miles south-west of Stansted Airport
Type of Flight:	Commercial Air Transport (Cargo)
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Minor damage to wiring
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	45 years
Commander's Flying Experience:	3,983 hours (of which 1,496 were on type) Last 90 days - 33 hours Last 28 days - 15 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot together with written submission provided by the company General Manager

Synopsis

The flight crew experienced a burning smell during the climb. A chafed wire was identified as the cause.

History of the flight

The aircraft, which was carrying no payload, was taxied in light rain for a departure. The windscreen wipers were therefore in use. Both were, however, switched off prior to the takeoff roll. The aircraft took off and climbed uneventfully to approximately 1,500 ft at which point there was a burning smell in the cockpit. The smell grew stronger fairly quickly. As there was no obvious visual sign of smoke in the cockpit, the commander opened the P1 cockpit door. He discovered a significant amount of what he assumed to be smoke at the rear of the main cabin.

He shut the door and instructed the first officer to declare an emergency and to ask for an immediate return to the airport. Vectors were then provided for a left-hand circuit back towards Runway 23 for an ILS approach to land. The circuit and landing were uneventful and once clear of the runway the commander re-checked the cabin and found that the smoke had cleared. After liaising with ATC and the fire crew, the aircraft was taxied to a remote stand where the latter attended. They used thermal imaging equipment to check for heat sources and, finding none, they stood down. There was no cabin smoke warning during this event.

In view of the short distance from the landing runway at which the event began and the fact that the smoke was not in the cockpit, the captain decided not to expend valuable time donning smoke hoods.

Technical investigation and corrective actions

It was reported that a small wire in a lighting circuit behind panel 4P above the first officer's head was found to have been chafing. This was presumed to have caused the smoke. The smoke in the rear of the cabin was considered to have been mist forming in the cargo area, caused by mixing of warm and cold airflows in the cabin. This was, at the time, misidentified and incorrectly associated with the burning smell. The cabin smoke detectors tested normally once the aircraft was back on the ground.

The chafing wire was re-routed and protected and the aircraft is reported to have operated subsequently with no further problems.

ACCIDENT

Aircraft Type and Registration:	Beagle Aircraft E3 (Auster AOP 11), G-ASCC
No & Type of Engines:	1 Continental Motors Corp IO-470-D piston engine
Year of Manufacture:	1962
Date & Time (UTC):	29 July 2007 at 1905 hrs
Location:	Filkins near Lechlade, Gloucestershire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 2
Injuries:	Crew - 1 (Minor) Passengers - 2 (Minor)
Nature of Damage:	Substantial
Commander's Licence:	Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	11,000 hours (of which 34 were on type) Last 90 days - 70 hours Last 28 days - 25 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and AAIB enquiries

Synopsis

During a go-around, the aircraft struck a tree. The pilot attributed the accident to distraction with the flap system during the go-around.

History of the flight

The pilot's intention was to land in a large field. After a low approach and fly-past to check the surface, the pilot began a landing approach. The aircraft floated further than anticipated and the pilot reasoned that he might be unable to stop safely in the distance remaining. He then applied full power and readjusted the flaps to the takeoff setting. Whilst positioning the flaps, the pilot's attention was focused on the flap lever. He then realised the aircraft had swung approximately 20 degrees to the left and was heading towards a tree at the edge of the field. Unable to avoid the tree, the pilot attempted to fly over it, but was unsuccessful. The aircraft struck the top of the tree and fell into the field beyond in a wings-level but nose-down attitude, and slid approximately 30 ft before coming to rest. The pilot and passengers were able to vacate the aircraft, although all three suffered minor injuries.

The pilot suggested that two factors precipitated the accident. One factor was that the flap lever hydraulic system required pumping, which diverted the pilot's concentration away from maintaining the intended heading during the go-around. The other suggested factor was the pilot's lack of familiarity with the go-around characteristics of the aircraft in an aborted landing situation.

ACCIDENT

Aircraft Type and Registration:	Cessna 152, G-BWEV
No & Type of Engines:	1 Lycoming O-235-L2C piston engine
Year of Manufacture:	1979
Date & Time (UTC):	2 May 2007 at 1230 hrs
Location:	Sandon, Chelmsford, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to both wing leading edges, propeller, engine cowling and left door
Commander's Licence:	Private Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	304 hours (of which 57 were on type) Last 90 days - 6 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquires by the AAIB

Synopsis

On a flight to Andrewsfield Airfield, Essex, from Shoreham Airport, Sussex, the aircraft's engine faltered and then stopped. The pilot carried out a forced landing in a field and the aircraft collided with a hedge. The aircraft had run out of fuel.

Background information

On the morning of the accident, the aircraft's fuel tanks were filled to a total of 80 litres. G-BWEV was then flown on a one hour instructional flight from its home base of Andrewsfield. The pilot of the accident flight did not fly this detail but was aware of its duration. Using commercially available software, he planned a flight to Shoreham and a return to Andrewsfield on his computer. The calculated fuel burn from Shoreham to Andrewsfield was 19 litres.

History of the flight

The pilot stated that prior to departing Andrewsfield, he dipped the aircraft's fuel tanks as he considered the aircraft's fuel gauges to be inaccurate. He measured 30 litres in the left tank and 40 litres in the right. The weather was CAVOK with a wind of 070º/15 kt at 3,000 ft amsl. The flight to Shoreham lasted 55 minutes and was uneventful.

At Shoreham the pilot dipped the fuel tanks again and measured 20 litres in the left fuel tank and 30 litres in the right. He estimated (using a fuel burn of 25 litres/hr) that this would give the aircraft an endurance of 2 hours. The pilot took off at 1135 hrs and cruised at 3,000 ft amsl, 90-95 kt and with a power setting of 2,200 rpm. At 1230 hrs, when 11 nm south-east of Andrewsfield, the pilot requested the current airfield information. About three minutes later the aircraft's engine began to falter. He selected carburettor heat ON, mixture fully rich and applied full throttle but the engine continued to falter. The left fuel gauge was "flickering" around empty and the right was indicating approximately ¼ full (18 litres). Suspecting fuel starvation, the pilot decided to make a forced landing and informed Andrewsfield of his intention. Shortly afterwards, the engine stopped.

The pilot's initial choice of field was not achievable so he chose a closer but smaller one. The aircraft touched down at approximately 60 kt with no flap selected. Realising he would not be able to stop the aircraft before the boundary hedge, he steered it through a gap into the adjacent field. The aircraft eventually stopped in a hedge on the far side of this second field. Before shutting the aircraft down, the pilot transmitted to an airborne aircraft that he was uninjured and was vacating the aircraft.

The Andrewsfield Airfield manager and an engineer from the maintenance organisation attended the accident site. On inspection, they found no fuel in the right tank and 10 litres in the left tank.

Fuel planning

G-BWEV was fitted with long range fuel tanks. This gave it a fuel capacity of 147 litres of which 5.5 litres were unusable. Prior to the first flight of the day the tanks were only filled to 80 litres to ensure the aircraft was flown within its weight and balance envelope. This was confirmed by the airfield manager who dipped the fuel tanks prior to this first flight using the same, aircraft-specific dip-stick as later used by the accident pilot.

The pilot's information manual for the Cessna 152 states that 3 litres is used during start up, taxi and takeoff (SUTTO) and that at 2,200 rpm and 3,000 ft amsl, the fuel burn would be approximately 19 litres/hr. The Chief Flying Instructor at Andrewsfield stated that she recommends a fuel burn of 25 litres/hr, depending on the sortie profile. This is based on experience gained from 20 years instructing on the Cessna 152.

Discussion

Using 25 litres/hr and 3 litres for SUTTO it is estimated that G-BWEV landed, after the first instructional flight, with 52 litres remaining. After landing at Shoreham it would have had approximately 29 litres, of which 5.5 litres would be unusable. This would have given an endurance of approximately 50 minutes. The engine stopping after 55 minutes of the subsequent flight supports these figures. Although the pilot accepts that he ran out of fuel, he cannot understand how he measured the fuel quantity incorrectly on two separate occasions. He was also unaware that the aircraft had been initially filled to a total of 80 litres that day. Had he been aware of this information, it is likely that he would have been suspicious of his initial dipping of the fuel tanks and investigated further before departing for Shoreham.

ACCIDENT

Aircraft Type and Registration:	Gardan GY80-160 Horizon, G-ASZS
No & Type of Engines:	1 Lycoming 0-320-B3B piston engine
Year of Manufacture:	1965
Date & Time (UTC):	11 August 2007 at 1439 hrs
Location:	Wellesbourne Mountford Aerodrome, Warwickshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to propeller and engine shock-loaded
Commander's Licence:	Private Pilot's Licence
Commander's Age:	55 years
Commander's Flying Experience:	249 hours (of which 111 were on type) Last 90 days - 4 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The pilot became distracted due to heavy traffic in the circuit and neglected to lower the landing gear prior to landing. The aircraft sustained minor damage in the wheels-up landing and the pilot was uninjured.

History of the flight

After a short flight in the local area, the pilot returned to Wellesbourne with the intention of carrying out circuit practice. Runway 18 was active and weather conditions at the time were good, with the visibility in excess of 10 km and a light, variable wind. The circuit was busy at the time, requiring aircraft to extend the downwind leg to allow other aircraft to take off.

The pilot completed two successful 'touch-and-go' circuits and, on the third circuit, the aircraft ahead performed a go-around. The pilot allowed himself to become distracted by this and other traffic and neglected to lower the undercarriage. He touched down with the landing gear up but, as the wheels protrude partially when the gear is retracted, he was able to maintain control of the aircraft and steer it onto the grass to the right of the asphalt runway. The only visible damage was to the propeller, which struck the ground and abruptly stopped the engine. The pilot was uninjured.

The aircraft is equipped with a warning horn designed to sound when the engine speed is below 1,600 rpm whenever the landing gear is up. The pilot reported that the horn failed to operate on this occasion.

ACCIDENT

Aircraft Type and Registration:	Luscombe 8E Silvaire Deluxe, G-BPZE
No & Type of Engines:	1 Continental Motors Corp C85-12F piston engine
Year of Manufacture:	1946
Date & Time (UTC):	8 July 2007 at 1130 hrs
Location:	Hardwick Airfield, Norfolk
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Minor) Passengers - 1 (Minor)
Nature of Damage:	Damage to aircraft nose area and tail structure
Commander's Licence:	Private Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	142 hours (of which 60 were on type) Last 90 days - 20 hours Last 28 days - 8 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft was taking off from a soft grass strip and failed to get airborne before striking the standing crop at the end of the runway.

History of the flight

The Luscombe 8E Silvaire Deluxe is a high-wing, tail-dragger aircraft, fitted with an 85 HP Continental C85-12F engine. Hardwick Airfield is an unlicensed airfield with two runways: Runway 13/31 is 1,000 m long with a concrete surface, and Runway 17/35 is a 500 m grass strip.

The pilot arrived at the airfield at approximately 1100 hrs and checked the conditions. The windsock and ATIS from Norwich indicated that the wind direction was 220º with a wind speed of around 5 kt and so he elected to use the grass strip. He completed the pre-flight checks and taxied along the length of the runway to the threshold of Runway 17. The taxi required very little engine power and this confirmed to the pilot his assessment of the runway condition as firm. The grass was dry and although not long, it had not been cut recently.

Arriving at the threshold, the pilot then turned the aircraft to head down the runway in order to complete the engine power and pre-departure checks. The pilot then applied full power for the takeoff. The aircraft accelerated normally, and after a short distance the tail lifted off. At approximately three-quarters of the runway distance, where the pilot normally would have expected the aircraft to become airborne, the speed seemed low and the aircraft did not lift off. The pilot steered the aircraft towards the left side of the runway which appeared to have a longer distance remaining. At the very end of the runway the aircraft did lift off, but as it did so the wheels struck the tops of the standing crop in the field beyond the runway. The aircraft continued into the crop and pitched nose down, flipped over and came to rest inverted. Both occupants sustained minor injuries but were able to release their harnesses and evacuate the aircraft unaided.

Following the accident the pilot observed from the windsock that the wind seemed to be varying between 220º and 320º at about 5 kt. The pilot considered that the lower than expected airspeed at the end of the takeoff run was due to the variable wind conditions and the surface of the runway being less firm than he had judged while backtracking along the runway. He had used this runway on several previous occasions, with the same aircraft loading, without any concerns about takeoff performance.

The CAA General Aviation Safety Sense Leaflet 7B '*Aeroplane Performance*' contains advice on many aspects of takeoff and landing performance and advises that takeoff distance to 50 ft can be expected to increase by at least 25% if the ground is soft. Leaflet 12C '*Strip Sense*' contains additional advice on operating from grass strips.

ACCIDENT

Aircraft Type and Registration:	Mickleburgh L107, G-BZVC
No & Type of Engines:	1 Martlet VW 1824 piston engine
Year of Manufacture:	2006
Date & Time (UTC):	9 June 2007 at 1203 hrs
Location:	Woodditton farm strip, 9 nm east of Cambridge Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Canopy shattered, damage to left wingtip, fin, rudder, propeller and spinner
Commander's Licence:	Private Pilot's Licence
Commander's Age:	68 years
Commander's Flying Experience:	174 hours (of which 15 were on type) Last 90 days - 16 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

After a normal landing on a grass strip the aircraft veered to the right into a crop field and turned upside down. The loss of control may have been due to inappropriate differential brake application.

History of the flight

The Mickleburgh L107 is a single-seat homebuilt fixed-wing aircraft of composite manufacture, with a low wing and tailwheel landing gear configuration. The pilot was on a cross-country flight from Fenland Airfield to a farm strip in Woodditton, near Cambridge, to visit his son. The grass strip was approximately 470 m long and lined with crop fields on either side. The wind was light and variable so the pilot planned an approach to Runway 24, in the direction of a slight upslope. The touchdown was normal, with no bounce, but the pilot reported that he then became aware that he was going too fast. He decided to brake rather than go-around and moved his heels over the brake pedals. The pilot reported that, either as a result of losing concentration or applying too much right brake, the aircraft veered to the right. He was not able to correct the turn in time to prevent the aircraft from running into the crop field. The aircraft pitched nose down and then the propeller spinner dug into the ground, resulting in the aircraft turning upside down.

The canopy shattered but the pilot was unable to exit.

