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COMMERCIAL AIR TRANSPORT

GENERAL AVIATION

SPORT AVIATION / BALLOONS

CONTENTS (Continued)

ADDENDA and CORRECTIONS

(ALL TIMES IN THIS BULLETIN ARE UTC)

MESSAGE FROM THE CHIEF INSPECTOR OF AIR ACCIDENTS

Welcome to the new look Air Accidents Investigation Branch Bulletin.

To publish reports into air accidents and serious incidents is a fundamental duty of the AAIB enshrined in UK legislation. The manner and format of reporting however is left to the Chief Inspector to decide. I have realised, through consultation with many of our stakeholders, that the AAIB monthly Bulletin has long been over due a makeover to bring it up to date in both its look and feel. With this in mind you will see that the physical makeup of the Bulletin has changed making it more robust and easily identifiable with details now printed on the spine. The two column format with embedded graphics makes is easier to relate the relevant text with its associated diagram or photograph and the highlighting of Safety Recommendations allows the reader to identify those reports that contain a significant safety message.

As well as investigating accidents and incidents and making safety recommendations to prevent a recurrence the AAIB has a role to inform and educate. This can only be achieved if we continue to attract as wide a readership as possible. I hope that this new format will achieve this aim. I would welcome comments on the new format which should be directed to **enquiries@aaib.gov.uk**.

David King
Chief Inspector of Air Accidents

ACCIDENT

Aircraft Type and Registration:	i) Airbus A340-313, 6Y-JMP ii) Boeing 777-222, N781UA
No & Type of Engines:	i) 4 CFM56-5C turbofan engines ii) 2 Pratt & Whitney PW4000 turbofan engines
Category:	1.1
Year of Manufacture:	i) 1992 ii) 1996
Date & Time (UTC):	14 July 2004 at 1254 hrs
Location:	Runway 27L Holding Area, London Heathrow Airport
Type of Flight:	i) Commercial Air Transport (Passenger) ii) Commercial Air Transport (Passenger)
Persons on Board:	i) Crew - 4 Passengers - 273 ii) Crew - N/K Passengers - N/K
Injuries:	i) Crew - N/K Passengers - N/K ii) Crew - None Passengers - None
Nature of Damage:	i) Damage to left winglet ii) Damage to right wing tip
Commander's Licence:	i) N/K ii) Air Transport Pilot's Licence
Commander's Age:	i) N/K ii) 47 years
Commander's Flying Experience:	i) N/K ii) 20,000 hours (of which 806 were on type) Last 90 days - 230 hours Last 28 days - 60 hours
Information Source:	AAIB Field Investigation

Synopsis

The holding area for Runway 27L at London Heathrow Airport is wide enough for two 'heavy' aircraft to position side by side and aircraft entering this area essentially follow a single yellow taxiway centreline, which then splits into two parallel lines. Prior to departure, an Airbus A340 was stationary, well short of the N2W traffic bar behind an Airbus A320, which was stopped at the NB2W traffic bar, in the holding area awaiting its turn to line up. It was positioned on the southern most line, on the right of the holding area. Whilst in that position, a Boeing 777 was instructed to taxi forward and hold on the left of the holding area. As it passed behind the A340, the handling pilot made use of reference points within the cockpit to assure wingtip clearance from the A340's tail but, as he continued along the northern taxiway line, the right wingtip of the B777 made contact with the left winglet of the A340. At the point of contact, the B777 had not reached the section of the line parallel to that upon which the A340 was parked. Although the B777 flight crew thought that the A340 was closer than it might be at other airports, this was not considered unusual for Heathrow. Four recommendations are made addressing issues arising from the preservation of Cockpit Voice Recorder data.

History of the flight

In daylight with fine weather and good visibility, an Airbus A340 (A340) was cleared to taxi from Stand 314 at Terminal Three, via taxiway B and Link 29, to holding point LOKKI, in preparation for a departure from Runway 27L[1]. A Boeing 777 (B777) which had pushed back from Stand 321, which is also at Terminal Three, had been cleared by the Ground Movement Controller (GMC) to follow the A340, again for a departure from Runway 27L. See Figure 1.

While taxiing, the crews in both aircraft were instructed to monitor the Heathrow ATC 'Tower' frequency.

Having held at LOKKI, the A340 was instructed by the Air Departures Controller (ADC), on the Tower frequency, "TO LINE-UP AND WAIT RUNWAY 27L" after an Airbus A310 (A310), which was holding at N2E on the left side of the holding area, had departed. The A340 taxied forward and held on the right of the holding area behind an Airbus A320 (A320), which was stopped at the NB2W traffic bar. The A310 had been cleared to line up on the runway after the A320 had departed. The A340 stopped well short of the N2W traffic bar, astern of the A320. The B777 was then instructed to "TAXI FORWARD, HOLD ON THE LEFT". A Boeing 747 (B747), which was approaching along Taxiway U on the B777's left, was instructed to give way to the B777

[1] For the locations of the various taxiways and holding area and traffic bars at London Heathrow Airport (LHR) referred to in the following narrative, see Figures 1 and 2.

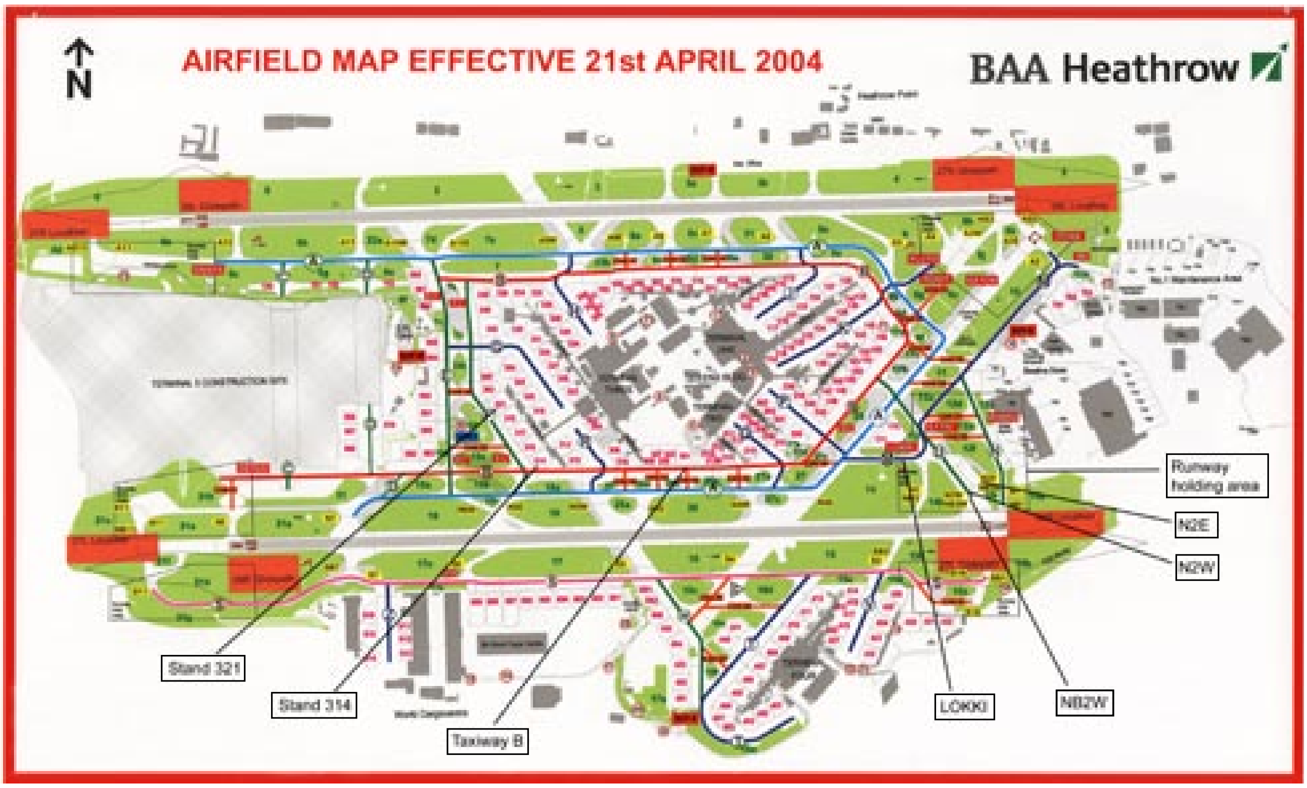

Figure 1

Taxi Chart

and also to hold on the left of the holding area. As the B777 taxied forward its crew were given their line-up clearance and were advised that they were number six in the departure sequence.

The B777 taxied behind the A340 towards the left side of the holding area. As it did so the commander, who was the handling pilot, made use of reference points on the flight deck of his aircraft, as advised in his company's operations manual, to ensure clearance between his right wing tip and the tail of the A340[2]. Although the crew thought that the A340 was closer than it might be at other airports, the co-pilot stated that this was not unusual for LHR, which has less space than other airports[3].

Having cleared the A340's tail, the B777 followed the taxiway centreline round to the right, leading to the left side of the holding area, so as to draw up on the left of the A340. During this turn the B777's right wing tip made contact with the A340's left winglet. The commander of the A340 advised ATC that he believed that his aircraft had been struck. He had felt a jolt and his cabin crew subsequently told their commander that they thought that the aircraft had been struck on the tail by the B777. Upon enquiry the crew of the B777 advised ATC that they had not noticed the contact. A ground vehicle was dispatched to check for signs of damage. Airport staff reported damage to the left winglet on the A340 and the right wing tip on the B777. Also some debris was found on the ground below the respective wingtips. The A340 and B777's line-up clearances were cancelled and both aircraft were advised to taxi back on to a stand to enable engineers to inspect the damage. The holding area was closed to allow the debris to be cleared up.

