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COMMERCIAL AIR TRANSPORT

FIXED WING

ROTORCRAFT

None

GENERAL AVIATION

FIXED WING

ROTORCRAFT

SPORT AVIATION / BALLOONS

None

ADDENDUMS and CORRECTIONS

None

CONTENTS (Continued)

(ALL TIMES IN THIS BULLETIN ARE UTC)

INCIDENT

Aircraft Type and Registration:	Airbus A340-311, 4R-ADB
No & Type of Engines:	4 CFM56-5C2 turbofan engines
Category:	1.1
Year of Manufacture:	1994
Date & Time (UTC):	26 June 2005 at 0913 hrs
Location:	School Hill Lane, Wargrave, Berkshire
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 14 Passengers - 304
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to right inboard flap, No 3 flap fairing and No 3 engine exhaust nozzle
Commander's Licence:	Air Transport Pilot's Licence
Commander's Age:	54 years
Commander's Flying Experience:	17,000 hours (of which 5,760 were on type) Last 90 days - 223 hours Last 28 days - 48 hours
Information Source:	AAIB Field Investigation

Synopsis

A member of the public informed the AAIB that an item, which they thought may have fallen from an aircraft, had been found in their wooden outbuilding. After lengthy investigation it was discovered that the item was the number three flap track fairing lower attachment fitting from a Sri Lankan Airbus A340-311. The reason for its separation from the aircraft was due to its attachment inserts pulling out of the fairing honeycomb structure, which allowed the fitting to rotate and unscrew from the eye end of the rod connecting it to the flap.

Background

The AAIB were informed by a member of the public that an item had been found in their wooden outbuilding on the morning of 26 June 2005, and that it appeared to have entered through the building's roof. The outbuilding was in a garden in Wargrave, Berkshire, which is overflown by many types of aircraft, including airliners which operate in and out of London Heathrow Airport (LHR). As this item appeared to be a component from such an aircraft, it was collected by the AAIB for examination.

Figure 1

The object, shown in Figure 1, had little distinguishing features except for part numbers on the bolt heads and the threaded eye end; it weighed approximately 1.5 kg. After a lengthy investigative process, it was established that the object had come from an Airbus A330, A340-200 or A340-300, and in fact was a flap fairing lower attachment fitting, see Figure 3.

With this knowledge, an organisation based at LHR which maintain Airbus A340 aircraft was contacted. This revealed that a Sri Lankan Airbus A340-311, registration 4R-ADB, had been in their facility on 27 June 2005 for 'ad hoc' maintenance as one of its lower flap fairing attachment fittings was missing and required replacement. Repair of damage to the right wing inboard flap, the No 3 flap track fairing and No 3 engine was also required.

History of the flight

The flight had started at Colombo, Sri Lanka, and was destined for LHR. After departure, two pieces of metal were found on Runway 22 and these were later discovered to be exhaust nozzle lower half tab fairings from the No 3 engine. The flight crew were aware that metal pieces had been found on the runway at Columbo and that they may have come from their aircraft but, as all the flight and engine parameters were normal, they elected to continue to LHR.

The aircraft was due to land on Runway 09L and the aircraft had been positioned to fly out to the west, to the north of the airport, before being turned back onto the extended centre line of 09L. Radar data for 4R-ADB at this time showed that the aircraft passed over Wargave, and directly over the location of the wooden outbuilding, at 0913 hrs. It was about this point in the approach that flaps would have been lowered in preparation for landing. The aircraft made an uneventful landing at LHR and it was only later that it was discovered that there was a problem with the No 3 flap fairing on the right wing, as it was hanging abnormally.

Description of flap system, Figure 3

On each wing of the Airbus A340-300 there are two trailing edge flaps, inboard and outboard. The flaps are mounted on flap carriages which are driven along flap tracks attached to the lower wing surface. To protect the flap tracks and reduce drag, each track is enclosed in a fairing. The rear section of the fairing is pivoted at the flap track and is allowed to move in sympathy with the flap by the use of a connecting rod attached to the underside of the flap at one end, and to a fork fitting on the flap fairing lower attachment fitting, at the other. As the flap moves aft and downward, the connecting rod transfers this motion to the flap track fairing lower attachment fitting, and pushes the rear section of the fairing downward.

Adjustment of the clearance between the fairing and flap is accomplished at the lower fairing attachment fitting. An access hole on the underside of the fairing gives access to a bolt that, in turn, alters the height of the fork fitting to which the connecting rod is attached. This changes the distance between the flap and the fitting. This means of adjustment is designed to preclude the need to perform any adjustment on either of the eye ends on the connecting rod.

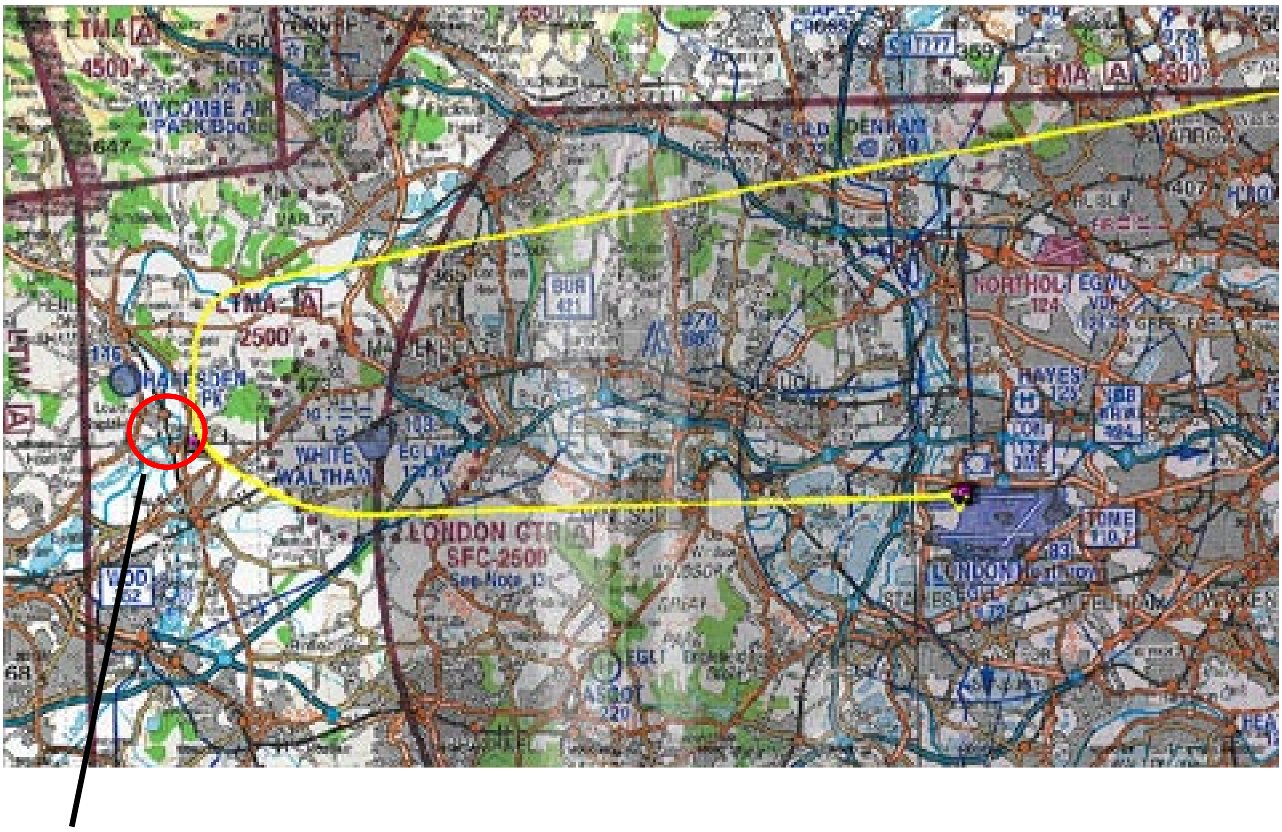


Figure 2

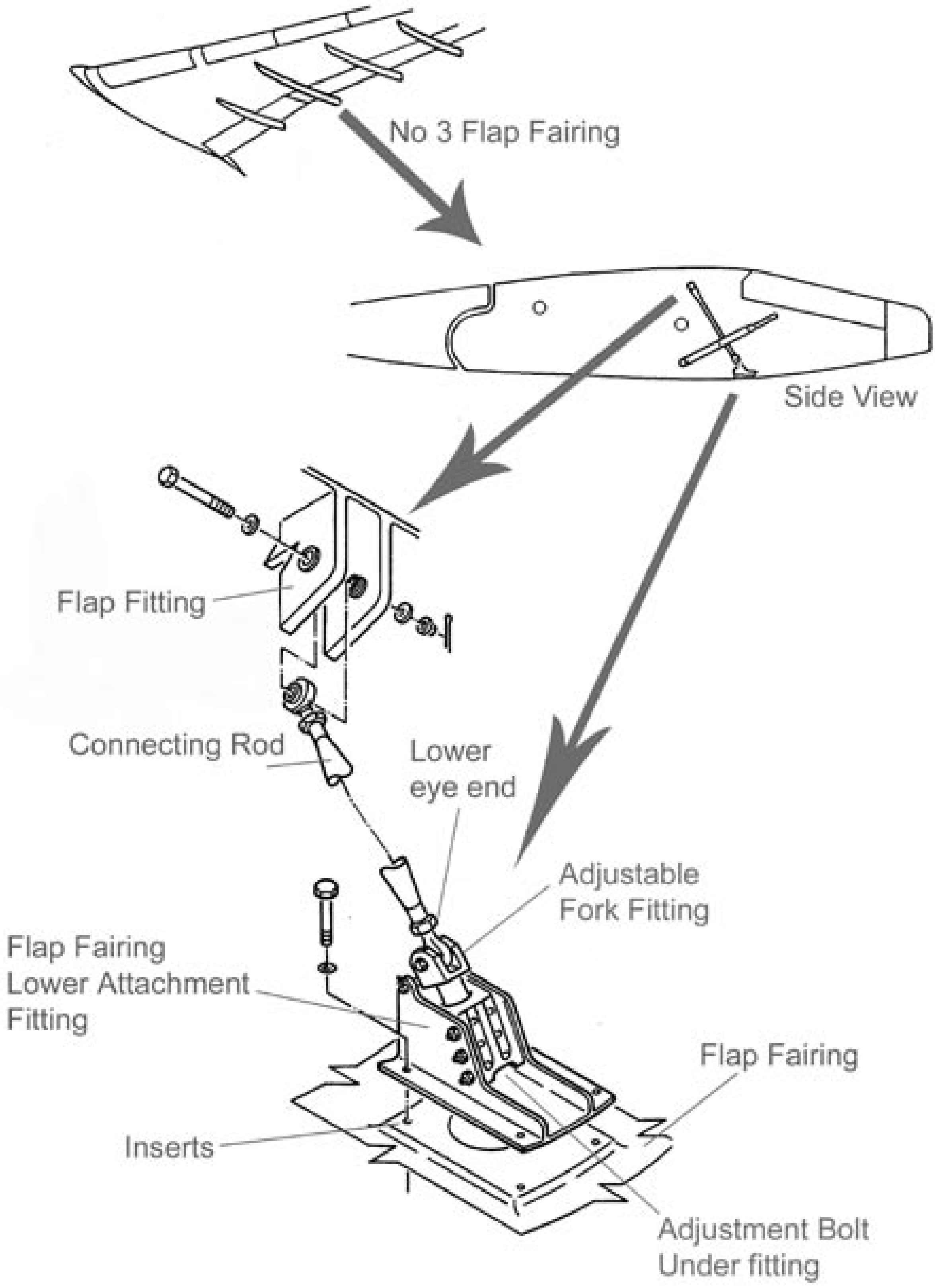

No 3 Flap Fairing
Side View
Flap Fitting
Connecting Rod
Lower
eye end
Adjustable
Fork Fitting
Flap Fairing
Lower Attachment
Fitting
Flap Fairing
Inserts
Adjustment Bolt
Under fitting

Figure 3

Aircraft examination

The damage to the No 3 engine, due to the loss of the lower exhaust nozzle half tab fairings, was wrinkling and cracking of its exhaust nozzle, with additional damage where the attaching screws of the missing tab fairings had pulled out.

The No 3 flap track fairing exhibited damage where the inserts that locate the attachment fitting had pulled out of the fairing honeycomb structure. In addition, there was damage to the trailing edge of the inboard flap directly aft of the flap track fairing. Inspection of the fairing attachment fitting revealed that the nut of the lower eye end of the connecting rod was close to the end of the thread. In addition, a bar located behind the connecting rod attachment point was bent downward, consistent with contact with the eye end; this could only have occurred once the eye end had become detached from the connecting rod. The four fasteners which normally secure the attachment fitting to the fairing were still locked in place, but the inserts into which the fasteners locate, which are normally bonded into the honeycomb structure of the fairing, had been pulled out of the fairing together with some honeycomb material, and remained attached to the fitting.

Maintenance

The last maintenance carried out on the No 3 flap track fairing was during a Major 8C check in March 2005; this was to repair damage to its inner surface. This work on the fairing required its removal and would have involved disturbance of the connecting rod and readjustment of the fairing when re-fitted to the aircraft.

Previous occurrences

There have been several occurrences of the flap fairing lower attachment fitting coming loose and damaging the inside of the fairing. As a result, the manufacturer issued Service Bulletin A340-57-4070 which introduced improved locking of the bolts that attach the fitting to the fairing structure. This was accomplished on 4R-ADB on 30 November 2003.

In April 2005, a pre-modification Airbus A340-300 suffered a loss of the flap track fairing attachment fitting and connecting rod, the cause of which was thought to have been due to loosening of the attachment bolts.

Discussion

From the nature of the damage it was evident that the No 3 flap track fairing attachment fitting had departed the aircraft via the rear of the fairing and, in the process, made contact with the trailing edge of the inboard flap. Fortunately, it landed in an unoccupied wooden outbuilding albeit in a relatively highly populated area.

The reason for the detachment of this fitting from the flap fairing was not established. The four attachment bolts had remained with the fitting and did not appear to have come loose, as their locking tabs were intact, and they were still engaged with the inserts. This, together with the fact that the inserts had been pulled from the honeycomb structure, suggested that the fitting had either experienced higher than intended loading or, possibly, had not been manufactured or repaired properly. However, had the fairing been defective since manufacture, then it might be expected that a failure would have occurred earlier in its life. Excessive loading on a serviceable fairing is not likely to be generated by normal 'operational' loads, otherwise detachment of the fitting from any fairing would likely be a fairly common event. Therefore, the possibility remains that excessive loads could have been generated by a combination of in-service loading, defective repair and/or incorrect rigging of the fairing to the flap upon its last fitment.

The departure of the fitting from the aircraft, once free from the fairing, was likely due to the airflow through the fairing having caused the unattached fitting to rotate and eventually unscrew from the lower eye end of the connecting rod. With the fitting now totally detached, it then departed the aircraft rearwards hitting the inboard flap in the process. Had the lower eye end not been able to unscrew, then the fitting would have remained with the aircraft, albeit with some damage being caused to the fairing and flap assembly.

Safety action

The manufacturer has been made aware of this incident and has already changed the design of the connecting rod such that the lower eye end always remains attached to the connecting rod. A Service Bulletin will be introduced to rework or replace existing connecting rods.

SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A340-642, G-VSHY
No & Type of Engines:	4 Rolls-Royce Trent 556-61 turbofan engines
Category:	1.1
Year of Manufacture:	2002
Date & Time (UTC):	23 April 2005 at 1130 hrs
Location:	London Heathrow Airport, London
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 19 Passengers - 200
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	Not relevant
Commander's Flying Experience:	Not relevant
Information Source:	AAIB Field Investigation and operating company report

Synopsis

The aircraft departed with the CG (Centre of Gravity) forward of the operator's allowable limits. The error was detected whilst the aircraft was still airborne. The aircraft crew was contacted and some passengers moved to bring the CG back to within limits. A review of statistics indicated that the operating company had recently experienced an abnormally high frequency of loading errors. The company is reviewing its procedures and its loading operations are being monitored by the CAA.

History of the event

The aircraft had arrived on Stand 340 at 1011 hrs and passengers began to disembark at 1025 hrs. In preparation for the subsequent flight, the cleaners arrived at 1045 hrs and the Turnround Coordinator (TCO) left the aircraft to compile the paperwork for the next flight. This next flight had a departure time of 1200 hrs with a destination of Tokyo Narita Airport. At approximately 1100 hrs, the TCO returned to the aircraft with a copy of the Loading Instruction Report (LIR), amongst other documentation, and discussed the loading of the aircraft with the handling company's 'Loading Team Leader', who also had a copy of the LIR. By 1125 hrs, the final passenger figures had been determined and the resultant loadsheet was sent to the aircraft at 1130 hrs. A minor Last Minute Change (LMC) was annotated on the loadsheet and the TCO took a copy of the signed final loadsheet from the commander and returned to her office. The aircraft left Stand 340 at 1159 hrs and tookoff at 1230 hrs.

Once the TCO had returned to her office, she was handed a copy of the Cargo Weight Statement, which had arrived by fax while she was overseeing the departure. On checking this document against the loadsheet, she noted a discrepancy in the total cargo weight of 1,660 kg. Closer examination of the paperwork revealed that one pallet had a weight of 2,015 kg on the Cargo Weight Statement whereas the LIR indicated a weight of 355 kg for the same pallet. After confirming the accurate weight to be 2,015 kg, the TCO requested the generation of a revised loadsheet. This resulted in an awareness that the aircraft CG was slightly forward of the operator's allowable limits.

A message was passed to the commander of the flight, which was now en-route, and by moving three passengers towards the rear of the aircraft, the aircraft was brought back within the operator's CG limits and a new load sheet was generated to reflect this change. Additionally, the commander confirmed that he had detected no unusual circumstances during takeoff. The aircraft continued on its flight to Tokyo culminating in a normal landing.

The company Safety Services Department were advised of the occurrence whilst the aircraft was still airborne and they arranged for all the cargo to be weighed on arrival at Tokyo. This revealed significant differences in weight compared to the weights annotated on the Cargo Weight Statement. The errors were subsequently traced to inaccuracies generated by the cargo scales at Heathrow; the source of these errors has now been eliminated.

Operator's report

The operator's Safety Services Department cooperated fully with the AAIB and carried out a comprehensive investigation into the incident. The investigation identified the initial error as a mistake made by a member of the Central Load Planning (CLP) facility (run by an outsourced contractor located overseas) when manually inputting cargo details into a computer planning system, which then generated the loadsheet.

The operator's investigation highlighted three areas for improvement: the electronic interface system between the company and CLP facility; the procedures for data transfer at CLP; and the loadsheet monitoring procedures by the TCO.

The report issued by the company Safety Services Department on 6 June 2005, contained numerous internal safety recommendations covering all aspects of loading procedures. Following the report, the operator is currently undertaking a full review of the loading procedures.

Previous incidents

During the previous year, there had been a number of reported loading related incidents involving the same company. These are summarised below:

10 July 2004: Incorrect loadsheet for a Boeing 747 indicating that the weight was 819 kg more than actual. The error was detected after the aircraft had departed but the aircraft remained within weight and CG limits.

16 August 2004: Incorrect loadsheet for an Airbus A340 indicating that the weight was 2,163 kg less than actual. The error was detected and rectified prior to the aircraft's departure.

20 September 2004: Incorrect loadsheet for an Airbus A340 indicating that the weight was 1,911 kg less than actual. The aircraft remained within weight and CG limits.

26 November 2004: Incorrect loadsheet for an Airbus A340 indicating that the weight was 1,665 kg less than actual and two passengers had not been included. The cargo error was detected after aircraft departure and the passenger error was detected at destination.

16 December 2004: Incorrect loadsheet for an Airbus A340 indicating that there were two fewer containers than actually loaded. The error was detected after aircraft departure. The aircraft remained within weight and CG limits.

8 February 2005: Incorrect loadsheet for a Boeing 747 with two passengers not included. The error was detected after aircraft departure. The aircraft remained within weight and CG limits.

19 March 2005: Incorrect loadsheet indicating that the weight was 2,290 kg less than actual. The error occurred when a pallet had not been off-loaded as expected at an intermediate airport. The error was detected at destination but the aircraft remained within weight and CG limits.

8 April 2005: Incorrect loadsheet indicating that the weight was 1,330 kg more than actual. The error was detected at destination.

Additionally, an NTSB investigation was initiated into an incident involving an Airbus A340 flight from Washington Dulles Airport to London Heathrow Airport on 7 June 2004. During flight, the crew saw an 'EXCESS AFT CG' warning activate on the flight deck. The warning went out after crew action to transfer fuel. Investigation at destination revealed that incorrect loading had resulted in the CG being 39.4% MAC on takeoff rather than 28.1% as shown on paperwork presented to the commander. This incident resulted in various recommendations made by both the NTSB and the company Safety Services Department.

Research of the CAA MOR database revealed that, during the period covered by the above incidents, the operator had a significantly higher frequency of significant loading errors than other comparable UK operators.

Subsequent actions

At the time of the incident, the CAA were involved in the annual audit of the operating company and, because of the number of recent loading incidents, the Authority included a specialist Loading Inspector as a member of the team. The audit revealed 'loading' as an area of concern. This has resulted in a programme of continued CAA monitoring of the company loading procedures.

Conclusion

The incident resulted from incorrect data entry into the computer-based planning system and the mistake was not detected until the aircraft was airborne. The result was that the aircraft was outside the operator's CG limits with the inherent risk of handling problems. While human mistakes will occur, there should be a robust monitoring system for all critical aspects of flight. Incorrect weight and CG can have very serious consequences and should be given a high degree of importance in terms of staffing, training, monitoring and auditing. The incident involving G-VSHY plus the number and regularity of previous loading incidents indicate that the operator had not given the necessary priority to loading issues.

With improvements by the operator and the present CAA involvement in the monitoring of the overall procedures, action is already in hand to improve the situation. In the light of this action, the AAIB has not made any safety recommendations.

ACCIDENT

Aircraft Type and Registration:	1) Boeing 767-204, G-SATR 2) Boeing 737-37Q, G-ODSK
No & Type of Engines:	1) 2 General Electric Co CF6-80A2 turbofan engines 2) 2 CFM CFM56-3C1 turbofan engines
Category:	1) 1.1 2) 1.1
Year of Manufacture:	1) 1989 2) 1997
Date & Time (UTC):	4 November 2004 at 1620 hrs
Location:	Manchester Airport, Manchester
Type of Flight:	Public Transport (Passenger)
Persons on Board:	1) Crew - None Passengers - None 2) Crew - None Passengers - None
Injuries:	1) Crew - None Passengers - None 2) Crew - None Passengers - None
Nature of Damage:	1) Left wing damaged 2) Tail damaged
Commander's Licence:	1) Airline Transport Pilot's Licence 2) Airline Transport Pilot's Licence
Commander's Age:	1) 50 years 2) 46 years
Commander's Flying Experience:	1) 8,040 hours (of which 6,234 were on type) Last 90 days - 75 hours Last 28 days - 36 hours 2) 4,070hours (of which 450 were on type) Last 90 days - 256 hours Last 28 days - 66 hours
Information Source:	AAIB Field Investigation

Synopsis

The left wing of the taxiing Boeing 767-200 struck the right horizontal stabiliser of the stationary Boeing 737-300. Both aircraft were awaiting departure from Runway 24 Left at Manchester. The investigation concluded that the B767 commander, who bore primary responsibility for collision avoidance, misjudged the available separation due to a combination of physiological limitations, distractions and a false assumption regarding his ATC clearance. Three safety recommendations are made, concerning flight crew awareness of clearance issues, recording of communications on the Airport Fire Service frequency and ATC procedures at Manchester Airport.