After a few minutes the pilot's son and a friend arrived at the scene and were able to lift the tail of the aircraft and help the pilot out. The pilot of another aircraft flying nearby had witnessed the accident and reported it to the Cambridge approach controller. Emergency services were dispatched but then stood down when the pilot of the accident aircraft contacted the police.

Pilot's assessment of the cause

The pilot had landed at this farm strip before, but during those occasions the crops lining the strip had been low or non-existent. On reflection, the pilot believes that his landing speed was normal and that the illusion of high speed was caused by the closeness of the high crops. He stated that he should have ignored this distraction and concentrated on keeping the aircraft tracking straight.

ACCIDENT

Aircraft Type and Registration:	Oldfield Baby Lakes, G-BTZL
No & Type of Engines:	1 Continental C85-12F piston engine
Year of Manufacture:	1986
Date & Time (UTC):	12 July 2007 at 1315 hrs
Location:	Welshpool Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - N/A
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to top wing, propeller, engine and tail fin
Commander's Licence:	Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	844 hours (of which 0 were on type) Last 90 days - 12 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Shortly after landing, the tail of the aircraft lifted and it nosed over. The pilot stated that he either inadvertently applied the brakes or released the elevator back-pressure during the landing roll. Another factor was his lack of recent experience of 'taildragger' aircraft, having last flown them in the 1970s.

History of the flight

The accident flight was the first time the pilot had flown a Baby Lakes, which is a single-seat taildragger biplane. He had last flown a taildragger in the 1970s, with his recent flying experience being mainly on Cessna 150 'nosewheel' aircraft.

Prior to the flight he had spent some time carrying out high-speed taxi runs in G-BTZL to gain a feel for the aircraft's handling characteristics on the ground. He also obtained guidance on the aircraft's handling and operation from the previous owner.

The intention of the flight was to carry out upper airwork in the local area before returning to Welshpool. The takeoff, subsequent upper airwork and handling were uneventful. On approaching Welshpool, the pilot initially decided to carry out an approach followed by a go-around to familiarise himself with the aircraft's handling. He accomplished this without incident.

The pilot then carried out a circuit and approached Runway 22 for a normal landing; the wind was reported as being from 240º at 8 kt. Shortly after touchdown, and during the landing roll, the tail lifted and the aircraft nosed over, before finally coming to rest inverted on the runway. The pilot was wearing a full harness and was uninjured; he was able to release himself and crawl out from underneath the aircraft. Although there was fuel leaking, there was no fire.

G-BTZL was fitted with heel brakes and the pilot later stated that it was possible that during the landing roll, and whilst he was operating the rudder pedals, he inadvertently applied the brakes. He also stated that it was possible that he released the elevator back-pressure during the landing roll. A factor in this accident was his lack of recent experience on taildragger aircraft.

ACCIDENT

Aircraft Type and Registration:	Piper PA-38-112, G-BNVD
No & Type of Engines:	1 Lycoming O-235-L2C piston engine
Year of Manufacture:	1978
Date & Time (UTC):	9 December 2006 at 1110 hrs
Location:	Durham Tees Valley Airport
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Left wing and main landing gear damaged beyond repair
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	63 years
Commander's Flying Experience:	22,300 hours (of which 140 were on type) Last 90 days - 110 hours Last 28 days - 25 hours
Information Source:	AAIB Field Investigation

Synopsis

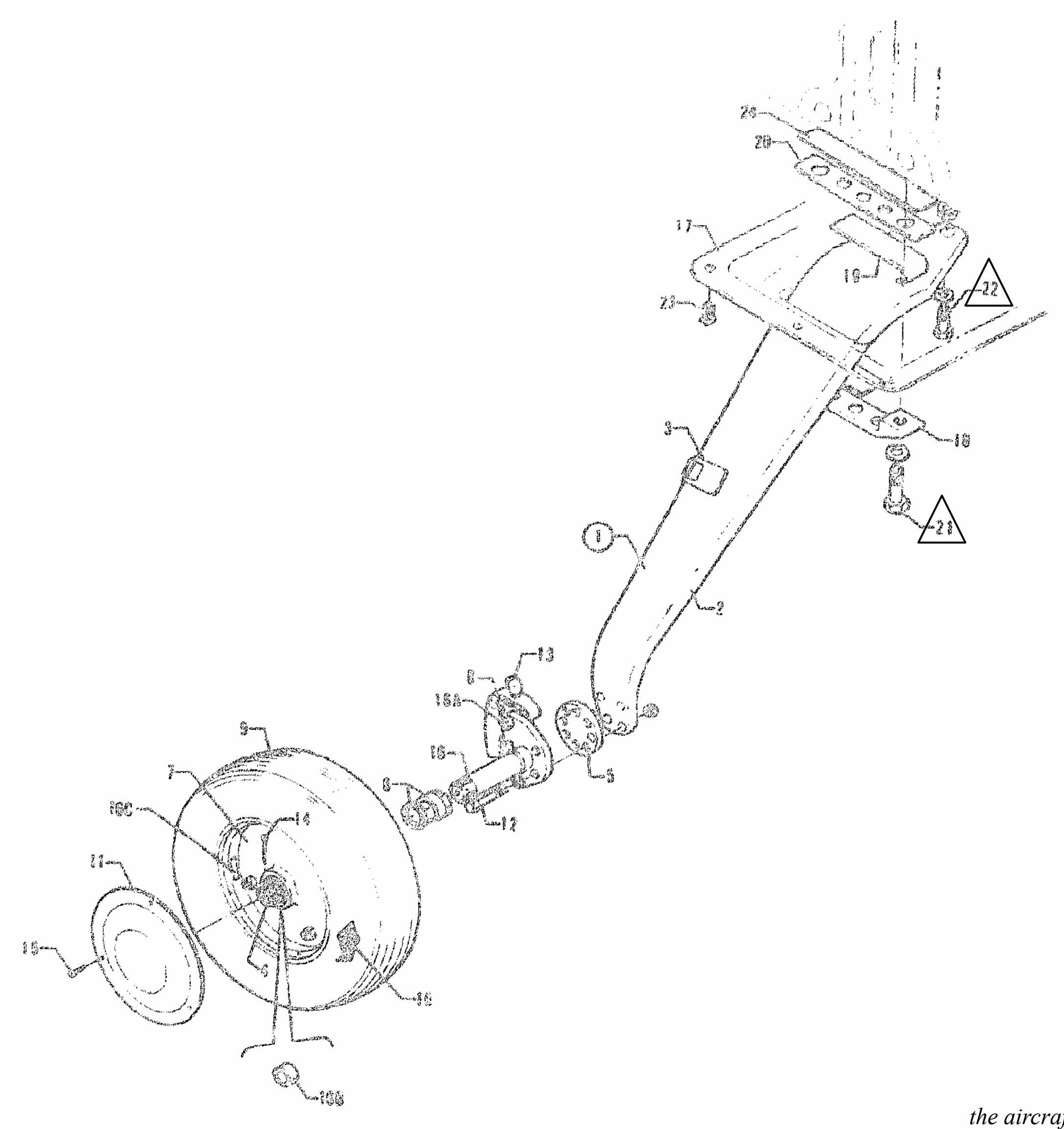
Whilst taxiing following a firm landing, the left main landing gear detached from the aircraft. Examination showed that one of the three landing gear attachment bolts had unscrewed and fallen out and the remaining two bolts had pulled out as the gear detached from the aircraft.

History of the flight

The aircraft was being flown by the student on a dual cross-country flight from Carlisle to Durham Tees Valley Airport. The landing at Durham Tees Valley was firm (but not hard enough to warrant a report) and with no bounce. Whilst taxiing along the runway following the completion of the landing roll, it was noticed by the crew that the left wing appeared to be lower than the right. This was initially attributed to the crosswind. The aircraft was taxied, at walking speed, off the runway and onto the taxiway when suddenly the left main landing gear detached from the wing and the aircraft stopped with the left wing tip touching the ground.

Engineering examination

Examination of the detached left main landing gear indicated that one of the three bolts (Figure 1, item 22), part number 401 511, that attach the landing gear to the aircraft, was missing. The other two bolts (Figure 1, items 21), part number 401 462, were attached to the landing gear with locking wire and exhibited very good



Courtesy of the aircraft manufacturer

Figure 1

Main Landing Gear

evidence of having been pulled out of their barrel nuts as the landing gear was in the process of detaching from the aircraft. A search of the runway touchdown area located the missing bolt, which, upon examination, showed that it had unscrewed and dropped out of the barrel nut located in the wing. There was no wire locking or lock washer and none were specified in the aircraft's Maintenance Manual.

Maintenance

The aircraft was maintained to the Civil Aviation Authority's (CAA) Light Aircraft Maintenance Schedule (LAMS) CAP 411 which requires Pre-Flight, Daily, 50 hour, 150 hour and Annual maintenance checks. The inspection for security of the landing gear attachment bolts is required during the 150 hour and Annual maintenance checks. There is no requirement to take the aircraft weight off the landing gears when carrying out this check. The aircraft manufacturer's Maintenance Manual requires Pre-Flight, 50 hour, 100 hour, 500 hour, 1,000 hour and Annual maintenance checks. The inspection for condition, torque and security of the main landing gear attachment bolts is required during the 100 hour, 500 hour, 1,000 hour and Annual maintenance check.

This aircraft had the main landing gear attachment bolts replaced during an Annual maintenance check on 19 January 2006 at 5,716:50 airframe hours. The bolts were those specified in Piper Service Bulletin (SB) 673B and were retorqued after 24 hours with the aircraft weight on the landing gears, in accordance with the aircraft's Maintenance Manual. Between the Annual maintenance check and the accident two 150 hour maintenance checks had been carried out on the aircraft during which the condition and security of the landing gear bolts was checked. At the time of this accident the aircraft had flown 108 hours since the last 150 hour maintenance check.

Civil Aviation Authority CAP 520, Part 3 titled '*Light Aircraft Maintenance Schedules*', paragraph 2.4 states:

> *'Generic light aeroplane scheduled maintenance inspection requirements have been included in the LAMS aeroplanes, consequently:*
>
> *a) inspections recurring up to and including 100 hr intervals which significantly differ from the inspections specified in the LAMS Schedule 150 hr check, may be completed at the 150 hr check.'*

Service Bulletins and Airworthiness Directives

The main landing gear attachment bolts on the Piper PA-38 series aircraft have been the subject of three Piper SBs; 673, 673A and 673B and two Federal Aviation Administration (FAA) Airworthiness Directives (AD) 83-05-04 and 90-19-03. These SBs and ADs required, within 100 airframe hours, a one-time replacement of the attachment bolts with higher strength bolts, barrel nuts and, if required, saddle clamps. They also introduced revised torquing procedures. There were no repetitive inspections called for as there is an inspection and torque check requirement every 100 hours in the aircraft Maintenance Manual.

Previous occurrences

The CAA Mandatory Occurrence Report (MOR) database shows that there have been ten reported incidents of Piper PA-38 main landing gear attachment bolts failing or becoming loose. Five of these incidents were reportable accidents which the AAIB investigated (AAIB Bulletin Nos 6/85, 1/88, 12/88, 10/89 and 3/90). Following the investigation into the accident to Piper PA-38, G-BMXL, on 25 November 1989 (AAIB Bulletin 3/90) the following Safety recommendation was made:

> *'A recommendation has been made to the Civil Aviation Authority that they re-examine Airworthiness Directive 83-05-04 with a view to introducing a repetitive and/or mandatory scrap life for these bolts.'*

The CAA responded to this Safety Recommendation on 28 February 1990 with:

> *'---the Authority already has this matter in hand. A CAA Additional Airworthiness Directive (PAAD 983) is currently being finalised, and it is hoped to have it issued by the end of April 1990. This directive will require NDT inspection of the bolts within 50 hours, a torque check*

every 50 hours thereafter, and subsequent NDT inspection and/or replacement with new bolts every 150 hours or on reported heavy landing.'

This Additional Airworthiness Directive was not subsequently issued.

In August 2007 the CAA commented that CAA/LAMS/1999/A Issue 2 does, in Section 3 paragraph 8, state that, in addition to the LAMS schedule, the owner/operator should also consider:

'Instructions for continuing airworthiness ... published by type design organisations ... to ensure the approved maintenance schedule remains valid for the aeroplane listed'.

Safety Recommendations

Safety Recommendation 2007-087

It is recommended that the Civil Aviation Authority reconcile the anomaly of the aircraft manufacturer's requirement to check the torque of the main landing gear attachment bolts on Piper PA-38 aircraft every 100 hours against the LAMS requirement to check the security of landing gear attachment bolts every 150 hours.

Safety Recommendation 2007-088

It is recommended that the Federal Aviation Administration require that Piper Aircraft introduce a form of locking on the main landing gear attachment bolt, part number 401 511, fitted to PA-38 series aircraft.

ACCIDENT

Aircraft Type and Registration:	Slingsby T67M-MkII Firefly, G-BUUD
No & Type of Engines:	1 Lycoming AEIO-320-D1B piston engine
Year of Manufacture:	1993
Date & Time (UTC):	16 July 2006 at 1356 hrs
Location:	Hoxne, Suffolk (close to the Norfolk border)
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	40 years
Commander's Flying Experience:	83 hours (of which 18 were on type) Last 90 days - 8 hours Last 28 days - 2 hours
Information Source:	AAIB Field Investigation

Synopsis

The pilot was performing a solo aerobatics sequence, in good weather. The aircraft appeared to depart from controlled flight at a height of around 4,500 ft agl during a looping manoeuvre and settled into an erect spin to the left. After the aircraft had descended about 2,500 ft, the pilot transmitted a 'MAYDAY' call in which he said that he was in a spiral dive and could not recover. The aircraft continued to spin and descend vertically until it struck the ground. The pilot was fatally injured in the impact.

No signs of a pre-impact anomaly with the aircraft were found, but the amount of evidence available from the wreckage was limited by severe ground fire damage and the possibility that a pre-impact deficiency had contributed to the accident could not be eliminated.

Two recommendations have been made, regarding the wearing of parachutes and the performing of solo aerobatics while undergoing a course of instruction.