[2] Flight crew on a B777 are unable to see their aircraft's wing tips from the flight deck so the operator had identified reference points on the flight deck windows which could be used by the crew to gauge whether an external obstacle fell outside the path to be followed by the aircraft's wing tips.

[3] London Heathrow Airport operates within a site of restricted size and it is apparent that the airport is often working to capacity.

Engineering examination

Examination of the aircraft involved showed that the A340 had suffered an impact into the trailing edge of its left winglet at a position approximately 30% (winglet) span, causing localised deformation of the trailing edge skins. The right wing tip fairing of the B777 exhibited bruising and paint smearing which extended rearwards from the leading edge back to the trailing edge, fracture of the navigation light lens and damage to other light fittings and lenses mounted on the fairing. Taken together, the pattern of damage was consistent with the right wing tip of the B777 having struck the left winglet of the A340 from behind, as the former was passing the latter. The extent of overlap between the two aircraft was minimal, of the order of 300 mm, and damage to both aircraft was confined to their removable wing-tips. The Minimum Equipment List (MEL) for each aircraft permits flight with one or both winglets or wing tip fairings removed.

It was confirmed that the B777's wing-tip was not visible from the cockpit.

Although the taxiway was cleared of debris by a mechanical sweeper before any record of its position could be made, a careful examination of the taxiway surface revealed some coloured glass shards consistent with the fractured lens on the B777's right wing tip. Although the precise position of the collision could not be determined from this debris, due to potential disturbance by the sweeping machine, it was considered unlikely that these items would have been displaced significantly from their original post-collision positions. Accordingly, the boundary of the region containing these items was noted for inclusion in a later analysis of aircraft and taxiway geometry, Figure 2.

Recorded data sources

The A340 aircraft was released for operation without the Cockpit Voice Recorder (CVR) or Flight Data Recorder (FDR) being removed or interrogated but the CVR and FDR were retrieved from the B777 and downloaded by the AAIB. The 30 minute duration CVR had overrun

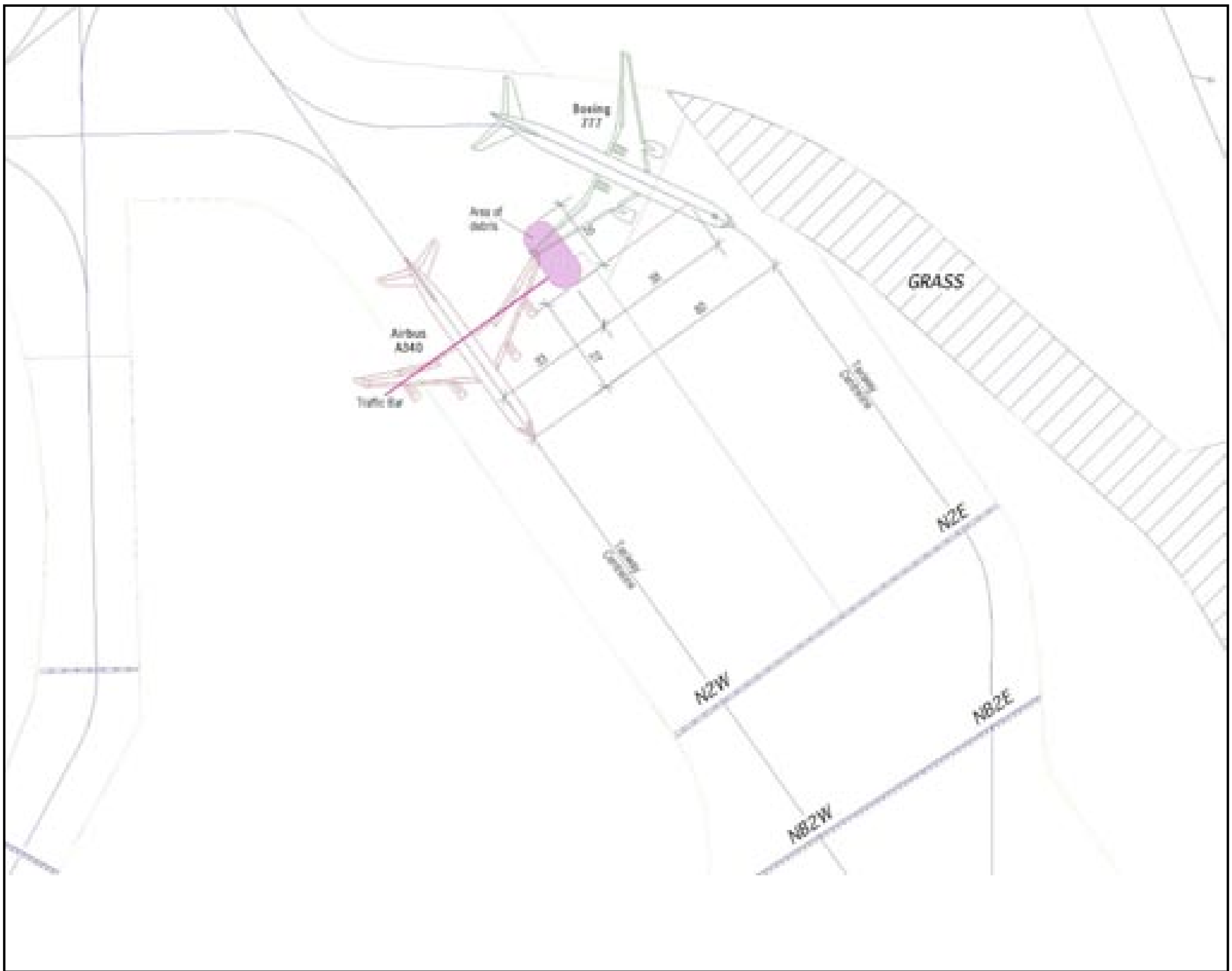

Figure 2
Aircraft positions at Runway 27L Holding Area
(measurements in metres)

before power was isolated but the FDR yielded useful information. ATC radio transmissions and the ground radar display at the time of the incident were also recorded and used during the investigation. At LHR, the ground radar is recorded, and this showed all ground movements of the aircraft with a radar signature overlaid with a marker derived from the 'multilateration' system. This system triangulates the location of the aircraft from the ATC transponder transmissions.

VHF keying was also recorded and enabled correlation with the CVR and ATC recordings to be made.

B777 CVR

The CVR was a 30 minute solid state unit manufactured by Honeywell. The unit was left running for more than 30 minutes after the incident and so information relating to the incident had been overwritten. Unusually, the circuit breaker for the CVR on the B777 is located in the electronics bay under the floor and this area is accessed via a hatch near the front left door. There is no apparent method for the crew to stop the CVR recording, and hence overwriting relevant data, from within the cockpit. A problem was identified with the cockpit area microphone channel recording, in that it had only recorded a large amplitude 400 Hz signal. The operator was informed of this defect and undertook to rectify the problem.

The operator's crew procedures, regarding the CVR after an incident, are contained in the Flight Operations Manual, VOL 1, POLICIES AND PROCEDURES under section 'Operating Information Enroute Procedures', pages 8.40.8 and 8.40.9, dated 21 May 04. Extracts from manual this are shown below:

> *'If an incident that requires immediate notification of the NTSB occurs within the last 30 minutes before landing, contact the FODM as soon as possible for instructions on how to remove power from the cockpit voice recorder. Reportable incidents include the following:*
>
> - *Flight control system malfunction or failure*
> - *Fire*
> - *Substantial damage to airplane (engine failures, tires, dents are not considered substantial)*
> - *Fatal or serious injury to any person'*

And

> *'Authorization to remove a specific tape may be given only by the Senior Vice President - Flight Operations, the Managing Director - Flight Standards and Training, Managing Director - Domicile Operations and System Chief Pilot, or the Vice President - Safety, Security, and Quality Assurance.'*

B777 FDR data

The data confirmed that the B777, which was crossing behind the stationary A340, was turning to take up a heading parallel to the A340 on its right. At the time the B777's right wingtip struck the rear of the A340's left wingtip, it was travelling at approximately 7 kt, and turning right, resulting in a wingtip speed of approximately 2.7 kt. The wingtip impact generated a lateral acceleration (g) of 0.05g to the left and, after the B777's wingtip rubbed along the A340 wingtip for approximately 1.5 seconds, a spike of 0.04g to the right. At this point the aircraft's speed was recorded as 6 kt and its magnetic heading samples either side of the initial impact g spike were recorded as 115°M and 118.5°M.

Recorded data analysis

The different sources of recorded data all used separate timebases. However, matching the FDR recorded VHF keying with the ATC radio transmissions, along with NATS records of the differences between the ATC audio and ground radar time bases, allowed the different sources to be correlated. Figure 3 shows the main parameters from the FDR. The collision occurred at 12:53:51 hrs and three ground radar plots covering this time, each separated by 1 second, are presented in Figures 4 to 6.

ATC Procedures

The Manual of Air Traffic Services (MATS) Part 1 states that:

> *'the movements of aircraft….on the manoeuvring area…. are subject to permission from aerodrome control'.*

The ATC Air Departures Controller (ADC) stated that, to maximise runway usage, Heathrow ATC aim to depart Heavy and Medium (weight) aircraft in alternating blocks of approximately six of each type. To facilitate this and avoid congestion on the taxiways, he was attempting to fill the Runway 27L holding area. MATS Part 2, which includes taxiing procedures for LHR, stipulates that, for the Runway 27L Holding Area;

> *'One heavy is permitted to hold at N2E and to be passed by Heavy and other aircraft taxiing to N2W'.*

While being aware of this, the ADC understood that if there was one Heavy aircraft on the left side of the holding area, at holding point N2E, and another Heavy aircraft on the right side at N2W, a further Heavy aircraft could join on the left. In understanding that, he had

Figure 3

Key FDR parameters from the B777.
Accident to N781UA / 6Y-JMP on 14 July 2004 at Heathrow

expected the A340 to stop further forward on the right, at N2W, thus giving room for the B777 to taxi to the left side of the holding area. However, the A340 could not do this until the A320 ahead of it had lined up on the runway. The ADC mentioned that, although it was a clear day, it was difficult to see precisely where the aircraft had stopped from his controlling position in the Visual Control Room (VCR) atop the tower.