History of the accident

The B737-300, G-ODSK, departed from Manchester's Terminal One at 1605 hrs and was instructed by the Manchester Ground controller to taxi to holding point 'D1'. The crew was subsequently transferred to the Air 1 controller, who issued a clearance to cross Runway 24 Right and to taxi to holding point 'V5'. The general layout of Manchester Airport is shown at Figure 1 and the accident area in detail is shown at Figure 2.

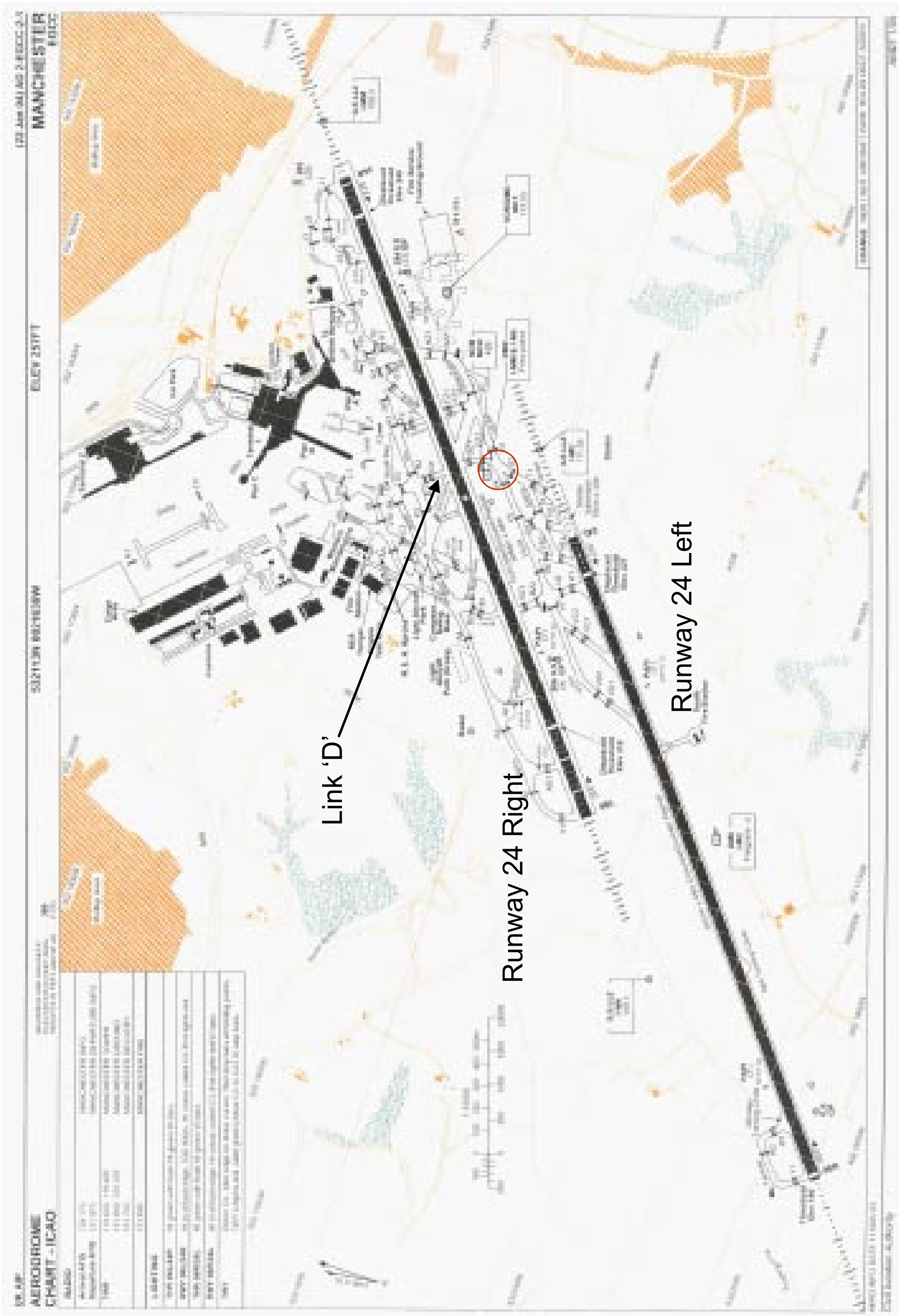


Figure 1

Manchester Airport - General layout

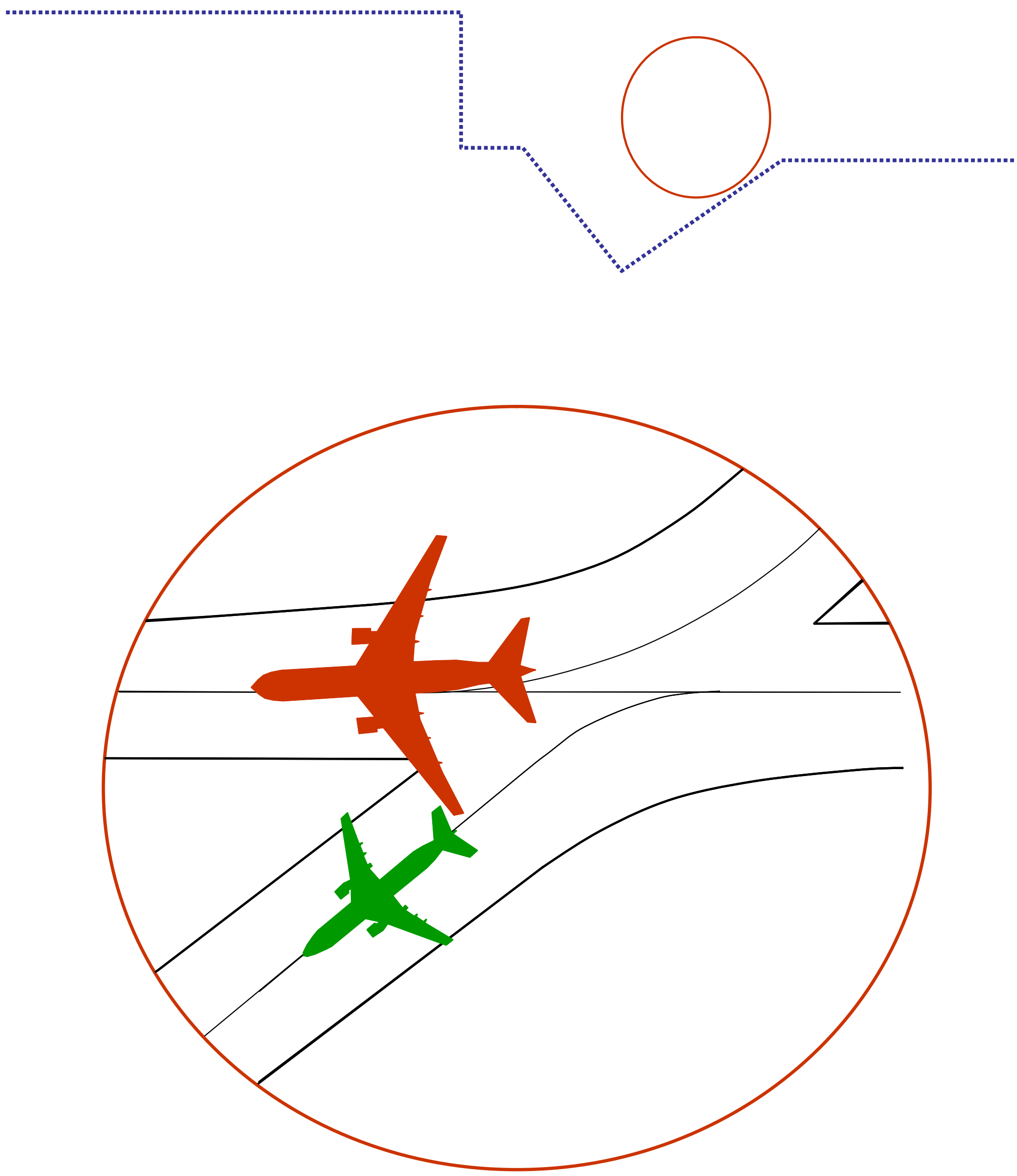


Figure 2

South Side Taxiways and Geometry of Collision

Once the aircraft had vacated Runway 24 Right, the crew was instructed to contact the Air 2 controller for Runway 24 Left. On checking in, the crew reported that they were taxiing for 'V5' but were told "…YOU CAN HOLD IN TURN NOW AT TANGO ONE PLEASE". The crew then taxied to follow a British Aerospace RJ100 which was ahead and also routing to holding point 'T1'.

The aircraft was being taxied by the commander who brought the aircraft to a stop, at what he assessed to be a safe distance behind the RJ100, and applied the parking brake. The flight deck crew completed their pre-takeoff checks and received a "cabin secure" notification from the Senior Cabin Attendant (SCA).

The B767-200, G-SATR, was being leased by its parent company to a lessee airline. The flight deck crew were employed by the aircraft operator whilst the cabin crew were employed by the lessee airline. The B767 crew reported for duty at 1430 hrs for a scheduled 1530 hrs departure for the 9 hour 17 minute flight to Goa in India. In addition to the commander and co-pilot, a second co-pilot was carried for the purpose of providing in-flight relief, so allowing an increased flight duty period. A ground engineer was also carried to meet engineering requirements down route. The second co-pilot and the ground engineer were to occupy the two flight deck observers' seats.

The crew encountered a number of operational problems prior to push back. The aircraft originally scheduled for the service was a 300 series B767 but was replaced by a 200 series aircraft due to maintenance activity. When the zero fuel mass was finalised it was 2,200 kg above that expected, which prevented the crew from loading the required fuel quantity for a direct flight to Goa. The commander liaised with the lessee airline's operations department with a view to organising a re-fuelling stop en-route, but was unable to establish a suitable airfield for this purpose. The operations department personnel were not sufficiently familiar with the recently introduced long-haul operations to offer the commander assistance. Problems with passengers were also encountered, including two drunken passengers who were subsequently removed from the aircraft under police escort. A positioning company captain had joined the aircraft for the flight to Goa but his suitcase had been delayed and was expected to arrive at the aircraft just before push-back, which it did.

The B767's departure was subject to a calculated take-off time (CTOT) restriction of 1619 hrs and the aircraft departed from Terminal Two at 1610 hrs with the issue of the re-fuelling stop still unresolved. The commander had decided to refuel en-route at Muscat in Oman, being aware that Muscat was suitable and had been used for this purpose some weeks earlier. However, there had not been time to amend the flight plan to reflect this course of action, nor to obtain a revised computer flight plan (CFP). The commander intended obtaining the new routing from operations once airborne and then re-filing the flight plan.

The B767 taxied to holding point 'D1', and was subsequently cleared by the Air 1 controller to cross Runway 24 Right and taxi to holding point 'T1'. Once the aircraft had vacated Runway 24 Right, the crew was transferred to the Air 2 controller for Runway 24 Left and reported to the controller that they were taxiing for 'T1'. The controller asked the crew "COULD YOU GO FROM VICTOR ALPHA ONE IN VIEW OF YOUR SLOT?" A brief discussion took place on the flight deck and the co-pilot answered "AFFIRM". The controller then said "ROGER FIRST RIGHT TURN THEN TAXI VICTOR ALPHA ONE."

The B767 commander could see the B737 holding in turn at 'T1' and, expecting to have to come to a stop behind it, had reduced taxi speed accordingly. When the revised taxi instructions were issued to the B767 crew, the commander continued taxiing to follow the marked taxiway centreline right onto 'V' Taxiway and called for the 'Before Take-off' checklist. As he did so, the co-pilot checked the taxiway chart to confirm the routing and located the appropriate checklist. Neither the commander nor the co-pilot thought that there was a problem regarding wing tip clearance between their aircraft and the B737. As the B767 was turning right onto Taxiway 'V', its left wing collided with the right horizontal stabilizer of the B737.

When the collision occurred, the B737 crew heard a loud noise, accompanied by a severe shaking. The commander had the impression that the aircraft was moving and leaning to the left, and thought initially that an undercarriage leg may have failed. However, the co-pilot then saw the B767 stationary to his right, and saw signs of damage to the B767's left wing leading edge. The co-pilot reported this to the commander and to the Air 2 controller, with a request that the Airport Fire Service (AFS) attend the scene. The B737 commander alerted the cabin crew with a public address (PA) "CABIN CREW AT STATIONS" to indicate that an emergency had occurred and to prepare them for a possible emergency evacuation. He called the SCA to the flight deck, briefed her on what had happened and instructed her to check the cabin for signs of fire. The cabin crew were seated when the collision occurred and no injuries were reported among passengers or crew.

The collision was felt but not heard on the B767's flight deck, but the commander did not realise immediately what had happened, thinking that the aircraft may have run over an object on the taxiway. The second co-pilot on the central jump seat thought that their aircraft had struck the B737 as it was the only possible obstruction, and he voiced his thought. The commander gently bought the aircraft to a stop approximately 35 m from the point of impact. When the collision occurred, the cabin crew had just finished the safety demonstration and were in the process of preparing the cabin for takeoff. The collision was felt in the cabin and likened by the SCA to running over a large pothole, but it was not severe enough to cause any of the crew to lose their footing. The SCA initiated communications with the flight deck crew via the interphone system and was told by the commander what had happened and asked to report to the flight deck. There were no reported injuries among the passengers and crew on board the B767.

In response to the transmission by the B737 co-pilot, the Air 2 controller initiated an Aircraft Ground Incident (AGI). The AFS arrived on scene approximately 90 seconds after the AGI had been initiated, and the airport fire officer established communications with the B737 crew on frequency 121.6 HMz. He informed the crew of the extent of the damage and that an immediate evacuation did not appear necessary. The flight crew shut down the left engine but the right engine was kept running to provide electrical power and to supply the air conditioning system; the APU had not been started due to possible damage in the collision. The second engine was shut down twenty minutes after the collision, prior to disembarkation of the passengers.

The B767 crew heard the transmission by the B737's co-pilot informing ATC about the collision. The commander made a PA to the passengers to inform them of the situation. After the aircraft had come to a stop, the flight crew became aware of the AFS vehicles approaching their aircraft. The commander attempted to call the AFS on frequency 121.6 MHz but received no reply and heard no other transmissions on that frequency. Knowing that the wing was damaged, the commander was aware of the possibility of a fuel leak with the attendant fire risk. He considered the possibility of an emergency evacuation but the actions of the fire crews outside the aircraft lead him to understand that the situation was not life threatening.

Soon after bringing the aircraft to a stop, the B767 commander had begun to feel unwell and subsequently fainted. The co-pilot assumed control of the aircraft and directed the SCA to give first aid to the commander. The SCA administered oxygen and the commander recovered consciousness after a short while. Meanwhile, the co-pilot successfully established communications with the AFS and continued to liaise with the Tower controller. The aircraft's APU was started and both engines were shutdown 13 minutes after the collision.

Wreckage and impact information

The two aircraft were still in the locations at which they had stopped after the accident when they were examined by the AAIB. Both nose wheels were effectively on the appropriate taxiway centerlines and the Boeing 737's nose wheel was 9.3 m from the S2 stop bar (note: this is only intended as a geographic reference, since the pilot had not positioned the aircraft using the stop bar as a guide). The Boeing 767 had continued some 35 metres after the collision, coming to rest 7.4 m beyond the V4 stop bar. Debris from the collision had blown back in the jet efflux of the Boeing 767 for about 100 m.

Approximately the outboard third of its right horizontal stabilizer and elevator was lying on the ground underneath the Boeing 737; there were no substantial pieces detached from the Boeing 767. It was clear that the first impact had been on the trailing edge of the left elevator of the Boeing 737, with evidence that this had forced the aircraft nose to yaw to the left a few centimetres. The left nose wheel was partially detached, apparently as a result of the sideways forces generated by this movement. There was evidence that the impact had caused the whole horizontal stabilizer to skew in the horizontal plane, since the leading edge on the right side had dug into the fuselage skin with a corresponding indentation from the elevator trailing edge on the left side, although the stabilizer had then returned to its normal position.

The Boeing 767 had less serious damage, largely confined to the outboard slat, which was in the take-off position and which had been crushed back from a point about 1.5 m from the tip. The adjacent slat also had damage as did the falsework behind. Fortunately, the main wing spar was not apparently affected.

Flight Recorders

The B737 was equipped with a 50-hour duration flight data recorder (FDR) and a two-hour cockpit voice recorder (CVR). The B767 was equipped with a 25-hour duration FDR and a thirty-minute CVR. The accident was not recovered from the CVR installed on G-SATR as it had been overwritten; the flight crew had not taken action to isolate the power to the CVR as was required by current regulations and the operator's operations manual. However, the accident was successfully recovered from the B737's CVR. Flight data was successfully recovered from both aircraft. The FDR systems on both aircraft recorded GMT from the respective captain's clock; the recorded times were found to be synchronised to within 8 seconds of each other. Times quoted are captain's clock unless stated. Ground speed was not available from the B767 FDR; approximate speeds were calculated using accelerometer data and rate of change of heading data.

Recorded data shows that the B737 was stationary with the parking brake applied at 1618 hrs. At 1619 hrs the B767 was stationary with the parking brake applied on a heading of 148º with both engines at idle waiting to cross the Runway 24 Right. Twenty seconds later the park brake was released. N1 shaft speeds for both engines were gradually increased to 55% over a 23-second period and the aircraft began to accelerate gradually. The N1's for both engines were then reduced to 46% on engine one and 42% on engine two and a further reduction was made some 5 seconds later to 42% on engine one and 35% on engine two.

As the B767 approached the right turn on a heading of 149º, the ground speed was calculated to be approximately 20 kt. As the aircraft commenced the turn the engines were reduced to idle and the aircraft began to decelerate. Both engines remained at idle for the next 18 seconds and ground speed reduced to about 6 kt. The aircraft was then approximately half way through the turn. The N1's for both engines were then increased to 39% on engine one and 33% on engine two and the rate of heading change increased slightly, as the turn was tightened. Ground speed remained at about 6 kt.

At 1621:20 hrs, as the B767 turned onto a heading of 237º and at a ground speed of about 6 kt, a longitudinal deceleration of 0.13 'g' was recorded for a two-second period; this was believed to be the impact with the B737. The B737 recorded a peak longitudinal acceleration of 0.34 'g' and a peak lateral acceleration of 0.22 'g' at impact. Approximately 9 seconds after what was believed to be the impact point the B767 came to a stop and 9 seconds later the park brake was applied. For a further 4 minutes 50 seconds the engine N1's remained at 39% on engine one and 33% on engine two, until they were reduced to idle. The B737's engine number one was shutdown at 1630 hrs with engine number two shutdown at 1641 hrs. The B767 crew shutdown both engines at 1634 hrs.

Aerodrome information

Manchester Airport is equipped with two runways, designated Runways 24L and 24R; the terminals and main airport buildings are to the north of the runways. When the accident occurred, both runways were in use in a 'segregated' mode of operation; Runway 24R or landing aircraft and Runway 24L for departing aircraft. Aircraft taxiing for takeoff were therefore required to cross Runway 24R at one of several crossing points, designated as links 'H', 'G', 'F', or 'D'.

Runway 24L is 3,047 m in length, and has a starter extension of 150 m. There are several points of access to the runway, but it is normally entered from one of three holding points. Holding point 'VA1' provides the full declared take-off run available (TORA), 'VB1' provides a slightly reduced TORA of 2,864 m and 'T1' provides for the use of the starter extension, giving an increased TORA of 3,197 m. The UK Aeronautical Information Publication (UK AIP) states:

> *'aircraft requiring the 150 m starter extension at Tango for maximum TORA must advise delivery at the earliest opportunity'.*

The normal holding points for Runway 24L are reached by taxiways 'V', 'S' and 'T'. These taxiways are marked by centre line yellow markings, green centre-line lights and blue edge lights adjacent to sharp bends. Taxiways in the area of concern are 23 m in width.

The taxiway system to the south of Runway 24R complies with the requirements of Civil Aviation Publication (CAP) 168, '*Licensing of Aerodromes*'. This document sets out the standards required at UK licensed aerodromes relating to physical characteristics, assessment and treatment of obstacles, visual aids, rescue and fire fighting services and medical services. However, the area is subject to certain restrictions governing the size and combination of aircraft types permitted to operate thereon. These restrictions are contained in Manchester Airport's 'Manual of Air Traffic Services (MATS) Part 2', though none of the restrictions listed were relevant to this accident. Information supplied to Manchester ATC by Manchester Airport when Runway 24L was first built addresses a clearance issue for aircraft stopped to the north of Stopbar 'S2' This is designated as a CAT1/2/3 hold, intended to protect the Localiser Sensitive Area for Runway 06R. The information contains an observation that, when aircraft are holding north of 'S2', Taxiway 'V' is blocked behind. There is no ILS on Runway 24L which would require protection, and holding point 'S2' was considered very unlikely to be used for the purpose of providing protection for Runway 06R, therefore the restrictions on its use were not incorporated in Manchester's MATS Part 2.

Air Traffic Control Procedures

Under Manchester Airport's 'segregated' runway operation, each runway is controlled by one of two controllers, designated Air 1 and Air 2, each with the call-sign "Manchester Tower." The Air 1 controller is responsible for arrivals on Runway 24R and the Air 2 controller is responsible for departures from Runway 24L. The Air controllers sit at adjacent positions in the Visual Control Room (VCR) of the ATC tower, which is situated within the terminal complex. Outbound aircraft are routed initially towards a crossing point for Runway 24R by a Ground Movement Controller, who sits on a raised platform behind the two Air controllers. When an aircraft is approaching Runway 24R it is transferred to the Air 1 controller who is responsible for issuing a crossing clearance for Runway 24R. The crossing clearance includes a clearance limit, which will be a holding position beyond the runway and is written on the aircraft's Flight Progress Strip (FPS) by the Air 1 controller when the clearance is issued. The responsibility for a section of the taxiway system south of Runway 24R is allocated to the Air 1 controller. This area, which is depicted on the diagram at Appendix 2, incorporates links 'DZ', 'FZ' and 'HZ', and taxiways 'V' and 'S' as far as stop bars 'V5' and 'T1'. Manchester Airport's MATS Part 2 states:

> *"Air 1 is responsible for the control of surface movements of all aircraft, vehicles and personnel wishing to operate within the delegated taxiway area" and that "Air 1 is responsible for assisting in preventing collisions in the delegated taxiway area."*

With regards to transferring of aircraft to Air 2, the manual states *"When crossing traffic is clear of conflictions.... control of the crossing traffic and the FPS may be transferred to Air 2*." Once the aircraft has vacated Runway 24R it is transferred to the Air 2 controller and the FPS is passed by hand between the controllers. The MATS Part 2 states *"Crossing clearance shall only be issued to the aircraft when there is sufficient room for the aircraft to vacate the runway and taxi clear of the CAT 1 holding point after crossing.* The MATS Part 2 further states *"Air 2's priority is to vacate the delegated area of taxiway to enable Air 1 to continue crossing traffic."* On transfer, the Air 2 controller issues the taxiing aircraft with a clearance limit, taking into account a number of variables. These may include: the sequence aircraft are transferred, the type of departure, wake turbulence considerations, requests for the starter extension and approved departure times.

Meteorological information

A weather observation was taken at Manchester Airport immediately after the accident. The surface wind was from 250º (M) at 12 kt and visibility was greater than 10 km. Some cloud was reported at 2,600 ft, with more extensive broken cloud at 5,600 ft. The surface temperature was +10º C and the QNH was 1021 mb. The taxiways and runways were dry. The time of sunset at Manchester Airport on 4 November 2004 was 1632 hrs.