History of the flight

Before the flight, the pilot had told a few close relatives that he was planning to perform an aerobatic sequence for a neighbour's retirement party, which was being held in the garden of a house in the village of Hoxne, Suffolk. He took off from Old Buckenham Airfield in G-BUUD at 1335 hrs with an estimated 60 to 70 litres of fuel on board, having made no mention of his intentions to those present during his preparations for the flight. The weather was good. At 1347 hrs the pilot contacted Norwich ATC to advise them that he was climbing to

5,000 ft amsl to carry out aerobatics in the area to the east of Diss. ATC acknowledged this radio call and gave the pilot a transponder code to 'squawk' so that he could be identified by secondary surveillance radar. The pilot selected this code, which the aircraft continued to transmit for the remainder of the flight.

Shortly after 1350 hrs those attending the party, and other witnesses in the vicinity, saw G-BUUD carry out some aerobatic manoeuvres just to the east of their position. A number of them described seeing the aircraft perform a rolling manoeuvre in a westerly direction, before turning onto a southerly course and enter a loop. At some stage after reaching the top of the loop G-BUUD was seen to enter a spiral descent.

One witness recalled seeing the aircraft perform the loop, then turn, following which the engine stopped. The aircraft then pitched nose down, possibly turning inverted, before appearing to tumble as it descended. Another witness, a current Private Pilot's Licence (PPL) holder, who was positioned 2 nm to the north of Hoxne, was alerted to the sound of an aircraft performing aerobatics. When he looked up he saw a yellow, low wing aeroplane at an estimated height of about 3,500 ft, in a spin. The aeroplane was descending vertically; it was pitched approximately 30º nose down and continued to spin without appearing to change its attitude. When the aircraft was at an estimated height of 1,500 ft, this witness perceived the engine noise to increase momentarily before becoming silent. He saw the aircraft complete 12 to 15 spin rotations, after which it disappeared below the tree line. Shortly afterwards he saw black smoke rising from the same direction. He thought he recognised the aircraft as being the Slingsby T67, which he had seen on a number of occasions at Old Buckenham Airfield.

Another witness, a PPL holder with experience of aerobatics, observed G-BUUD from a property 1.5 nm to the east of Hoxne. He described seeing the aircraft perform a rolling manoeuvre on a westerly heading whilst climbing slightly. During the course of this manoeuvre the aircraft's track altered 10º to 15º to the right. He considered that the rate of roll sped up during the last 180º of the manoeuvre. Following this, the aircraft entered a loop in the last quarter of which it appeared to perform a vigorous rotation, possibly to the right. After two full rotations, the aircraft settled into a flatter attitude and began to spin in a "stable upright fashion". This witness recalled being concerned because he considered that the entry into the spin was unintentional and he believed that the engine noise reduced after four or five rotations. The aircraft continued to spin in a stable manner with no discernible change in pitch attitude, which he assessed as being 20º nose down, at a constant speed of rotation and with a high rate of descent. Following the reduction in engine noise he saw the aircraft complete another three full turns before it disappeared from his view.

Other witnesses also recalled hearing the engine noise cease. Two people who were at the garden party stated that this happened after the aircraft had completed about three turns, following the commencement of spinning.

At 1355:44 hrs, as the aircraft was descending, the pilot transmitted a 'MAYDAY' call saying, initially, that he was "IN A SPIRAL SPIN" and then amplified this by adding that he was "OVERHEAD HOXNE IN A SPIRAL DIVE CANNOT RECOVER".

The aircraft continued to spin, probably to the left, until it struck the ground in a field about 10 m away from the back gardens of two semi-detached cottages. Immediately after it had struck the ground and stopped, two witnesses, one in each garden, saw the pilot slumped forward and motionless inside the aircraft. They both observed that a fire had developed on the right side of the fuselage, in front of the right wing. One of these witnesses ran to collect two fire extinguishers from his cottage, which was 30 m away but, by the time he had returned to the end of his garden, the fire had developed and was so intense that he was unable to approach it. In addition, he was concerned that there was a danger of explosion. Another witness in one of the two cottages called the emergency services immediately after the crash and they arrived ten minutes later.

A number of other witnesses rushed to the scene as well but they were also unable to approach the aircraft. About three minutes after it had struck the ground, there were two loud explosions from the aircraft.

The aircraft's manoeuvres were recorded on still photographs taken bytwo witnesses on the ground. One set of photographs, taken sequentially, appear to show the aircraft inverted, initially, and then in descending turns to the left in an erect attitude. Another camera captured the aircraft as it disappeared from view behind a hedge shortly before it struck the ground. At this point G-BUUD appears to be pitched nose down about 35º.

A post-mortem examination indicated that the pilot had died almost instantaneously as a result of the injuries he had sustained during the crash, and before the subsequent fire. There was no evidence of any medical factor that had contributed to the accident, which was considered non-survivable.

Recorded information

Recorded radar data for G-BUUD was provided by the National Air Traffic Service. The aircraft was fitted with a Mode C transponder and therefore, in addition to positional information, altitude data (to the nearest 100 ft) was available; these data were recorded every 5 seconds.

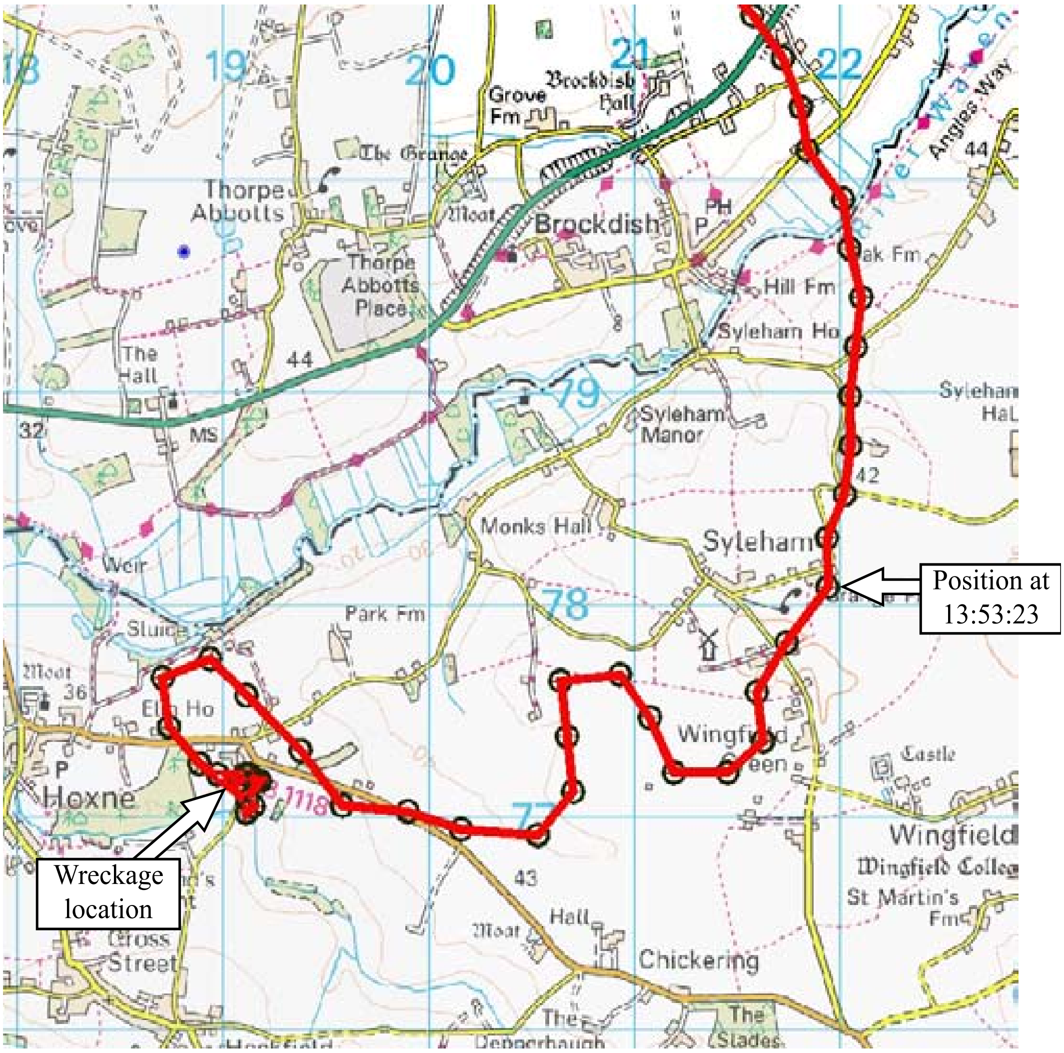


Figure 1

Plan view of G-BUUD recorded radar

The radar returns commenced around 2 nm north-east of Old Buckenham Airfield and the track shows the aircraft flying in a southerly direction towards Syleham. The first radar return was recorded at 13:43:57 hrs; around 5 minutes later the first Mode C altitude was recorded as 4,800 ft.

At 13:53:23, at a recorded altitude of 5,000 ft, G-BUUD began a turn to the right towards Hoxne (Figure 1). Correcting this altitude for a QNH of 1027 hPa, and the elevation of the local terrain, gives a height of 5,238 ft agl.

The data shows the aircraft continuing in the general direction of Hoxne (Figure 2), making several turns on the way whilst maintaining an altitude of about 5,000 ft. The final concentration of 10 radar returns occupy a small area, which contained G-BUUD's ground impact position, with the final radar return recording an altitude of 1,100 ft.

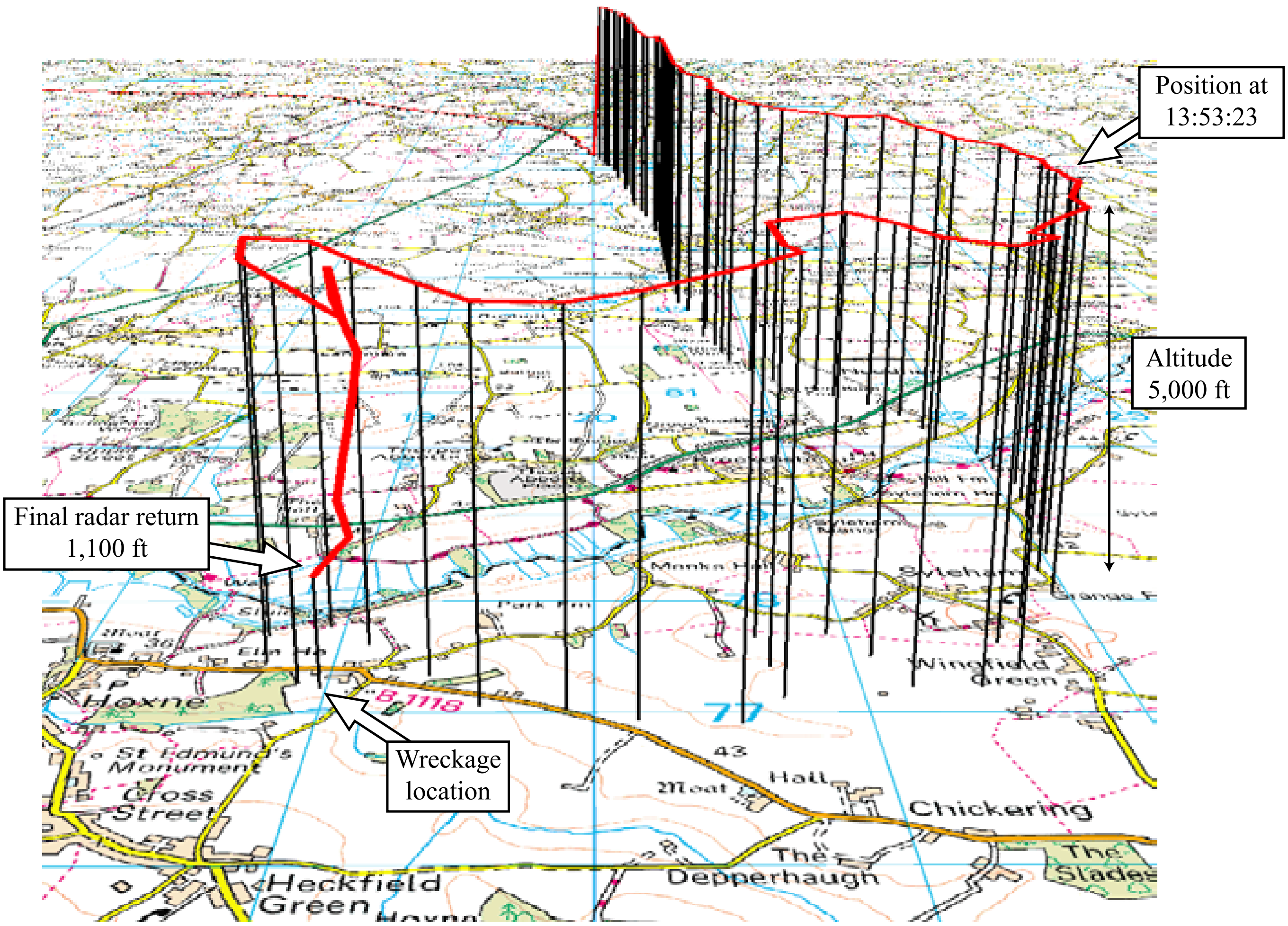


Figure 2

Isometric view of G-BUUD recorded radar

Aircraft description

Aircraft details

The Slingsby T67M-MkII Firefly is a single-engined low-winged monoplane with a low-mounted tailplane and fixed tricycle landing gear (Figure 3), designed to be fully aerobatic. Two side-by-side seats are provided. The aircraft is constructed principally of glass reinforced plastic; carbon fibre reinforced plastic and timber are also used in some areas. It is powered by a 160 shp, fuel-injected, petrol, reciprocating engine driving a constant-speed, two-bladed propeller. The aircraft's wingspan is 34.8 ft, the length 23.9 ft and the maximum takeoff weight 2,150 lb.

Fuel is carried in a tank in each wing. Cockpit transparencies consist of a fixed windscreen and a canopy that swings upwards and rearwards to open.

Flight controls are conventional, with dual cockpit controls. Each control stick operates the ailerons and elevators via a cockpit mechanism that drives rod and bellcrank linkages connected to the control surfaces. Pitch trim is provided by a trim wheel on the cockpit centre console driving a trim tab on the left elevator via a push-pull cable. Wing flaps are manually operated, via a lever and a rod and bellcrank system.