Civil Aviation Publication (CAP) 637, entitled 'Visual Aids Handbook', explains in general terms the purpose and significance of the visual aids currently employed at licensed aerodromes in the United Kingdom (UK), as notified in the appropriate aerodrome entry in the UK Aeronautical Information Publication (AIP). It states:

> *'Taxiway centrelines are located so as to provide safe clearance between the largest aircraft that the taxiway is designed to accommodate and fixed objects such as buildings, aircraft stands etc., provided that the pilot of the taxiing aircraft keeps the **'Cockpit'** of the aircraft on the centreline and*

Figure 4
Ground radar - 12:53:50 UTC - video time reference

Figure 5
Ground radar - 12:53:51 UTC - video time reference

Figure 6
Ground radar - 12:53:52 UTC - video time reference

that aircraft on a stand are properly parked. 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 LHR entry in the Aerodrome section of the UK AIP includes a section on Local Traffic Regulations. Under the title 'Ground Movement' it gives general instructions which include the following:

'Runway Holding Areas for aircraft departing on Runways 27L… At all times in good visibility an ATIS [Automatic Terminal Information Service] message will remind pilots that they remain responsible for wing tip clearance.'

The LHR ATIS message, transmitted at all times except during Low Visibility Procedures (LVPs), states:

> *"Pilots are to exercise caution when manoeuvring in the Runway Holding Areas as wing tip clearance is not assured".*

Following this incident, London Heathrow MATS Part 2 was amended to reflect the removal of runway traffic bars NB2E and NB2W in a bid to reduce the risk of wing tip collision in the Runway 27L holding area. This means that the CAT I/II and III Runway Guard Bars are now co-located at the N2E and N2W traffic bars.

Actions following previous accidents/incidents

Following a very similar accident at the same place on the airport in 1997 (AAIB Bulletin 9/97), Heathrow Airport Limited, the airport authority, undertook to set up a working party to, (a), examine the current daylight (non Low Visibility Procedure) procedures for runway holding areas, (b), examine whether or not pilots should be given additional guidance within runway holding areas and (c), review the British Airports Authority (BAA) design standards for runway holding areas.

It was not possible to find a record of the working party's conclusions.

Analysis

This serious incident stemmed from a desire by ATC to maximise the number of aircraft at the holding area for Runway 27L, which was a consequence of the need to prevent congestion on the taxiway. The perception in the minds of the B777 flight crew was that it was not unusual at LHR to see another aircraft as close as the A340 appeared to be and their belief that, having cleared the tail of the A340, they would avoid other obstructions if they followed the taxiway centreline.

The B777 had received permission to taxi on beyond the LOKKI holding point but, as stated in the various UK publications, the crew was expected to take all possible measures to avoid collisions with other aircraft. Their vantage point in judging clearances from other aircraft, obstructions, etc, was far better than that of the ADC, although the crew were constrained by being unable to see the wingtips of their own aircraft. It is likely that, having reference points within the flight deck to ensure wingtip clearance from external obstacles, increased the crew's confidence in their ability to manoeuvre in a confined space. This, in turn, may have encouraged them to comply with the clearance to taxi forward and hold on the left without delay, although it would also be natural for a pilot to comply with ADC instructions sooner rather than later. However, being number six in the departure sequence, there was no urgency for their aircraft to taxi on to the left side of the holding area until the A340 had moved further forward. That was what wasenvisaged by the ADC and this arrangement would not have contravened the instructions in MATS, Part 2, relating to the holding area for Runway 27L. In this case, the damage to each aircraft was minimal and the A340 resumed its schedule after a short delay. The removal of the NB2E and NB2W holding points addresses the possibility of wing tip collisions as the Holding Area narrows at its southern end. Bearing in mind the particular constraints at LHR, the ATIS message concerning wing tip clearance is designed as a reminder for crews facing this sort of situation.

Safety Recommendations

The CVR fitted to the B777 aircraft had a recording period of 30 minutes. The crew were required by their company procedures to contact another person for information on how to isolate power to the CVR. It is fair to assume that the shortest reasonable time between such an incident occurring and the actual isolation of power to the CVR, would mean that most if not all of the 30 minutes of recorded data would have been overwritten. The crew procedures also do not adequately identify the scope of serious incidents that require the preservation of the CVR information. The combination of limited CVR recording time and crew procedures does not adequately address the need for preservation of data in the event of an incident or accident. The FAA have recently published a NPRM declaring the intent for CVRs which are fitted to have a minimum duration of 2 hours, but this will only apply to aircraft within their jurisdiction. In order to maximise the probability that pertinent CVR information will be available, after a serious incident or accident, the following Safety Recommendations are made:

Safety Recommendation 2005-051

It is recommended that the Joint Aviation Authorities, in common with the Federal Aviation Administration intent, mandate a minimum recording duration of two hours for all aircraft currently required to be fitted with a Cockpit Voice Recorder.

Safety Recommendation 2005-052

It is recommended that the Federal Aviation Administration and the Joint Aviation Authorities review their processes of oversight of Operator's procedures and training support to ensure the timely preservation of Cockpit Voice Recorder recordings in accordance with ICAO Annex 6 Part I, 11.6, following a serious incident or accident. The operator procedures and training should provide the necessary skills and information to identify accidents and serious incidents and implement the necessary tasks to preserve these recordings in a timely manner.

Safety Recommendation 2005-053

It is recommended that the Federal Aviation Administration require United Airlines, and any other airline regulated by the Federal Aviation Administration with similar procedures, to amend their procedures to ensure prompt identification of accidents and serious incidents and timely preservation of Cockpit Voice Recorder recordings.

The United Airlines requirement for their flight crews to gain authorisation from senior company employees before a 'specific tape' from a CVR can be 'removed', is contrary to the requirements of ICAO Annex 13 to the Convention on International Civil Aviation, paragraph 5.6, and has no legal standing when an incident such as this occurs within the UK[4].

On this occasion, the loss of CVR data did not impede the AAIB investigation. However, in different circumstances it might, and there would be significant implications for the Operator's flight crew who would find themselves in a position whereby they must choose to either contravene their Company policy or fail to comply with the legal requirements of a national Investigative Authority and the obligations of ICAO Annexe 13. The following recommendation is therefore made.

Safety Recommendation 2005-054

It is recommended that the Federal Aviation Administration require United Airlines to amend their relevant procedures so as to ensure that flight and ground crews are made fully aware of their obligation following an accident or serious incident to allow unhampered access by the appropriate national Air Accident Investigation authorities to the flight recorders by complying with the requirements of ICAO Annexe 13, paragraph 5.6, and associated national legal requirements.

[4] An equivalent situation exists with regard to the powers of the NTSB should a notifiable event, such as this, have occurred within the USA to a UK registered aircraft.

INCIDENT

Aircraft Type and Registration:	DHC-8-311 Dash 8, G-NVSB
No & Type of Engines:	2 Pratt & Whitney PW123 turboprop engines
Category:	1.1
Year of Manufacture:	1998
Date & Time (UTC):	24 March 2005 at 0930 hrs
Location:	5.7 nm west of Isle of Man (Ronaldsway) Airport
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 20
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Air Transport Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	17,500 hours (of which 1,200 were on type) Last 90 days - 100 hours Last 28 days - 25 hours
Information Source:	Aircraft Accident Report Forms submitted by the crew and further enquiries by AAIB

Background

The crew was flying a visual approach to Runway 08 at Isle of Man (Ronaldsway) Airport. The aircraft descended below the notional glidepath while it was still some distance from the runway. The resulting proximity to terrain triggered an Enhanced Ground Proximity Warning System (EGPWS) warning, which met with a delayed crew response. The co-pilot submitted an Air Safety Report Form 11 days after the incident, which was then referred to the AAIB by the aircraft operator. The commander subsequently completed an Air Accident Report Form at the request of the AAIB.

The flight crew comprised a senior and very experienced captain, with experience in airline training acquired prior to joining the operator in 1998, and an inexperienced co-pilot who had commenced line flying with the company some five months previously. Significant differences existed between the commander's account of the incident and that of the co-pilot, to the extent that it was not possible to combine the reports in a single narrative.

History of Flight

Co-Pilot's Report

The flight crew had reported at 0610 hrs for a duty which was to include two return flights from the Isle of Man to Manchester. The aircraft departed Manchester on the first return leg at 0845 hrs with the co-pilot acting as the handling pilot. The co-pilot reported that he attempted to brief the commander on the expected Localizer/DME (LLZ/DME) approach to Runway 08 at Ronaldsway; the glide slope for that runway being temporarily unavailable. However, the commander indicated he was satisfied that a brief was not necessary. A visual approach was therefore not discussed either. The meteorological report for the airport at 0920 hrs showed a surface wind from 130°(M) at 7 kt, visibility in excess of 10 km, small amounts of cloud at 1,000 feet and broken cloud cover at 4,500 ft. As the aircraft approached the island under radar vectors from ATC, the co-pilot announced that he was "visual". He intended this to be an information call to the commander, but in response the commander requested a visual approach, which was approved by ATC. The aircraft then flew downwind at 1,700 ft altitude until it commenced its final turn, at a range of about 6.5 nm from the runway (Figure 1). During the downwind leg the co-pilot called for the initial landing checks, but the commander also lowered the landing gear and selected landing flap without reference to the co-pilot, thus completing all the pre-landing check items. The commander also re-tuned the radio navigation receivers from the LLZ/DME frequency to the Isle of Man VOR/DME frequency and selected the flight director system to standby. The co-pilot, who was visual with the airfield, commenced a descent soon after initiating the final turn. The Isle of Man VOR/DME is located on the approach to Runway 08, at 4.6 nm from the airport.