Air Traffic Controllers' actions

At the time of the accident, all ATC equipment relative to the task of the two Air controllers was serviceable. At 1618 hrs the Air 1 controller issued the B767 with a conditional crossing clearance for Runway 24R, with a clearance limit of 'T1'. The controller was aware that the aircraft was subject to a take-off time of 1619 hrs and verbally informed Air 2 of this, but was confident that the aircraft would be able to depart within the permitted time extension of 10 minutes. The controller's normal practise was to transfer control of the aircraft to Air 2 as soon as the tail was clear of Runway 24R, which she would assess visually. She reported that use of the Surface Movement Radar (SMR) encouraged a 'heads down' approach which she tried to avoid. The controller annotated the clearance limit of 'T1' on the FPS and passed it to the Air 2 controller.

The Air 2 controller had previously amended the clearance limit for the B737 from 'V5' to 'T1'. When the B767 called on frequency he asked the crew if they could accept a departure from 'VA1' and, when they said they could, had instructed the B767 to turn right onto Taxiway 'V' and to taxi to 'VA1'. At this time the Air 2 controller, who later assessed his workload as "moderate," was also arranging separation of two other aircraft which had non-compatible departure routings.

The controller stated later that it was not normal practise for Air 2 to be 'pre-warned' about an aircraft unless time was a critical factor or if the pilot had requested the starter extension, in which case this information would normally be passed by the Ground Movement Controller. In this case, he was unaware of the B767 until it was transferred to him by Air 1. The controller thought that, had he known about the B767 in advance, he may have sent the BAe RJ100 to 'VB1' to avoid a build up of traffic at 'T1'. In the event, when the B737 was transferred to him, he saw no advantage in sending the aircraft to 'V5' as it had been originally cleared, so amended the clearance limit to 'T1'.

Other controllers at Manchester were asked how they allocated clearance limits to departing aircraft, and the responses varied. One controller would always clear aircraft to 'VA1' or 'VB1' initially, unless otherwise requested, in order to 'fill-up' the available space and leave 'T1' free for any aircraft specifically requesting it. Another controller would attempt to sequence aircraft in the most suitable stream taking into account the planned departure routing. The Air 2 controller at the time of the accident would normally clear all aircraft to 'T1' unless there was a specific reason to do otherwise. When Runway 24 L was first opened, general guidelines for controllers in respect of the south side taxiways were issued but were not adopted as formal policy.

Surface Movement Radar (SMR)

Manchester airport is equipped with SMR which was serviceable at the time of the accident. The SMR was recorded and available for replay. An SMR display is situated at each Air controller's position and may be set to show all of the manoeuvring area or zoomed into any desired part thereof. One of the Air 1 controller's responsibilities as defined in MATS Part 2 is the monitoring of SMR, although this is not listed as a responsibility of the Air 2 controller, since it is primarily used during Low Visibility Operations, in which case dual runway operations would cease. MATS Part 2 states:

> *"…the Surface Movement Radar (SMR) must not be used to relieve pilots and drivers from any of their responsibilities for avoiding collisions on the ground".*

Published information

Civil Aviation Publication (CAP) 637 '*Visual Aids Handbook*' gives advice and guidance for pilots and other personnel engaged in the handling of aircraft. Under the heading *"Paved Taxiway Markings"* it includes the following:

> *"Taxi Holding Positions are normally located so as to ensure clearance between an aircraft holding and any aircraft passing in* ***front*** *of the holding aircraft, provided that the holding*

> *aircraft is properly positioned **behind** the holding position. Clearance to the rear of any holding aircraft cannot be guaranteed. When following a taxiway route, pilots are expected to keep a good lookout and are responsible for taking all possible measures to avoid collisions with other aircraft and vehicles."*

The Air Navigation Regulations, Rule 37 "Right of way on the ground" contains the following text:

> *"Notwithstanding any air traffic control clearance it shall remain the duty of the commander of an aircraft to take all possible measures to ensure that his aircraft does not collide with any other aircraft or with any vehicle."*

The Manual of Air Traffic Services (MATS) Part 1 states the responsibilities of an aerodrome controller concerning aircraft, vehicle and obstructions on the manoeuvring area. The manual states:

> *"Aerodrome control is responsible for issuing information and instructions to aircraft under its control to achieve a safe, orderly and expeditious flow of air traffic and to assist pilots in preventing collisions between ... aircraft and vehicles, obstructions and other aircraft on the manoeuvring area"*

Flight crew training

There is limited information available to flight crews to assist them to judge wing tip separation from fixed or stationary obstacles. Guidance for pilots from the aircraft manufacturer is contained in the aircraft's Flight Crew Training Manual. The manual describes the turning radius of the aircraft and the area 'swept' by the wing tip, with a caution that turns away from obstacles should not be commenced if the obstacle is within 15 ft (4.6 m) of the wingtip or within 45 ft (13.8 m) of the nose.

The wingtips of the B767 are not normally visible from the captain's seat. This and other limitations preclude the use of flight simulators for effective training in this regard. However, the commander had received training to improve his awareness of the position of the wing tips, during which an instructor stood ahead of the aircraft in line with the wing tip. This allowed the pilot to select a suitable reference to allow him to judge the line the wing tip would take. Enquiries with other operators confirmed that training regarding wing tip clearance was often limited to a discussion of the subject. In most cases flight crew are cautioned that if clearance is ever in doubt, the aircraft should be stopped and additional measures, such as 'wing walkers' employed.

Prior to promotion to the rank of captain, the B767 commander had no experience of taxiing large transport aircraft. This is not unusual, since many such aircraft are either not fitted with a steering tiller at the co-pilot's station, or their operators choose to limit the occasions when the co-pilot is allowed to taxi the aircraft.

The need for avoidance of possible distractions during the taxi phase of flight is routinely stressed during training and in operators' manuals. The B767 operator's Operations Manual contained the following guidance to flight crews:

> *"In congested areas or in the proximity of obstructions, checks will be delayed until safe taxiing conditions permit. The RHS (right hand seat) pilot will assist in keeping a lookout and will not allow copying clearances or reading the checklist to degrade this function".*

Human factors

The commander of the B737 had stopped his aircraft at what he considered to be a safe distance from the aircraft in front which was holding at 'T1'. Although the aircraft stopped short of holding point 'S2', this holding point was not being used, was never referred to by ATC and was not a factor in the commander's decision to stop where he did.

The B767 commander believed that his aircraft was guaranteed safe separation provided that he taxied on the marked taxiway centre line. He did not fully appreciate that the marked centreline provides protection only from fixed obstacles and from other aircraft in the limited cases detailed in CAP 637. The commander also believed that the Air 2 controller would not have issued the revised taxi instruction if there was any doubt about the available separation. Although the crew had agreed between them that the available take-off distance from 'VA1' was sufficient, the commander was not convinced of this fact and, as he continued taxiing, mentally resolved to review the performance figures prior to committing to take off.

The judgement of separation between objects at the distances involved in this accident cannot be precise, and is reduced still further in this case by additional factors. Firstly, the wing tip is some considerable distance behind the commander and cannot be seen. Secondly, the commander's attention is not focused exclusively on the other aircraft, but also to his right, in the direction of the taxiway. The commander recalled looking at the B737's vertical stabiliser as he passed, which would have been a more prominent obstacle than the horizontal stabiliser.

The B767 commander was subject to a medical examination by the CAA's Medical Division. This established that his post accident faint was due to shock and that no underlying medical condition existed that could have contributed to the accident.

Previous recommendation (96-43)

The AAIB investigated a similar accident at Heathrow Airport on 23 November 1995 in which the wing of a taxiing Airbus A340 struck the tail of a Boeing 757 which was stationary and some way short of a taxiway holding position. As a result of this investigation, the AAIB made the following recommendation to the CAA (Recommendation 96-43):

> *"The CAA should, in liaison with the appropriate ICAO committees, consider what action may be taken in the longer term to ensure that flight crews of large public transport aircraft are better able to achieve a positive clearance between their aircraft and others while manoeuvring on the ground."*

The CAA accepted this recommendation and advised that:

> *"It will seek to have this issue raised within ICAO and will draw to the attention of ICAO any particular measures, identified as a consequence of this accident, which might help to minimise problems of this nature. In the mean time the Authority is publishing, early in 1997, a Visual Aids Handbook which will give guidance to pilots on the interpretation of aerodrome visual aids, including taxiway markings."*

The Visual Aids Handbook (CAP 637) was published in 1997 and will be subject to an update in 2005.

The UK CAA raised the issue with the ICAO Air Navigation Bureau, with a request that the subject of ground collisions be addressed globally. The ICAO Airport Design Study Group was tasked to consider the matter through its various working groups and, as part of that process, the UK CAA continued to submit working papers to the ICAO Visual Aids Panel. These actions were complementary to an ongoing ICAO review of Surface Movement Guidance and Control Systems (SMGCS). It was recognized that current SMGCS were not always capable of providing the necessary support to aircraft operations in order to maintain required capacity and safety levels, especially under low visibility conditions. In 2004 ICAO issued Document 9830, "*Manual of Advanced Surface Movement Guidance and Controls Systems*" (A-SMGCS). The A-SMGCS concept makes use of modern technologies to provide increased safety and airport capacity, particularly in low visibility operations, through automation and a high level of integration between the various functionalities. However, A-SMGCS remains at an early stage of development. When implemented, it will enhance the 'see and be seen' principle but will not relieve the aircraft commander of the responsibility for safe manoeuvring of his aircraft.

Communications

After the collision both aircraft established communications with the AFS on frequency 121.6 MHz, which is an aeronautical radio frequency dedicated to this purpose but which is not an ATC frequency. The aircraft flight crews discussed with the airport fire officer the damage to their aircraft and possible evacuation considerations. Had an evacuation become necessary it is possible in this case that it would have been initiated at the request of the AFS. Frequency 121.6 MHz was not recorded at Manchester. There is no requirement for it to be recorded, although it is recommended in CAP 168. This denied the investigation valuable information and could equally hamper future investigations. A safety recommendation is made in this regard.

Analysis

The flight crew's actions

Both aircraft were serviceable and their crews were adequately rested and close to the beginning of their duty periods. The accident occurred in fine weather conditions and although sunset was approaching, the B767 commander did not consider the light conditions to be a factor in the accident. The B737 commander was entitled to stop his aircraft where he did and bore no responsibility for the clearance, or lack of it, between his aircraft and any passing behind. As the B737 was stationary, the assessment of separation and ultimately the responsibility for collision avoidance rested with the B767's crew and in particular the commander, who was taxiing the aircraft. All three flight crew on the B767's flight deck thought that the wing tip clearance was adequate, therefore this analysis concentrates initially on the procedural, environmental and human factors which may account for this fact.

Analysis of the SMR and the nature of the damage to both aircraft indicated that the B767 was on or very close to the marked taxiway centre line during the turn and at the point of collision. The aircraft would therefore have begun to turn away from the B737 when it was still some distance from it. As the turn continued, the B737 would have moved into the commander's left side window, giving him the impression that his aircraft was moving away from the B737 when the wingtip was still, in fact, moving towards it. As the tail of G-ODSK moved further aft, the task of monitoring it and looking ahead and to the right to follow the taxiway would have become increasingly difficult, with the commander having to monitor two points separated by about 150º. It is not certain that the pilot was physiologically equipped to assess the separation between a wing tip which he could not see and which was behind him, and the tail of the B737, particularly when his taxi route was turning away, albeit gradually, from the stationary aircraft. Additionally, the B737's fin and rudder would be far more obvious than the horizontal stabiliser, due to the aspect of the latter, yet the tip of the horizontal stabiliser would have been some 6 m closer to the B767 than the rearmost part of the aircraft's fin and rudder.

Swept wing aircraft are subject to a phenomenon known as 'swept wing growth' or 'wing creep'. This occurs during a turn when the wing tip describes an arc greater than the normal wingspan due to the geometry of the aircraft and the arrangement of the landing gear. It is one of the reasons for the manufacturer's caution in the Flight Crew Training Manual. Although this effect is less noticeable at the moderate curvature of turn in this case, it still served to erode the perceived wing tip clearance.

The crew of G-SATR had experienced a busy dispatch with a number of operational problems, some of which continued to occupy the commander's mind up to the point of the accident. There was also an element of time pressure on the crew. Being initially cleared to 'T1', they would have been aware of the two aircraft ahead of them, and therefore that time was available to complete pre take-off tasks, such as configuring the aircraft for an air conditioning 'packs off' takeoff and completing the before take-off check list. The change of clearance to 'VA1' with the implied early departure re-instated the time pressure on the crew and served to generate further distractions. The first officer wished to check the taxiway route to 'VA1' and consulted his chart in the critical moments leading up to the collision. He also had to locate the 'before take-off' checklist in response to the commander's request, which he had just done when the collision occurred. According to their company's operations manual, the crew would have been expected to delay non essential activities such as reading checklists until clear of the congested area, thus allowing both pilots to give their full attention to the safe manoeuvring of the aircraft.

The time between ATC's enquiry about the suitability of 'VA1' and the co-pilot's response was very short, supporting the commander's recollection that the second co-pilot, who was familiar with Manchester, had said straight away that it was acceptable and that the other two crew members had concurred. However, the commander was not satisfied that this was the case and mentally resolved to check the available runway distances from 'VA1' before accepting a departure clearance. In fact, the aircraft performance figures calculated by the crew were based on departure from 'VA1', though the commander was not sure of this at the time. The B767's operator had introduced take-off performance figures from 'T1' which would have allowed the aircraft to fly direct to Goa, though these figures had not been issued at the time of the accident. If the commander had believed that a take-off from 'T1' was necessary, he should have notified ATC in advance as required by the AIP. As he had not notified ATC of this, it was reasonable for the controller to expect the crew to accept a departure from 'VA1'.

When G-SATR was re-cleared to 'VA1', the commander's expectation was that it would be safe to taxi as cleared. Both he and the rest of the crew believed that clearance would be assured provided that the aircraft stayed on the marked taxiway centreline. It became clear during the course of the investigation that this expectation is not uncommon among professional pilots, despite the information to the contrary published by the CAA, and a safety recommendation is made in this regard. In this case, the expectation would have been reinforced by the controller's statement "IN VIEW OF YOUR SLOT…" since this would suggest to the commander that the controller also believed that there was sufficient clearance to pass the B737 as otherwise he would not, in the minds of the crew, have issued the revised instruction. The second co-pilot, who was occupying an observer's seat was not directly occupied with pre-take-off preparations but his perception of the available separation may have been influenced by the fact that he was not at his usual position on the flight deck.

With the operational problems, performance queries and flight deck activity, it is probable that, as the commander continued taxiing his aircraft on the revised routing, he was suffering from a degree of quantitative overload which would have narrowed his attention and made a misjudgement of the available separation more likely. The commander's perception of the problem was also influenced by past experience. The commander had extensive experience of taxiing on the centreline and thus far this had proved to be a safe thing to do. His experience, the ATC clearance, the visual cues and the distractions combined to produce a mental model of the situation which was incorrect. However, distractions during the taxi phase are not uncommon and procedures are normally developed to reduce distractions to a minimum. In this case, the distractions for the crew during the turn were partly self generated in that they were unsure of the take-off performance parameters and had initiated a checklist at an inappropriate moment.

Air Traffic Control

The Air Navigation Order places the responsibility for collision avoidance whilst on the ground with the aircraft commander, notwithstanding any ATC clearance. However, both MATS Part 1 and Manchester's MATS Part 2 also place a responsibility on controllers to assist pilots in avoiding collisions. The investigation therefore also examined to what extent the controllers concerned could or should have assisted the commander of G-SATR in this case, and what part ATC procedures at Manchester may have played in the accident.

Manchester's MATS Part 2 describes that part of the south side taxiway system which is delegated to Air 1 and places the responsibility for assisting in preventing collisions within that area to the Air 1 controller. It also states that crossing traffic may be handed over to Air 2 when it is *"clear of conflictions"*. If handover to Air 2 should occur before the aircraft reaches its clearance limit, as is frequently the case, then it would be reasonable to assume that the responsibility to assist in prevention of collisions also transfers to Air 2, though this is not explicitly stated in MATS Part 2. As the Air 1 controller therefore technically retains responsibility for the traffic, it is questionable whether the Air 2 controller should be able to revise the clearance limit on anything other than safety grounds. Additionally, a factor in Air 1's choice of clearance limit would be the requirement to avoid congestion on the south side, so allowing the controller to continue to cross aircraft. As Air 1 has more situational awareness regarding aircraft that are waiting to cross the runway than Air 2, this would further suggest that a change to the clearance limit should not be made on ground of convenience.

One of the effects of the Air 2 controller's change of clearance limit for the B737 was to create a potential congestion in the area adjacent to link 'D' which was being used by Air 1 as a main crossing point for Runway 24R. This was not the controller's intention, as he expected the B737 to move further forward before stopping, though there was no guarantee of this. Although the revised clearance may have been more convenient for the aircraft concerned, it was contrary to the controller's priority as described in MATS Part 2 to vacate the area of Air 1's responsibility and so enable

Air 1 to continue to clear traffic across Runway 24 Right. As the area of Air 1's responsibility extends to holding point 'T1', it may be expected that Air 2 would feed aircraft towards 'VA1' and 'VB1' initially, which would also keep 'T1' free for those aircraft specifically requesting it in accordance with the AIP. In clearing the B767 to 'VA1', the controller was attempting to relieve the congestion, though this was apparently driven more by the take-off time consideration.

From the control tower, the view would have been almost directly stern-on to the B737. It would have been difficult for the Air 2 controller to determine, either visually or using SMR, if the B737 was stationary or moving forward slowly. The controller stated that, had he known that insufficient separation may have existed between the two aircraft, he would not have issued the revised taxi instruction or added a caution to that effect, and expect the B767 commander to continue taxiing when he was able, though he was not required to do either. Just as the commander of G-SATR had an expectation that separation existed because he had been cleared by ATC, so the controller had an expectation that the commander would assess the separation for himself and not proceed unless it was safe to do so. The difference is that the B767 commander's expectation was based on a false assumption while the controller's expectation was based on an awareness of the commander's own responsibility for safe manoeuvring.

The SMR did show the potential problem but was not routinely used in fair weather conditions for separation purposes, nor was it required to be. This is understandable, as the SMR has limitations and controllers could not monitor the whole manoeuvring area, issuing cautions when thought necessary, as then the absence of a caution would itself imply that clearance was assured. Nevertheless, the SMR is an aid and could conceivably be used by controllers in certain situations to assist in the prevention of collisions on the ground. Therefore the MATS Part 2 statement that the SMR *"...must not be used to relieve pilots...from any of their responsibilities for avoiding collisions on the ground"* could be considered to be at variance with the instructions elsewhere to controllers concerning their own responsibilities to assist pilots in avoiding collisions.

Limitations applicable to holding point 'S2' were omitted from MATS Part 2, on the basis that the holding point is not used. However, the information may have provided controllers with an awareness of a likely problem should an aircraft be stationary or slow moving in the vicinity of 'S2', as was the case in this accident. A safety recommendation is made concerning the south side holding points and associated procedures.

Conclusion

The accident was due to the left wing of G-SATR striking the horizontal stabiliser of G-ODSK as a result of insufficient separation between the two aircraft. Notwithstanding any ATC clearance, the Air Navigation Order places the responsibility for collision avoidance on the ground with the commander of the aircraft. The B767 commander's misjudgement of the clearance between the aircraft was probably due to a combination of physiological limitations, distractions due to operational and time pressures, and a false assumption that his ATC clearance implied that separation would be assured. The Air 2 controller had no reason to believe that the B767 commander would not see and take into account the presence of the B737. Whilst the investigation highlighted some procedural and operational inconsistencies with air traffic control procedures, these are not judged to have been causal factors to the accident.

Safety Recommendations

The following safety recommendations are made:

Safety Recommendation 2005-124

The Civil Aviation Authority should consider publicising the circumstances of this accident with a view to raising flight crews' awareness of their responsibilities for collision avoidance during taxiing as detailed in CAP 637 and the Air Navigation Order.

Safety Recommendation 2005-125

The Civil Aviation Authority should consider mandating the recording of frequency 121.6 MHz at those airfields where provision of the frequency is required.

Safety Recommendation 2005-126

Manchester Airport Air Traffic Control should review local working practises with regard to the south side taxiways to ensure that they are standardised and accurately reflect the requirements of MATS Part 2. Furthermore, MATS Part 2 should be reviewed to ensure that the fullest information on the south side taxiways is included to assist controllers.

ACCIDENT

Aircraft Type and Registration:	Cessna T310R, G-VDIR
No & Type of Engines:	2 Continental Motors Corp TSIO-520-B piston engines
Category:	1.2
Year of Manufacture:	1975
Date & Time (UTC):	4 September 2005 at 1522 hrs
Location:	North Weald Airfield, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Landing gear doors, propellers and tail cone damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	800 hours (of which 260 were on type) Last 90 days - 32 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot, and telephone inquiries to the insurance assessor

The pilot reported that whilst preparing to land at North Weald Aerodrome to take on fuel, he became aware that he did not have a 'three greens' undercarriage indication in the cockpit. Air Traffic Control subsequently confirmed that the main landing gear did not appear to be fully extended.

The pilot embarked on a period of circling in the local area whilst he attempted to extend the gear fully, both by cycling the retraction system electrically and by using the manual crank mechanism. These attempts were abandoned after about 30 minutes, when an electrical burning smell became apparent and the gear had still failed to lock down correctly. Subsequently, a gentle touchdown was accomplished on the grass adjoining the runway with the gear in a partially extended condition, following which the gear collapsed and the aircraft subsided onto its fuselage. After sliding a short distance, it came to rest and the pilot disembarked.

The aircraft was examined subsequently by an insurance assessor who reported that, after the aircraft had been lifted and appropriately supported, he was able manually to extend and lock down all three landing gears. However, deformations of the various rods and cranks which made up the electrically actuated system, caused by the gear collapsing after touchdown, prevented him from determining the cause of the original malfunction.

ACCIDENT

Aircraft Type and Registration:	DH89A Dragon Rapide, G-AIYR
No & Type of Engines:	2 de Havilland Gipsy Queen 3 piston engines
Category:	1.2
Year of Manufacture:	1943
Date & Time (UTC):	9 July 2005 at 1721 hrs
Location:	Duxford Aerodrome, Cambridgeshire
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 1 Passengers - 8
Injuries:	Crew - None Passengers - None
Nature of Damage:	Lower right wing burned for about 3.3 metres of span outboard of the engine
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	53 years
Commander's Flying Experience:	5,835 hours (of which 1,400 were on type) Last 90 days - 140 hours Last 28 days - 22 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and enquiries by the AAIB

History of the flight

The aircraft was being used for a number of short consecutive pleasure flights. Following one of these flights the engines were closed down whilst the passengers were disembarked and a new group embarked. This took approximately 10 minutes. With the port engine running the pilot started the starboard engine and observed flames appearing over the leading edge of the lower starboard wing, outboard of the engine. No fuel priming was carried out to either engine prior to start-up. The pilot closed down both engines and evacuated the passengers and himself. Once he had ensured that the passengers were safely away from the aircraft, he assisted ground staff to extinguish the fire.

An eye witness, who was standing in front of and to the right facing the aircraft, saw a long flame shoot out of the exhaust of the starboard engine during start-up (the exhaust being on the starboard side of the engine). This flame started a fire on the rear fabric-covered under-surface of the lower starboard wing, just outboard of the engine.

Engineering examination

A detailed examination was carried out by the operator's engineer who found no evidence of the fire initiating inside the wing's structure. No explanation, other than a flame emanating from the engine's exhaust, could be found to account for the initiation of the fire. The engine was examined and test run and there were no fuel or oil leaks. The test runs and subsequent flight tests showed no fault with the engine and no adjustments had to be made to the engine systems following the fire.

Other information

There was a taxiway edge storm drain within one metre of the point on the aircraft's wing where the fire started. Examination of this drain revealed no evidence of burning/scorching or having contained inflammable gas or liquid.