Rudder pedal assemblies operate a dual cross-shaft mechanism in the cockpit that is connected by a cable and fairlead system to the rudder. Deflection of the mechanism by the pedals also steers the nose wheel, via a control rod. Each pedal can be pivoted by pushing a bar at its top which applies the brake on its respective main wheel. The pedals are numbered from 1-4 across the aircraft from left to right. A slider mounting mechanism allows each pedal pad to be individually adjusted fore and aft to accommodate variations in leg length. This

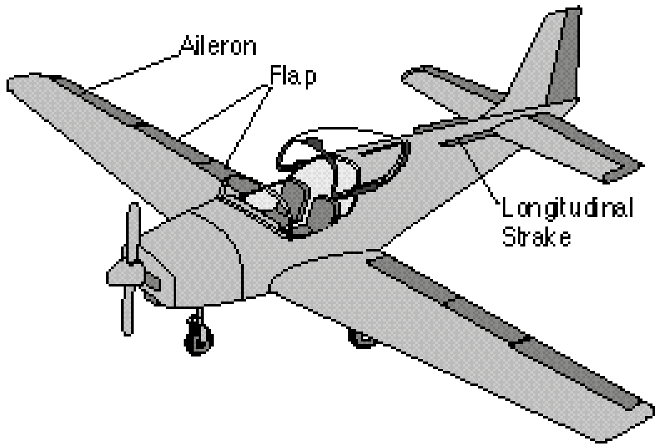


Figure 3

machanism can then be locked by a pin that locates in one of four holes in the slider.

Most components of the control system mechanisms within the cockpit are of steel but some, including the rudder pedal pads, are of aluminium. Outside the cockpit, the rudder and pitch trim cables are of steel but the rods, bellcranks and fairleads in the systems are of aluminium.

The aircraft manufacturer reported that, prior to initial type certification, there had been some difficulty in achieving recovery from a spin within a maximum allowable time when an incorrect recovery action was applied and the specified recovery actions were reversed (ie control stick moved forwards before anti-spin rudder applied). In order to resolve this problem a longitudinal strake had been fitted to each side of the fuselage immediately forward of the horizontal stabiliser. Additionally, the rudder rigging requirements had been altered, to change the maximum rudder angle from 30±2° to 30±1°. These measures had been incorporated on all production T67 aircraft at manufacture.

Background of the Slingsby T67 Firefly

The Firefly was first certificated in 1984, as the T67B, by the UK Civil Aviation Authority (CAA). A number of other versions were subsequently developed, including the 160 shp T67M-MkII, the 200 shp T67M200 and the 260 shp T67M260. In total 280 aircraft have been built. The different models were generally similar to each other but the T67M260 was provided with a larger rudder than the other versions to counteract the effects of the heavier powerplant. The United States Air Force (USAF) had acquired 113 T67M260 aircraft, designated as the T-3A, starting in 1993. The USAF aircraft were grounded in 1997 and were subsequently scrapped. At the time of G-BUUD's accident around 130 T67 aircraft remained in service, including around 15 T67M-MkII aircraft.

History of G-BUUD

Aircraft records indicated that G-BUUD (Serial Number 2114) had been maintained in accordance with the appropriate Maintenance Schedule; CAA/LAMS/A/1999/Iss 2. The last scheduled maintenance of the aircraft, including its engine and propeller, had been on 9 March 2006, at a 6 Monthly/ 50 Hour Inspection conducted 37 operating hours before the accident. At the time of the accident the Certificates of Airworthiness, Registration and Scheduled Maintenance Statement Release to Service were valid. The records indicated that the level of deficiencies experienced in the months prior to the accident had been low and that no major rectification work had been necessary. The only reported known defect at the time of the aircraft's departure on the accident flight was an inoperative landing light. G-BUUD had accumulated a total of 2,991 operating hours since new at the time of the accident.

Aircraft examination

Photographic evidence

A study of the photographs taken by witnesses of G-BUUD during its descent did not indicate any anomaly with the aircraft. Efforts were made to computer-enhance the images but, because of the appreciable distance from which the photographs were taken, their intrinsic resolution proved insufficient to enable the deflections of the aircraft control surfaces to be reliably determined.

Accident site

The aircraft crashed in gently rolling countryside 0.5 nm east of the village of Hoxne, at an elevation of 118 ft amsl. Ground impact was onto a field of sugar beet, on a level area with dry sandy soil of moderate density. The impact was close to two houses located outside the village and the aircraft came to rest 7 m from a fence separating the rear gardens of the houses from the field.

Witness evidence suggested that a ground fire had started in the region of the engine compartment immediately after ground impact. The fire had grown to engulf and destroy much of the aircraft, until extinguished by the fire service.

Examination of the accident site showed that the aircraft had remained substantially intact on impact. The windscreen frame and parts of the canopy were found on the ground around 12 m from the cockpit, consistent with these parts having fractured and been forcibly ejected from the aircraft when it struck the ground. In addition, small fragments of the transparencies, glass reinforced plastic material and other small aircraft parts had been distributed on the ground in the immediate vicinity of the aircraft. The engine remained generally in place, but came to rest rotated about 25º right of the fuselage heading. The pilot was located in the left seat.

Ground markings and wreckage distribution, together with the available evidence from aircraft damage characteristics, indicated that G-BUUD had initially struck the ground while upright and with a pronounced nose-down and left wing down attitude. Because of the extensive ground fire damage the impact attitude could not be quantified. The lack of extensive break-up indicated a moderate descent rate at impact. At initial ground contact the aircraft's heading had been approximately 302ºM. During the ground impact sequence it had yawed 25-30º to the left (anti-clockwise rotation, viewed from on top) before coming to rest. The evidence showed that there had been virtually no horizontal translational movement of the main wreckage after the initial ground contact.

Detailed wreckage examination

Much of the aircraft had been severely damaged by the ground fire, including almost the whole of the fuselage and the powerplant and most of the right wing and the empennage. In the affected areas the structure had largely been reduced to glass or carbon fibre cloth or rovings with the resin burnt away. Steel components remained intact, albeit severely corroded, consistent with the effects of fire exposure, but many aluminium components in the fire-damaged areas had melted and most of the combustible materials, such as furnishings, seat belts and papers, had burnt away.

Examination indicated that the aircraft had been complete at ground impact, including all primary and secondary flight control surfaces. No signs suggestive of pre-impact structural failure were found.

Reliable evidence on the settings of the primary control surfaces at impact was not available. Most pivots for the primary control surfaces and their operating linkages were located. Ground fire damage had destroyed appreciable portions of aluminium control rods and/or bellcranks of the aileron, flap and, particularly, the elevator systems. Most parts of the rudder control system were identified, including the steel cockpit mechanism. However, the aluminium pedal pads had been destroyed and extensive fire damage to the pedal adjustment mechanism prevented the pedal fore and aft adjustment position from being positively established. Examination of the available components revealed no signs of pre-impact disconnection of the flight control linkages. A detailed inspection was made for any evidence of a pre-impact restriction or jam of the controls and for the presence of foreign objects but, given the level of destruction, the results were not conclusive and it was not possible to determine whether a restriction or jam might have occurred.

Evidence suggested that the flaps had been in the retracted position at impact. The pitch trim system components, mostly of steel, largely survived the ground fire and the evidence indicated that the trim had been set close to neutral.

Both propeller blades had been severely fire-damaged but the fibre cloth laminates forming their main structural elements remained intact without any signs of impact damage. It was concluded that the propeller had not been rotating when the aircraft struck the ground. No signs of anomaly with the powerplant were apparent, although fire damage prevented meaningful assessment of many of the accessories; it was judged, given the circumstances of the accident, that engine strip examination was not relevant.

Meteorology

During the investigation, a meteorological aftercast was obtained. The weather at the time of the accident was fine and dry. An area of high pressure was covering the British Isles, feeding a light easterly flow over the county of Suffolk. In general, the winds in the area were calculated to be from 120º at 8 kt on the surface, and from 130º at 15 kt at 5,000 ft.

The surface visibility was between 20 and 40 km but the air to ground visibility was not determined. There were, perhaps, some very isolated patches of shallow cumulus cloud at 3,800 ft and thin layers of cirrus cloud at 24,000 ft. However, photographs taken of the aircraft during and after the aerobatics sequence showed only scattered high level cloud.

The actual weather, recorded at 1350 hrs, at Norwich Airport, 20 nm to the north of the accident, gave a: surface wind of 070º/12 kt, visibility in excess of 10 km, no cloud below 5,000 ft, a surface temperature of 26ºC and a dew point of 11ºC. At the same time, at Wattisham Airfield, 16 nm to the south west, the conditions were very similar; except the surface wind was from 120º at 8 kt and the surface temperature was 27ºC.

The mean sea level pressure was 1027 hPa.

Pilot information

The pilot had received a trial flying lesson in 1999 and commenced training for a Private Pilot's Licence (Aeroplanes) (PPL(A)) in August 2004. All except one hour of his flying training was conducted in a Cessna 150. In November 2005, after a total of 57 hours of flying instruction, he was issued with his PPL(A).

In January 2006 the pilot commenced the Aircraft Owners and Pilots Association (AOPA) Aerobatics Course in the Firefly T67M-MkII. His initial training included instruction on flying the type and revision on stalling and steep turns.

The pilot had completed 18 flights in the T67, all in G-BUUD, of which nine had included aerobatic manoeuvres. He was trained by two instructors, both of whom taught him aerobatics. He flew three solo flights, for a total of 2 hours and 20 minutes; he had not been briefed to carry out any aerobatic manoeuvres on these flights and did not record doing so. His last flight before the accident was with an instructor on 29 June. Apart from two flights in January, on a PA-28 and Cessna 150 respectively, and another flight in February in the same Cessna 150, the pilot flew only in G-BUUD, carrying out his flying on a total of 10 days, over a period of six months.

In March, the pilot had received instruction in stalling in the turn and spinning in both directions, recovering successfully from two spins himself. In April, during another dual training flight his instructor demonstrated a further spin to point out the rate of descent and the importance of the turn needle.

Recorded comments on the pilot's progress sheet indicate that his proficiency at general handling and aerobatics was inconsistent. It was noted that he had a tendency to roll the aircraft to the right or to the left in looping manoeuvres, rather than following a vertical flight path, and one of his instructors commented that the pilot did not always maintain a smooth rate of pitch during the manoeuvre, sometimes pulling back on the control column unevenly, giving the loop a 'square' shape. There was also evidence that his level of alertness varied and that during some flights he was unable to process information at the necessary rate. It was assessed that, on the basis of his progress, the pilot was between 33% and 50% of the way through the AOPA Aerobatics syllabus.

The pilot was in the habit of wearing light clothing during his training flights and the importance of having a clean cockpit and empty pockets for aerobatic manoeuvres was particularly impressed upon him. Other than a map, it was considered that he would not have had anything else with him on the accident flight.

In March 2006 the pilot had bought a half share in G-BUUD, thereby becoming a co-owner with one of his instructors.

Two parachutes, each weighing 9 kg, were available to the pilot as part of the aircraft's equipment. However, he had not worn one during his previous flights and did not do so on this occasion either, although it would not have adversely affected the weight or balance of the aircraft if he had done so.

Aerobatic training

The Rules of the Air Regulations state that:

> *'an aircraft shall not carry out any aerobatic manoeuvre… over the congested area of any city, town or settlement.'*

No other rules apply specifically to flights outside controlled airspace during which a pilot carries out aerobatic manoeuvres, and a pilot is not required to have any qualification or rating to perform solo aerobatics beyond possession of a PPL(A). The CAA considers that completion of an AOPA Aerobatics Course is a practical alternative to a compulsory rating for any pilot who wishes to perform solo aerobatics.

The AOPA course comprises eight hours of ground instruction plus a minimum of eight hours dual flying with an approved instructor who is qualified to give aerobatic instruction, covering the basic aerobatic manoeuvres. Spin training is included in the course, covering both incipient spinning, in which recovery is commenced at the first stage of the spin, and fully developed spinning. Pilots are also taught recoveries from markedly unusual attitudes, including those near the vertical and when semi-inverted.

The AOPA Guide and Syllabus of Instruction for the Aerobatics Certificate Course emphasises that the aerobatic manoeuvres covered in the syllabus must only be undertaken if the Owner's/Flight Manual/ Pilot's Operating handbook specifically states that these manoeuvres are permitted on the aeroplane type, as is the case with all variants of the T67.

During the course of the investigation a visit was made to a UK military flying training establishment where ab-initio pilots are instructed on the T67M-260. It was noted that these student pilots are not authorised to practise solo aerobatics until they have completed a 'spinning and aerobatics' check flight with an instructor. It is also standard practice for the instructors and students to wear parachutes on all flights.

Spinning and aerobatics

General

The CAA General Aviation Handling Sense 3 leaflet, entitled *Safety in Spin Training*, explains that:

> *'the spin is a stalled condition of flight with the aeroplane rolling, pitching and yawing all at the same time. There are aerodynamic forces and gyroscopic forces (caused by the rotating mass of the aeroplane) which may be pro-spin or anti-spin. In a stable spin the aerodynamic and gyroscopic forces balance out leaving the aeroplane rolling, pitching and yawing at a constant rate.'*

The CAA General Aviation Safety Sense Leaflet 19a, entitled *Aerobatics,* advises pilots who are learning to fly aerobatics to:

> *'become familiar with the entry to and recovery from a fully developed spin since a poorly executed aerobatic manoeuvre can result in an*

> *unintentional spin. Training in recovery from incorrectly executed manoeuvres and unusual attitudes is essential.'*

Following a spinning accident to G-BLTV on 3 November 2002, the AAIB made the following Safety Recommendation:

> *'The Civil Aviation Authority should conduct a review of the present advice regarding the use of parachutes in GA type aircraft, particularly those used for spinning training, with the aim of providing more comprehensive and rigorous advice to pilots.'*

This was accepted by the CAA and an updated Safety Sense Leaflet 19a *Aerobatics* was published containing the following information on parachutes:

> *'While there are no requirements to wear or use specific garments or equipment, the following options are strongly recommended:*
>
> *.....Parachutes are useful emergency equipment and in the event of failure to recover from a manoeuvre may be the only alternative to a fatal accident. However, for physical or weight and balance reasons their carriage may not be possible or practicable, the effort required and height lost while exiting the aircraft (and while the canopy opens) must be considered. If worn, the parachute should be comfortable and well fitting with surplus webbing tucked away before flight. It should be maintained in accordance with manufacturer's recommendations. Know, and regularly rehearse, how to use it, and remember the height required to abandon your aircraft when deciding the minimum recovery height for your manoeuvres.'*

T67 information

During the investigation G-BUUD's weight and CG position were calculated and found to be within the prescribed limits. The Take Off Weight was 852 kg (the maximum for aerobatics is 975 kg), and the aircraft CG was at 24.7% mean aerodynamic chord, which represents a mid CG position. As such, the aircraft was approved for aerobatics. The manufacturer's Pilot's Notes advise the following precaution:

> *'Ensure that aerobatics are carried out at sufficient altitude to recover to normal flight and to switch fuel tanks if the engine should cut.'*

The advised entry speeds for the slow roll and the loop are given as 110 kt IAS and 115 kt IAS, respectively.