As the final turn progressed, the co-pilot became increasingly uncomfortable regarding his visual contact with the airport, and eventually lost visual contact altogether. He later attributed this to the distraction of the commander's actions and their effects on the aircraft's handling, as well as a reducing visibility in haze, though he did not voice his concern to the commander. The aircraft flew through the runway centreline, still descending, and the commander informed ATC of this before enquiring whether the co-pilot was still visual with the airport, to which the co-pilot replied "NEGATIVE". The commander then made right aileron inputs on the control column though did not assume control of the aircraft. In response, the co-pilot surrendered control to the commander but did not verbalise this. The co-pilot recalled that, at about this time, there was a brief discussion on the flight deck about the DME indication and the fact that the VOR/DME was not located on the airfield. The co-pilot later said that the situation was very confusing, and believed that he was mislead by the DME which he thought was indicating range to the runway, as it would have for a LLZ/DME approach.

The aircraft by this stage was on a south easterly heading, correcting towards the runway centreline from the north and still descending. There was then an EGPWS 'TERRAIN' warning followed immediately by a 'PULL UP' hard warning. Nothing was said by either crew member, though the co-pilot thought that the commander did reduce the rate of descent. There was then a delay, followed by at least one further warning. The commander, now as handling pilot, announced that they would go-around, and flew the go-around manoeuvre. The co-pilot reported the go-around to ATC and the aircraft subsequently flew a Localizer / DME approach to Runway 08 without further incident.

Commander's Report

Note: Information common to both reports is not repeated.

The commander reported that the co-pilot had given a good briefing for the approach, which was completed while descending towards the airport. The weather was very good and an early visual contact was made with the runway while it was still some distance away. The commander asked the co-pilot if he would like to fly a visual approach, who replied that he would. The commander asked for, and was given, ATC approval for a visual approach to Runway 08. The commander did not subsequently re-tune the navigation aids; his own VHF navigation receiver was selected to the VOR/DME and he believed the co-pilot's receiver was selected likewise, as the approach checklist (which includes navigation aids) had been completed after the decision to fly a

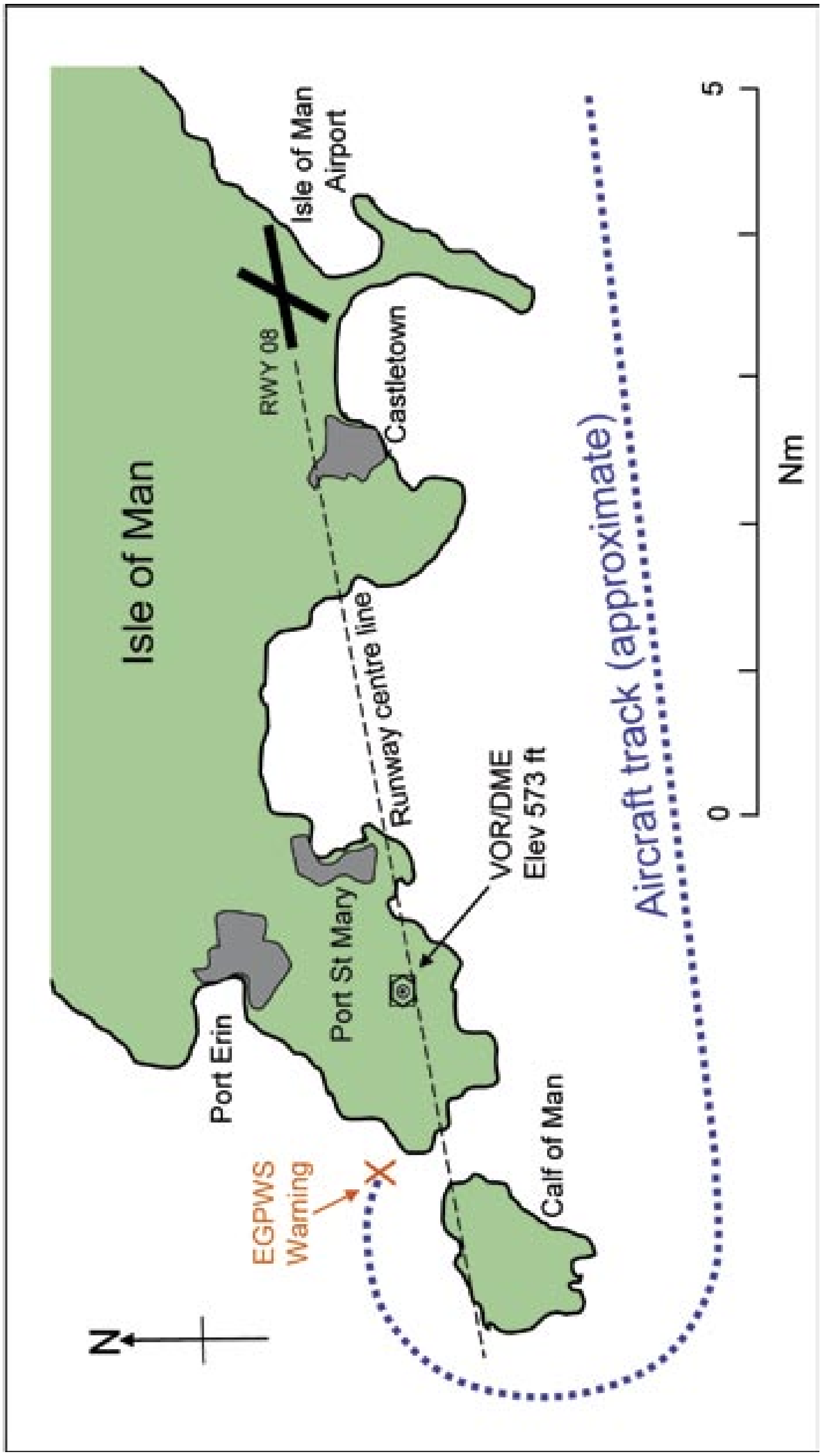
Isle of Man
Isle of Man Airport
RWY 08
Castletown
Runway centre line
Port St Mary
Port Erin
VOR/DME Elev 573 ft
Calf of Man
EGPWS Warning
Aircraft track (approximate)
0
5
Nm
N

Figure 1

visual approach was made. The aircraft began a visual down wind leg at about 3,000 ft, and the commander twice prompted the co-pilot to descend and turn finals. However, the co-pilot seemed reluctant to follow his guidance, and the commander decided to let the co-pilot extend the down wind leg while losing height. The commander reported that he did not make any selection of landing gear or flap, and the aircraft commenced the final turn in a clean configuration. He was aware of the aircraft's position relative to the airfield, and could not recall why he had let the co-pilot descend where he did, but was content to allow the descent to continue as the weather was good and the aircraft was over the sea. It was only as the finals turn was nearly completed that the commander realised how low the aircraft had become in relation to the runway.

At this point the commander could see the high ground ahead, and believed that the aircraft would clear it by between 300 and 400 ft. The landing gear had not been lowered by this point, as this action would normally be carried out about 4 nm from touchdown. The commander then heard what he believed to be an EGPWS "TOO LOW - GEAR" alert. In response to the EGPWS alert, the commander took control of the aircraft, called for selection of landing gear and flap 15 (which the co-pilot selected) and started to slow the aircraft to its minimum approach speed. The EGPWS then generated a "PULL UP" hard warning, so the commander initiated a gentle climb. His intention was to carry out a steady climb to re-establish on the correct glide path, but became concerned about the effect the persistent and loud "PULL UP" hard warning would have on the passengers sitting at the front of the cabin, so announced a go-around. The commander first considered taking control when it became clear that the co-pilot was flying a poor approach. However, it was only when the EGPWS alert triggered that he actually assumed control, stating "I HAVE CONTROL", to which the co-pilot replied "YOU HAVE CONTROL"

Other witness information

A company flight crew member, who had recently operated the same type and been based at the Isle of Man, was flying as a passenger on the aircraft and submitted a report to the operator at the latter's request. The flight crew member, who was seated at the front left of the cabin, reported that he was aware that the aircraft was down wind for Runway 08 and had passed Port St Mary, where the final turn is normally commenced when flying a visual approach. The aircraft commenced a turn when at about 5 to 7 nm from the airport, which took the aircraft through the runway centre line until it was on a south easterly heading. The aircraft had started to descend in the turn, becoming abnormally low for its position relative to the runway. As the aircraft crossed the coast, there was a "TERRAIN" warning followed by a "PULL UP" hard warning, which could be heard in the passenger cabin. The aircraft was still descending and several warnings followed before there was an obvious increase in power and pitch attitude.

Aerodrome information

Isle of Man (Ronaldsway) Airport is situated on the south coast of the Isle of Man and has a main runway orientated 08/26. Instrument approaches to Runway 08, are based on the ILS/DME, LLZ/DME or VOR/DME, and pass over terrain which reaches an elevation of 573 ft amsl, 4.6 nm from the airport. The Isle of Man VOR/DME is situated at the summit of this high ground, which forms the extreme south western tip of the Isle of Man, and is thus 4.6 nm from the aerodrome. The ILS/DME procedure establishes a minimum altitude of 1,700 ft until descent on the glide path, at 5.2 nm from the runway; range and altitude information is also published to assist pilots to follow a notional 3° glide path when following the LLZ.DME procedure. Minimum Safe Altitude (MSA) within 25 nm to the south west of the airport is 2,600 ft amsl.