In the early 1950s a number of DH89A aircraft suffered 'start-up fires'. As a result, in 1954, the aircraft manufacturer issued Technical News Sheet series CT(89) number 17 titled '*Fire Precautions*'. This News Sheet mentioned the application of an engine modification, which had been embodied on G-AIYR, specific maintenance inspections and adherence to the engine shutdown procedure. This advice was repeated in an article in the August 2003 edition of 'The de Havilland Gazette' which is an informal news update for Technical News Sheet subscribers published by de Havilland Support Limited, the airframe Design Authority.

INCIDENT

Aircraft Type and Registration:	Embraer 145EU, G-EMBP
No & Type of Engines:	2 Allison AE 3007/A1/1 turbofan engines
Category:	1.1
Year of Manufacture:	2000
Date & Time (UTC):	5 August 2005 at 1735 hrs
Location:	Birmingham Airport, West Midlands
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 18
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	38 years
Commander's Flying Experience:	7,650 hours (of which 2,150 were on type) Last 90 days - 115 hours Last 28 days - 64 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft was on a scheduled flight from Frankfurt to Birmingham. Whilst in the cruise at FL360 the cabin crew observed some hazy smoke in the central cabin area. The senior crew member informed the flight deck crew who donned their oxygen masks and declared an emergency to ATC.

Because of information passed to them from an onboard positioning crew, that they had experienced an air conditioning pack problem earlier in the day, an initial descent to FL240 was carried out in anticipation of possible single pack operation. The emergency/abnormal procedure for 'Air Conditioning Smoke' was carried out following which the cabin crew reported that the smoke had cleared.

The commander decided to continue the flight to Birmingham and there was no re-occurrence of the smoke en-route. Descending through FL50, towards the final approach to land, the cabin crew informed the commander that the smoke had returned and was now more to the front of the cabin area. A 'PAN' call was made and the flight crew put on their oxygen masks again. ATC were informed that it might be necessary to carry out a passenger evacuation on the runway after landing. Shortly before landing the cabin crew advised the commander that the smoke had cleared.

After landing the commander stopped the aircraft on the runway and liaised with the Airport Fire Service (AFS) who were in attendance. AFS personnel came on board the aircraft and were unable to find any evidence of smoke or fire. The passengers were evacuated, as a precaution, following which the aircraft was towed off the runway to a stand.

The source of the smoke was subsequently traced to a faulty bearing on the cabin air recirculation fan. The recirculation fan would have been turned OFF as part of the procedure carried out by the crew.

ACCIDENT

Aircraft Type and Registration:	ARV Super 2 (ARV1), G-TARV
No & Type of Engines:	1 Hewland AE75D piston engine
Category:	1.3
Year of Manufacture:	2001 (rebuilt)
Date & Time (UTC):	30 April 2005 at 1135 hrs
Location:	Naish Farm, Clapton in Gordano, Bristol
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:	71 years
Commander's Flying Experience:	624 hours (of which approximately 33 were on type) Last 90 days - 3 hours Last 28 days - 1 hour
Information Source:	AAIB Field Investigation

Synopsis

The accident occurred during a takeoff from a private airstrip under light wind conditions. The aircraft struck the edge of a wood and then some power cables. There was no evidence of any mechanical malfunction. Examination of a Pilot Operating Handbook for the aircraft type showed that the airstrip was unsuitable for the operation of the aircraft and, with the existing meteorological conditions, the take-off distance available was less than was required for takeoff.

Aircraft information

The ARV Super 2 was designed in the early 1980s to create an affordable two-place light aircraft, built in the United Kingdom. From 1985 the aircraft was produced at Sandown Airport, on the Isle of Wight. There were several weight-saving innovations in the design, including the Hewland AE75 inverted three-cylinder two-stroke water-cooled engine and the use of superplastically-formed aluminium panels in the forward fuselage.

About 30 aircraft were completed and since then, a number of the aircraft have continued to be operated. G-TARV ceased flying in 1986 after an accident but had been rebuilt and flew again, in 2001, with the more developed AE75D version of the original engine but with the same power. The aircraft was operating on a Permit to Fly, under the auspices of the Popular Flying Association.

History of the flight

On 16 April 2005 the pilot had flown the aircraft for the first time that year from his private airstrip, when he had completed a short local flight. At the end of that flight, he had reportedly commented that the aircraft was performing very well.

On the morning of the accident, he had decided to fly to Dunkeswell Aerodrome, near Taunton, and then return to his airstrip. Figure 1 shows the airstrip in the take-off direction. The pilot moved sheep from the airstrip, put up his windsock and positioned his aircraft at the eastern end. At about 1130 hrs, an eye witness heard an increase in engine noise and looked towards the airstrip. The eye witness watched the aircraft travel along the airstrip. She had previously watched the aircraft takeoff and had the impression that it was not going as fast as normal. It also appeared to lift-off later than normal and the witness saw the aircraft airborne and banked to the right before losing sight of it. Shortly after, there was a loud bang and the witness started to run towards the site of the crash. On the way, she alerted a neighbour, who telephoned for an ambulance. At the accident, the aircraft was inverted with the pilot still strapped in but motionless. The witness checked the pilot but could not detect any pulse.

The emergency call was recorded at 1144 hrs. By 1158 hrs, the first emergency vehicle was on the scene. Additionally the Air Support Unit helicopter was alerted at 1153 hrs and arrived overhead shortly after 1200 hrs.

Medical information

A Post Mortem examination was carried out on the pilot. This indicated that he had died from head and spinal injuries. Additionally, there was no evidence of any toxicological factor which could have contributed to the cause of the accident or to the cause of death. The pilot's weight was 93 kg.

Airstrip information

The airstrip is orientated 260º/080º and is approximately 600 m long. It is at an altitude of approximately 400 ft amsl and has a level grass surface, which was firm and dry at the time of the accident. The area is normally used for sheep grazing and the grass varied in length from no greater than two inches long in some areas up to four inches long in other areas. To the east, a road with a hedge bounded the end of the airstrip and there were power lines, on pylons, crossing north to south just beyond the airstrip boundary. Further 11 kV power lines, on wooden poles some 27 ft high, were located parallel to the northern edge of the airstrip and these diverged towards the northwest from a point approximately 420 m along the airstrip. At the western edge of the airstrip, there was a line of trees orientated north/ south; these were approximately 110 ft high. Entries in the pilot's log book indicated that G-TARV was the only aircraft that he had operated from the airstrip. He had first flown the aircraft into the airstrip in October 2001. His next recorded flight from the airstrip was in July 2003 and he had subsequently flown out of the airstrip on 15 occasions prior to the accident. There was no evidence that any other aircraft had operated from there. Witnesses commented that the pilot would only takeoff in a westerly direction. Figure 1 shows the layout of the strip in the direction of takeoff on the accident flight.

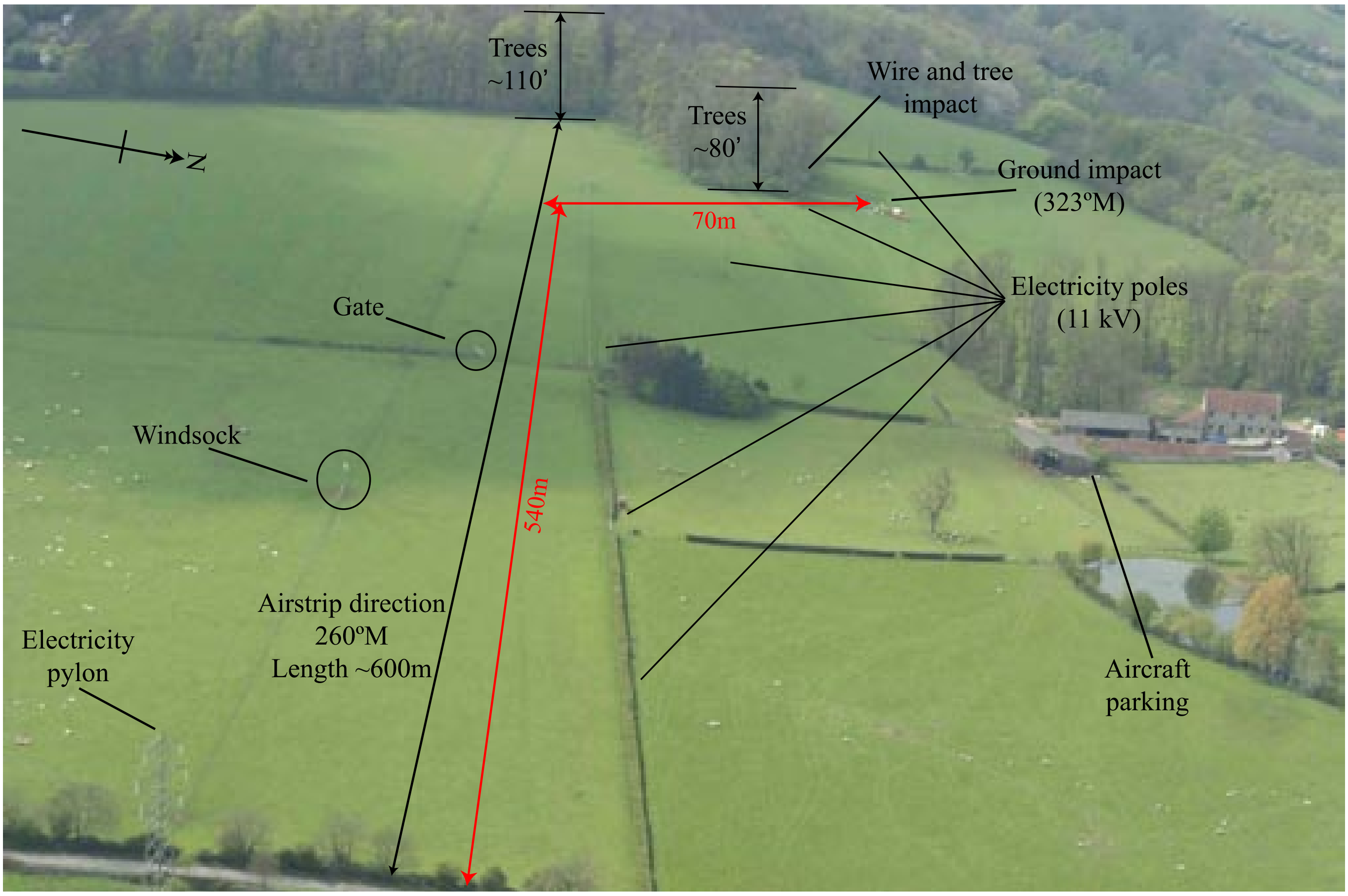


Figure 1

Airstrip at Naish Farm, 30 April 2005

Initial engineering examination

The aircraft had come to rest inverted, close to where a set of 11 kV power cables ran along the edge of the wood. The point of impact with the trees and cables was some 70 m to the right of the airstrip and abeam a point approximately 540 m from the eastern end. It was apparent that the aircraft had struck, and severed, all three of the cables, as well as bringing down some light branches from the edge of the tree line. It appeared that two of the cables had been cut by the propeller and the third by the main spar of the left wing, close to the wing root. The geometry of the impact with the cables and the ground indicated that, at the cables, the aircraft was close to being banked 90º to the right, travelling in a direction of 320º to 325ºM, and descending at about 10º below the horizon. The roll to the right continued after contact with the cables and the aircraft struck the ground inverted. The point of impact with the cables was some 10 to 15 ft above the elevation of the runway.

There had been no structural failure before the impact and there was no indication of any problem with the flying controls. The flaps were found set at the take-off position of 25º. Two features noted in the examination of the landing gear were the relatively small rolling radius of the tyres (six inches) relative to the grass length in some areas and a build up of corrosion on the brake discs, leading to a distinct drag on the rotation of the right wheel. Both of these features would have reduced the take-off performance of the aircraft.

Weather information

The witness who watched the aircraft travel along the airstrip stated that the weather was dry and sunny with a light surface wind. Prior to takeoff, the pilot had placed a portable windsock at the southern edge of the strip approximately 150 m from the eastern end. A review of the video recording from the Air Support Unit helicopter, which arrived on the scene within about 20 minutes, indicated that the surface wind was light and from approximately 170º/160ºM.

The Met Office provided an aftercast of the weather. The synoptic situation at 1200 hrs showed a light south-easterly flow covering the Bristol area. Cloud was FEW Cumulus base 3,000 ft amsl, surface visibility was 10 to 20 km and the air temperature was 18ºC with a dew point of 11ºC. The surface wind was 140ºM/06 kt. Using the CAA diagram from LASORS, moderate carburettor icing could have been expected at cruise power for the existing conditions.

The Met office also provided an aftercast of the wind conditions on 16 April 2005, which was the date of the previous takeoff by the pilot in G-TARV from the airstrip. This indicated that the surface wind at the time of takeoff (1440 hrs) was westerly at about 12 kt and that the air temperature was 10ºC.

Operational information

The Pilot's Operating Handbook (POH) for the aircraft type included information that the aircraft stall speed (power off) at maximum weight and 25º flap would be 49 kt with wings level and 73 kt at 60º bank. At less than maximum weight and with high engine power, these speeds would be slightly less. After the accident, the POH for G-TARV was not found.

In addition to that contained within the POH, the CAA provides information on aircraft performance and on operating from airstrips. This information is provided in LASORS Safety Sense Leaflet 7 (*General Aviation Aeroplane Performance*) and Safety Sense Leaflet 12 (*Strip Sense*). Leaflet 7 provides valuable information on the calculations required and recommended safety factors (1.33 for takeoff) for operating light aeroplanes and Leaflet 12 provides information on setting up a private airstrip and operating from it.

Performance calculations

G-TARV was weighed following the aircraft rebuild in 2001. A copy of the Weight and Balance Form was provided by the PFA. This showed an empty weight for the aircraft of 682 lb. The weight of the pilot was approximately 205 lb resulting in a total weight of 887 lb plus weight of fuel. The amount of fuel on board could not be positively determined but a full fuel load would have weighed 79 lb. It was probable that there was at least half fuel on board resulting in a fuel weight of about 40 lb. Therefore, the aircraft was estimated to weigh some 927 lb for takeoff. This was below the Maximum Gross weight of 1,100 lb.

The POH for the aircraft type included information on take-off performance. The figures assumed that the engine was operating at full throttle and with flaps selected to 25º. The aircraft would be rotated at 50 kt IAS and would have accelerated to 65 kt at 50 ft agl. The basic take-off distances up to 50 ft agl were shown in metres for an aircraft at maximum weight on a hard dry runway and were dependent on temperature and runway altitude. This indicated that, at an air temperature of 18˚C and at an altitude of 400 ft amsl, the aircraft at maximum weight would have achieved a height of 50 ft in a take-off distance of 771 m. This distance would be reduced by 17.5% to take account of the actual aircraft weight and then increased by 20% for short dry grass. The result was that G-TARV would have been at a height of 50 ft some 763 m after the start of the take-off run. On the day of the accident, the wind was light and generally appeared to be directly across the runway. Although this would have resulted in no change to the take-off distance, any wind would have made a difference to the performance. The effects of a headwind would have been to reduce the distance by 14% for every 10 kt and that of a tailwind would have been to increase the distance by 24% for every 10 kt.

On the day of the accident, the required take-off distance was 763 m without any safety factor. Calculations for the previous flight on 16 April 2005, assuming the same pilot and fuel weight, resulted in a basic take-off distance of less than 742 m. **Note:** The POH does not give take-off distances for temperatures of less than 15ºC. Factoring in the effect of a 12 kt headwind would have resulted in a take-off distance of less than 617 m.

Engineering information

The engine was examined in detail by the AAIB at an agency with extensive experience of this unconventional design of engine. The examination showed no evidence of any mechanical failure or distress within either the engine or the gearbox. The evidence from the engine spark plugs and the crowns of the pistons indicated that the engine had been operating correctly.

A sample of fuel was taken from the fuel tank during the aircraft recovery and this was analysed. According to the Engine Manual, the fuel should be 100LL, with a 40:1 mixture of fuel with a particular two-stroke oil. The analysis indicated that the fuel from G-TARV matched the specification for 'four star' auto fuel, with a 20:1 mixture of fuel to a different two-stroke oil. However, the engine examination did not show any evidence that this had had any effect on the engine. Airworthiness Notice 98 from the CAA specified those aircraft approved for the use of 'four star' and 'unleaded' auto fuels and the ARV Super 2 did not appear on either list. The Popular Flying Association confirmed that they had not issued an approval for the use of auto fuel in the Hewland AE75 engine.

Analysis

The examination of the aircraft after the accident did not show any evidence of a technical defect which would have contributed to this accident. Although the engine was not in a condition to be tested, the fact that the pilot initiated and continued the takeoff indicated that he was satisfied with the engine's performance; the possibility that there was a degradation of engine power which the pilot did not detect or judged to be acceptable cannot be wholly discounted. However, the slight brake drag would have adversely affected the take-off performance. Environmental factors, which would also have had a detrimental effect on take-off performance would have been the lack of headwind and the length of the grass, allied to the tyre size. Additionally, it was not possible to determine if the pilot had used carburettor heat prior to take off but the conditions were not particularly conducive to carburettor icing at high engine power.

While these factors would have reduced the take-off performance, an examination of the aircraft POH showed that the airstrip was not suitable for the operation of an ARV Super 2. With the right wind and temperature conditions, it was possible to take off from the airstrip as the pilot had achieved on 16 April 2005 and on occasions over the previous two years. However, calculations for 16 April 2005 indicated that the aircraft would have been very close to the departure trees. There was no doubt that the pilot was aware of the performance limitations of the airstrip as evidenced by his always using the same direction for departure. It was also possible that he may have normally used a right turn shortly after takeoff to avoid the line of trees directly ahead. With lower ground to the right, this track, while visually tempting, would have reduced his available take-off distance and would still have required an initial climb to avoid the end of the trees and the power lines. At the time of impact, the aircraft attitude was assessed to be close to 90º right bank and would indicate that the pilot was trying to turn to the right. This may have been his usual procedure or may have resulted from the pilot becoming aware that G-TARV would not clear the trees directly ahead. However, the POH target speed of 65 kt at 50 ft agl was close to the stall speed once the pilot had started to bank the aircraft and it was likely that G-TARV stalled shortly before contacting the cables.

Conclusion

Even without using the recommended CAA safety factor, information within the POH showed that the airstrip was not suitable for the operation of G-TARV.

ACCIDENT

Aircraft Type and Registration:	Avions Pierre Robin DR400-180R, D-EKSI
No & Type of Engines:	O-360 piston engine
Category:	1.3
Year of Manufacture:	1978
Date & Time (UTC):	7 August 2005 at 1330 hrs
Location:	Lasham Airfield, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Destroyed by fire
Commander's Licence:	JAR Commercial Pilot's Licence
Commander's Age:	34 years
Commander's Flying Experience:	1,200 hours (of which 840 were on type) Last 90 days - 90 hours Last 28 days - 70 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft was engaged in aerotow operations at Lasham Airfield and was in the process of carrying out its second glider launch after refueling.

At about 30 ft after takeoff, the pilot sensed the glider release and, upon checking in the mirror, saw smoke and heard a radio call announcing that the aircraft was on fire. She responded by immediately closing the throttle and landing straight ahead, touching down on the grass strip to the north of the paved runway, and completing the 'immediate actions' for engine fire during the latter part of the landing. As the aircraft decelerated, she steered back onto the hard runway and applied maximum braking but was unable to stop before running off the end of the paved surface.

The aircraft came to rest approximately 20 m into the grass overshoot area for Runway 27 and, after confirming that the ignition, fuel and electrics were OFF, the pilot vacated the aircraft in the normal manner. By this stage, smoke was already entering the cockpit and flames were visible outside the aircraft. The pilot had a quick look for the fire extinguisher, but as the fire was already burning quite fiercely, she decided it was safer to vacate the area. Because it presented no threat to life, no attempt was made to extinguish the fire subsequently and the aircraft was totally destroyed.

The tug master witnessed the incident and described seeing smoke coming from beneath the engine cowl as the aircraft started its take-off roll. Flames were by the time it reached a height of approximately 40 ft. He confirmed that the pilot was informed of the fire by radio, at about the time when the glider released, and his description of the ensuing events accords with that given by the pilot. He stated that immediately after the aircraft came to rest, flames were visible in the forward bulkhead area and the fire quickly took hold. He described the smoke which he saw as the aircraft took off as blue/white in colour, and very dense, consistent, in his opinion with oil, possibly from the oil cooler, spraying on to the exhaust system.

The severity of the fire was such that little remained of the wooden aircraft, other than the landing gear and basic engine block, and as such, no meaningful investigation was possible to establish the cause of the fire.

ACCIDENT

Aircraft Type and Registration:	Beagle B121 Series 1, N556MA
No & Type of Engines:	1 Rolls-Royce 0-200-A piston engine
Category:	1.3
Year of Manufacture:	1968
Date & Time (UTC):	13 July 2005 at 1550 hrs
Location:	Near Thurrock Airfield, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Minor) Passengers - None
Nature of Damage:	Extensive
Commander's Licence:	FAA Commercial Pilot Licence with Flying Instructor Rating
Commander's Age:	48 years
Commander's Flying Experience:	6,500 hours (of which 10 were on type) Last 90 days - 40 hours Last 28 days - 23 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

History of the flight

The aircraft was being flown from Thurrock Airfield back to Norwich Airport, having originally been flown from Norwich Airport by the same pilot. The pilot and his passenger had flown in separate aircraft and delivered one to Thurrock for an annual inspection.

During a conversation with the owner of the resident maintenance organisation, the pilot mentioned that the aircraft was an early Beagle Pup version fitted with a 100 HP engine. The owner of the resident maintenance organisation, himself a private pilot, expressed his concern that the aircraft might be limited in performance due to the fact that the weather was hot, there was little wind and there are electricity pylons situated on rising ground on the take-off path; he therefore suggested using the 100 m paved extension at the start of Runway 07. This advice was subsequently seen to be heeded.

The pilot reported that the aircraft was started, with approximately 11 imperial gallons of fuel remaining, and taxied out for takeoff. Runway 07 was in use and its 650 m grass surface was dry. Having completed the pre-takeoff checks and selected 10º of flap he commenced the take-off roll. He stated the aircraft became airborne after a ground run of approximately 300 m and climbed away at 60 kt. At approximately 250 ft the flaps were retracted. On passing 300 ft the engine began to loose power; there were no sign of rough running or noises from the engine prior to this. The pilot verified that the fuel pump was selected ON, both tanks were selected and he checked for carburettor icing by selecting Carburettor Heat to ON momentarily. With the engine running at a reduced power the pilot turned away from the approaching power lines and commenced a turn downwind for Runway 07. After a turning through about 90º the engine stopped. The pilot then completed a flapless forced landing into a field of standing crops below because he had no time to extend the electric flaps.

The aircraft came to rest after a ground run of approximately 25 m. When the aircraft stopped the pilot and his passenger exited the aircraft without assistance and telephoned the emergency services. The pilot suffered a minor back injury and the passenger was uninjured. The crash site was attended 15 minutes later by the police and local fire service.

Weather

The Meteorological Office provided an aftercast for the area at the time of the accident. It indicated that a ridge of high pressure covered the British Isles with a light air flow over south east England. The surface wind was expected to be 120º at 5 to 10 kt, with a temperature of +24ºC, a dew point of +14ºC and a relative humidity of 54%. The visibility was expected to be greater than 10 km with little, if any, cloud below 10,000 ft.

The pilot reported that the surface wind was light and variable with a temperature of +22ºC and the weather was CAVOK.

Aircraft examination

The aircraft was inspected by the maintenance organisation from Thurrock Airfield the following morning, before the aircraft was moved. The aircraft was found to be in a severely damaged condition. One blade of the propeller was bent, the undercarriage had collapsed and various engine ancillaries were detached from the bottom of the engine. The engine had a sufficient level of oil, there were no signs of any leaks and the ignition system appeared intact. Before the aircraft was removed approximately 12 imperial gallons were drained from the aircraft's fuel tanks.