The Pilot's Notes also give guidance on the height loss to expect during a spin. They state:

> *'The height loss is about 250 ft per turn and recovery takes about 500 ft. These height losses may vary, dependant on how many turns of the spin are done and how prompt and correct the recovery action is. They may be used as a basis for planning recovery which should be complete by 1500 ft above ground level. It is recommended that inexperienced pilots allow a further 1000 ft to the entry height. Thus the entry height for a 4 turn spin for an inexperienced pilot should be…… 4000 ft above ground level.'*

The technique for intentional spin entry is:

> *'At stall warning apply full rudder in the intended direction of spin and at the same time bring control column fully back. Hold these control positions. If the correct control movements are not applied a spiral dive may develop as shown by an airspeed increasing above 80 kts.'*

The Pilot's Notes also include the following information about *Erect Spin Recovery*.

The *Standard Recovery Technique'* is:

> *'a) Close the throttle.*
> *b) Raise the flaps.*
> *c) Check direction of spin on the turn co-ordinator.*
> *d) Apply full rudder to oppose the indicated direction of turn.*
> *e) Hold ailerons firmly neutral.*
> *f) Move control column progressively forward until spin stops.*
> *g) Centralise rudder.*
> *h) Level the wings with aileron.*
> *i) Recover from the dive.*
>
> *WARNING: WITH C OF G AT REARWARD LIMIT THE PILOT MUST BE PREPARED TO MOVE CONTROL COLUMN FULLY FORWARD TO RECOVER FROM SPIN'*

The guidance for use in the event of an *Incorrect Recovery* is as follows:

> *'A high rotation rate spin may occur if the correct recovery procedure is not followed, particularly if the control column is moved forward, partially or fully, BEFORE the application of full anti-spin rudder. Such out-of-sequence control actions will delay recovery and increase the height loss. If the aircraft has not recovered within 2 complete rotations after application of full anti-spin rudder and fully forward control column, the following procedure may be used to expedite recovery.*
>
> *a) Check that FULL anti-spin rudder is applied.*
> *b) Move the control column FULLY AFT then SLOWLY FORWARD until the spin stops.*
> *c) Centralise the controls and recover to level flight (observing the 'g' limitations).'*

Later in the same publication information is given about the aircraft's characteristics during erect spinning. After initiation:

> *'the spin progressively stabilizes over about three turns, ending up with about 50º of bank and the nose about 40º below the horizon. The rate of rotation is about 2 seconds per turn [and] the IAS stabilizes at about 75 kts to the right and 80 kts to the left. If full pro-spin control is not maintained throughout the spin, the aircraft may enter a spiral dive or a high rotational spin. A spiral dive is recognised by a rapid increase in airspeed with the rate of rotation probably slowing down as the spin changes to a spiral dive. The wings can be levelled by using aileron with rudders central and the dive then recovered using elevator. A high rotational spin is recognizable by a steeper nose down attitude and a higher rate of rotation than in a normal spin; airspeed will be higher than a normal spin but will not increase rapidly; recovery is as given [for] Incorrect Recovery.'*

This guidance indicates that the rate of descent during a stable spin is about 6,000 fpm.

As part of the investigation a flight was conducted in a T67M-MkII, during which aerobatic and spinning manoeuvres were carried out. In the course of performing a loop, it was noted that the vertical distance between the top and the bottom of the manoeuvre was 600 ft. An aileron roll was also completed, as well as exercises in stalling and intentional spinning. The height loss during a four-turn spin to the left, plus standard recovery, was 1,500 ft, as advised in the Pilot's Notes. A further two loops were carried out, during which the controls were mishandled after the aircraft had reached the top of the manoeuvre, in an attempt to induce a spin. On each occasion the aircraft departed from controlled flight. The controls were immediately centralised, the normal procedure for recovery from an incipient spin, and the aircraft responded within one turn. This flight also demonstrated the potentially disorientating effects of spinning.

These results reflected the comments by the manufacturer, T67 instructors at two UK military flying training establishments and an experienced international aerobatics competitor, that the aircraft is predictable and responds as described in the manufacturer's Pilot's Notes. Their comments also complemented the results of tests on other models of the T67, all of which have been designed with the stability characteristics required for an aerobatic aircraft.

As a military training aircraft, the T67M-MkII has been spun many hundreds of times. Instructors involved in this training have observed students using the correct and incorrect techniques to recover from spins. In all cases, the aircraft recovered when the correct technique was employed.

The pilot owned a copy of the AOPA publication, *Basic Aerobatics* (by R D Campbell and B Tempest). The book includes a section on *The Spiral Dive*. It describes the condition as one in which the nose of the aircraft is allowed to drop too low during the entry into, or while in a steeply banked turn. It states that:

> *'once the aircraft has adopted this attitude the airspeed will increase rapidly…. The correct recovery action is to close the throttle completely and positively roll the wings level, following this the aircraft can be eased out of the dive.'*

Amongst the pilot's possessions was a copy of an Essential Knowledge Quiz which had been compiled by his instructors and which students were encouraged to complete before commencing flying on the aerobatics course. The quiz had been completed and included answers to questions which asked for the symptoms of a spiral dive and a spin, respectively. The two answers given indicated the differences between the two conditions.

T67 studies

Certification testing

A T67M-MkII aircraft was submitted for flight trials prior to type certification. It was established that the aircraft spin recovery characteristics fully complied with the appropriate British Civil Airworthiness Requirements (BCARs) and Federal Aviation Regulations (FARs). Also, the specific requirements of the CAA in relation to an incorrect recovery action, in which forward movement of the control column precedes application of full anti-spin rudder, were met. In that case the aircraft was required to recover within four turns. These trials were conducted over a range of aircraft weights and CG positions.

Aerobatics trials were also conducted and the aircraft type was again shown to comply with the relevant BCARs and FARs.

Tests by United States Air Force

Tests carried out by the USAF in 1998 on the T-3A (the 260 hp version of the T67) included approximately

1,000 spins. It was established that spins were predictable and easily recognisable and that the Flight Manual spin recovery technique was always effective.

Tests by a CAA test pilot

Another variant of the T67, the T67C, was flown twice by a CAA Test Pilot following an accident in 2005 involving G-FORS (see AAIB Bulletin 3/2006). This assessment confirmed that the aircraft characteristics in a spin, and during the recovery, were in accordance with the Pilot's Notes. On the second flight the Test Pilot deliberately released the back pressure on the control column during three of the spins. As a result, the turn rate increased and the recovery from the consequent high rotational spins took between two and three turns.

Previous relevant events

T67 spinning

The Incorrect Recovery procedure was issued by the manufacturer following two events involving Slingsby T67M-MkIIs in 1993 and 1995. The incident in 1993 involved a delayed recovery from a spin following initial incorrect recovery action. In July 1995 an instructor and his student pilot abandoned G-BUUH (see AAIB Bulletin 10/95) during an instructional flight when they were unable to recover from an intentional spin. In this instance, the student had put the aircraft into a spin to the left at Flight Level (FL) 70 and was ordered to recover from the manoeuvre as the aircraft passed FL57, having completed four turns, as planned. The student applied partial opposite rudder and simultaneously moved the control column about half way from the back stop to the neutral position. Then, or shortly afterwards, the nose of the aircraft suddenly pitched down and the rate of rotation increased. The instructor took control and, checking that the throttle was closed and the flaps were retracted, applied full anti-spin rudder and moved the control column progressively to the fully forward position. He later stated that these actions had no noticeable effect on the apparent stability of the spin. He made another check of the configuration and confirmed that the attitude and rotation still showed no indication of recovery. Consequently the crew commenced abandonment of the aircraft as it descended through FL43 and parachuted to safety.

Spinning accidents with other aircraft types

This investigation prompted a review of light aircraft accidents in the UK since 1976 in which spinning has been a factor. The list includes aerobatic and training aircraft but also features a wide variety of other aircraft types. There were peaks in 1976, 1988 and 1996, when the accident numbers reached double figures, and from January 2001 to December 2006 there have been an average of four such accidents per year.

T67 flight control incidents

No evidence was found to indicate that control deficiencies had been a factor in previous T67 accidents. The aircraft manufacturer reported receiving no reports of cases of disconnection of any T67 flight control system linkages, or of restriction or jamming of the aileron or elevator controls. A number of instances of restriction in T67 rudder pedal movement had been experienced. These restrictions were all considered to have been caused by interference between moving parts of the cockpit rudder mechanism (generally a pedal pad or brake bar or a pilot's boot) and either other parts of the rudder, wheelbrake and steering mechanisms or adjacent static parts of the aircraft.

In one incident, to a T67M260 aircraft (G-EFSM) in November 2006, an instructor attempting to recover from an intentional left spin initiated by his pupil found himself initially unable to move the pedals from their full left position. After pushing very hard on his right pedal the mechanism released with a loud noise and a recovery was made from the spin. Inspection indicated that the jam had probably been due to interference between part of the No 3 pedal and an engine control cable support bracket. The bracket, associated with quadrant-type engine controls used on the T67M260 and the T67M200 aircraft, is not fitted to the T67M-Mkll. However, clearances for the rudder pedal mechanism are relatively small in a number of areas.

Procedures aimed at ensuring adequate rudder mechanism clearance were not provided in the Aircraft Maintenance Manual but at the time of G-BUUD's accident they were contained in a number of Service Bulletins (SBs) issued by the aircraft manufacturer over the service life of the T67. Following the incident to G-EFSM the manufacturer issued two additional SBs (Slingsby No 187, for the T67M260 and two T67M200 aircraft; and No 188, for the T67B, T67C, T67M-Mkll and the other T67M200 aircraft). These latter Bulletins aimed to bring together the various check and adjustment procedures for rudder mechanism clearance provided in the previously published SBs. The intention was:

> *'to reinforce the importance of ensuring correct clearances and maintenance of the rudder operating mechanism, mountings and stops to ensure the required clearance for safe operation.'*

The European Aviation Safety Agency issued Airworthiness Directive (AD) No 2007-0132 on 11 May 2007, which mandated incorporation of the Slingsby SBs 187 & 188.

Specified minimum rudder mechanism clearances were generally in the range 10-20 mm (0.39-0.79 inch) but were considerably less in two areas, including that between the No 2 Pedal and the steering arm bolt, specified as 1 mm (0.04 inch). SBs 187 and 188 noted that 'during the clearance checks the pedals do not necessarily have a direct fore and aft load applied, there will be side loads on the pedal pads deflecting the pedal pad laterally or pivoting it about its slider'. The magnitude of the lateral load to be applied during the checks was not specified but was intended to take up any play in the mechanism.

The manufacturer considered that cockpit rudder mechanism clearances, while small in some areas, were adequate, provided the SB measures had been incorporated and the system was correctly adjusted and maintained. The AAIB concluded from the investigation of G-EFSM's incident that, in view of the small clearances, modification was required in order to reduce the risk of rudder restriction. The proposed measures were for improvements to the lateral stiffness and strength of the rudder bar support brackets and to the bracket attachments, and for changes to the engine control cable bracket, where fitted.

Discussion

The pilot commenced the aerobatic manoeuvres at around 5,000 ft agl in good weather. The aircraft departed from controlled flight during the second half of a loop and entered a spin, probably at a height of at least 4,500 ft agl. It is unclear in which direction the aircraft first entered the spin but photographic and radar evidence and the recollections of witnesses support the conclusion that the aircraft settled into a spin to the left, which it sustained until striking the ground. The indications from the crash site and the aircraft wreckage of moderate vertical speed, very low horizontal speed and yaw rotation of the aircraft to the left at impact also showed that G-BUUD had impacted the ground whilst in a left spin. Any other manoeuvre, such as a spiral dive, would inevitably have resulted in a much higher descent rate and more severe aircraft break-up.

The complete absence of impact damage to the propeller blades indicated that the engine had stopped rotating before ground impact. While no definitive reason for this was apparent, the gyroscopic effects of spinning could cause the engine idle speed to reduce and it was possible that centrifugal effects experienced during prolonged spinning could affect the fuel supply to the engine. Stoppage of the engine would not hinder spin recovery but could be distracting.

The evidence indicated that the aircraft had not suffered structural failure in flight and that no parts had detached before ground impact. The possibility of a disconnection in the flight control system could not be positively eliminated as some components of the flight control linkages had been destroyed in the post-crash fire. However, there was no aircraft type history of failure of any of the missing rods and bellcranks and it was possible to examine most of the linkage pivots, the most likely area for a disconnection. Thus it was judged that pre-impact disconnection of the flight controls was unlikely.

The possibility of a control system restriction or jam was considered. Any interference that occurred could leave witness markings on the components, but it was unlikely that this evidence would have been available during the wreckage examination, given the severe and extensive fire damage. A number of in-service instances of rudder restriction had been experienced with the aircraft type, although this had been a rare occurrence and the manufacturer considered that all the known problem areas in this regard had been addressed. Moreover, if the pilot had encountered a control restriction or jam it is probable that he would have made some mention of this in his radio transmission. It was therefore judged unlikely that a control system restriction or jam had occurred on G-BUUD and that this had hindered the recovery from the spin. However, the possibility could not be eliminated.

There was sufficient height for the pilot to carry out a standard recovery from the spin. The pilot had conducted intentional spinning, under instruction, some three months earlier. When entering these intended spins, full rudder in the direction of the spin together with full aft stick would have been applied and maintained. In this instance, having entered an unintentional spin from an aerobatic manoeuvre, the flight controls would most probably have been in different positions, and this may have confused the pilot.