Recorded information

This serious incident was reported some time after it occurred; relevant data from the Flight Data Recorder and Cockpit Voice Recorder had been over-written and was not available for analysis. However, limited data was recorded in the EGPWS memory which provided valuable information regarding the EGPWS warnings. The equipment manufacturer was able to determine that the EGPWS warnings were legitimate.

The EGPWS first issued a "TERRAIN TERRAIN PULL UP" hard warning when the aircraft was at 680 ft amsl, flying at 115 kt on a heading of 139°(M) and with a descent rate of 730 ft/minute. At this point the aircraft was configured with the landing gear down and flaps at the landing setting. The aircraft was 5.7 nm from the runway, heading toward the high ground on which the VOR/DME is located, 1.3 nm ahead of the aircraft and at an elevation of 573 ft. The aircraft descended to 650 ft, at which point it levelled off and then began a slight climb. At 1.1 nm before the VOR/DME, at about 670 ft amsl, the EGPWS produced a "CAUTION TERRAIN" alert. The aircraft maintained a slight climb, until at 0.95 nm before the VOR/DME and at 680 ft, when a further "TERRAIN TERRAIN PULL UP" hard warning was triggered. The aircraft continued a gradual climb, until a go-around profile appears to have commenced at 700 ft, at which point the aircraft was 0.75 nm from the VOR/DME and the associated high ground. Based on the ground speed at the time of the first EGPWS alert, the go-around manoeuvre commenced 21 seconds after the first "PULL UP" warning, and some 8 seconds after the second "PULL UP" warning.

Operator's regulations

Procedures to be followed by flight crew in the event of an EGPWS warning are given in the operator's operations manual. This states 'a full energy pull-up manoeuvre must always be flown if a Hard Warning is received below MSA.' The manual further states that it is permissible to treat a warning as a caution and continue to land only if the aircraft is below 1,000 ft, the runway is in sight, and the aircraft is in the landing configuration with the landing checks completed.

The operator's operations manual contained procedures to be followed for a visual approach and these had been modified some four months prior to the incident. The change had been 'signed as read' by both pilots as routinely required. The relevant extracts from these procedures are:

'During a visual approach, if visual reference to the airport or its environment are lost, a go-around must be initiated immediately.'

'Pilots must not accept a visual approach unless the approach has been pre-briefed during the pre-descent approach briefing. This briefing should include a target altitude and distance for the intended turn onto finals, paying particular attention to any special visual approach requirements detailed in the AERAD plates. It should also include any particular landmarks, terrain features (for visual cues) or high ground within the relevant area.'

Note: AERAD plates are chartlets depicting approach and landing procedures, together with other relevant airport information.

Reporting procedures

The Civil Aviation Authority (CAA) operates a Mandatory Occurrence Reporting Scheme (MORS) which is described in CAP 382. This scheme is intended to ensure that the CAA is aware of potentially hazardous incidents and defects, as well as ensuring that personnel and organisations are able to learn from safety related incidents. An EGPWS warning that arises when an aircraft comes into closer proximity to the ground than had been planned or anticipated is included as an item which should be reported, normally within 96 hours.

The Air Navigation Order defines the categories of persons or organisations which are required to report occurrences and these include, but are not restricted to, the operators and commanders of public transport aircraft. In this case, the commander, who would have been expected to submit a report, stated that it was his intention to report the event but that a period of leave and ill health had delayed him doing so. The co-pilot reported that the flight crew had not discussed the incident after landing and that he was unsure what action he should or could take. After some consideration and discussion with colleagues he approached his company to report the incident.

Analysis

The differing accounts of this incident from each flight crew member and lack of data from the FDR or CVR make it impossible to define a precise sequence of events leading up to the incident, though certain key facts are evident. It is clear that the aircraft was descended at an inappropriate point, that corrective action was delayed and that the crew did not respond to the EGPWS warning in the correct manner.

The decision to fly a visual approach appears to have been reasonable given the weather conditions, though it is doubtful whether the crew met their company's briefing requirements for this. The downwind leg was extended beyond the normal point, and this may have been due to excess height or speed, or to a loss of situational awareness on the part of the co-pilot, possibly caused in part by an unrequested selection of services and re-tuning of the navigation aids. The co-pilot recalls basing his final turn point on the DME, believing it to be referenced to the runway, but which was actually tuned to the Isle of Man VOR/DME at the time. The co-pilot's visual contact with the airfield was tenuous at this stage, so he was basing his decision to descend the aircraft largely on the DME indication. The fact that the discrepancy between the DME indications and the visual cues did not alert the co-pilot to a problem suggests that the co-pilot's situational awareness was already degraded at the start of the finals turn.

The commander reported that he was aware of the aircraft's position as it turned finals but he could not account for his action in allowing the co-pilot to descend so far without intervention; the aircraft was well below a notional glide path for Runway 08 at the start of the final turn and any descent at this stage would have been inappropriate. However, due to his position on the left of the aircraft, the commander had only limited visual cues from the terrain and would not have been visual with the airfield during the down wind leg or initial part of the finals turn. The co-pilot did not voice his concerns regarding his visual references, had he done so it should be expected that the commander would have taken earlier action to correct the situation.

Significant discrepancy exists regarding each pilot's recall of the EGPWS event. The data recovered from the EGPWS memory supports the co-pilot's recollection regarding the nature of the warning and the aircraft's landing configuration. The commander thought that the EGPWS first generated a "TOO LOW – GEAR" alert and he recalled that he responded by ordering the gear down and flap 15. The fact that the EGPWS data differs from the commander's recall may indicate that the commander's own situational awareness had also degraded by this time. If this were so, it is possible that he may have mistaken the approaching coastline with that later in the approach, the latter being the only coastline that would be crossed during a 'normal' visual circuit.

Regardless of the events leading to the EGPWS warning, when it did finally trigger, the commander did not take the actions that would be expected, namely a positive climb away from the terrain at maximum power.

The circumstances of this incident and the manner in which it was reported suggest the possibility of shortcomings in the crew's application of the principles of good Crew Resource Management (CRM), though specific examples are hard to extract with any confidence due to the differing accounts. The co-pilot was inexperienced and relatively new to the company, whilst the commander was a very experienced captain. Had the basic principles of good CRM been followed, it would be hard to imagine how a situation could have arisen whereby the co-pilot became so disoriented that he commenced an inappropriate descent without intervention or comment from the commander. It is not clear whether an adequate briefing was given for the approach, but the subsequent events would suggest that the items required by the company to be briefed were not covered, since details of the visual cues for the finals turn, terrain features and hazards would have been fresh in both pilots' minds.

Conclusion

The aircraft was descended at an inappropriate point, causing it to fly well below the notional glide path for the runway in use and into conflict with terrain. The crew's response to the subsequent EGPWS was delayed and not in accordance with their company's instructions.

INCIDENT

Aircraft Type and Registration:	Fokker F27-500, EI-SMF
No & Type of Engines:	2 Rolls-Royce Dart 532-7 turboprop engines
Category:	1.1
Year of Manufacture:	1984
Date & Time (UTC):	8 September 2004 at 0114 hrs
Location:	Stansted Airport, Essex
Type of Flight:	Public Transport (Non revenue)
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Overheat and turbine damage to left engine
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	46 years
Commander's Flying Experience:	2,730 hours (of which 1,700 were on type) Last 90 days - 60 hours Last 28 days - 28 hours
Information Source:	AAIB Field Investigation

Synopsis

At approximately 75 kt on takeoff from Runway 05 at Stansted the aircraft deviated to the right but was recovered to the centreline by a reduction in power and use of rudder. When power was re-applied to continue the takeoff the aircraft turned significantly to the left and the takeoff was abandoned. As the aircraft came to a stop external indications lead the commander to believe that the left engine was on fire. The Airfield Fire and Rescue Service attended the scene and the left engine was successfully shutdown without further incident. Subsequent examination revealed that the left engine turbine had burnt out as a result of the left propeller being hung on the flight fine pitch stop at the time the throttle was re-opened. Furthermore, a defect was discovered in the Nose Wheel Steering (NWS) follow-up control valve that caused vibration of the NWS and damaged the dowel pins in the steering gearbox leading to erratic changes in the NWS datum making the aircraft difficult to steer.

History of flight

The crew positioned the aircraft from Paris to Exeter for a return cargo only flight to Stansted. The crew had noted a higher than normal level of vibration from the right engine but this was deemed to be acceptable and no source of the vibration could be identified during the subsequent ground inspection. The only 'Deferred Defect' recorded in the Technical Log and of relevance to the incident was: 'Nose wheel steering very sensitive' necessitating it to be operated in accordance with the Minimum Equipment List (MEL).

The flight from Exeter was normal and the aircraft landed at Stansted at 2309 hrs. The commander carried out the 'turn-round' inspection and supervised the refuelling whilst the First Officer (FO) remained on the aircraft preparing for the return flight to Exeter. The commander was to be the Pilot Flying (PF) for the sector. After a normal engine start the aircraft was pushed back off stand at 0002 hrs and taxied to hold at point 'HA1' for a flapless, rolling, dry (no water methenol injection) takeoff from Runway 05. The ATIS, timed at 2350 hrs, gave the surface wind as 050°/09 kt, visibility 10 km, few clouds at 900 feet, temperature 13°, dew point 12°C and a QNH 1034 mb.