The engine was subsequently tested by an independent test facility where it was found to function satisfactorily with a slave oil sump and carburettor.

Weight and balance

The aircraft last had a weight and balance measurement in September 2002. Utilising these figures a summary of the weights of the aircraft at the time of the accident is shown in Table 1.

Empty weight	1207
Maximum take-off weight	1600
Useful load	393
Fuel on board (11 Imp Gallons)	79[1]
Weight of pilot and passenger	400
Weight at takeoff	1686

[1] Imperial gallons to lbs conversion is 10.0223 X 0.72 (Specific gravity) X Quantity

Table 1

Weight figures for N556MA in lbs

The aircraft therefore exceeded its maximum permitted take-off weight by approximately 86 lbs. However, if the 12 gallons of fuel that were drained from the aircraft are allowed for then it would have been approximately 94 lbs above the maximum permitted take-off weight.

An extract from the CAA's Safety Sense Leaflet 9, *Weight and Balance*, found in LASORS is shown below:

> *THE LAW AND INSURANCE*
>
> *a) Article 43(d) of Air Navigation (No. 2) Order 2000 states that 'the Commander of an aircraft registered in the United Kingdom shall satisfy himself before the aircraft takes off that the load carried by the aircraft is of such weight, and is so distributed and secured, that it may safely be carried on the intended flight'.*
>
> *b) In addition ANO Article 8 requires that all aircraft have a valid Certificate of Airworthiness (C of A) or Permit to Fly. These documents, either directly, or by reference to a Flight Manual/Pilots Operating Handbook which forms part of a C of A, specify the weight and centre of gravity limits within which the aircraft must be operated. If these limitations are not observed, the pilot is failing to comply with a legal condition for the operation of his aircraft.*

Aircraft performance

An eye witness, who was near the threshold of Runway 07, saw the aircraft become airborne having used approximately 75% of the available runway. This equates to a take-off run of about 560 m, including the 100 m of the paved extension that was used.

The take-off distance required, obtained from the aircraft's operating manual at maximum take-off weight of 1,600 lb and with 10º flap selected, factored for dry grass, is 648 m. The take-off run required should not exceed 60% of the take-off distance; this equates to 389 m.

To ensure a higher level of safety it is strongly recommended by the CAA that a safety factor of 33% is added to figures obtained from operating manuals. This increases the take-off distance required, at maximum take-off weight, to 862 m, with an associated take-off run of 517 m.

Safety Sense Leaflet 7, *Aeroplane Performance*, states that:

> *To ensure a high level of safety on UK Public Transport flights, there is a legal requirement to apply specified safety factors to unfactored data (the result is called Net Performance Data). It is* ***strongly recommended*** *that those same factors be used for private flights in order to take account of:*
>
> - *Your lack of practice*
> - *Incorrect speeds/techniques*
> - *Aeroplane and engine wear and tear*
> - *Less than favourable conditions*

Carburettor icing

The aftercast temperature and dew point, for the time of the accident, were plotted on the Carb Icing Chart in Safety Sense 14, found in LASORS and AIC 145/1997. They fall, at best, in the *Serious icing - descent power* area, and at worst, in the *Moderate icing - cruise power/ Serious icing - descent power* area.

Though carburettor icing might have existed, the ambient conditions and the flight profile were not conducive to its formation.

Conclusion

The aircraft exceeded its maximum take-off weight and should not have attempted to get airborne without reducing its weight to 1,600 lbs or less. Since the actual take-off weight exceeded the maximum permissible take-off weight the take-off distance required will have been in excess of the figures presented above. It can thus be seen that the take-off performance was marginal in the prevailing conditions. No explanation for the reported engine failure could be determined.

ACCIDENT

Aircraft Type and Registration:	Boeing A75N1 Stearman, G-BTFG
No & Type of Engines:	1 Continental Motors Corp W-670-6N piston engine
Category:	1.3
Year of Manufacture:	1940
Date & Time (UTC):	10 September 2005 at 1515 hrs
Location:	Manston Airport, Kent
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Left wing tip, aileron and landing gear damaged
Commander's Licence:	Basic Commercial Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	2,586 hours (of which 21 were on type) Last 90 days - 270 hours Last 28 days - 90 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

After a half hour trial flying lesson, the commander made a normal landing on Runway 10 at Manston with the surface wind reported as 060º/3 kt. The landing was made in a three point attitude and was uneventful until the speed had decayed to approximately 30 kt. At that point a gust of wind lifted the left hand wing; the pilot attempted to correct this uncommanded motion with left aileron and rudder. The aircraft then yawed to the left and the left wing came down, with the wing tip hitting the ground. Immediately after this, the aircraft yawed to the right, coming to a halt almost 180º off the original runway heading. The aircraft was vacated without incident.

Inspection of the aircraft revealed that the left side landing gear had collapsed and marks on the runway would indicate that this had occurred after the aircraft had started yawing right. With ground loop occurrences such as this, control is often lost with the aircraft turning the opposite way from the initial swing. This can be due to overcontrolling the aircraft in response to the first turn, although in this incident the pilot has no recollection of doing so.

ACCIDENT

Aircraft Type and Registration:	Extra EA300, D-EZOZ
No & Type of Engines:	1 AEIO 540 piston engine
Category:	1.3
Year of Manufacture:	1996
Date & Time (UTC):	4 August 2005 at 1035 hrs
Location:	Wing Farm near Warminster, Wiltshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Main landing gear, fuselage and propeller
Commander's Licence:	Dutch Private Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	2,000 hours (of which 1,000+ were on type) Last 90 days - 50 hours Last 28 days - 20 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

The pilot was returning to Wing Farm after a formation flight that involved nine aircraft flying over Stonehenge, Wiltshire. Wing Farm is a grass strip, 500 m in length. Runway 27 was in use and the grass was dry. An aftercast obtained by from the Meteorological Office states that the surface wind would have been approximately 290°/7 to 11 kt. The pilot reports that the surface wind was 340°/6 kt.

D-EZOZ was number four in the formation and was briefed to land fourth. The first three aircraft landed and waited at the end of the runway, as they had to back track the runway to get to the parking area by the threshold of Runway 27.

The pilot reports that during the final approach he was side-slipping the aircraft, as he usually did, to slow down and to increase his forward visibility. Having removed the side slip and flared, he noticed that he landed with the tail wheel before the main landing gear, which touched down firmly. At this point the right main landing gear leg broke and began to dig into the grass. This caused the aircraft to yaw to the right and slide to a rapid stop. During the slide the left main landing gear was also damaged.

The pilot informed other aircraft, which were on approach, about the accident. Having checked that his passenger was not injured he isolated the aircraft electrically and vacated it with his passenger. Having ensured there was no risk of fire, the aircraft was moved off the runway to allow the rest of the formation of aircraft to land.

An assessment of the damage, by the repair agency, found that the right main landing gear had broken off, there was damage to the left main landing gear and minor damage to the underside of the wings and fuselage. All of the propeller blades had suffered impact damage and the engine was shock-loaded. The agency also stated that the maintenance schedule requires routine visual inspection of the landing gear, but no routine load testing. Thus, there was the possibility of a pre-existing weakness in the main landing gear.

ACCIDENT

Aircraft Type and Registration:	Lancair 320, G-CBAF
No & Type of Engines:	1 Lycoming IO-320-B1A piston engine
Category:	1.3
Year of Manufacture:	2002
Date & Time (UTC):	11 June 2005 at 1652 hrs
Location:	Lydd Airport, Kent
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Failed nose wheel attachment, damaged lower end of nose landing gear strut, shattered propeller and engine shock loaded
Commander's Licence:	Private Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	298 hours (of which 16 were on type) Last 90 days - 18 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and metallurgical examination

History of the flight

The aircraft had been purchased by the owners about three months prior to the accident and the majority of their flying in it had been with an instructor. Prior to the accident flight the pilot/co-owner carried out a pre-flight check of the aircraft but did not notice anything unusual with the landing gears. Following a successful local flight in good weather conditions, the pilot made a normal approach to Runway 03 which has an asphalt surface. The surface wind at the time was 030º/07 kt. In the flare with the speed reducing below 80 kt, the main wheels touched down on the runway followed a few seconds later by the nose wheel. The pilot assessed that the landing was very smooth and with no drift (it was described by more than one person as "a real greaser"). About one second after the nose wheel touched down, the nose tipped down and the aircraft rapidly came to a halt. As the aircraft's nose tipped down, the propeller tips struck the runway which stopped the engine.

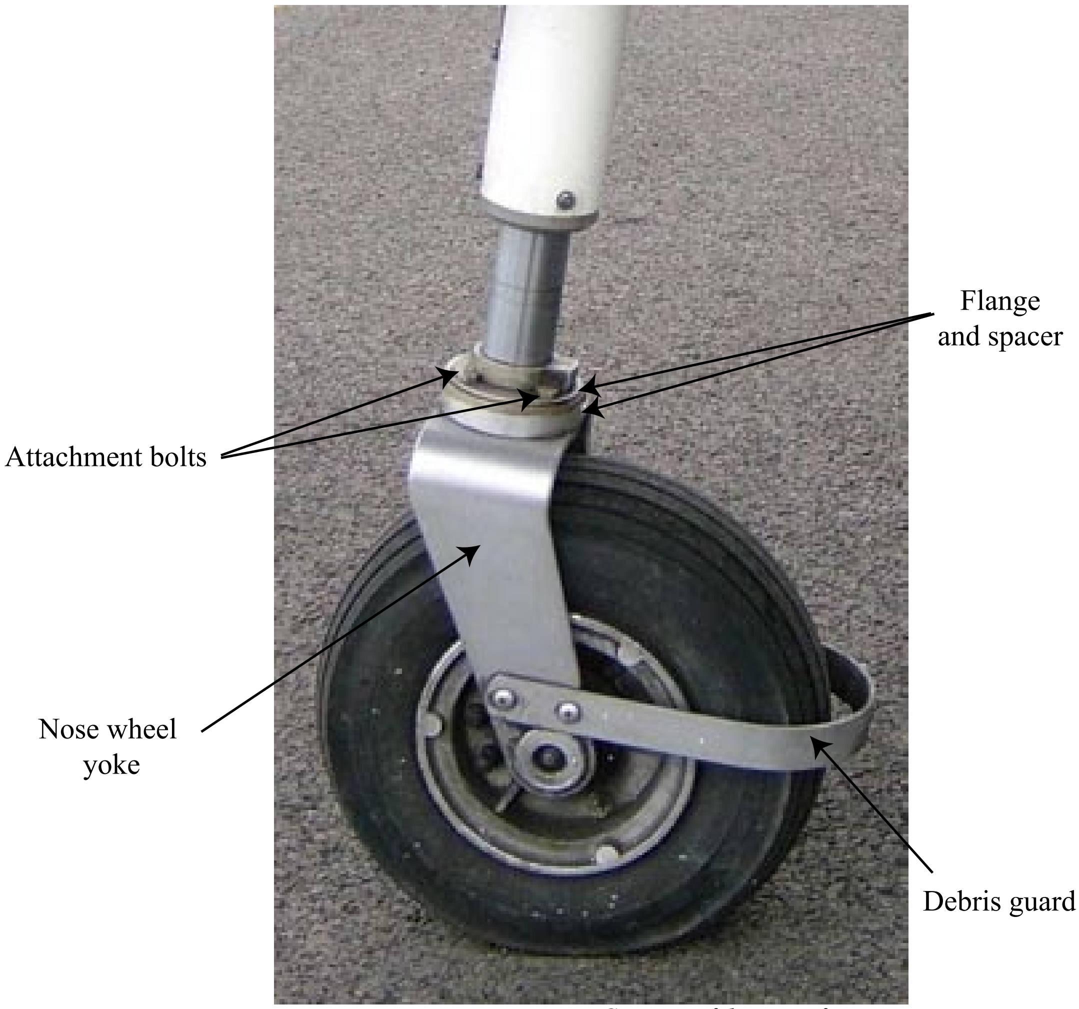
Other information

There were two eye witnesses, both of whom had flown in the aircraft on the previous two flights. Their view of the accident was very similar to that of the pilot except that they estimated that the nose wheel detached from the aircraft some 300 m after it touched down on the runway.

Engineering examination

Examination of the aircraft showed that the nose wheel mounted in its attachment yoke had become detached from the nose leg (Figure 1). All four bolts that attached the yoke to the nose leg had remained located within the flange and spacer assembly that was fitted at the bottom of the nose leg. Three of the four stiff nuts from the attachment bolts were found scattered between the aircraft and the runway threshold.

All these items were taken to a metallurgical laboratory for examination. It was seen that the debris guard had been deformed to an extent that allowed it to come into contact with the tyre, stopping the wheel from rotating. The tyre was in a very good condition with no evidence of scuffing which would suggest that the wheel was free to rotate at touchdown and that the damage to the debris guard had occurred after the wheel had detached from the aircraft. Evidence of mechanical damage was seen at the forward edge of the nose wheel attachment yoke which is consistent with impact damage with the runway after the wheel had become detached.



Courtesy of the aircraft owners

Figure 1

Picture of the nose landing gear

The two rear attachment bolt holes in the nose wheel yoke were deformed in a rearward direction. The two forward attachment bolt holes showed a very minor degree of deformation and some damage in the forward faces of the holes. This indicates that the two forward attachment bolts were extracted in a mainly vertical direction while the yoke pivoted rearwards about the rear attachment bolt line. This would cause the ends of the forward attachment bolts to contact the forward faces of their holes in the yoke and the rear attachment bolts to bend within their holes causing the hole deformation.

The threaded ends of all four attachment bolts had extensive surface abrasion and evidence of heat tinting indicating that some frictional heating had occurred, consistent with contact with the runway during landing. This abrasion destroyed any evidence of a fatigue failure if there had been one. The two rear attachment bolts showed evidence of bending consistent with the pivoting of the nose wheel yoke along the rear bolt line.

Only three of the four attachment bolt nuts were recovered. All three nuts showed very good evidence of thread stripping which is indicative of the nuts being pulled off the attachment bolts during tensile loading. Because the fourth nut was not recovered, it is possible that it may not have failed in a similar manner.

Routine landing gear tests and inspections

The previous owner of G-CBAF reported that the aircraft had undergone a thorough pre-sale inspection carried out by an engineer. This inspection included retraction tests and examination of the nose landing gear to establish conformity with a manufacturer's directive concerning security of the strut flange. The flange was of the latest modified type. The previous owner had completed five more landings before parting with the aircraft. When the ownership changed the aircraft had accrued about 60 flying hours; at the time of the accident it had accrued some 93 flying hours.

Discussion

It is possible that one of the attachment bolts failed in fatigue and that the bolt tail, with the nut still attached, separated prior to the detachment of the nose wheel assembly. However, if this was the case and one of the attachment bolts had failed prior to the accident landing, it seems unlikely that the nose wheel assembly would detach in the way it did because on landing the joint between the nose wheel yoke and the leg is put into compression. Failure of at least three of the attachment bolts had occurred due to tensile loading causing the threads in the nuts to strip. For this to occur, in a manner that would cause pivoting about the rear attachment bolt line, the aircraft has to be moving forward while the nose wheel is impeded, such as by striking a raised lip or pothole. This may have happened at some time prior to the accident flight and possibly before the owners purchased their aircraft from its previous owner. The wheel could have struck an object causing it to bend, deforming or even stripping the forward attachment bolt nuts. Then on the accident landing the wheel may not have been co-linear to the strut causing it to buckle and detach.

ACCIDENT

Aircraft Type and Registration:	MCR-01 Club, G-DGHI
No & Type of Engines:	1 Rotax 912 ULS piston engine
Category:	1.3
Year of Manufacture:	2004
Date & Time (UTC):	17 June 2005 at 1745 hrs
Location:	Fridd Farm, Ashford, Kent
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Landing gear, propeller and under-fuselage damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	577 hours (of which 30 were on type) Last 90 days - 16 hours Last 28 days - 8 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot had intended to fly to Le Touquet with a passenger. As this was to be his first flight across the channel in this aircraft he decided to perform several circuits, on the day prior to the planned flight, in order to check that it was fully serviceable. Three such circuits were carried-out, stopping after each one to perform magneto-drop and temperature and pressure checks, which all proved satisfactory. After a break of about an hour he checked the fuel contents with a calibrated dip-stick, confirming that he had 70 litres on-board, and then carried out the full pre-flight checks before lining-up for takeoff on the grass strip with the electric fuel pump switched on. All of the required checks prior to take off were completed but, at approximately 150-200 ft, the engine 'coughed' and stopped suddenly.

The pilot realised that he could not land straight ahead since the field in front had numerous obstructions, including sheep and there were similar problems to the right, so he decided to land to the left, in a field of oil seed rape. Upon touchdown the nose landing gear leg folded upwards and back but the aircraft stayed upright and, after switching off the electrical master switch and fuel cock, the pilot exited the aircraft normally. Injury was confined to minor scratches on both hands.

G-DGHI had been built by its owner/pilot from a 'fast-build' kit supplied by Dyn-Aero of France. It had flown about 31 hours at the time of the accident. The owner decided that the aircraft should be repaired by the main agent for Dyn-Aero in France and it was despatched there with an undertaking that the reason for the engine failure would also be investigated. The company has reported back that a piece of material, identified as a piece of heat-resistant sleeving used around hoses in the engine compartment, was found to be obstructing fuel flow to the carburettors. It was reasoned that this material must have been introduced during build, since it was downstream of the filter which would have prevented it from reaching the location where it was found had it dropped into the fuel tank, for example.

ACCIDENT

Aircraft Type and Registration:	i) Piper PA-28-161 Cadet, G-EXON ii) Piper PA-28R-200 Cherokee Arrow II, G-RONG
No & Type of Engines:	i) 1 Lycoming O-320-D3G piston engine ii) 1 Lycoming IO-360-C1C piston engine
Category:	1.3
Year of Manufacture:	i) 1989 ii) 1973
Date & Time (UTC):	19 June 2005 at 0937 hrs
Location:	Elstree Aerodrome, Hertfordshire
Type of Flight:	i) Private (Training) ii) N/A
Persons on Board:	i) Crew - 1 Passengers - None ii) Crew - None Passengers - None
Injuries:	i) Crew - None Passengers - N/A ii) Crew - N/A Passengers - N/A
Nature of Damage:	i) Substantial ii) Starboard wing written off and damage to cowling
Commander's Licence:	i) Student Pilot ii) Not applicable
Commander's Age:	i) 33 years ii) Not applicable
Commander's Flying Experience:	i) 33 hours (of which 32 were on type) Last 90 days - 14 hours Last 28 days - 9 hours ii) Not applicable
Information Source:	Aircraft Accident Report Form submitted by the pilot, and AAIB enquiries

The student pilot had accumulated a total experience of 33 hours, with approximately 5 hours in command on type. She had been authorised for her second solo navigation exercise from Elstree to Southend, having flown the route with her flying instructor the previous day. The conditions were suitable for the flight, with the surface wind at Elstree reported as 180º/5 kt.

The pilot reports that she completed all the usual pre-start, power and pre-takeoff checks and was then instructed to take off at her discretion by the FISO. She then lined up on Runway 26 and began the take-off roll, applying the appropriate cross-wind take-off technique. As the aircraft just became airborne, at about 65 kt, she felt the aircraft move laterally to the left, into the crosswind, and the left tyre make contact with the ground again. She felt that the aircraft was going to continue to roll left, and applied right rudder to regain control. The aircraft was now on the grass running parallel to the runway. The pilot closed the throttle and mixture controls and attempted to brake, however this was ineffective and the aircraft continued to drift left across the parallel taxiway, now tracking south west. The right wing then made contact with the wing of a Cherokee Arrow, G-RONG, which was parked to the south of the taxiway. This caused both aircraft to spin round through about 180° and G-EXON came to a stop. The pilot shut down the aircraft and vacated it without injury.

In a frank report the pilot considered that, although she had applied the correct crosswind technique, due to her inexperience she probably did not use enough rudder, and may have experienced a slight southerly gust. Her instructor reported that she was a very competent student, thorough in all aspects of her flying, and that she had flown the route with him the previous day to her usual high standard.

The Meteorological office was asked to provide details of the surface wind conditions at the time. The charts for the day, and radiosonde data suggested that the wind at 2,000 ft had been about 180º/15 kt. No gusts had been reported, however gusts of less than 10 kt. above the mean wind speed are not included in METARs. In the meteorologist's opinion, the surface wind at Elstree was averaging between 6 and 10 kt with gusts perhaps as high as 10-12 kt, however there were no actual reports.

The demonstrated cross wind limit for the Cadet is 17 kt. Discussions with the maintenance organisation indicated that there was no pre-existing mechanical problem with the aircraft.

INCIDENT

Aircraft Type and Registration:	PA-28R-201 Cherokee Arrow III, G-BYYO
No & Type of Engines:	1 Lycoming IO-360-C1C6 piston engine
Category:	1.3
Year of Manufacture:	1994
Date & Time (UTC):	13 July 2005 at 1128 hrs
Location:	Stapleford Aerodrome, Essex
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Scrape to wing tip, wing step damaged
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	63 years
Commander's Flying Experience:	9,572 hours (of which 4529 were on type) Last 90 days - 126 hours Last 28 days - 55 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot, and AAIB enquiries

The pilot reported that on arrival back at Stapleford she selected the landing gear to 'down' but only two green lights illuminated. She flew past the radio operator and was advised that the right main landing gear was not extended. The pilot decided to leave the circuit to troubleshoot the problem, and reports that she selected the gear emergency extension lever to 'down', yawed the aircraft and pulled some 'g', all without effect. She also tried swapping the indicator bulbs.

With the right main gear still retracted, she elected to land on the grass Runway 22. She carried out a flapless approach and touched down on the left main gear, holding the right wing up as long as possible. During the landing the aircraft yawed to the right, however the landing had been well executed and the only damage to the aircraft was to the step behind the right wing.

The PA-28R-201 Arrow has a hydraulically operated landing gear and also has an emergency landing gear extension system. This is operated by holding down an emergency extension lever which is mounted between the front seats. When operated it allows hydraulic fluid to recirculate across the jacks and therefore allows the landing gear to be lowered by gravity irrespective of the landing gear switch selection or hydraulic pressure. The gear is locked down by spring forces. There are no uplocks, hydraulic pressure being used to maintain the gear in the retracted position. The main landing gear is partly enclosed when retracted, with a single gear door attached to each main landing gear oleo. There are no separate doors to cover the main wheels. Many of these aircraft also have an automatic back up gear extender system which will extend the gear normally if the speed is sufficiently low and the throttle is retarded. G-BYYO was not so equipped, however.

The aircraft was jacked up and the right main landing then gear extended and locked down without difficulty.

The Chief Engineer advised that the aircraft was towed to a hangar and repeated checks of the normal and emergency extension systems were made without any malfunction of the gear being observed. During these checks, no evidence of any interference between the landing gear and anything in or around the landing gear bay was observed. The aircraft was returned to service and has since flown in excess of 200 hours without any recurrence of this malfunction.

ACCIDENT

Aircraft Type and Registration:	Pulsar, G-BSFA
No & Type of Engines:	1 Rotax 582 piston engine
Category:	1.3
Year of Manufacture:	1992
Date & Time (UTC):	27 May 2005 at 1523 hrs
Location:	Gloucester Airport, Gloucestershire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nose landing gear broken, propeller destroyed, engine mounting framework damaged, right main landing gear damaged, underside of left wing root damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	58 years
Commander's Flying Experience:	448 hours (of which 1 was on type) Last 90 days - 1 hour Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot and telephone enquiries by AAIB

The pilot had purchased the aircraft on 11 May 2005. He had asked a Popular Flying Association coach to give him tuition on it, as he had no previous experience on the type, but the coach explained that he could not do this until the aircraft was formally registered in the new owner's name. The pilot then obtained a verbal brief on the aircraft from the previous owner, and elected to fly the aircraft solo.