The timing of his 'MAYDAY' radio transmission was estimated to have been made after the aircraft had descended about 2,500 ft from the point of entering the spin, during which time it could have completed up to 10 turns. This number of turns was potentially very disorientating, but the pilot had sufficient awareness to transmit the radio call. From the information he gave, albeit in extremely stressful circumstances, it is not clear whether he had accurately determined the aircraft's flight profile.

In his brief radio transmissions the pilot referred to both "A SPIRAL SPIN" and "A SPIRAL DIVE..". Although he had covered the differences between the two conditions during his training, it is not possible to know what flying control inputs he made, or techniques he employed, in an attempt to recover from the situation. The first action in the recovery from both a spiral dive and a spin is to close the throttle. Allowing for any delay between the engine being throttled back and witnesses on the ground perceiving a reduction in the engine noise, it seems that this action was taken as, or shortly after, the aircraft departed from controlled flight. If the pilot then took the recovery actions for a spiral dive, the aircraft would never have recovered from the spin.

If the pilot had correctly diagnosed that the aircraft was spinning, and applied the standard spin recovery, all the evidence indicates that the aircraft would have recovered. Even if the pilot had moved the control stick forward before applying anti-spin rudder, and maintained these control positions, the aircraft would still have recovered, although this incorrect recovery technique would have delayed the recovery and increased the height loss. If the pilot attempted to recover from the spin using an incorrect technique then a high rotation rate spin might have occurred, although the witness accounts did not reflect the high rate of rotation and steep nose-down attitude associated with such a spin.

For an inexperienced pilot used to the aircraft recovering within one turn after application of the correct recovery procedure, who was probably becoming increasingly disorientated and progressively more concerned, it would have taken a high degree of discipline to recall the guidance given in his training, maintain the flying controls in the full recovery position and wait for the aircraft to stop spinning.

The increase in engine noise during the descent, reported by one witness, cannot be explained other than that the pilot may have been trying further control inputs to recover from the spin.

The CAA do not require a pilot with a PPL(A) to have a compulsory rating in order to perform solo aerobatics, considering the AOPA Aerobatics Course to be a practical alternative. In addition, CAA General Aviation Safety Sense leaflets give advice on aerobatics and spin training. The accident pilot had elected to undertake the AOPA Aerobatics Course, during which he had received training in both basic aerobatics and spin recoveries. He was considered to be part of the way through the course but was making inconsistent progress. The accident occurred on what seems to have been his first attempt to fly aerobatics on a solo flight, although this had not been authorised by his instructor.

Therefore, the following Safety Recommendation was made:

Safety Recommendation 2007-081

It is recommended that the Aircraft Owners and Pilots Association advise those pilots undertaking their Aerobatics Course not to fly solo aerobatics until they have been trained and proved competent in spin recognition and recovery, and their instructor has advised them that they are competent to practise specific aerobatic manoeuvres solo.

A parachute was available to the pilot but, as was his custom, he flew the aircraft without one; he therefore had no opportunity of abandoning the aircraft. The wearing of parachutes may not always be possible or practical; nevertheless, the following Safety Recommendation was made:

Safety Recommendation 2007-082

It is recommended that the Aircraft Owners and Pilots Association provide comprehensive and robust advice on the use of parachutes for flights where spinning and aerobatics are planned, reflecting the guidance given in the Civil Aviation Authority's Safety Sense Leaflets.

Conclusion

Failure to recover from a spin continues to be a cause of accidents to light aircraft types. Considerable flight test and operational experience indicates that recovery from a spin reliably occurs if the appropriate actions, as published in the Pilot's Notes, are taken. However, a successful recovery relies on correct identification of the spin and the maintenance of anti-spin flight control inputs until the spinning ceases.

ACCIDENT

Aircraft Type and Registration:	Vans RV-7A, G-CDRM
No & Type of Engines:	1 Lycoming O-360-A1A piston engine
Year of Manufacture:	2006
Date & Time (UTC):	9 June 2007 at 1445 hrs
Location:	Croft Farm, 10 miles north of Gloucester
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Minor) Passengers - None
Nature of Damage:	Substantial damage to airframe and engine shock-loaded
Commander's Licence:	Private Pilot's Licence
Commander's Age:	56 years
Commander's Flying Experience:	807 hours (of which 101 were on type) Last 90 days - 20 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft touched down normally on the threshold of Runway 09 at Croft Farm. During the landing roll, the aircraft encountered a series of undulations in the grass runway surface and the nose landing gear forks dug in. The aircraft pitched over and came to rest inverted on the runway.

History of the flight

The pilot and a colleague flew from Halfpenny Green to Croft Farm strip to attend a 'fly in'. Croft Farm has a single runway orientated 09/27, 570 m in length and 18 m wide; its grass surface was described by the pilot as dry and firm. The daily inspection of the aircraft was carried out by the pilot and it was found to be fully serviceable. The nose landing gear wheel spat had been removed for modification.

The weather at Croft Farm was good with a light wind, visibility in excess of 10 km and no cloud below 5,000 ft. The pilot contacted Croft Farm on the radio and was requested to join for Runway 09. He reduced speed downwind and lowered two of the three stages of flap before turning onto the final approach. The third stage of flap was then lowered and the IAS reduced to 80 kt, the normal approach speed.

The aircraft touched down at the runway threshold on main landing gear wheels. The grass surface was undulating and the pilot experienced some difficulty in settling the nosewheel before applying the wheel brakes. Approximately halfway down the runway the aircraft had slowed enough to cause the pilot no concerns about completing a successful landing, although the aircraft had migrated to the left of the runway centreline. There was then another undulation which caused the nosewheel to lift off the ground before dropping back down again. The nosewheel attachment forks contacted the ground causing the aircraft to pitch down rapidly. The nose landing gear leg bent back, the propeller contacted the runway and the aircraft pitched over onto its back.

The Airfield Rescue and Fire Fighting Service attended the scene immediately and with the assistance of others managed to raise the left wing, which allowed those onboard to escape.

Having inspected the area after the accident the pilot noted a furrow made by the nose landing gear some 10 ft long. At the beginning of the furrow was a small depression in the runway surface, into which the nosewheel appeared to have dropped.

Analysis

The pilot considered that the touchdown was normal but he was surprised that he experienced so much difficulty in settling the nosewheel on the runway. He believed that the depression in the runway surface may have initiated the marked nose-down pitch, and considered that his braking may have increased this effect. The nosewheel was of a castering design but there was no damage to indicate it had turned across the direction of travel.

ACCIDENT

Aircraft Type and Registration:	Vans RV-8, G-DAZZ
No & Type of Engines:	1 Superior XP-IO-360-B1AA2 piston engine
Year of Manufacture:	2006
Date & Time (UTC):	22 July 2007 at 1700 hrs
Location:	Wishanger farm strip, Farnham, Surrey
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Bent wing, broken spar, minor propeller damage, bent tail wheel spring, distorted rear fuselage, minor canopy crack
Commander's Licence:	Private Pilot's Licence
Commander's Age:	46 years
Commander's Flying Experience:	155 hours (of which 26 were on type) Last 90 days - 15 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During landing, the aircraft drifted right in a crosswind. The right wing tip struck crops flanking the right side of the runway, slewing the aircraft around to the right. The aircraft came to rest in the crop.

History of the flight

After a local flight, the aircraft joined at 1,000 ft for a left-hand circuit to Runway 27 at Wishanger Farm. There was a slight crosswind and as a result the aircraft drifted too far to the right, resulting in the right wing clipping crops to the north of the runway. The aircraft then slewed right into the crop, coming to rest on its left wing and its nose. The damage sustained consisted of a broken right wing tip, a broken spar, a bent tailwheel spring, distortion of the rear fuselage and a minor canopy crack. The two occupants were uninjured and able to vacate the aircraft normally.

The pilot later commented that he had flared too early and, as such, was holding off too high. He recalls being preoccupied about losing height without stalling the aircraft, which diverted his attention away from the aircraft's relative position above the runway. A slight unanticipated crosswind further compounded the level of drift experienced. The pilot felt these two factors precipitated the accident.

ACCIDENT

Aircraft Type and Registration:	Enstrom 480B, N480KP
No & Type of Engines:	1 Allison C20W turboshaft engine
Year of Manufacture:	2003
Date & Time (UTC):	11 July 2007 at 1517 hrs
Location:	Shoreham Airport, Sussex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 2
Injuries:	Crew - None Passengers - None
Nature of Damage:	Creasing to tail boom, tail rotor drive and control runs separated. Skid assembly damaged
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	50 years
Commander's Flying Experience:	16,275 hours (of which 317 were on type) Last 90 days - 31 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During a sales demonstration a simulated engine-off landing resulted in a hard landing.

History of the flight

N480KP was being used for a sales demonstration flight. The final part of the demonstration was a simulated engine off landing onto a grass helicopter training area. At 300 ft agl, with the engine already at idle, the pilot increased the airspeed to 60 kt. During the last 100 ft, the rate of descent increased and the pilot attempted to reduce this by carrying out a gentle flare. This had no effect so he increased collective pitch but the high rate of descent continued. The rotor low rpm horn sounded just before N480KP touched down on its left skid in a nose-low attitude at approximately 30 kt. N480KP ran along the ground on the left skid for 10 ft before turning gently to the left, despite full right pedal being applied and then dropped onto the right skid. The commander checked the other occupants were uninjured, informed ATC of the incident and shut the helicopter down.

Weather

The Shoreham METAR for the time of the accident indicated a surface wind of 230°/15 kt, gusting to 25 kt.

Pilot's Assessment

The pilot considered that the heavy landing was probably caused by windshear.

INCIDENT

Aircraft Type and Registration:	Robinson R44 Raven II, G-CEFR
No & Type of Engines:	1 Lycoming IO-540-AE1A5 piston engine
Year of Manufacture:	2006
Date & Time (UTC):	16 December 2006 at 1115 hrs
Location:	On approach to Ballymena, Northern Ireland
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 3
Injuries:	Crew - None Passengers - None
Nature of Damage:	Distorted lower rib within mast fairing
Commander's Licence:	Not known
Commander's Age:	Not known
Commander's Flying Experience:	Not known
Information Source:	CAA occurrence report and further enquiries by the AAIB

Synopsis

During an approach to land the almost-new aircraft started to oscillate in pitch with vibration felt through the cyclic control. The pilot was unable to reduce the oscillation or vibration using control inputs so he made an expedited run-on landing. The vibration was a result of new, softer, main rotor gearbox mounts allowing excessive fore and aft rocking of the gearbox. The manufacturer has replaced these mounts with stiffer types on new aircraft.

History of the flight

The pilot had just completed an uneventful 15 minute local sightseeing flight, with three children onboard, from a private site at Greenisland, near Belfast. Shortly afterwards the pilot departed on his second flight, with three adults onboard, to ferry them to a rugby club approximately 20 miles away. On arrival at the site, the pilot positioned the aircraft for a right-hand circuit and into-wind approach. While on the downwind leg, in a shallow descent at a height of approximately 700 feet agl and an airspeed of 75 to 80 KIAS, the aircraft suddenly started to oscillate in pitch and the pilot felt high vibrating control forces through the cyclic control. The pilot was unable to arrest the oscillation or vibration using normal control inputs. The magnitude of the oscillations and vibration continued to increase to the point where the pilot was concerned about the helicopter's structural integrity. He decided to land immediately and employed a run-on landing procedure. The aircraft came to a rest without any apparent damage to the aircraft or injury to people on board. During the engine shutdown the vibration was still present, although engine temperatures and pressures were in the normal range.

This aircraft had completed a total of 18.1 hours since new.

Weight and balance

The aircraft's weight at the time of the incident was estimated at 2,470 lb, which was 30 lb below the maximum takeoff weight. The aircraft's CG was estimated at 93.9 inches aft of datum. The forward CG limit at that weight was 93 inches and the aft limit was 98 inches.

Examination of the aircraft and rectification work

The maintenance organisation carried out a number of inspections of the aircraft as recommended by the manufacturer. The only damage found was a distorted aluminium lower rib within the mast fairing assembly. It was suspected that this damage was caused by excessive rocking of the main rotor gearbox, causing the rear hydraulic servo to impact the rib.

The main rotor hub 'teeter' friction was measured at 22 lbf, which was 3 lbf beyond the 19 lbf limit. It was adjusted down to 6.2 lbf. The main rotor blade coning hinge frictions were found unevenly set, with one set to 4.5 lbf and the other to 2 lbf (no limit specified). Both were adjusted to 2.2 lbf.

The two forward main rotor gearbox rubber isolation mounts (p/n A653-1) were replaced with newer stiffer mounts (p/n A653-2), following the manufacturer's advice. The aircraft was subsequently flight tested at various weight and CG configurations, including maximum weight and maximum forward CG, with no recurrence of the vibration or oscillation problem.

Previous incident on this aircraft

The aircraft had suffered a previous incident of heavy vibration in November 2006 when the aircraft had logged 10.1 hours since new. During this incident the aircraft had been loaded to 2,566 lb (66 lb above maximum takeoff weight) with a CG of 93.64 inches (near the forward limit of 93 inches). Following this flight the maintenance organisation had carried out an inspection and flight test (at 2,350 lb) which did not reveal the same vibration problem. The maintenance organisation recommended that the aircraft should not be flown above the maximum takeoff weight and to avoid a CG near the forward limit, until the manufacturer had been consulted about the problem.

Manufacturer's assessment of the cause

The manufacturer stated that they first experienced this vibration problem during flight test in 1993. It manifested itself at forward CG when the CG was located forward of the main rotor gearbox. The vibration was caused by the gearbox rocking fore and aft on its mounts, which was then felt as a 0.6 per 'main rotor revolution' vertical vibration (the natural frequency of the rotor system). The pilot was able to cure the problem by increasing power.

To eliminate the excessive vibration the manufacturer replaced the forward gearbox mounts (originally p/n C653-4) with stiffer mounts (p/n A653-1). Following the incident to G-CEFR the manufacturer measured the stiffness of new A653-1 mounts and found that they were softer than A653-1 mounts manufactured in the year 2000. The manufacturer believes that this softening of the mounts resulted in a recurrence of the vibration problem. They have not found evidence that hub teeter friction or coning hinge friction contributes to the problem.