Having held briefly to allow another aircraft to land, the aircraft lined up and held to allow the landing aircraft to clear the runway. When cleared for takeoff the commander increased power with his right hand whilst keeping his left on the nose wheel steering control. When the engines were stable he moved both power levers to the fully forward position setting take-off power which was confirmed by the FO. The aircraft accelerated normally but the nosewheel steering seemed sluggish. The FO called "60 kt" and confirmed both ASIs were indicating correctly. The commander removed his left hand from the steering control to the control column and shortly after the aircraft deviated sharply to the right migrating towards the edge of the runway. The commander reacted to the situation by applying left rudder and reducing power; more on the left engine than on the right.

Having contained the yaw to the right the commander re-applied full power but as he did so the aircraft yawed to the left, crossed the runway centreline and began to move towards the left side of the runway. The FO was unable to check the engine instruments but seeing the move to the left called "STOP STOP". The commander had however, already started to retard the power levers. Ground Fine pitch was selected and using positive braking the aircraft was brought to a stop. As the aircraft slowed the commander became aware of an orange glow originating outside the cockpit over his left shoulder. He believed this to be a fire in the left engine for he could see sparks emanating from the engine jet pipe. When the aircraft stopped the commander applied the parking brakes, the FO informed ATC of the situation and the Rescue and Fire Fighting Service (RFFS) attended the scene immediately. Meanwhile the commander moved the left engine fuel cock lever into the propeller feather gate and the left engine ran down; the sparks reducing as it did so. The crew could not recall the exact Jet Pipe Temperature (JPT) but they noted that the left engine JPT was indicating approximately 1,000°C rather than the normal 400°C.

Minimum Equipment List (MEL) requirements

The nose wheel steering was recorded in the technical log as being 'very sensitive' but was not placed as inoperative although the entry did require the aircraft to be operated in accordance with the MEL. The crew had noticed this 'very sensitive' tendency during previous taxiing but had been able to compensate satisfactorily with differential braking. No problems had been experienced during the previous takeoff or landing rolls.

The MEL permits operation of the aircraft with the nose wheel steering inoperative providing the following conditions are met:

Nose Wheel steering is selected 'OFF'
Take-off distance is increased by 10%.
Maximum crosswind is limited to 10 kt, and
The a/c may continue the flight or a series of flights but shall not depart an airport where repairs or replacements can be made.

Engine investigation

Arrangements were made to remove the left engine for detailed examination. However, whilst the engine was being removed, checks on the steering found that the Follow-Up Control Valve (FUCV) was defective, and this was also removed for investigation.

Although an engine fire had been reported, inspection of the aircraft on the apron found no evidence of fire, but metallic debris in the left engine jet pipe indicated that an engine overheat condition had occurred. Additionally, a large quantity of oil had flowed from the engine from around the reduction gearbox but this had not ignited.

The engine, serial 13209, was subjected to a strip examination and some items were tested under the supervision of AAIB. The engine could not be turned, however, when the compressor and turbine were separated the compressor was free to turn but the turbine was seized. Progressive dismantling of the turbine assembly showed that the High Pressure (HP) nozzle guide vanes were in a satisfactory condition and free of debris. It was apparent from the loose pieces of the turbine blades lodged between the Low Pressure (LP) nozzle guide vanes however, that the temperature had exceeded the threshold at which the Intermediate Pressure (IP) turbine blades begin to melt. The LP turbine blades had extensive impact damage to the aerofoil leading edges. The IP nozzle guide vanes had impact damage as a result of the molten release of the HP turbine blades. Residue of the HP blades was found adhered to the HP nozzle guide vane and HP blade path. Crystallised HP blade material was also found distributed as a powder in all turbine stages. After removing the HP disc, the HP shaft and location bearing were removed and dismantled. The bearing was found to be intact and free to rotate.

Oil pressure filter and scavenge filters were found to be free of contamination. A check of the fuel burners for condition and flow rates was carried out, and this was found to be typical of an engine returned for routine overhaul. The Fuel Control Unit (FCU) control settings were satisfactory and the fuel pump was found to operate satisfactorily. The Propeller Control Unit (PCU) was rig tested, and the governor was found to be slightly out of tolerance.

It therefore appeared that the engine had experienced a turbine burnout due to incorrect fuel air mixture ratio, however there was no significant defect in the engine's fuel system and no engine defect related reason for the burnout was established.

The observed oil leak was attributed to the continued operation of the feathering pump after the engine had been shut down. This resulted in oil leakage because the scavenge pump was no longer operating and the reduction gearbox therefore overfilled.

Turboprop engines and constant speed propellers

The combination of a turboprop engine, such as the Dart, and a constant speed propeller such as that fitted to this engine, requires that a system of safety devices known as propeller pitch stops be fitted to prevent the propeller from accidentally entering a fine pitch condition in cruising flight. When the aircraft is on the ground, at low speed, these stops must be withdrawn to allow sufficient air to pass through the engine. The fuel air mixture of a turboprop engine is always lean, so if insufficient air is available, the mixture will become progressively richer and gas temperatures in the turbine will rise very rapidly. It is possible to overheat and burn out a turbine in a second or two if the throttle is advanced too rapidly while the engine is at a low speed and the propeller is hung on a pitch stop.

In 1997, because of the frequency of this kind of occurrence, Rolls-Royce re-issued a Notice To Operators (NTO) of Dart engines (NTO 1106) which highlighted the importance of strict adherence to the manufacturer's Aircraft Flight Manual (AFM) requirements in order to avoid engine burnout.

Follow-up control valve (FUCV) investigation

During the initial rectification of the aircraft and replacement of the engine, the steering system FUCV was removed as unserviceable. Subsequently the Centralisation Control Valve (CCV) was also changed, and a further change of the FUCV also occurred during repeated attempts at rectification of the Nose Wheel Steering (NWS).

The FUCV had been suspected because, when the steering was checked, the FUCV was found to have an incorrectly functioning lever spring. This spring normally provides centralisation of the valve spool. In this case the gap between the levers of the spring was much larger than expected, allowing considerable free play of the valve spool. In a correctly functioning FUCV the steering demand from the tiller operates against the lever spring tension and in doing so causes pressurised air to be progressively metered to the steering actuator. This in turn causes the follow up mechanism to cancel the demand at the FUCV when the desired NWS angle has been reached (Figure 1). Operation of the system is therefore smooth and progressive. The defect found would cause maximum pressurised air to be applied at any slight steering demand, with a tendency for the mechanism to oscillate between the relaxed constraints of the lever spring. This condition would have caused vibration of the NWS.

The FUCV, part number AC62276, carried the serial number AB140. The data plate on the FUCV was engraved 'Mod:6'. It appeared that the '6' had previously been a '5' and had been altered by further hand engraving.

A Mod 5 (Issue 5) valve differs from its predecessors by the incorporation of the manufacturer's modification C2050. This modification changed the selector drum, pin, spring and spring housing of the valve to a later standard. The purpose of the modification was to improve the service life of the spring.

To raise the FUCV to Mod 6 (Issue 6) required the incorporation of a further modification; C2631. Modification C2631 simply removed a set screw in the spring housing that was previously used to adjust the spring. Following modification C2050, no spring adjustment was required.

The FUCV bore markings which showed it had last been overhauled in Florida, U.S.A. It carried the date '6-2003'. The spring housing did not contain a set screw, in accordance with a post mod C2631 condition. However, the selector drum was marked with the part number ACM26505, which was a 'pre-mod 5' part. Part numbers were not found on the spring or spring housing, but the spring appeared to have been deformed to allow it to fit inside the spring housing, which was too small for it. This had the effect of preventing the spring from centering the valve spool.

The most likely explanation for this appeared to be that while the FUCV was in a 'pre-mod 5' state, it was incorrectly fitted with a 'post-mod 5' spring, and 'Mod 5' engraved on the plate. Subsequently mod C2631 was also embodied. However, it was not possible to determine when these events took place.

History of the FUCV and NWS technical log entries

FUCV serial AB140 was overhauled in the USA during June 2003, and held in a supplier's store until it was supplied to the operator. It was fitted to the aircraft on 26 August 2004, as part of rectification work input for a NWS defect. On 6 September 2004 a further NWS defect was recorded as 'extremely sensitive with a centre notch – very difficult to steer'. The CCV was changed as a rectification action. The same day a second entry was recorded as 'Nose wheel steering very sensitive'. A 'Carried Forward Defect' was raised to permit continued operation in accordance with the Minimum Equipment list (MEL) section 32-50-01'. The MEL permitted continued operation with the NWS selected to 'OFF'. The subject incident occurred two days later.

Further incident

A further incident occurred on 18 November 2004 when the operator's F27 Fleet Captain was handling the aircraft. During taxi, there was a sharp uncommanded pull to the left followed by a violent turn right requiring maximum braking to stop the aircraft. The departure was discontinued and the aircraft was grounded for further investigation. The previous day some difficulties with NWS vibration and uncommanded steering inputs had arisen, but flight operations had continued.