The aircraft departed Gloucester without incident, and the pilot flew around the local area for some time, before returning to land. The pilot described the first touchdown on Gloucester's Runway 09 as *'heavy'*, and stated that the aircraft bounced slightly before touching down again in a level attitude. Soon after the second touchdown, the nose landing gear collapsed and the propeller struck the runway surface, causing the engine to stop. The aircraft slid to a stop and the pilot vacated the aircraft uninjured and without difficulty.

ACCIDENT

Aircraft Type and Registration:	Reims Cessna F152, G-WACT
No & Type of Engines:	1 Lycoming O-235-L2C piston engine
Category:	1.3
Year of Manufacture:	1982
Date & Time (UTC):	2 October 2005 at 1644 hrs
Location:	Near Newcastle, Tyne and Wear
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Wings extensively damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	55 years
Commander's Flying Experience:	319 hours (of which 34 were on type) Last 90 days - 6 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and enquiries by the AAIB

History of the flight

The pilot had been airborne from Eshott Airfield on a local flight for some two hours and was routing back towards the airfield at 3,000 ft amsl, when he experienced a loss of engine power. After establishing a glide, he confirmed that the engine had stopped and declared a 'MAYDAY' to Newcastle Approach. He was offered a glide approach and landing at Newcastle Airport but declined because of the surrounding area of population. Selecting a suitable field for a forced landing, he informed ATC of his intentions. However, as he descended he noted a number of people in a sports field over which he would have to fly, and altered his target landing area to a nearby golf course. He made a successful touchdown but the grass was wet and the aircraft braking was poor resulting in the right wing impacting a tree. This swung the aircraft to the right but it continued on its original track and the left wingtip struck a fence.

Additional information

During the aircraft recovery, it was noted that there was very little fuel in the aircraft's fuel tanks. The pilot subsequently confirmed that he had flown for a total of about 4 hours since the aircraft had been fully refuelled. His previous experience of a similar type was that this would give approximately 4½ hours endurance. Since the accident he had been advised that G-WACT had an endurance of no more than 4 hours.

The pilot also confirmed that, shortly before the engine stopped, the left fuel gauge was reading zero and the right gauge was reading approximately ⅛ full.

Analysis

The engine stopped through lack of fuel and the pilot then made a forced landing with no injuries to himself or anyone else. Nevertheless, it was unwise to continue flight with the indications of fuel quantity shown on the gauges. Furthermore, even with an expectation that the aircraft had an endurance of 4½ hours, the pilot was close to the time limit for continued safe flight. Fuel planning and fuel monitoring is one of the essentials of good airmanship and the following practical advice on the subject is provided in LASORS 2005 Safety Sense 1 *General Aviation*:

'a. 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, a headwind may be stronger than forecast and frequent use of carb heat will also reduce range.

b. 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.

c. 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.'

ACCIDENT

Aircraft Type and Registration:	Socata TB10 Tobago, G-BOIU
No & Type of Engines:	1 Lycoming O-360-A1AD piston engine
Category:	1.3
Year of Manufacture:	1988
Date & Time (UTC):	28 August 2004 at 1056 hrs
Location:	Bournemouth International Airport, Dorset
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 2
Injuries:	Crew - 1 Passengers - 2 (1 Fatal)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	54 years
Commander's Flying Experience:	1,456 hours (of which 1,310 hours were on type) Last 90 days - 50 hours Last 28 days - 27 hours
Information Source:	AAIB Field Investigation

Synopsis

Shortly after takeoff from Runway 26 at Bournemouth International Airport the pilot radioed to Air Traffic Control (ATC) that he had a problem and was returning to land. The aircraft was seen to enter a left turn at a low height. In the turn, it started to descend and then impacted a fence just outside the airfield boundary. A severe post impact fire started from which only two of the three occupants escaped.

History of the flight

On the morning of the accident the aircraft was flown by the pilot, accompanied by two passengers, from Guernsey to Bournemouth where it landed on Runway 26 at 0933 hrs. After landing the aircraft backtracked on the runway a short distance before turning off onto a taxiway. As it cleared the runway the pilot of another aircraft, a Cherokee Arrow which had just taken off from Runway 26, radioed to ATC that he was returning for an immediate landing on Runway 08 with an engine problem. The aircraft made a successful landing on Runway 08.

The pilot of G-BOIU was then cleared for taxi to a parking area on the south side of the airport where the aircraft was shut down at 0940 hrs. At 1018 hrs having booked out for Henstridge Airfield, the pilot requested clearance to start and taxi to the north side of the airport. At 1025 hrs the aircraft parked on the north side, where the pilot and his passengers went into a hangar to look at some other aircraft.

At 1046 hrs the pilot requested start once again and then taxi clearance for departure. He was cleared to the holding area on the north side of Runway 26. At 1053 hrs he reported ready for departure and, on receipt of a clearance, lined up and took off from the full length of Runway 26 at 1055 hrs.

The tower controller, having issued the take-off clearance watched the aircraft start to roll and then attended to another task. His attention was drawn back to the aircraft shortly after, by a radio call from the pilot saying "GOLF UNIFORM RETURNING TO FIELD IMMEDIATELY AS WE'RE NOT GAINING AIRSPEED". The controller could see the aircraft had just passed in front of the tower and was now flying along the runway at a height that he estimated at between 100 and 200 ft. He replied to the pilot, advising him that he could put down wherever possible, and then telephoned the Airport Fire Service (AFS) to alert them to the emergency. He continued to watch the aircraft and saw it start a level turn to the left and then while still turning, start to descend. He then saw it crash near the airfield boundary and observed that there was an immediate fire. The aircraft was airborne for a total of some 40 seconds.

The aircraft had initially climbed above the runway then, from a position about two thirds of the way along its length, started a turn to the left which continued until ground impact. The turn was within the airfield boundary at first, but the aircraft then crossed low over the B3073 road to the south of the airport and across an open grass field before hitting wooden fence posts at the entrance to an amusement park. The aircraft slid a short distance across some grass, then tipped up and caught fire as it struck a substantial hedge.

The pilot and the rear seat passenger were able to climb out and get clear of the aircraft. There were several people close to the accident site who went to assist, two men first helping the pilot and then one of the passengers away from the area of the burning aircraft. They were advised of one more person still inside and returned to try to assist him, but were driven back by fierce fire and heat.

A fireman inside the fire station heard the radio call from the pilot of G-BOIU and ran towards his fire vehicle. As he passed through the building he could see the aircraft was about to crash and therefore deployed immediately. He drove out of the station and in a straight line across the grass to the boundary fence where he could see the aircraft on fire. From this position foam was sprayed onto the aircraft across the road outside the airport boundary. Two further fire vehicles left the airport through an access gate and drove along the road to reach the accident site. The fire was quickly suppressed but they were unable to rescue the second passenger in time.

The pilot and passenger who escaped from the aircraft suffered severe burns and were airlifted directly from the accident site by air ambulance to a specialist hospital.

Aircraft information

G-BOIU was a four/five place low wing fixed undercarriage aircraft with a single carburettor equipped engine driving a two blade constant speed propeller. It was fitted with electrically operated flaps which typically take 5 to 7 seconds to fully extend from the up position.

Although evidence was limited by the fire it was estimated that the aircraft was operating within the required Weight and Balance and performance limitations. The stall speed of the aircraft, as it was loaded and with 10º of bank and 10º of flap, was calculated from data supplied in the Pilot's Operating Handbook (POH) at about 60 kt.

The POH also provided a procedure for engine failure immediately after takeoff. It recommended maintaining an airspeed of 70 kt, mixture to 'full rich', changing fuel tanks and switching the fuel pump on. If no restart, then a procedure to shut the engine down and land straight ahead is provided. It also contained the following warning: *'Never try to turn back'*.

Pilot information

The pilot had owned a half share of the aircraft for many years. He first obtained his Private Pilot's Licence (PPL) in 1993 and had flown regularly since then, including several flights in the week prior to the accident. Although most of his flights originated in Guernsey he had, over the years, visited many different airfields and was familiar with Bournemouth Airport.

Pilot training

There have been many fatal accidents in the past where pilots have attempted to return to an airfield following a loss of power. The extra manoeuvering required to turn further reduces the available performance, therefore only gentle turns towards the most suitable forced landing area ahead are recommended.

The training syllabus for the PPL includes practice in Engine Failure After Take Off (EFATO) procedures and recommends that a forced landing ahead of the aircraft should be carried out with turns being kept to the minimum necessary. During training an engine failure would normally be simulated by the instructor closing the throttle and then the pilot would practice continuing to fly the aircraft while locating a suitable landing area ahead. Once control of the aircraft was established and a landing area selected the exercise would be complete. One limitation with this type of training is that it simulates only the situation where there is a complete loss of power, rather than a partial loss of power, making identification of the problem, and the decision to land more straightforward.

The aircraft's engine was fitted with a constant speed governor regulated propeller, designed to maintain a constant engine/propeller speed over a wide range of manifold pressure (power). This arrangement can disguise some of the symptoms of a loss of power that occur with a fixed pitch propeller[1]. Present licensing regulation requires pilots to undergo 'Differences Training' to convert to an aircraft type with a 'complex' feature, for example, a Variable Pitch/Constant Speed propeller, within the Single Engine Piston (SEP) class rating. Instruction in both theoretical and practical knowledge are required to complete this training. However, this training has only been introduced over the last few years and since the pilot began flying G-BOIU; previously there was no requirement for formal training of this nature. The pilot stated however that he had carried out conversion training with an instructor when he first flew this type of aircraft.

Airport information

Runway 26 at Bournemouth has a Take Off Run Available of 2,026 m (6,645 feet) and a Take Off Distance of 2,086 m (6,842 feet). There are areas of open grass to the south of the runway. The ATC tower is located some 700 m along Runway 26 on the south side.

Meteorological information

The weather observation at Bournemouth taken immediately after the accident was as follows: Surface wind from 200º at 7 kt, visibility 33 kilometres, few cloud

Footnote

[1] With a fixed pitch propeller, any reduction or loss of power is usually most readily detected by the change in the sound of the engine as the propeller slows down. With a constant speed propeller, the governor will maintain the selected engine/propeller speed, particularly if the airspeed is maintained, thereby reducing the cues available to the pilot.

at 3,200 ft, scattered cloud at 5,000 ft, temperature 17ºC, dewpoint 12ºC and QNH 1012 mb. The chart reproduced at Figure 1 below shows that the temperature/dewpoint spread would have put the aircraft in the moderate risk of carburettor icing range.

Symptoms of carburettor icing

The symptoms of carburettor icing for an engine fitted with a constant speed propeller are of a progressive reduction in manifold pressure for a constant throttle setting when flying at a constant altitude. If the icing becomes severe there may be a complete loss of power. The presence of ice may be detected by applying carburettor heat but this, in any case, will cause a small reduction in power, indicated by a drop in manifold pressure. However, if ice is present some rough running may occur as it melts, followed by recovery of the manifold pressure to a value higher than the starting value.

Recorded information

Air Traffic Control (ATC) voice communications with the aircraft were recorded and available for the investigation.

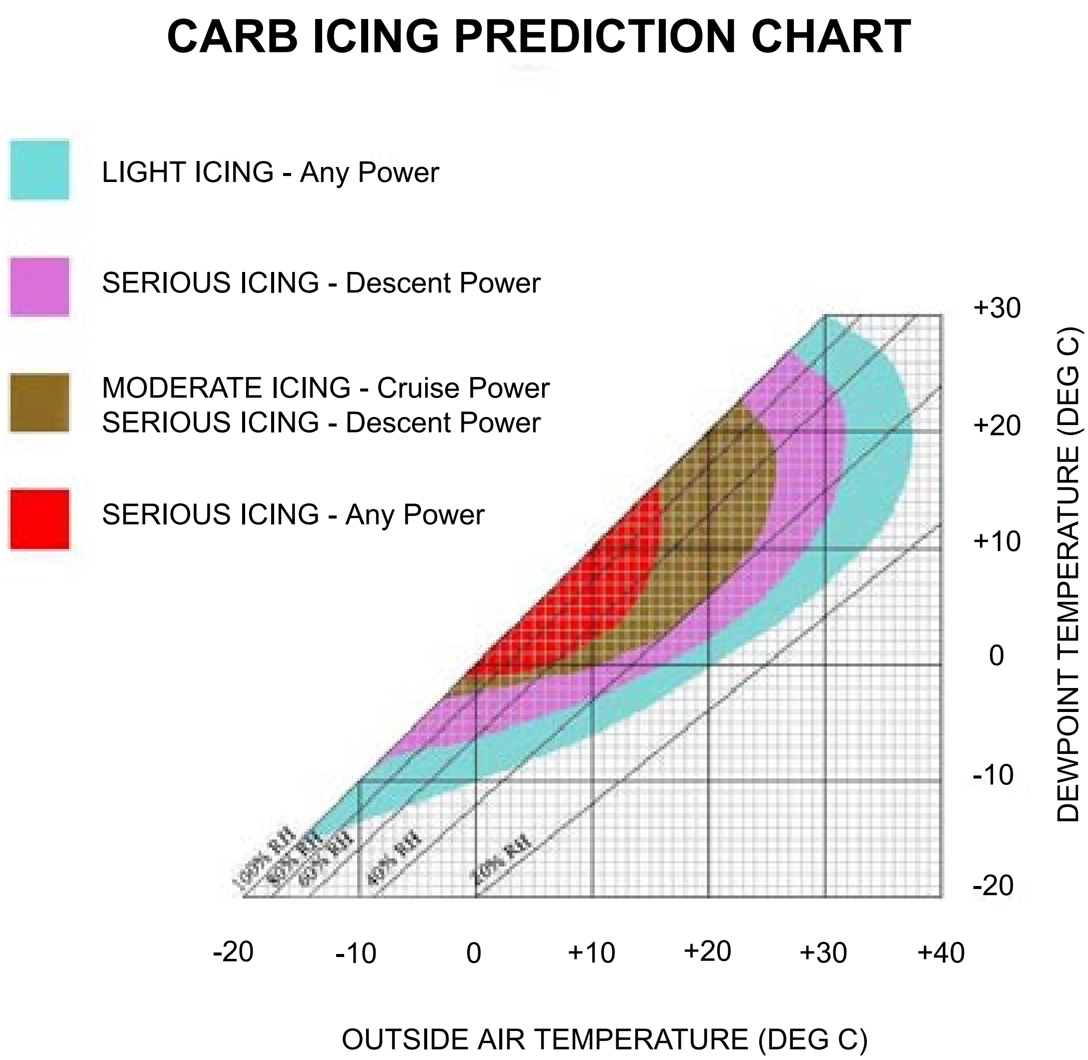


Figure 1

The transmissions from the aircraft on both the inbound flight from Guernsey and the accident flight were analysed to determine whether there was any detectable sound signal that might help to identify the cause of the loss of performance, but none was apparent.

Examination of the wreckage

Wreckage and impact information

The distribution of wreckage and pattern of ground marks showed that the aircraft's left wing initially struck the top of a wooden fence bounding the entrance road to an amusement park just to the south of the airfield. At this stage, it was in a shallow descent, banked approximately 10º to the left, and tracking approximately 085º. The fence caused extensive damage to the wing leading edge and disruption of the integral fuel tank, and yawed the aircraft to the left. The aircraft touched down a short distance beyond the fence, still with a low rate of descent but by that stage sideslipping to the right. Thereafter, it travelled at a shallow angle towards a line of substantial hedging with embedded small trees and chain-link fencing, running along the southern edge of a road which adjoins the airfield's southern boundary. Some 35 m beyond the point of initial impact with the wooden fence, the aircraft slid partially sideways into the hedge, with its speed substantially undiminished, causing the engine to be torn partially from the airframe. Concrete posts supporting the chain-link fencing caused additional extensive damage to both wing leading edges and fuel tanks. More significantly, the right side of the fuselage impacted a small tree with sufficient force to uproot it, bringing the aircraft abruptly to rest on its right side with fuel leaking from both wings and from the disrupted engine pipework.

The impact sequence overall is consistent with the aircraft having been in controlled flight, in a gentle descending turn to the left at an airspeed slightly above the stall, when it struck the fence. The fuselage survived the impacts substantially intact and there were no significant intrusions into the cabin interior, except in a localised region on the right side, in line with the instrument panel. Here the cockpit side was pushed inwards against the deceased passenger's legs at about the knee position.

With the aircraft lying on its side, the right hand cabin door would have been unusable. 'As found', the left side cabin door was closed and latched but much of its glazing, and that of the windscreen, was missing and the remnants burnt away. Numerous pieces of broken perspex, mainly from the windscreen, lay in and around the wreckage. The front seat passenger harness was burned away, but its buckle (on the left side of the seat) was still engaged.

Fire

An extensive post impact fire consumed much of both wings, particularly in the vicinity of the fuel tanks. It had also involved the forward part of the fuselage and engine, causing major damage in these areas. Additionally, several isolated pockets of ground fire were noted in debris and vegetation immediately forward of the point of impact with the wooden fence.

It was evident from the condition of the surviving parts of the fuel tank structure in both the left and right wings, that fuel would have been released potentially from the left wing during the initial collision with the fence, and from both tanks during the subsequent sequence of impacts. The fuel delivery pipe on the outlet side of the fuel boost pump, mounted on the forward face of the firewall, was torn from the pump casing during the impacts with the hedge and fence, creating a further potential source of released fuel, albeit of small volume.

The ignition source for the post impact fire could not be positively identified; however, a number of electrical cables were damaged in proximity to the disrupted boost pump pipework. This damage almost certainly was produced concurrently with the latter, providing a potential source of ignition at about the time the aircraft was coming to rest. Whilst it was not possible to exclude totally the possibility that fuel released during the initial impact with the wooden fence ignited immediately, the evidence points more strongly to ignition at a later stage in the impact sequence, or after the aircraft had actually come to rest. The isolated pockets of burning on the ground just forward the wooden fence were most likely caused by the secondary ignition of vapours by the fire at the main wreckage.

Wreckage examination in situ

The examination of the aircraft in situ was necessarily limited. 'As found', the engine and propeller controls were all in the fully forward position. Whilst the possibility of a disturbance of these controls during the impact sequence could not be ruled out entirely, the configuration and routeing of the control runs was such as to make any disturbance tending to cause movement forwards unlikely. The facing of the magneto switch and the plastic parts of the associated ignition key were destroyed by the fire, but the surviving steel part of the key was still inserted in the switch. The orientation of the key was consistent with it having been switched to the LEFT magneto position before the post impact fire had become established; however, there was no way of establishing when it had been moved into this position.

Light circumferential scoring was evident on the forward face of one propeller blade, which was bent rearward through approximately 30° at the mid span position, consistent with this blade striking one of the concrete fence posts whilst still rotating. This blade also exhibited a series of nicks in the leading edge, characteristic of low energy interactions with a steel wire fence. The opposing blade exhibited no significant scoring or leading edge damage. Overall, the character of the damage sustained by the propeller blades was consistent with it being driven under low power at the time of impact.

The remains of the flap actuating mechanism were consistent with a takeoff setting of around 10º, at impact. The elevator trim tab was set to an approximately neutral position.

Detailed examination of wreckage

The wreckage was recovered to the Air Accidents Investigation Branch facility at Farnborough, where it was examined in detail.

The elevator and rudder control systems survived the fire undamaged, but the aileron control circuits in the wings were extensively burned. No evidence of any pre impact abnormality was found in the surviving parts of the flying control system. It was confirmed that the magneto switch 'as found' was selected to the LEFT magneto position.

The fuel system pipework in the vicinity of the fuel tanks was destroyed by fire. In addition, the fuel selector valve located in the wing centre-section, together with fuel pipework forward of the engine bulkhead, was extensively damaged by the post impact fire. Consequently, the pre-impact integrity of the fuel system per se could not be determined. Progressive disassembly of the fuel valve showed that it was selected to the left tank at the time of the crash.

A detailed external inspection of the engine and associated ancillary components did not reveal any evidence of pre-impact abnormality. The carburettor 'hot air' flap was in the cold air (normal) position at impact, and its rubber hinge seal, which is the subject of a Service

Bulletin inspection (SB 10 -086) following instances of its detachment and obstruction of the air inlet path, was securely attached and in good condition.

The engine and propeller were taken to an approved overhaul facility where they were subject to bulk disassembly under the direction of the AAIB, sufficient to provide access to all relevant components. Key components were fully disassembled and/or subject to functional testing. With the exception of damage directly attributable to the forces of impact and/or to the post impact fire, no evidence of abnormality was found relating to the core engine. In particular: the crankshaft rotated freely; all rockers and valves operated correctly; the pistons and cylinders were all in good condition, with no visible signs of valve seat damage, excessive coking, or any other indications of abnormality; the camshaft was in good condition; the ancillary drive train was in good condition, and the drive to the engine driven fuel pump was intact. The engine driven fuel pump itself was checked and found to pump effectively.

The carburettor was examined in detail. The throttle-stop housing had fractured as a result of the throttle spindle being driven back against the stop during the impact, and the resulting over travel had caused buckling of the throttle butterfly plate. The mixture control lever had also fractured in the impact. The float level was tested and found to be within the normal range, with no evidence of leakage at the float valve. The carburettor was fully disassembled and found to be in good condition, with no evidence of corrosion, debris, deterioration or damage to the float, seals, or any other component part. All of the jets were clear.

After external cleaning, the propeller governor was installed on a test rig in its 'as found' state and function-tested against the appropriate test schedule. The maximum speed setting was found to be slightly higher, and the relief valve setting slightly lower, than the specified values but the unit operated satisfactorily and its performance was judged to be acceptable for an in-service unit.

The dual magneto and ignition harnesses were inspected and rig tested. Prior to removal from the engine, whilst the drive to the magneto was still intact, its timing was checked and found to be set correctly. Because of fire damage, the pre-accident serviceability of the high-tension harnesses could not be confirmed. Testing of the capacitors revealed that the capacitor for the left side of the magneto was open circuit, but it was considered unlikely that this would have materially affected the ability of the left side of the magneto to deliver an effective spark; rather, its likely effect would have been to increase the probability of radio interference. A visual inspection of the magneto did not reveal any overt signs of abnormality and, after substitution of a serviceable cap and HT harness for the accident damaged items, the unit was installed on a test rig where it performed faultlessly.

A full strip examination of the propeller established that the pitch-change peg on the bent blade (the blade that also exhibited wire damage on its leading edge and circumferential scoring on the forward face) had fractured as a result of gross overload during the impact, allowing this blade to over-travel into a flat pitch position. The propeller appeared to have been in a fully serviceable condition prior to impact.

In summary, detailed examination of the aircraft wreckage failed to identify any significant pre-accident defect or abnormality. No explanation could be found for the apparently low-power output of the engine at the time of the crash. The atmospheric conditions were conducive to carburettor icing, but evidence of such a condition would not have survived after the crash and consequently no definitive conclusion could be reached as to its possible relevance to this accident.

Survival aspects

Except for the impact with the tree and associated deformation of the right side of the cabin adjacent to the front seat passenger's lower legs, the impact forces were relatively light and the accident would almost certainly have been survivable had the aircraft not caught fire. The post impact fire, however, necessitated a rapid escape from the aircraft.

The aircraft had a door on each side but because it was lying on its right side one of these was not available. The other door was not opened, but it was evidently possible to escape through the broken left side window and/or the windscreen. Bystanders, at some risk to themselves, were able to assist two persons away from the area of the wreckage before the arrival of the emergency services. However, the fire was too severe for them to be able to help the third person, whose legs were almost certainly trapped to some extent by the deformation of the cabin in that area, and whose seat belt was found subsequently to be still fastened. The AFS arrived at the scene rapidly, having been initially alerted by the radio call made by the pilot saying that he was returning to the airfield, but were too late to assist in the escape.