The manufacturer has therefore started installing new, stiffer, mounts (p/n A653-2) on their new aircraft and these were retrofitted to G-CEFR. The manufacturer has also found that as the mounts age in service, the rubber becomes harder. The mounts take a compression set from the heat and loads experienced during flight, and this makes them stiffer. This explains why the problem has mainly affected relatively new aircraft. Since June 2007 the manufacturer has been conditioning the mounts by heating them in a 200ºF (93ºC) environment under a 1,000 lbf load for 12 to 24 hours, thereby giving the mounts the compression set they would eventually take in service.

On 28 August 2007, the manufacturer reported to the AAIB that they were no longer encountering the vibration problem during production flight test and that they had not received any further reports of vibration incidents from in-service aircraft. Therefore, the manufacturer does not plan to issue a service letter about the problem, although this situation would be reconsidered if new reports of vibration were received.

INCIDENT

Aircraft Type and Registration:	Cameron Z-275 Balloon, G-TCAS
No & Type of Engines:	Cameron Stealth and Shadow triple burners
Year of Manufacture:	2003
Date & Time (UTC):	8 April 2007 at 1858 hrs
Location:	Souldrop, Bedfordshire
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 1 Passengers - 12
Injuries:	Crew - 1 (Serious) Passengers - 1 (Minor)
Nature of Damage:	None
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	58 years
Commander's Flying Experience:	1,659 hours (of which 1,500 hours were on type) Last 90 days - 6 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The pilot made a normal approach to a suitable landing area in a large field. The surface wind was 6 to 10 mph and in order to minimise the dragging of the passenger basket across the field, the pilot used the rapid deflation line to deflate the envelope. On touchdown the pilot was ejected from the basket, which passed over him causing serious injuries. The pilot had not connected his safety harness to the restraint line; he was therefore not secured to the basket and was particularly vulnerable when operating the rapid deflation line.

History of the flight

The flight was planned to depart from a hotel near Northampton and to last for approximately one hour, with the possibility of landing at the Santa Pod Raceway. The weather conditions were generally good with the visibility in excess of 10 km and small amounts of cloud at about 5,000 ft. The surface wind was estimated to be gusting between 6 to 10 mph and the 2,000 ft wind was forecast to be westerly at 12 to 15 kt.

The pilot completed the passenger flight and safety briefing and after a short delay the balloon was inflated. The pilot and passengers boarded the basket and the balloon departed at 1800 hrs. Despite limited steerage between the surface and 1,800 ft the balloon generally followed a direct track to the Santa Pod Raceway and the pilot commenced an approach. During the approach, he was contacted on the balloon radio frequency by Santa Pod to confirm that he was permitted to land but he was warned that cars were using the competition area. The balloon was tracking directly towards the end of the competition area and with the limited steerage available the pilot decided not to land at Santa Pod.

During the approach the pilot had noted a suitable landing area in a large field approximately 0.5 nm beyond Santa Pod and he climbed the balloon to about 100 ft to assess it. The pilot briefed the passengers to prepare for landing and warned them that the landing would be firm with a possibility of the basket tilting and dragging. The passengers adopted their briefed landing position with their backs towards the direction of travel and their knees bent. They all held on to the hand holds provided on the sides of the basket.

The pilot completed the approach, easing the rate of descent as the balloon neared the ground. At about 10 ft agl, he pulled the red deflation line using both hands. This causes the parachute valve within the balloon envelope to invert, leading to a rapid loss of the hot air and deflation of the balloon envelope. Whilst this action commits the balloon to a landing it reduces the landing distance and the associated dragging of the basket. When the balloon touched down the basket tilted onto its front and the pilot was ejected. The basket passed over the pilot causing him serious injuries. Nevertheless, he was able to retain a hold on the red deflation line until the balloon stopped moving. The basket was dragged approximately 35 m across the field before coming to rest.

Pilot technique

The pilot had aimed for a touchdown point approximately one third of the distance into the field. This allowed the balloon to clear the trees on the approach and minimise any crop damage. The earthen surface of the field was smooth, dry and hard providing no cushioning for the landing and allowing significant dragging of the basket by the balloon envelope. In order to minimise the dragging, the pilot activated the rapid deflation system just prior to touchdown. Whilst this increases the rate of descent of the balloon, causing a firmer touchdown, it also minimises the distance over which the basket is likely to be dragged.

Operational requirements

The pilot is required to wear a safety harness which he attaches to a strap secured to the floor of the basket. This permits him to move around but prevents him falling out of the basket. This equipment must be worn and connected during public transport flights.

The Operations Manual sets out the requirement as follows:

> **'Restraint Harnesses**
>
> *All pilots must now use the pilot restraint harnesses that are fitted to all our balloons. It must be worn and attached before the balloon restraint is released, worn throughout the flight and not be released until the end of the flight and you are completely sure the balloon has come to a complete and final standstill. There must be no chance of a gust of wind or thermal lifting the balloon off the ground without you aboard.'*

Analysis

Whilst the landing was firm and the basket tilted onto its front none of the passengers were ejected from the basket. They had adopted the landing positions as briefed and were holding onto the hand holds provided. Although the pilot was prepared for the landing his safety harness was not attached to the safety strap. He was therefore not secured to the basket and was particularly vulnerable when operating the rapid deflation line with both hands. He could not recall why he had not attached the safety harness to the strap since he was normally conscientious in doing so.

ACCIDENT

Aircraft Type and Registration:	Chevvron 2-32, G-MVGE
No & Type of Engines:	1 Konig SD 570 piston engine
Year of Manufacture:	1988
Date & Time (UTC):	11 August 2007 at 1700 hrs
Location:	North Moor, Scunthorpe, North Lincolnshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Landing gear separated, damage to fuselage underside and propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	62 years
Commander's Flying Experience:	251 hours (of which 18 were on type) Last 90 days - 12 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft suffered a power loss on final approach due to carburettor icing. The aircraft was damaged in the subsequent forced landing.

History of the flight

The Chevvron 2-32 is a side-by-side two-seater mid-wing monoplane microlight which has conventional 3-axis controls. It has a glide ratio of 17:1 with the engine stopped.

G-MVGE had departed from Sandtoft Airfield at 1510 hrs local time and climbed to 2,000 ft where the pilot shut down the engine and continued to climb using thermals. The aircraft arrived over North Moor Airfield and the pilot restarted the engine at 2,000 ft. The aircraft entered the downwind leg for approach to Runway 27 and the wind was southerly at approximately 5 mph. The pilot completed the checks which included operating the engine briefly at maximum rpm. However, on final approach the engine lost power; the pilot attempted to restart the engine without success. He retracted the trailing edge drag flaps and turned right thorough 180º in an attempt to avoid power lines and to clear standing crops before landing in a stubble field approximately into wind. However, the aircraft did not reach the selected field and stalled into the tops of a maize crop approximately 8 ft high. There were no injuries to the pilot or passenger.

Pilot's comments

The pilot considered that following a low power descent from 2,000 ft to circuit height and setting the approach power, the high air temperature of around 24ºC and humid conditions were the cause of the power loss, due to carburettor icing. No carburettor heating was available on this particular aircraft, although there is a modification available which can be fitted to provide such heating.

ACCIDENT

Aircraft Type and Registration:	Pegasus Quasar TC, G-MWSH
No & Type of Engines:	1 Rotax 503-2V piston engine
Year of Manufacture:	1991
Date & Time (UTC):	6 April 2007 at 1710 hrs
Location:	Shifnal microlight site, near Telford, Shropshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Substantial
Commander's Licence:	Private Pilot's Licence (Microlight)
Commander's Age:	58 years
Commander's Flying Experience:	315 hours (of which 1 hour was on type) Last 90 days - 8 hours Last 28 days - 3 hours
Information Source:	AAIB Field Investigation

Synopsis

The pilot, flying a flex-wing microlight, completed one circuit during which he appeared to have some difficulty in controlling the aircraft and which resulted in a go-around. On the second approach he was low on the final approach and collided with a hedge. The pilot was fatally injured in the impact.

History of the flight

The owner, who was not a qualified pilot, purchased the microlight in March 2007. On the day of the accident the owner asked a friend, who was a qualified pilot, to familiarise himself with the aircraft by flying a couple of circuits before taking him flying.

The weather conditions were generally good with a light northerly airflow. The pilot, assisted by the owner, rigged the aircraft during the morning. At one stage in the process, he went to look at the wing of a similar aircraft, apparently to check on which side the red and green tipped wing battens should be fitted. The rigging process took some time; a securing pin was missing and the pilot had to return to his home to find an alternative pin. By the time the aircraft was rigged and ready for flight, thermal activity and associated turbulence had developed making the weather conditions far from ideal for flex-wing, weightshift microlight flying. The flight was therefore delayed until conditions improved; meanwhile, the pilot completed several flights in a 3-axis type, Ikarus C42 microlight.

At around 1745 hrs the weather conditions became calmer so the pilot prepared to fly G-MWSH. He taxied out from the parking area and completed some taxi runs along Runway 36; a grass strip 300 m long and 30 m wide. During these runs the aircraft was seen to "hop" into the air once or twice, but only to a height of 1 to 2 ft.

The aircraft then took off from Runway 36, getting airborne approximately halfway along the runway. Two witnesses described its climb rate as "poor" relative to other aircraft types that fly from the airfield. One witness described the climb as stopping at around 100 ft before recommencing. Other witnesses saw the aircraft on its subsequent approach to Runway 36. They described it as flying erratically and approaching at a height close to the top of a prominent hedge located on short finals. As the aircraft crossed the runway threshold it was seen with the left wing low and close to the ground. Power was then applied and, instead of flying along the runway as expected, it turned to the right. It was described as 'wobbling' in flight with the pod moving from side to side. The aircraft flew low over another aircraft, which was waiting some 50 m to the right side of the runway, before it turned to the left and climbed to follow the normal circuit pattern for Runway 36.

The second circuit was carried out at low level and the aircraft was positioned on the approach to Runway 36. Witnesses described seeing the aircraft through the hedge rather than above it, and said that it was rocking or "wobbling" in flight. The aircraft was then seen to descend directly into the hedge; some witnesses described a nosedive. At around the same time the engine was heard to go to high power. Several witnesses went over to the hedgerow in an attempt to assist the pilot but he had suffered fatal injuries in the impact.

Accident site

The aircraft had struck a hawthorn hedge and trees located 65 m from the threshold of Runway 36. The hedge, which ran perpendicular to the runway, varied in height along its length. Embedded within the hedge, mainly to the west of the approach path, were several trees that exceeded the height of the hedge (see Figure 1). The lack of any ground marks prior to the hedge indicated that the aircraft had not contacted the ground before striking it.

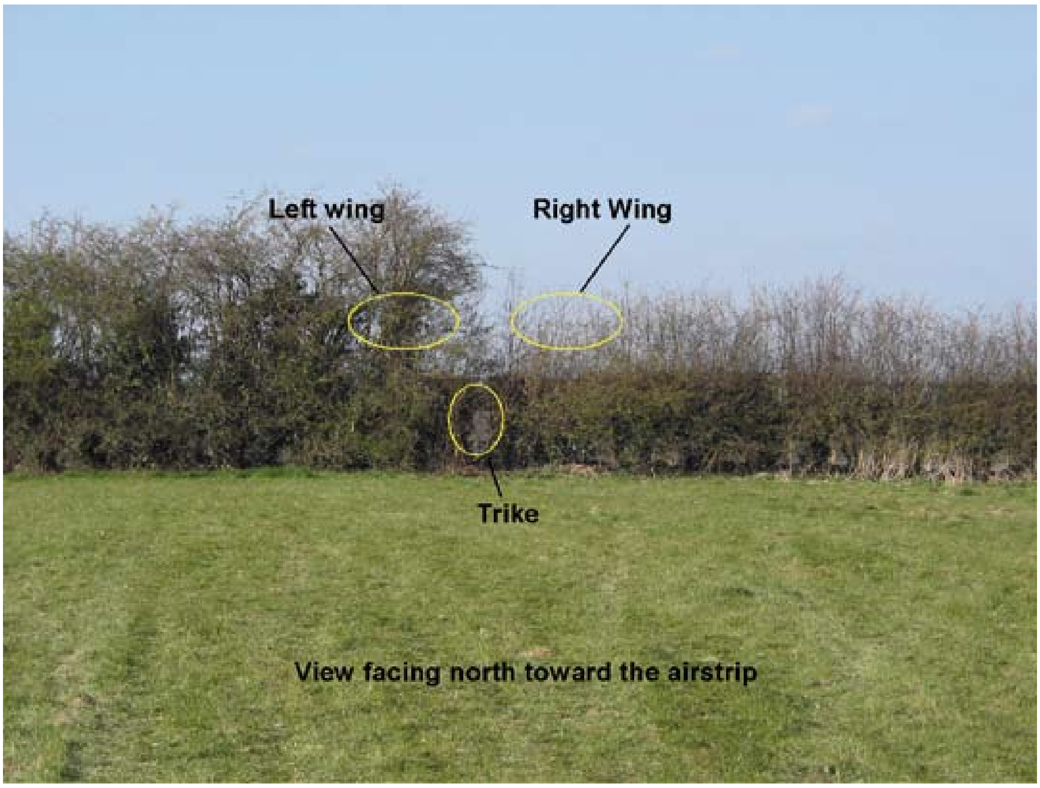


Figure 1

Hedge and tree damage after the recovery of the aircraft

Damage to the hedge and trees were consistent with the aircraft impacting it in a wings level attitude with the trike about 1 m above the ground. It was not possible to establish the exact pitch attitude at impact.

The leading edge of the left wing had initially struck a tree that had grown to a height above the hedge; the right wing did not strike anything significant except for small branches extending upwards from the hedge. The trike had continued to move forward and into the hedge, under its own engine power. The tree had restricted the wing from moving further forward, causing the trike to rotate about the hang point, before pulling forward against the wing structure, fracturing the wing keel in two places. Additionally, as the A-frame was still attached to the wing, as the trike moved forward in relation to the wing, the pilot became trapped between the lower bar of the A-frame and the trike's seat back. When the trike's rear wheels came into contact with the hedge the trike was brought to a halt.

Damage to the tips of the three propeller blades indicate that the engine was under power at the time the trike struck the hedge.

Examination of the aircraft at the accident site revealed that all the flying wires, king post and luff lines were correctly attached and secure. Additionally, the rigging wires for the wing cross-boom were correctly installed, tensioned and on the restraint cable stud with the securing pin still in place. All the wing battens were in place and secured by a single loop of a bungee. The wing fabric was still intact although some tearing had taken place as a result of the accident and the subsequent attempts by the emergency services to remove the pilot. The fuel tank had remained intact, despite severe crumpling, and there was no fire. About 36 litres of fuel were drained from the fuel tank.