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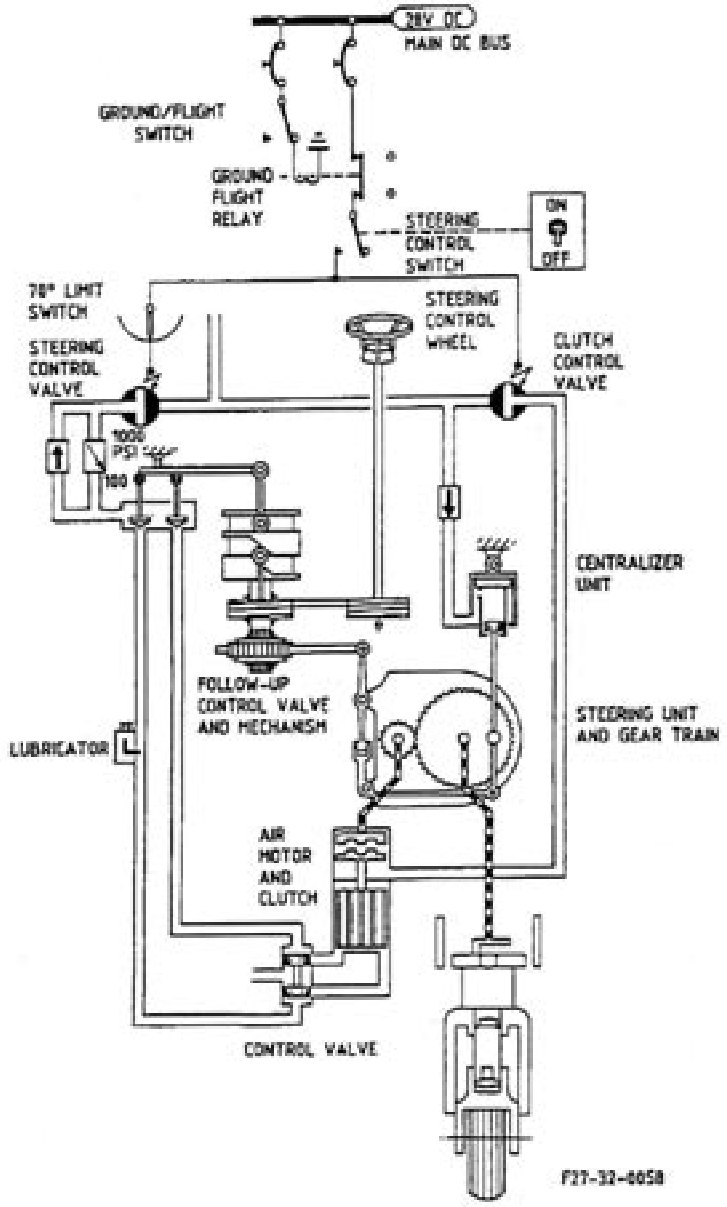
FOKKER F-27

MAINTENANCE MANUAL



NOSE WHEEL STEERING SYSTEM - OPERATION

"END"

32-51-00
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Figure 1

Steering gearbox investigation

Following the incident on 18 November, the aircraft was placed on maintenance indefinitely until the cause of the steering problems could be positively identified. Since most of the components other than the nose landing gear and steering gearbox had already been replaced, the investigation focussed on these components.

The Nose Landing Gear and Steering Gearbox were separated. (Figure 2). Four dowel pins, three of which were broken, located the steering gearbox. It is unusual for these pins to break, but if they are broken or distorted they can permit the steering gearbox to rotate relative to the nose gear itself, and thus induce a steering error on a random or erratic basis. The Steering Gearbox was despatched for investigation and overhaul. The survey and test report stated that the unit had a broken housing tube assembly, a damaged gasket and was supplied with a missing grommet and plate. When these parts were repaired and replaced, the unit functioned satisfactorily. The four dowel pins were not recovered at the time and were subsequently unavailable for investigation.

Subsequent to this work, the aircraft was returned to service and operated without further reports regarding the NWS.

Analysis

Flight crew actions

The crew did not consider the nose wheel steering to be inoperative and therefore did not apply the requirements of the MEL to place the nose wheel steering selector switch to 'OFF' or apply any of the other requirements. The taxi to Runway 05 at Stansted had been achieved without difficulty using the combination of nose wheel steering and differential braking. The rolling takeoff was normal with directional control being maintained using the nose wheel steering up to 60 kt. At that point, and when the PF removed his hand from the steering control, the aircraft continued to accelerate rapidly but at about 75 kt it deviated to the right. In order to prevent the aircraft departing the right side of the runway the commander reduced power, applied left rudder and was able to manoeuvre the aircraft back to the runway centreline. He had not realised that when he retarded the left engine power lever he had moved it to, or near, the idle position.

Having reduced power to that degree, the left propeller blades would have remained at the 20° angle limited by the flight fine pitch stop. It is essential, when at idle power, that the power lever is moved into the ground fine range to withdraw the stop and allow the propeller to move to the ground fine setting of 0°. At 0° propeller angle, when the power lever is advanced, the engine is able to overcome propeller drag and increase engine and propeller RPM without exceeding the engine Jet Pipe Temperature (JPT). At a 20° propeller angle however, the engine is not able to overcome the drag without exceeding the engine JPT. The right engine power lever was not retarded to the same degree and when its power lever was advanced, the engine and propeller accelerated causing the aircraft to yaw to the left at which point the takeoff was abandoned.

Engineering

Although it was not possible to determine conclusively the pitch angle of the left propeller relative to the flight fine pitch stop, the data shows that it is very likely that the propeller was hung on the stop at the time the throttle was re-opened. This would have resulted in the almost instantaneous burnout of the turbine, and is confirmed by the very high JPT observed by the crew.

The defect in the FUCV would have caused vibration of the NWS, and some difficulty with steering the aircraft. It would also have caused large forces to be repeatedly applied to the steering gearbox and nose landing gear. These forces could have damaged the dowel pins in the steering gearbox and would lead to erratic changes in

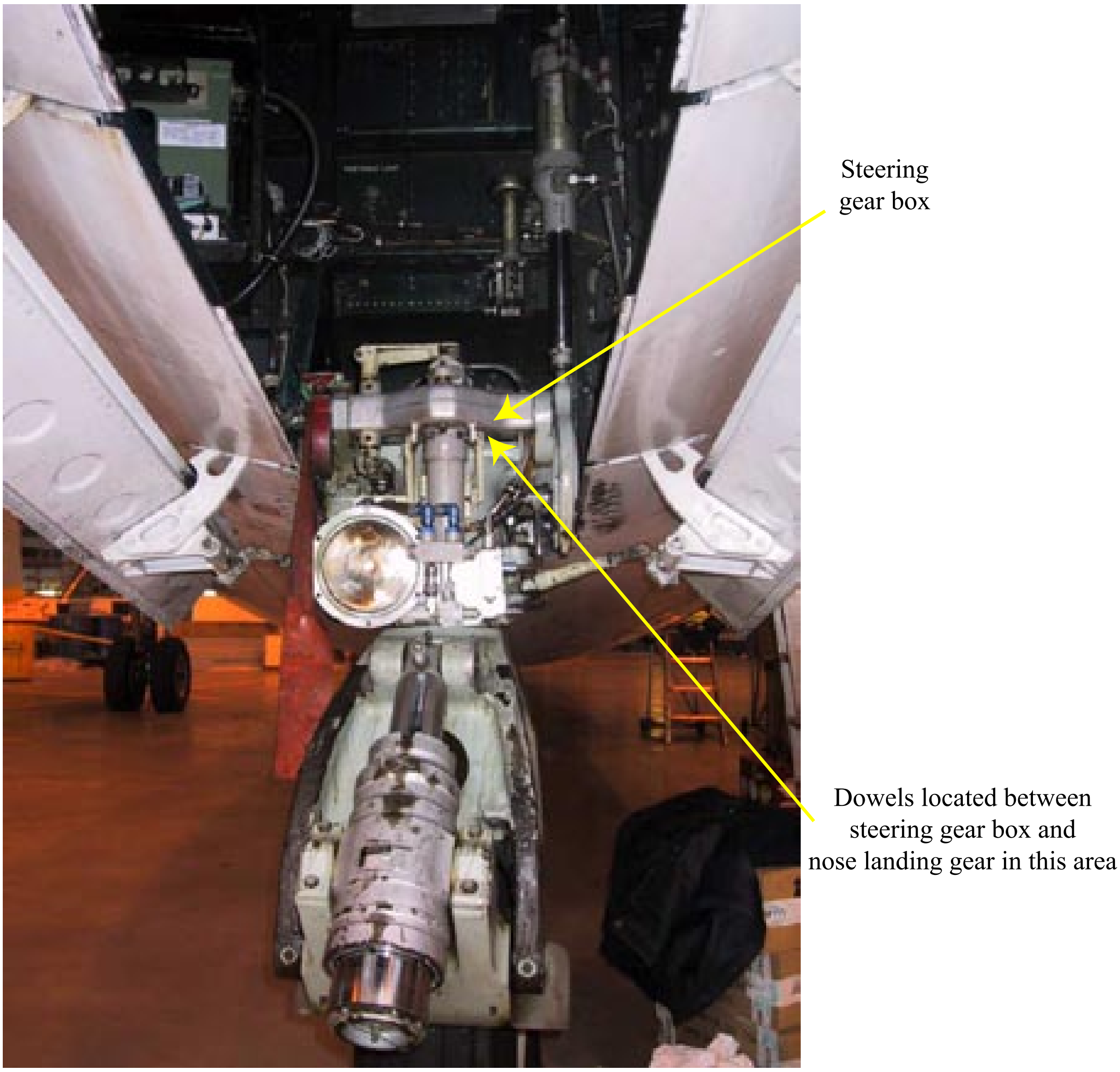

Figure 2
F27 Nose Landing Gear

the NWS datum. Unfortunately, attempts to recover the dowel pins were unsuccessful, so this possibility could not be confirmed from their condition. Even so, the only two faults found throughout the investigation concerned the FUCV and the dowel pins, and while the former could have caused the latter, the opposite is not true.

Conclusion

The subsequent technical investigation found that the engine burnout occurred because the left throttle had been retarded when directional control was lost. The engine had slowed, but the propeller was almost certainly above the flight fine pitch stop. Almost immediately after this the left throttle was re-opened, causing the turbine to overheat. The steering problem had been due to defects in the FUCV and the Steering Gearbox. The right engine did not overheat because it had been handled somewhat differently in an attempt to regain directional control. Selecting the nose wheel steering switch to 'OFF' may not have prevented this incident.