Witness information

There were a large number of witnesses on the ground in the vicinity of the accident and there were also several persons who witnessed the entire flight. The descriptions were generally in agreement and allowed an estimate of the flight track to be constructed. A nose high attitude and slow speed were observed after takeoff, followed by a continuous descending turn which took the aircraft just outside the airfield boundary. There was, however, only limited information as to the sound of the aircraft during its flight but generally people commented that there was little obvious engine noise. Some of the persons who assisted at the accident site spoke with the pilot at the time. They recalled that he had told them that the aircraft had lost power and he was trying to return to the airport.

Pilot's recollection

The pilot, who was seriously injured, was interviewed three months later. He was able to remember many of the events leading up to the accident but some of his recollections did not concur with other factual evidence, probably as the result of the passage of time and the considerable trauma that he had suffered.

The pilot recalled that prior to departure he had taxied to the holding point where he had completed his pre-takeoff checks according to the checklist. He was then, without any significant delay, cleared for departure.[2] As was his normal practice he ran the engine up to full power on the runway before releasing the brakes. The takeoff appeared normal but, shortly afterwards, he noticed the airspeed was not increasing. This was the first indication to him that there was a problem with the aircraft, he thought that at this time he had attained a height of around 500 ft. He lowered the nose to maintain speed and at the same time made a call to ATC saying that he wasn't gaining airspeed. He turned the aircraft to the left, towards an area to the south where he thought he could land. He stated afterwards that he saw people in the area of the airfield boundary fence at the far end of the runway and he did not want to risk running into them if he landed ahead. He

Footnote

[2] Seven months after the accident the pilot advised that, during his power checks, he always selected left then right fuel selector, then returned to left for take off, all of which he would accomplish before reducing power again.

heard the stall warning sounding (this operates 5 to 10 kt above the stall speed) and was conscious that he needed to maintain speed above the stall.

The pilot described feeling a gentle touchdown before the aircraft tipped over at a fairly slow speed and caught fire. Although he remembered he had unlatched the door prior to landing he was unable to open it, but managed to escape through the front windscreen. Once out of the aircraft, bystanders were able to assist him to a safe area.

Analysis

The pilot flew regularly and was familiar with the aircraft. Shortly after takeoff he recognised that there was a problem and, as evidenced by his radio call, immediately decided to return to the airfield. At this stage he must have considered that there was enough performance available to enable a safe turn and approach to land. At some point thereafter he could no longer maintain height and was forced to descend and, although he may have thought he would just reach the airfield, the aircraft came down short.

The POH does provide a procedure for an attempt to restart the engine but not one for a partial loss of power. In either case any actions that can be completed will necessarily be limited by the time available, the first priority always being to maintain control of the aircraft. It is not known what actions the pilot was able to carry out but the evidence shows that the aircraft was in controlled flight until the point of impact and, but for the obstacles in its path, should have been able to make a successful forced landing.

At the position where the pilot recognised a problem, there were both runway and clearway ahead of the aircraft and open fields beyond the airfield boundary ahead and to the south. The general advice given for an engine failure after takeoff is never to attempt a turnback. Thus it is worth examining some factors which may have influenced the pilot in his decision to attempt to turn back to the airfield.

The pilot recognised a loss of airspeed after takeoff but did not appear to associate it immediately with a loss of engine power. Some of the symptoms of a power loss could have been disguised by the effect of the propeller constant speed unit, as this would attempt to maintain propeller speed, thus eliminating the characteristic sound of a reduction of engine/propeller speed associated with an engine power loss which occurs with a fixed pitch propeller. Other engine instruments might have given an indication but they would be unlikely to have been seen by the pilot during takeoff. Thus, the loss of aircraft performance was the main indication of the problem. This potential for a constant speed propeller to disguise a reduction or complete loss of engine power may not be widely recognised by all pilots. It should however be covered in any course of formal 'Differences Training'.

A decision to attempt a forced landing ahead, with the possibility of damaging the aircraft, may be more difficult where there is only a perceived partial loss of performance, rather than a catastrophic failure, and the aircraft remains under control. Although the principle of not turning back is well established in training, it is possible that some pilots are not sufficiently aware that a loss of power/performance can be insidious in nature and not always as easy to detect as the type of engine failure after takeoff generally practised at training organisations.

In the absence of a clear appreciation of a power loss, the pilot may initially have thought he could complete a turnback to the airfield or even a circuit. On the inbound flight from Guernsey, just after landing, the pilot witnessed another aircraft with an engine problem make a successful return to land on the reciprocal runway.

Although he did not afterwards recollect the details of this event it remains a possibility that at the time it influenced his decision.

After takeoff, with the aircraft in a relatively nose high attitude and at a slow speed, the view ahead and to the right would have been restricted, whereas the pilot's view to his left side would have been good. It would be reasonable for there to have been a natural tendency for the pilot to turn towards an area that could be clearly seen and, in this case, initiate a left turn.

Conclusion

The aircraft crashed just short of the airfield boundary fence while turning back towards the airfield following a loss of power. The reason for the loss of power could not be established from the available evidence but, whilst some failures could be ruled out, it was not possible to eliminate carburettor icing, a fuel supply or an ignition problem.

ACCIDENT

Aircraft Type and Registration:	Robinson R44 Raven II, G-SPAL
No & Type of Engines:	1 Lycoming IO-540-AE1A5 piston engine
Category:	2.3
Year of Manufacture:	2004
Date & Time:	19 September 2004 at 2057 hrs
Location:	Kentallen near Oban, Scotland
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Serious) Passengers - 1 (Fatal)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence with Night Rating
Commander's Age:	53 years
Commander's Flying Experience:	492 hours (of which 401were on type) Last 90 days - 25 hours Last 28 days - 18 hours
Information Source:	AAIB Field Investigation

All times in this report are local times (UTC + 1 hour)

Synopsis

The pilot was returning from Perth (Scone) Airfield to a private landing site at night with one passenger on board. As he was about to begin manoeuvring in the vicinity of the landing area, the passenger slumped across the flight controls and shortly afterwards, the helicopter impacted the side of a hill in level flight at slow speed. The pilot was able to free himself from the wreckage but the unconscious passenger was fatally injured in the subsequent fire.

History of the flight

Three days before the accident, the pilot flew the helicopter to a private landing site at Ardsheal near Kentallen. The site belonged to friends of the pilot and he spent the following days flying them on several local flights. On the day of the accident he flew the helicopter to the Island of Mull before returning to Ardsheal at about 1500 hrs having refuelled the machine at Oban (North Connel) Airfield. Whilst at Oban he had sought advice on a low cloud-ceiling route to Perth (Scone) Aerodrome and en-route alternates. The weather in the local area had been much the same all day and after checking the weather forecast on a home computer at Ardsheal, he decided to fly again. At about 1600 hrs he departed the Ardsheal site for Perth Aerodrome with two passengers. Due to a forecast of inclement weather, an indirect route was flown via Loch Lomond, avoiding the more mountainous terrain. This flight was uneventful and after the aircraft had landed at about 1720 hrs, one of the passengers left the aircraft at Perth. The pilot's intention was then to return to Ardsheal with the other passenger. Whilst at Perth, the aircraft was refuelled to full tanks and a weather update obtained from the radio operator at Oban Aerodrome. The pilot was advised that the visibility had improved since the time he had passed Oban on the outbound flight. On preparing to leave Perth, the helicopter's engine failed to start; the problem was traced to a loose wire on the engine inhibitor circuit. This was rectified by a suitably qualified engineer and the pilot and his passenger boarded the aircraft as the sun set at about 1915 hrs. The helicopter departed Perth shortly afterwards for the flight to Ardsheal which the pilot expected to last for about one and a half hours.

The pilot's intention was to reverse the route he had flown earlier, knowing that the final part of the route and landing would have to be completed after nightfall. Night officially began at 1958 hrs at Ardsheal and the moon set at 2041 hrs. Having left Perth, the pilot made no further radio transmissions but monitored the Glasgow Radar frequency whilst transiting to the north of Glasgow Airport. At this stage the aircraft was cruising at around 1,500 ft amsl with its groundspeed reduced to approximately 70 kt by a strong south-westerly wind. The pilot considered the flight conditions "challenging" but he felt "comfortable" and "in control". He stated that the flight was uneventful until passing Lochgilphead (approximately 295°/35 nm from Glasgow Airport) when the passenger, who was seated in the front left hand seat, moved towards him and initially did not respond when asked to move away. When physically shaken by the pilot, the passenger replied to his request and moved back into his seat but during that period some control of the aircraft was momentarily lost. During this brief period the pilot became disorientated and the aircraft gained height rapidly before full control was regained. With the aircraft back under control, the pilot told the passenger that if he was sleepy, it was in order for him to sleep throughout the remainder of the flight.

After commencing the final leg of the return route on a northeasterly heading, following the coastline by observing the surf, the pilot descended from about 1,000 ft to 500 ft agl or lower to obtain the best visual cues. By that time it was dark but the pilot stated that he had other visual cues such as silhouettes of higher ground. He reported "navigating 90% visually, just using the GPS as a back up".

He had flown in this area in poor weather before but never at night. Passing Oban Aerodrome the pilot still felt content to continue the flight but he was agitated by the incident with his passenger. A strong tailwind component gave the aircraft a groundspeed of 147 kt, so the pilot prepared his arrival strategy for the landing site on that basis. The pilot provided a sketch map of his intended track and this is shown at Figure 1.

According to the pilot, not having landed at Ardsheal by night, he planned to follow the coast until he estimated he was abeam the landing site on his north-easterly track. He then planned to turn northwards, out into Loch Linnhe, towards the lights of the Corran Ferry. He would then continue this downwind leg on a northerly heading until the lights of Kentallen appeared from behind Ardsheal Hill on his right hand side which would be his cue to turn right, back into wind on a reciprocal heading towards the landing site. He intended to cross the shoreline just to

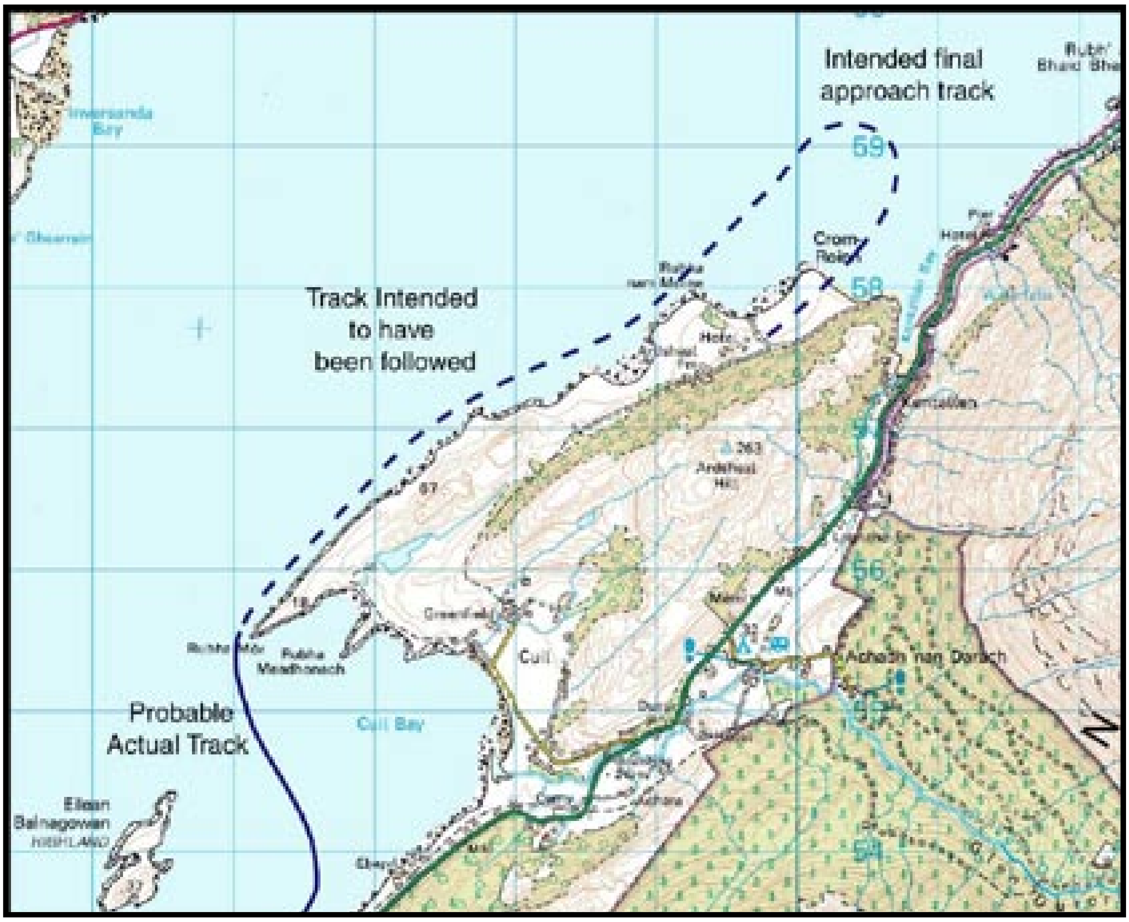


Figure 1

Pilot's intended approach path to landing site

the north of Ardsheal House and then descend towards the landing site, switching on the helicopter's landing and emergency lights at a height of about 100 ft or less. These manoeuvres were intended to allow an into-wind approach and to produce a long, slow, stable approach to the landing site. He was particularly concerned by the proximity of high ground to the north-east of Ardsheal Hill which extends towards the mouth of Kentallen Bay. Ardsheal hill rises to 864 ft amsl and is one kilometre to the south of the site (see Figure 1). He was aware that if he could not see the landing site having turned into wind, he had the option of switching on the landing light and/or the emergency night lights to assist him once he had crossed the shoreline. However, his main concern was avoiding the high ground of Ardsheal Hill.

The pilot followed the coast to within about two miles of the landing site when the passenger, who was wearing a lap and diagonal seat harness, "flopped" onto the pilot and had to be physically moved off the flying controls and back into his seat. This time the passenger showed no sign of response and the pilot temporarily lost control. He became disorientated for a period and the aircraft again climbed rapidly; this time it entered cloud momentarily but full control was regained. Once back beneath the cloud, the pilot re-orientated himself using visual cues and the GPS but he had lost sight of the coastal track that he intended to follow. He recalled that this time there was no response from his passenger and he then became "very stressed". There was no response from the passenger for the remainder of the flight.

The pilot reported that almost immediately afterwards, as he started to execute his turn northwards towards the lights of the Corran Ferry and Ardgour Peninsula, his passenger "flopped onto" him for a "second time" (it was the passenger's third reported involuntary movement across the cabin but only the second time he had obstructed the controls). The passenger had to be physically pushed back into his seat as he appeared unconscious and control of the aircraft was lost. The pilot stated that having placed the passenger back into his seat, clear of the controls and against the passenger's door, as he brought his head up to regain control of the aircraft there was a loud bang and the helicopter hit the ground.

When the aircraft came to rest, the pilot, despite multiple injuries, was able to free himself from the wreckage and he attempted, without success, to rescue his unconscious passenger. An explosion followed by intense heat and flames forced the pilot to leave the area and he slid down a steep slope to the top of a waterfall. He remained there until rescued by the local emergency services and was subsequently flown by helicopter to hospital.

Witness Information

Several people witnessed segments of the last part of this flight. Most reported the weather conditions as bad with heavy rain and strong winds. One described the weather as "atrocious" and said that it had been like that for most of the day. Some witnesses were attracted to the presence of the helicopter by its distinctive noise although others who saw its lights said they could not hear it; some of the latter attributed this experience to the overpowering sound of the wind. One witness who reported seeing the helicopter's lights stated that it was so dark outside that the outline of Ardsheal Hill could not be seen from the witness's house which was approximately 400 m east of the accident site.

The passenger's wife observed what she believed to be the helicopter, flying between the landing site and Ardsheal Hill (see Figure 2), heading north-east. She had earlier switched on some of the house lights to assist the pilot with locating the landing area, approximately 400 m away. She thought it "seemed to be quite high" and that it was "a bit unusual that the helicopter seemed to be towards Kentallen Bay". Another witness on the eastern side of Kentallen Bay observed the helicopter's lights. The helicopter was flying down the Bay, on a steady heading at low height and with a groundspeed of between 20 and 25 mph. Further witnesses reported seeing the helicopter flying at a height similar to Ardsheal Hill in a south-westerly direction along Kentallen Bay. These witnesses, also situated on the eastern side of the Bay, stated that the helicopter "was coming up towards Ardsheal, it would have been from the Onich/Ballachulish direction" meaning from the north-east. The only lights seen on the helicopter were two red/purple lights, possibly flashing. The helicopter was then seen to continue down the Bay before turning slowly to the right and impact the hillside. One witness saw it, when directly opposite him, drop about 30 ft followed immediately by flames appearing from the same location. Another witness said the helicopter "travelled diagonally across the Bay in front of our living room window. I then saw it drift into Ardsheal Hill. I did not think it fell from the sky". She saw flames appear "within 5 to 10 minutes of hitting the hill".

One of the pilot's rescuers stated that whilst he was assisting the injured pilot on the hillside before the fire service and mountain rescue teams arrived, the pilot said that "the crash had been caused by a gust of wind which made the helicopter uncontrollable" and that "they were trying to land anywhere at Ardsheal." A different witness, also present during the early stages of the rescue, stated that he told the pilot he had done well to land the helicopter, to which the pilot replied that he "didn't land it,

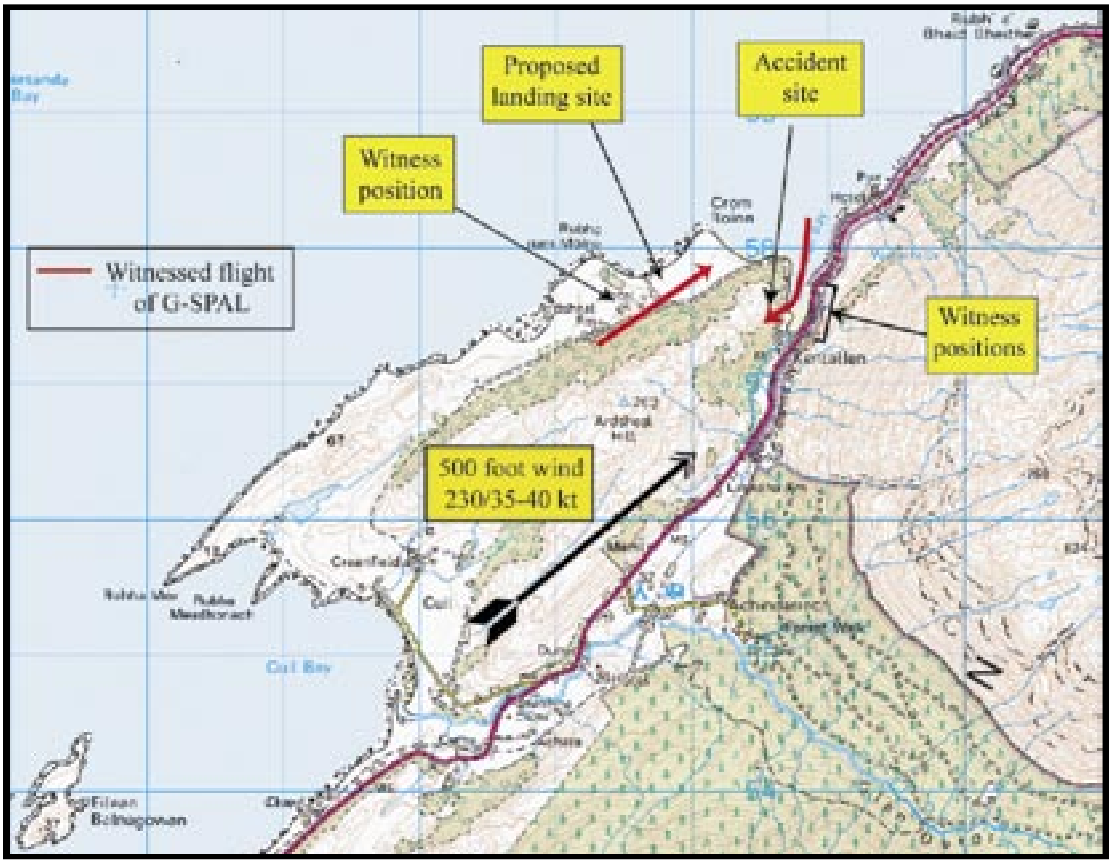


Figure 2

Witnessed flight path and position of accident site

it grabbed me or we just fell". A few hours later the pilot explained to another witness that his passenger "had twice slumped over from his seat towards him", that "there had been some interference with the controls" and that when the passenger slumped a second time, "he was unable to recover the helicopter".

Radar information

Area radar data captured by the Lowther Hill and Tiree antennae were obtained. The helicopter was not equipped with transponder mode C and so no encoded altitude information was available. Radar coverage along the pilot's return route was poor except along the west coast of the mainland where the track between Lochgilphead and Port Appin was consistent with the pilot's recollection of his general routing. The irregular flight path was suggestive of flight through the Crinan Canal valley and then following the coast over the water with occasional overflights of coastal features. The recorded data terminated some 7 miles short of the destination, probably because of terrain obscuration.

Accident site

The accident occurred on the eastern side of Ardsheal hill, at a point aligned with the southern end of Kentallen Bay. The initial rotor contact point was on a tree located some 300 ft above sea level. At the same time as the tree strike, one rotor tip had also struck the side of the hill. Shortly after this, the front of the helicopter's right skid struck the hillside. This would have caused a downward pitching moment and the lower right side of the helicopter stuck the rocky hillside, with damage to the perspex canopy. This brought G-SPAL to a halt on the edge of a steep slope, the helicopter then slid down this slope, rolling onto its left side and uprooting small trees in the process; additionally the tail boom, from aft of the cabin bulkhead, detached during this sequence. The main body of the helicopter finally came to rest on its left side, supported by an uprooted tree, on a heading of 163ºM. During the slide, the left main fuel tank had ruptured and a severe localised post-crash fire ensued that engulfed the majority of the helicopter's main airframe, with only the detached tail escaping the flames.

The compact site and the small wreckage spread indicated that the ground speed of the helicopter was low; it was estimated to be between 10 and 20 kt. The tree strike, ground marks and damage were also consistent with either low or no vertical speed, with a level pitch attitude, but with about 15° of right bank on the rotor disc. Measurements taken from the front right skid, after it was inserted into the hole left by the skid when it struck the hill, indicated that the helicopter was on a heading of around 230ºM.

Only one rotor blade had extensive damage, with a large piece of this blade being found some distance away, behind the wreckage and down the hill. This piece had separated during the initial rotor strike as the blade tip dug into the hillside. It had been thrown backwards and during its ballistic trajectory, struck a tree. Damage to the tree indicated that the rotor was under high power and had contained a lot of energy at the time of the initial rotor strike. The other main rotor blade had been damaged by the fire but still showed bending consistent with a rapid stop of the rotor disc.

Detailed aircraft examination

The aircraft was recovered from the hillside and taken to the AAIB facility at Farnborough for a detailed examination. The helicopter had been equipped with three GPS units, two Skyforce 3 and one Garmin 250XL, unfortunately all three units were extensively damaged during the accident and the post crash fire, which precluded any data retrieval. The main fuel gauge showed its contents at ¼ full. However, the calculated fuel load on the helicopter at the time of the accident suggests that the auxiliary tank should have been empty and the main fuel tank should have contained about 19 US gal (slightly more than half full) which would have been sufficient for at least another hour's flight. The remaining instruments did not show any meaningful information, although the altimeter barometric setting was set to 997 mb.