Aircraft information

The Pegasus Quasar weightshift microlight, a flex-wing aircraft type, was first flown in 1989. The wing shape is maintained by battens which are held in place by double looped bungees. There is provision for a pilot to make small adjustments to the handling characteristics of the aircraft by changing the profile of the battens, thereby altering the shape of the wing. Each batten can be adjusted up to a limit of 15 mm; guidance as to the method and amount of adjustment is given in the operator's handbook, supplied with the aircraft. The pilot manoeuvres the aircraft by positioning a crossbar in front of him. Pitch and roll control inputs on this bar have the opposite effects to conventional 3-axis type controls; pushing the bar forwards causes the aircraft to pitch up and moving the bar to the right causes the aircraft to turn to the left.

Aircraft examination

The aircraft was recovered from the field and taken to the AAIB facilities at Farnborough for a detailed examination.

Weighing the aircraft showed it to have an empty weight of 197.7 kg; the maximum authorised empty weight is 180 kg. With 36 litres of fuel this would have given a weight without the pilot of 223.25 kg. The maximum all up weight allowed for the aircraft was 381.6 kg, thus for this flight, with only one pilot on board, the weight would have been well below the maximum.

The pitch of the propeller blade as fitted was found to have been correct at 15°. A replacement propeller was fitted to the aircraft and the engine was started and run using the fuel previously drained at the accident site. The engine started normally, using the electric start, and responded smoothly to the hand and foot throttle. The engine also continued to run normally when operated independantly on either of the two ignition systems. Full engine power of 6,800 rpm was achieved during the static engine run.

A check of the batten profiles for the wings revealed that the correct battens had been used during the rigging of the wing. However, a comparison of the batten profile against the profile drawings supplied by the aircraft manufacturer revealed that although the left wing battens matched the profile drawing, the right wing battens were significantly different. The outer batten, number 11, had been damaged during the attempts to recover the pilot, however batten numbers 6,7,8,9 and 10 had significant over-camber when compared to the drawing. Batten number 10 showed the greatest deviation, with an additional 46 mm to the camber, (see Figure 2).

Despite some tearing of the wing fabric, a Bettsometer test of the wing sail fabric was satisfactory. (A Bettsometer test is designed to check for any degradation of fabric wing surfaces.) The mylar inserts for the wing leading edge showed signs of crumpling although it was not known if this occurred prior to, or as a result of, the accident.

As a result of the discovery of the altered batten profiles on the aircraft, a series of test flights was carried out on a similar aircraft by the manufacturer. The battens were set to the same profile as found on G-MWSH and the handling characteristics were assessed. The flight test showed that the aircraft had a tendency to turn to the left and required 1 to 2 kg of right roll effort on the bar to fly in a constant direction, although the test pilot assessed the effect as 'not severe'. Other flight characteristics were not significantly affected and the test pilot noted that the aircraft would have been acceptable for a Permit to Fly (PTF) revalidation except for the tendency to turn left. The manufacturer also advised that although the bungees should have been secured by a double loop, a

Figure 2

Wing batten profiles as found following the accident flight single loop arrangement should not have significantly affected the flight characteristics.

Aircraft history

The aircraft, manufactured in April 1991, had nine previous owners. The last PTF was issued in June 2006. During the PTF renewal the BMAA inspector checked the wing batten profiles against the batten profile drawing. He also test flew the aircraft which did not show any abnormal handling characteristics. After the PTF renewal the aircraft flew on eight occasions with the last recorded flight on 2 July 2006. At the time of the accident G-MWSH had completed 543 airframe hours.

The aircraft was sold on in October 2006 to a new owner, who intended to use it to learn to fly. He stored the de-rigged aircraft in a shed with the wing and its battens stored in their protective bags. He then sold the aircraft without ever rigging or flying the aircraft.

The current owner bought the aircraft in March 2007. He made the purchase after having been to view it accompanied by the pilot involved in this accident, who had provided advice regarding its condition and suitability. After the purchase he transported it to his garage for storage. The owner took the aircraft to Shifnal a week prior to the accident, but due to unsuitable weather, the pilot decided not to rig it. The wing was left, de-rigged in its bag, in a hangar at the airfield, whilst the trike was taken back to the owner's garage. On the morning of the accident the trike was transported back to Shifnal for rigging. This was the first occasion that the aircraft had been fully rigged since October 2006 and the subsequent flight was the first since July 2006.

When the current owner took possession of the aircraft he was handed a series of documents. Despite several manufacturer's drawings and the operator's handbook being included in the package, the manufacturer's batten profile drawings were missing.

A review of the aircraft logbook indicated that it had been inactive from July 2001 to March 2004 and from June 2005 to June 2006. A more significant gap in the logbook was during the period July 1994 until September 1999. The PTF records for the period revealed that it had accumulated 423 airframe hours at a rate of just less than 100 hours a year.

Several modifications had been incorporated into the aircraft, the majority of which were installed prior to 2001 and had not been recorded in the aircraft logbook or recorded with the BMAA. The only recorded modifications were the installation of strobes in May 1993 and a fuel gauge in May 2005.

The aircraft had been weighed in 2004; at that time the empty weight was 180 kg, which was the maximum authorised.

Pilot information

The pilot had been flying microlight aircraft for ten years. He had first learned to fly in a flex-wing type and then in 2001 had converted to a 3-axis type. In 2001 he bought a Thruster 3-axis aircraft, which he kept at Shifnal; at the time of the accident he had recorded 200 hours of flight in this aircraft. In the six months prior to the accident his only recorded flight time was in an Icarus C42, a 3-axis machine. Since the end of 2001 he had recorded only one flight in a flex-wing type, a flight of 20 minutes in a Quasar in April 2003.

The owner of G-MWSH noted that in a conversation prior to the flight the pilot had said that he would need to be careful not to put in the wrong controls, because he had not flown a flex-wing for some time. It was reported that it had been the pilot's intention to fly G-MWSH on a regular basis, both to regain his familiarity with and to maintain flying practice on a flex-wing type.

The pilot had been appointed as a BMAA inspector on 15 August 2006. He was qualified to carry out inspections on 3-axis and flex-wing aircraft types for PTF renewals, but was not qualified to conduct the PTF flight tests.

Meteorological information

The flight conditions at the time of the accident were described by another pilot who was flying at the time as being a little turbulent but quite manageable. There was a northerly wind of around 10 kt, with good visibility and no low cloud. The meteorological report from RAF Cosford, 3 nm from the accident site, recorded at 1655 hrs was: surface wind from the north at 9 to 13 kt, visibility 5 km, scattered cloud at 3,600 ft, temperature 15ºC, dewpoint 3ºC, and pressure 1025 hPa.

Aerodrome information

The Shifnal microlight site is a grass airfield with two runways, Runway 10/28 and Runway 18/36. The circuit direction for Runway 36 is to the left; shortly after takeoff the climb out path crosses a railway line running in a cutting. There are local instructions for the circuit regarding noise sensitive areas; within the circuit there are a number of open grass fields with hedgerows between and several areas of farm buildings. There is a line of telegraph poles carrying power lines some 45 m to the left of the final approach path for Runway 36. There is a tall hedgerow which has to be crossed 65m before the threshold of Runway 36.

In northerly wind conditions it was reported that this hedgerow, together with the surrounding terrain profile, can give rise to some localised turbulence on the southern side.

Medical information

A post-mortem examination was carried out on the pilot. There was no evidence of any pre-existing disease or condition which could have had a bearing on the accident. The cause of death was a result of injuries sustained to the pilot's chest.

Survivability

The pilot was wearing a crash helmet and a lapstrap. The seats had been fitted with seat belts; the rear passenger seat had a lap strap and over shoulder harnesses, whereas the pilot seat only had a lap strap. The harness did have a provision for a diagonal shoulder strap for the pilot but this had not been fitted.

The fatal injuries suffered by the pilot were consistent with crushing between the A-frame and the pilot's seat back. Examination of the seat revealed that repairs and modifications had taken place around the pilot's seat back. The seat back and post had been modified with the addition of an inner sleeve of metal within the seat post. There was also evidence that the seat back had been removed and refitted to the seat post. The fibreglass seat had been subjected to repairs in the past due to cracking. However, additional packing had been added within the recess in which the seat post would sit. The packing consisted of a crushed metal bar secured in place by fibre-glass, using a pink coloured resin, (see Figure 3).

The only record of a repair to the seat was in May 2005. The owner at the time, who also carried out the repair, does not recall ever fitting a metal packer into the recess of the seat. Similarly the BMAA inspector that carried out the PTF renewal in June 2006 also does not recall seeing the seat back packer.

Examination of the seat after accident indicated that bending had occurred to the seat post and that it had

Figure 3

Seat back repair

reacted against the packing in the seat recess. A dent to the plastic outer sheath of the seat post was consistent with a large rearward force being applied. The seat also exhibited cracking to the sides of the seat and behind the recess, again indicative of a large rearward force on the seat post.

There is no requirement for the pilot's seat back to collapse when a rearward force is applied, however had the seat back given way in this accident then the injuries may not have been fatal

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A seat back that does collapse when a rearward force is applied, would not be beneficial in many situations, as for example, in the case of a heavy landing where the seat back collapses and results in the pilot not then being able to control the aircraft.

Witness information

A relatively inexperienced pilot, who was flying at a height of 500 to 600 ft in the circuit at the time, watched G-MWSH as it flew the circuit and he described the flight pattern as "unusual". This was because it was flying a tight circuit at a considerably lower height.

Some of the witnesses were also microlight pilots. One watched the whole flight from a distance of about 400 m from the accident site and he reported that the aircraft did not appear to climb well after takeoff and never got above a height of about 300 ft. His impression was that the aircraft seemed to be flying too slowly and, as a result, there was not enough control available during the first approach. He, along with several others, described it as being low on the second approach; he then saw it nose-dive into the hedge.

Analysis

The pilot rigged the aircraft himself, with the owner's assistance. He also checked it again immediately before he flew it. His depth of knowledge on how to rig this particular wing type is uncertain, although as a BMAA inspector he should have had sufficient knowledge to determine whether the aircraft was in a suitable condition to fly.

However, it is known that at one stage in the rigging process he went to look at the wing on a similar aircraft, apparently to see on which side the red and green tipped battens should be fitted. The owner fitted the bungees to the wing battens himself. These were secured with a single loop as opposed to double looped; he did this under the direction of the pilot, who was therefore presumably satisfied with the arrangement. During the subsequent investigation the manufacturer advised that although the bungees should be secured by a double loop, a single loop arrangement should not have significantly affected the flight characteristics of the aircraft.

The unusual batten profiles, found after the accident, should also not have affected the aircraft's handling such that it was unmanageable by an experienced pilot. The air tests carried out by the manufacturer showed that the aircraft was flyable in the configuration in which it was rigged. However, less than ideal or unusual handling characteristics could have contributed to a difficulty for a pilot who was not in current practice on a flex-wing aircraft.

The weather conditions for the flight were adequate, as demonstrated by the fact that a relatively inexperienced pilot was flying a flex-wing aircraft in the circuit at the same time, without difficulty. However, the high hedge on the final approach could have given rise to disturbed air and turbulence on the downwind side in the northerly wind.

The flight did not appear to follow a normal circuit pattern; the circuits were described as being low and the flight path erratic. It seems likely, therefore, that the pilot was experiencing some difficulty in flying the aircraft. If the problem had been severe, or if there had been a major failure, it is probable that he would have attempted to land in one of the available fields around the airfield. The fact that he continued in the circuit suggests that his problems were neither severe nor unmanageable.

The pilot had only one flight of 20 minutes duration in a Pegasus Quasar aircraft recorded in his logbook, and that had been carried out four years prior to this flight. In the intervening four years he had flown only 3-axis types and in the previous six months only one type, the Ikarus C42. The handling and performance characteristics of the Quasar would have been completely different from those of the 3-axis C42, the type on which all of the pilot's recent experience had been attained and which he had flown several times on the day of the accident. In particular the roll and pitch control inputs required to manoeuvre the machine would have been in the opposite sense. These differences, which can be overcome if a pilot is in regular practice on the different types, could have caused some confusion. It is therefore considered likely that the pilot's lack of recent experience on this type of aircraft gave rise to his difficulty in flying it successfully around the circuit.

The combination of an aircraft that was not performing particularly well, as a result of the characteristics of its wing, and a pilot who was not in recent flying practice on a flex-wing aircraft could have caused the erratic flight described by the witnesses. Furthermore, being low on the final approach would have compounded the problem by placing the aircraft into an area of turbulence created by the northerly wind. However, a medical problem affecting the pilot, or some other undetermined event, cannot be excluded.

FORMAL AIRCRAFT ACCIDENT REPORTS ISSUED BY THE AIR ACCIDENTS INVESTIGATION BRANCH

2005

2/2005 Pegasus Quik, G-STYX
at Eastchurch, Isle of Sheppey, Kent
on 21 August 2004.

Published November 2005.

3/2005 Boeing 757-236, G-CPER
on 7 September 2003.

Published December 2005.

2006

1/2006 Fairey Britten Norman BN2A Mk III-2 Trislander, G-BEVT
at Guernsey Airport, Channel Islands
on 23 July 2004.

Published January 2006.

2/2006 Pilatus Britten-Norman BN2B-26 Islander, G-BOMG, West-north-west of Campbeltown Airport, Scotland
on 15 March 2005.

Published November 2006.

3/2006 Boeing 737-86N, G-XLAG
at Manchester Airport
on 16 July 2003.

Published December 2006.

2007

1/2007 British Aerospace ATP, G-JEMC
10 nm southeast of Isle of Man (Ronaldsway) Airport
on 23 May 2005.

Published January 2007.

2/2007 Boeing 777-236, G-YMME
on departure from London Heathrow Airport
on 10 June 2004.

Published March 2007.

3/2007 Piper PA-23-250 Aztec, N444DA
1 nm north of South Caicos Airport, Turks and Caicos Islands, Caribbean
26 December 2005.

Published May 2007.

4/2007 Airbus A340-642, G-VATL
en-route from Hong Kong to London Heathrow
8 February 2005.

Published September 2007.

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