The post-crash fire had destroyed the majority of the airframe and had melted many of the aluminium push rods used to control the helicopter. However, of the flying control items remaining, it was possible to establish that these were correctly connected. Both main rotor pitch control links had fractured in overload, most probably as a result of the rotor blade's contact with the hill side. G-SPAL was equipped with dual controls, but these had been disconnected and although carried, they were not fitted during the accident flight.

The rotor blade damage previously described indicated that the helicopter was under power at the time of the crash and further examination of the remains of the engine did not reveal any pre-existing problems.

G-SPAL had been equipped with an emergency night light kit; this consisted of two high power lights fitted to the rear of the skids. The right night light had smashed during the crash, but the left light remained intact.

The pilot and passenger harnesses on the aircraft were of the lap strap and diagonal type. Due to the extensive fire it was not possible to ascertain if the passenger's harness was securely fastened during the accident. Tests were carried out in another Robinson R44 to establish the amount of 'play' in the diagonal seat belt strap. It was ascertained that a person of similar size to the passenger could fall across the right hand seat, thereby obstructing the cyclic and collective flying controls, whilst remaining strapped into the left hand seat.

Weather

On the day of the accident there was a deep area of low pressure centred near the Faeroe Islands with a cold front passing through western Scotland during the evening. At 1555 hrs Glasgow Airport promulgated a Terminal Aerodrome Forecast (TAF) to cover the period between 1700 hrs and 0200 hrs the following morning. It stated that the wind was expected to be 220º /18 kt gusting to 32 kt with 7,000 m visibility in rain and a main cloudbase of 2,400 ft amsl. The TAF also mentioned that there was a 40% probability that between 1700 hrs and 2300 hrs, the visibility would reduce to 3,000 m in heavy rain and the cloudbase would lower to 1,200 ft amsl. At 2050 hrs, seven minutes before the accident, Glasgow Airport, the nearest active airport, issued a weather observation of visibility 5,000 m in rain, scattered cloud at 1,100 ft and broken cloud at 1,800 ft. The QNH was 998 mb.

An aftercast provided by the Meteorological Office stated that the accident area would have been subjected to a fresh to strong west-south-westerly airflow with low cloud and often heavy rain. The aftercast also indicated that the wind at 500 ft agl was from 230º at 35 to 40 kt; there was a visibility of 5,000 m. The cloud structure was: scattered or broken stratus with base between 1,000 and 1,500 ft amsl plus broken or overcast stratus, base 2,000 ft. Above these layers there was multi-layered stratoform cloud up to 10,000 ft and layers of alto-cumulus rising to 27,000 ft.

Landing Site

The private landing site where the pilot intended to land was one of several large fields about 400 m from Ardsheal House, the nearest building. The fields resemble parkland with isolated trees within them and the site is almost at sea level. No specific lighting was available at the landing site and the absence of nearby buildings or lit roads meant there was no local ambient light. The pilot had operated from this site on numerous occasions, including in poor weather conditions but never previously by night.

Pathology

A post-mortem examination of the passenger concluded that he suffered debilitating injuries such as rib and sternum fractures, abdominal injuries and a superficial head wound which may or may not have rendered him unconscious. However, the helicopter came to rest on its side and his position within it, coupled with his injuries, would have made it difficult for him to vacate the aircraft even if he had been conscious. He died from the effects of the post crash fire.

The post mortem examination of the passenger also '*revealed narrowing of his left anterior descending coronary artery of sufficient degree to account for any collapse which he may have suffered during the flight*'. The examination was *'unable to provide evidence to confirm that he had indeed collapsed or to determine his level of consciousness prior to the accident'*.

Toxicological tests established that there was no evidence of alcohol, drugs or substance of abuse within the passenger's body.

Aircraft equipment

The aircraft was fitted with an emergency night light kit as previously described. The primary aim of the emergency night lights is to identify hazards such as trees and people during the landing phase; they are not designed as an aid to acquiring the landing area. A familiarisation flight was conducted in a similar aircraft fitted with these lights to assess their effectiveness. With both landing lights and emergency lights switched on, ground features showed usable definition at heights up to 300 ft. When flying in precipitation, it is understood from the Chief Pilot of a UK Robinson Helicopter distributor, that their effectiveness is reduced, sometimes considerably, due to light being reflected and scattered by the visible moisture droplets.

Night flying regulations and licence privileges

Rule 22 of the current '*Rules of the Air Regulations 1996*' states that an aircraft flown in the UK at night '*outside a control zone shall be flown in accordance with the Instrument Flight Rules*' (IFR). Rule 29 of the Instrument Flight Rules which specifies minimum heights states that '*an aircraft shall not fly at a height of less than 1000 feet above the highest obstacle within a distance of 5 nautical miles of the aircraft.*' (This altitude is commonly known as Minimum Safe Altitude and abbreviated to MSA). If flying at or above MSA is impractical, an alternative means of complying with the IFR outside controlled airspace is afforded to aircraft under Rule 29(d). This clause permits an aircraft to fly IFR provided that *'the aircraft is flying at an altitude not exceeding 3000 feet above mean sea level and remains clear of cloud and in sight of the surface'*.

Joint Aviation Regulation–Flight Crew Licensing (JAR-FCL) paragraph 2.026 requires a pilot without a valid instrument rating to fly three circuits at night during the 90 days prior to flying a passenger at night. According to the pilot's logbook, he last flew at night on 1 November 2003 which was 323 days before the accident flight.

Helicopter manufacturer's information

The limitations section of the Pilot's Operating Handbook for the Robinson R44 Raven II states the following:

> *'Orientation during night flight must be maintained by visual reference to ground objects illuminated solely by lights on the ground or adequate celestial illumination'.*

On 7 July 2004, the aircraft manufacturer re-issued a safety alert entitled *'Always Avoid Flying After Dark* to all registered owners, operators and distributors of their aircraft. This safety alert emphasised the difficulties of flying cross-country flights in poor weather after dark. It referred to three R44 accidents in the USA during the previous two years involving seven fatalities and commented that these flights were undertaken over unfamiliar rural terrain with few visible ground lights and very little, if any, celestial illumination. Enclosed with the safety alert was the following safety notice:

> *NIGHT FLIGHT PLUS BAD WEATHER CAN BE DEADLY*
>
> *Many fatal accidents have occurred at night when the pilot attempted to fly in marginal weather after dark. The fatal accident rate during night flight is many times higher than during daylight hours.*
>
> *When it is dark, the pilot cannot see wires or the bottom of clouds, nor low hanging scud or fog. Even when he does see it, he is unable to judge its altitude because there is no horizon for reference. He doesn't realise it is there until he has actually flown into it and suddenly loses his outside visual references and his ability to control the attitude of the helicopter. As helicopters are not inherently stable and have high roll rates, the aircraft will quickly go out of control, resulting in a high velocity crash which is usually fatal.*
>
> *Be sure you never fly at night unless you have clear weather with unlimited or very high ceilings and plenty of celestial or ground lights for reference.*

Light helicopter accidents

Analysis of accidents occurring in light helicopters registered in the United Kingdom shows that a significant number of serious accidents result from pilot disorientation in conditions of low cloud and poor visibility, with 18 out of 44 fatalities (40.9%) in the period 1997 to 2003 being attributed to this cause.

Analysis

On departing Perth the aircraft appeared to have been fully serviceable and the engineering investigation was able to confirm the pilot's report that the accident was unlikely to have been caused by mechanical failure. The pilot reported that the accident occurred due to loss of control as a direct result of the passenger's unwitting interference with the flying controls followed by his loss of concentration and heightened levels of stress and fear as he attempted to reposition his passenger.

Although the pilot's original intention was to fly the return route by daylight, the engine starting problem at Perth, which incurred a delay in departure of at least an hour, meant that he departed Perth knowing that the majority of the route to Ardsheal would have to be flown at night. Since flight at night outside controlled airspace must be conducted IFR, the pilot had to observe the provisions of Rule 29 but because there was an overcast layer of cloud below MSA, flying in accordance with the basic Rule 29 at 1,000 feet above obstacles was impracticable. Consequently, he had to rely on the provisions of Rule 29(d) which are, in practice, similar to those for day VFR flight outside controlled airspace (Rule 26(b)). In practical terms the main difference at night is the reduction in available visual cues. Consequently, pre-requisites for safe, visual, transit flight in darkness are reasonably good weather, suitable topographical charts, pre-flight planning, natural or cultural light and accurate navigation.

Despite the improved visibility at Oban relative to the outbound flight, the forecast general weather, particularly the strong gusty winds, the 40% probability of 3,000 m visibility in heavy rain and a 1,200 ft cloud base, would have suggested that conditions along the West Coast could be problematic. Indeed, after the accident, the pilot reported that he had found them "*challenging*", especially on the final north-easterly leg after he had passed Lochgilphead. Nevertheless, until his passenger's involuntary movement across the cabin and the subsequent disruption to the pilot's intended track, he was feeling comfortable, relaxed and fully capable of operating safely in the prevailing conditions. At that point, some 2 nm from the landing site, his situation deteriorated due to the collapse of his passenger leading to temporary control problems.

It was also dark. The coastal area north of Lochgilphead has minimal cultural lighting and numerous obstructions above 500 ft amsl, the upper limit of the pilot's en-route altitude. Moreover, the sun had set about 1 hr 45 mins before the accident, the moon had set about 15 mins before the accident and evening nautical twilight, the time after which the horizon becomes indistinguishable at sea, began at 20:53 hrs, four minutes before the accident. The extensive layers of rain cloud in the Ardsheal area would have obscured any starlight so the visible external cues in the vicinity of Ardsheal would have been restricted to the sparse cultural lighting. Nevertheless, the required weather minima were maintained with the exception of a brief, unintentional entry into cloud. The validity of the pilot's Night Rating when flying with a passenger and his currency for night navigational and landing techniques, were doubtful because, before the day of the accident, the pilot had not flown at night for more than 10 months. However, he had been night flying during the 59 minutes preceding the accident.

The strong tailwind from 230º at the pilot's cruising height of 500 ft or thereabouts contributed to the abnormally fast 147 kt groundspeed (for a helicopter with a maximum permitted airspeed of 130 KIAS) during the leg towards Ardsheal on a track of about 050º. The meteorological aftercast indicated that the wind at 500 ft agl was from 230º at 35 to 40 kt which in turn suggests that the helicopter was cruising at an airspeed between 107 and 112 KIAS. This speed would be consistent with the advertised cruise speed of 'up to 113 kt'. This south-westerly wind component would have much reduced the helicopter's ground speed during its flight down Kentallen Bay on a heading (at impact) of 230º so, if the helicopter had maintained a constant cruising IAS, the groundspeed should have been in the order of 70 kt. However, the pilot stated that he was trying to regain control whilst repositioning the passenger so the airspeed under those circumstances was unlikely to be steady. Moreover, the helicopter's flight path was also unlikely to be steady.

Witnesses thought the machine was closing with Ardsheal Hill in level flight at a speed of about 20 kt. The accuracy of witness estimates of the height and speed of a black-liveried helicopter judged solely by the movement of its lights may be questionable but the narrow confines of Kentallen Bay limit the scope for misjudging the machine's distance from the witness. Therefore, estimates of its speed, height and height keeping by interpretation of its apparent angular movement within the Bay area were unlikely to be compromised by any inability to discern the helicopter's size or silhouette. Consequently, it is likely that the helicopter's airspeed had significantly reduced for some reason and none of the witnesses reported that it appeared to them to be out of control. Their general impression of a slow-speed, apparently controlled flight into the ground is supported by analysis of the accident site impact marks.

The pilot stated that his passenger's first obstruction of the controls occurred when the helicopter had about 2 nm to run to abeam the landing site and at this time he became disorientated when repositioning the passenger. Consequently, when the aircraft was observed flying between the landing site and Ardsheal Hill, it was either only under partial control or control had been regained temporarily between the passenger's two involuntary movements across the cabin. In either case the pilot had lost sight of the coastline and the helicopter was to the east of his desired track due to the temporary control difficulties and consequent loss of navigational accuracy. Therefore, unless the pilot turned left for a period before turning 180º to the right, as he had intended to do, the helicopter was bound to be further east than the pilot intended when he crossed the shoreline inbound to the landing area. Indeed, the displacement to the east was such that had he not allowed for it, a right turn into wind would have brought the helicopter into the vicinity of Kentallen Bay.

However, the pilot reported that he was starting a left turn towards the lights of the Corran Ferry when the passenger collapsed again and obstructed the flight controls a second time. This time control was not regained before the machine struck the hillside.

When the helicopter was seen by witnesses in Kentallen it was observed for some time in apparently level flight and proceeding slowly down the Bay before starting a gentle right turn and then hitting the ground. It may have been cruising much slower along this last leg because of the unintentional manoeuvres that disorientated the pilot. If the meteorological aftercast and the witness's estimates of the helicopter's speed are accurate, then it must have been flying at an airspeed of about 55 to 60 KIAS to make good a groundspeed of approximately 20 to 25 mph (about 20 kt). This airspeed would also be consistent with an interim approach speed and not so slow as to significantly compromise the helicopter's directional stability in forward flight.

The inherent instability of all types of light helicopter means that level flight cannot be sustained without frequent, corrective, cyclic control inputs, particularly in gusty wind conditions. The investigation considered the pilot's own conclusion that he was spatially disorientated and unaware that the aircraft was in relatively level flight during this period. He stated that he was still struggling to re-position the passenger a second time and to regain control when the helicopter hit the lower slopes of Ardsheal Hill. He also stated that "while contending with his passenger the Pilot felt that his control inputs were more instinctive than controlled, but his efforts on both occasions were clearly more effective than he might have dared to hope". The helicopter was observed flying at low speed up Kentallen Bay for a distance of at least 200 m to the accident site. If this distance was flown at a groundspeed consistent with the evidence, the machine was out of control for 20 seconds or more whilst it flew up the Bay. This is a long time for a helicopter to be out of control and yet appear to witnesses to be under control in reasonably level flight. However, since the pilot was still 'head down' at impact, he would not have seen the cultural lights in Kentallen.

Conclusion

The accident occurred before the pilot commenced his approach when, having encountered problematic lighting and forecast weather conditions, his task was complicated by the collapses of his passenger and the latter's obstruction of the flight controls. Although it is not possible to plan or legislate for passenger distraction or interference with the flying controls, the lack of ambient lighting, the poor weather and the pilot's lack of night flying recency would, in combination, have been likely to degrade his ability to cope simultaneously with an out of control situation and a navigational displacement. Flying at night in the prevailing conditions would have been demanding and would have left little spare mental capacity for dealing with an emergency.

Moreover, although the pilot had developed a strategy for his arrival at the landing site, it is not a recommended procedure to land at night without ground lighting or adequate celestial illumination; indeed it is contrary to instructions in the pilot's operating handbook. Not only does ground lighting provide a geographical reference, it also allows the pilot to monitor closing speed, provides a means of attitude reference, allows judgement of the angle of approach and early recognition of aircraft drift.

Related safety action

In view of the high accident rate involving light helicopters in poor weather conditions, the UK CAA is currently reviewing the minimum flight visibilities authorised for flight by visual reference in helicopters and gyroplanes.

Also, the pilot stated that had the helicopter passenger's seat been fitted with a four-point seat harness, it is likely that the enhanced restraint would have prevented an incapacitated passenger from obstructing the controls. A manufacturer's representative stated that four-point harnesses are a factory-fitted optional extra for the type.

SUMMARY of AIRCRAFT ACCIDENT REPORT No 2/2005

This report was published on 15 November 2005 and is available on the AAIB Website www.aaib.gov.uk

REPORT ON THE ACCIDENT TO PEGASUS QUIK, G-STYX at EASTCHURCH, ISLE OF SHEPPEY, KENT on 21 AUGUST 2004

Registered Owner and Operator:	Privately owned
Aircraft Type:	Pegasus Quik
Nationality:	British
Registration:	G-STYX
File Reference:	EW/C2004/08/03
Place of Accident:	Eastchurch, Isle of Sheppey, Kent
Date and Time:	21 August 2004 at 1341 hrs All times in this report are local (UTC +1)

Synopsis

The Pegasus Quik microlight, with an instructor and passenger on board, departed Rochester Airfield for a trial lesson. Thirty five minutes into the flight, as it was flying at 500 ft along the north coast of the Isle of Sheppey, it pitched up steeply to the near vertical and entered a series of tumbling manoeuvres. As the microlight tumbled the trike unit, containing the two occupants, separated from the wing and descended vertically to the ground. Neither the pilot nor his passenger survived the impact. The initiation of the pitching moment and subsequent entry into the tumbling sequence was brought about by the failure of the right upright upper fitting, which caused full nose-up trim to be suddenly applied.

Some time previously the microlight's uprights upper fittings had been modified to comply with Service Bulletin 116 requiring the fitting of additional rivets. The additional rivets were not only fitted incorrectly, and without reference to the Service Bulletin, but two of them did not match the specification of those rivets supplied by the manufacturer in the modification kit. Additionally, no duplicate independent inspection was carried out on the correct embodiment of the modification.

The investigation identified the following causal factors:

(i) Failure of the right upright upper fitting caused the microlight to enter a tumble manoeuvre from which it was not possible to recover.

(ii) Service Bulletin 116, which introduced additional rivets in the upper fitting, was not correctly embodied.

Findings

1 With the exception of the 'A' frame uprights the engine, trike and wing were serviceable prior to the aircraft entering the tumble.

2 Whilst flying at approximately 100 mph, the microlight entered a series of tumbling manoeuvres, which resulted in the failure of the monopole and front strut allowing the trike to separate from the wing.

3 The accident was not survivable.

4 Failure of the right upper fitting resulted in the tightening of the trim cable, which increased the wing reflex causing the microlight to exceed the pitch limit and enter the tumble.

5 The upper fitting failed because the additional rivets, introduced by Service Bulletin 116, were fitted in the wrong place.

6 An independent duplicate inspection was not carried out following the embodiment of Service Bulletin 116.

7 The BMAA inspector who undertook the modification on G-STYX did not refer to the Service Bulletin.

8 Where individuals referred to the Service Bulletin the modification was correctly embodied.

9 The aircraft did not appear to have been maintained in accordance with the manufacturer's recommend maintenance schedule.

10 There was no record that the 100 hour inspection, due at 300 hours, and wing overhaul had been carried out, thus the opportunity to discover the incorrect fitment of the Avdel rivets was missed.

11 The BMAA inspector who signed as having inspected the modification did not have the minimum engineering qualifications and experience specified by the BMAA.

12 The BMAA inspector did not understand how the upright was constructed, the different type of rivets available and the airworthiness issues resulting from incorrectly fitting fasteners in primary structure.

13 The BMAA Guidelines for the Inspection and Maintenance of Microlight Aircraft made no reference to the different types of rivets available and the locations where they should or should not be used.

14 The BMAA specify the minimum engineering qualifications and experience required of an inspector.

15 The BMAA's policy for the waiving of the minimum engineering qualifications and experience for inspectors is not objectively based.

16 Continuation training for BMAA inspectors is not compulsory and not a requirement for revalidation.

17 The records held by the BMAA on inspectors were incomplete.

18 The CAA audit of the BMAA did not identify all the shortcomings in the BMAA's inspectorate.

Safety Recommendations

Eleven safety recommendations have been made as a result of the investigation.

The following safety recommendations were made on 16 September 2004:

Safety Recommendation 2004-080: It is recommended that the British Microlight Aircraft Association, take the necessary immediate steps to ensure the continued safe operation of the Pegasus Quik microlight aircraft with regard to the application of Service Bulletin 116.

Response to recommendation:

Mandatory Permit Directive 2004-009 R2, requiring Service Bulletin 116 Issue 2 to be undertaken before the next flight, was issued by the CAA on 29 September 2004.

Safety Recommendation 2004-081: It is recommended that the British Microlight Aircraft Association consider reviewing its policy, procedures and standards with regard the implementation and inspection of 'field fitted' modifications and service bulletins.

Response to recommendation:

The BMAA advised the AAIB on the 21 October 2004 that they would consult widely and produce a Code of Practice, which would be published as a BMAA Technical Information Leaflet.

The following additional Safety Recommendations are made:

Safety Recommendation 2005-082: It is recommended that the Civil Aviation Authority review its policy on the use of crash helmets and shoulder harnesses on microlight aircraft.

Safety Recommendation 2005-083: It is recommended that the Civil Aviation Authority conduct a review of the British Microlight Aircraft Association (BMAA) policy on the selection, training and revalidation of inspectors with a view to establishing; the minimum engineering skills and knowledge; appeal procedures and the individuals within the BMAA who should authorise a reduction in the minimum engineering standards.

Safety Recommendation 2005-084: It is recommended that the Civil Aviation Authority review their audit procedures of the British Microlight Aircraft Association.

Safety Recommendation 2005-085: It is recommended that the Civil Aviation Authority ensure that Service Bulletins involving work conducted on primary aircraft structure include a statement that duplicate independent inspections are required, and that both inspections are to be recorded in the aircraft logbook.

Safety Recommendation 2005-086: It is recommended that the Civil Aviation Authority and Mainair Sports Limited take appropriate action to ensure that Pegasus Quik uprights that have been modified by owners are replaced with factory modified items.

Safety Recommendation 2005-087: It is recommended that the British Microlight Aircraft Association (BMAA) liaise with industry to ensure that advanced copies of Service Bulletins are passed to the BMAA so that comments can be made on their owner/members' and inspectors' ability to competently satisfy the instructions.

Safety Recommendation 2005-088: It is recommended that the British Microlight Aircraft Association (BMAA) ensure, through the issue of the Permit to Fly, that microlight aircraft are fitted with the correct placards and are maintained in accordance with either the manufacturer's or BMAA recommended maintenance schedule and that all maintenance is recorded in a Civil Aviation Authority approved log book.

Safety Recommendation 2005-089: It is recommended that the British Microlight Aircraft Association review and regularly update their document entitled '*Guidelines for the Inspection and Maintenance of Microlight Aircraft*'.

Safety Recommendation 2005-090: It is recommended that Mainair Sports Ltd takes action to ensure that the limitation placard on the Pegasus Quik is protected, or relocated, so that the data remains clearly visible to the pilot.

FORMAL AIRPORT ACCIDENT REPORTS ISSUED BY THE AIR ACCIDENTS INVESTIGATION BRANCH

2003

1/2003 Hughes 269C, G-ZAPS
at Hare Hatch, near Twyford,
Berkshire on 8 March 2000.

Published February 2003.

2/2003 Shorts SD3-60, G-BNMT
near Edinburgh Airport
on 27 February 2001.

Published April 2003.

3/2003 Boeing 747-2B5F, HL-7451
near Stansted Airport
on 22 December 1999.

Published July 2003.

4/2003 McDonnell-Douglas MD-80, EC-FXI
at Liverpool Airport
on 10 May 2001.

Published November 2003.

2004

1/2004 BAe 146, G-JEAK
during descent into Birmingham
Airport on 5 November 2000.

Published February 2004.

2/2004 Sikorsky S-61, G-BBHM
at Poole, Dorset
on 15 July 2002.

Published April 2004.

3/2004 AS332L Super Puma, G-BKZE
on-board the West Navion Drilling Ship,
80 nm to the west of the Shetland Isles
on 12 November 2001.

Published June 2004.

4/2004 Fokker F27 Mk 500 Friendship,
G-CEXF at Jersey Airport,
Channel Islands on 5 June 2001.

Published July 2004.

5/2004 Bombardier CL600-2B16 Series 604,
N90AG at Birmingham International
Airport on 4 january 2002.

Published August 2004.

2005

1/2005 Sikorsky S-76A+, G-BJVX
near the Leman 49/26 Foxtrot Platform
in the North Sea on 16 July 2002.

Published February 2005.

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

Published November 2005.

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http://www.aaib.gov.uk