INCIDENT

Aircraft Type and Registration:	Reims Cessna F406, G-SFPB
No & Type of Engines:	2 Pratt & Whitney Canada PT6A-112 piston engines
Category:	1.2
Year of Manufacture:	1991
Date & Time (UTC):	14 January 2005 at 0946 hrs
Location:	40nm northwest Sumburgh VOR, Shetland Islands
Type of Flight:	Aerial Work
Persons on Board:	Crew - 3 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	11,505 hours (of which 6,750 were on type) Last 90 days - 150 hours Last 28 days - 35 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and additional AAIB enquiries

Circumstances

The aircraft was on a fisheries patrol flight and at the time of the incident had just completed a low level (200 ft) pass over a fishing vessel, for photographic purposes, which involved a 30° banked turn to the left. On completing the pass, a right turn was made in order to return the aircraft to straight and level flight. A further correction to the left was then attempted but the handling pilot, who was the First Officer (FO), encountered a strong resistance. He alerted the commander to the problem and together they found that an excessive force was required to maintain straight flight. Pitch control was found to be normal and the aircraft was climbed to 1,000 ft. A gentle right turn was initiated, which required normal control force. However, reverting to a wings level attitude required excessive effort when the control yoke was some 3° to 5° left of the central position.

The commander assumed control and, having made a 'PAN' call, positioned the aircraft for a straight-in approach to Runway 15 at Sumburgh. The control difficulties continued during the approach, with corrections to the left requiring considerable effort. The aircraft landed without incident and whilst taxiing in the commander attempted a 'full and free' check of the flight controls; he found the resistance to a left aileron input exactly the same as in flight. He invited the FO to try, who, after experiencing the same resistance, felt a jolt and the control restriction disappeared, allowing normal movement and associated forces throughout the range of operation. The commander later commented that the restriction had seemed to occur whenever an attempt was made to turn the control wheel to the left, regardless of its position. This led him to additionally comment that the restriction felt "electrical" in origin, despite the fact that the autopilot was disengaged.

At the time the crew initially became aware of the problem, the aircraft was clear of cloud, with an ambient temperature of + 6°C and dew point of +3°C.

Subsequent investigation

An engineer was flown from the operator's base at Inverness to Sumburgh later on the day of the incident. The control restriction was no longer present and no evidence of one remained despite an extensive inspection of all cables, chains, linkages and attachment points. This involved the removal of various access panels and shrouds. The autopilot was also checked and its operation was found to be normal, with no restrictions on the flying controls. The aircraft was cleared for a test flight and two days later was flown to Inverness without further incident.

On return to Inverness, the cabin floor was removed and a repeat inspection made of the control system. No defects or loose articles were found. As a precaution, all four aileron attachment bearings, which were noted to be stiff in operation, were replaced. The aircraft was returned to service and the problem has not subsequently recurred.

Examination of aileron bearings

The aileron bearings were sent to AAIB who commissioned a metallurgical examination of them. It was found, following disassembly that the grease in three of the bearings had dried out, leaving a powdery deposit. The fourth, the left hand inboard, was from a different bearing manufacturer and had a relatively large amount of grease applied. It was also of a different design in that it had a single row of convex rollers and no cage. The others were a dual race design, with concave rollers and a cage.

The dual race bearings all displayed extensive corrosion on the surfaces of the rollers and raceways. Corrosion was also apparent on the single race component, although it was less extensive. The effect of the corrosion was to cause the bearings to be stiff in operation, but there was no sign that they had seized. Had they done so, it would be reasonable to expect to find evidence, in the form of flats, worn on the roller surfaces.

Discussion

The fact that aileron movement was restricted in one direction only, coupled with the outside air temperature of +6°C, meant that the possibility of ice in the bearings, or indeed any other part of the system, could be excluded as a potential cause. Similarly, the uni-directional nature of the restriction tended to discount an autopilot malfunction (not withstanding the commander's comments), this conclusion being given increased confidence by satisfactory operation since the aircraft was returned to service.

The crew report suggests that the problem may have been due to a small object causing a restriction in the movement of a bellcrank, lever or cable quadrant. Despite an exhaustive examination, no trace of such an object, which might include a nut or rivet, was found, although there would be ample scope for a small article to remain undetected in the bottom of the fuselage.

The only significant finding was the stiff operation of the aileron bearings, which were found to be in a corroded condition although they had remained intact. This particular aircraft spends a considerable amount of time at low level over the sea in a salt-laden atmosphere, and thus experiences an increased exposure to corrosion relative to conventional operations. However, the condition of the bearings was considered to have caused nothing worse than a slightly elevated level of aileron control forces throughout the range of movement.

The aircraft manufacturer similarly does not believe that the condition of the bearings were responsible for the reported restriction. Nevertheless, as a precautionary measure, they are proposing to issue a Service Bulletin (SB) that calls for a periodic inspection of the aileron and rudder bearings (the elevator bearings are already subject to regular inspections). The Aircraft Maintenance Manual will eventually be amended to reflect the intent of the SB.

INCIDENT

Aircraft Type and Registration:	Saab-Scania SF340A, G-RUNG
No & Type of Engines:	2 General Electric CT7-5A2 turboprop engines
Category:	1.1
Year of Manufacture:	1987
Date & Time (UTC):	28 December 2004 at 1618 hrs
Location:	Guernsey Airport, Channel Islands
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 3 Passengers - 7
Injuries:	Crew - None Passengers - None
Nature of Damage:	Nil
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	46 years
Commander's Flying Experience:	2,564 hours (of which 1,840 were on type) Last 90 days - 171 hours Last 28 days - 88 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft landed at Guernsey on Runway 27 following a flight from Jersey. After landing the commander attempted to turn off the runway at taxiway 'Charlie' but discovered that there was insufficient steering authority to complete the turn. The right main landing gear went onto the grass surface alongside the taxiway and sunk in as the aircraft came to a halt. There was no damage to the aircraft and the passengers were disembarked onto the taxiway.

The weather conditions were clear, the surface wind was from 320° at 15 kt and the runway surface was wet. The landing distance available on Runway 27 was 1,453 metres (4,767 feet), with the entrance to taxiway 'Charlie', a 90° turn, located at 1,070 metres (3,510 feet) on the left hand side.

Following the incident the aircraft was inspected by the contracted maintenance organisation. No fault was found with any of the aircraft systems. The commander attributed the loss of steering, as the aircraft left the runway, to his continuous use of brakes through the landing roll producing a reduced pressure in the hydraulic system, leading to a temporary loss of pressure to the nosewheel steering when he tried to use it. Then as the pressure recovered the nosewheel steering became effective, but too late for him to be able to maintain the taxiway.

The nosewheel steering is operated by a single hydraulic actuator and is controlled by a wheel mounted on the left seat pilot's side panel and spring loaded in the up position. To steer, the wheel must be pushed down to engage mechanically with the steering system and to complete the electrical circuit to open the steering shutoff valve. If the steering wheel is released it will extend into the disengaged position. When the nosewheel is deflected more than approximately 15° without the steering wheel being pushed down, it will lock in its present position and limit further deflection of the nosewheel.

ACCIDENT

Aircraft Type and Registration:	Beech 58 Baron, N80HC
No & Type of Engines:	2 Continental IO-520 piston engines
Category:	1.3
Year of Manufacture:	1975
Date & Time (UTC):	4 July 2005 at 1648 hrs
Location:	Wellcross Farm, Slinfold, West Sussex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Collapsed nose landing gear and slight damage to the tips of two of the right propeller blades
Commander's Licence:	FAA Private Pilot's Licence
Commander's Age:	63 years
Commander's Flying Experience:	1,607 hours (of which 108 were on type) Last 90 days - 28 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

History of the flight

The aircraft had completed an uneventful transit from Guernsey to Wellcross Farm, Sussex. The weather was good with isolated thunderstorms, one of which had recently passed over Wellcross Farm Airstrip. The runway had a short grass surface orientated 04/22, 650 m long by 40 m wide with an initial upslope on Runway 22. The weather on arrival was surface wind calm, visibility 10 km and broken cumulo-nimbus cloud at 2,000 ft.

The aircraft was configured with landing flap and gear down, and a normal approach was made to Runway 22 at an approach IAS of 80 kt. The aircraft touched down approximately 35 to 40 m from the threshold and because the runway slopes up at that point, braking was not initiated until approximately 200 m along the runway. Initially as the brakes were applied, the aircraft appeared to accelerate and despite modulating the application of the wheel brakes, the braking action was very poor. The pilot decided that it was too late to initiate a go-around so the braking was continued with little effect. It was apparent to the pilot that an overrun of the runway was inevitable and so he attempted to steer the aircraft to the right into an adjacent wheat field. During the turn the aircraft skidded sideways through about 110°. The pilot selected the mixture levers to CUT OFF and turned the magnetos to the OFF position. Shortly afterwards, the aircraft departed the right side of the runway where the nose landing gear entered a drainage ditch and collapsed. The aircraft came to rest and both occupants vacated the aircraft through the normal exit.

Landing performance data

The landing roll distance for the type is quoted to be 318 m (1,044 ft). This distance will apply to the aircraft landing at maximum weight on a hard, dry surface in still air conditions. CAA Safety Sense Leaflet No 12 ('Strip Sense') states that aeroplane performance must be appropriate for the proposed strip and that pilots using a strip must be fully familiar with the contents of Safety Sense Leaflet 7B (Aeroplane Performance) or AIC 12/1996 (Pink 120) 'Take off, Climb and Landing Performance of Light Aeroplanes'. The content of the Safety Sense Leaflet is available on the Internet from the CAA's website and within LASORs.

Analysis

The pilot considered that the accident occurred due to the poor runway friction and aquaplaning caused by the short wet grass and pools of standing water resulting from the recent thunderstorm.

Applying the cumulative performance factors listed in Safety Sense Leaflet 7B indicates that the practical required ground roll length was in the order of 591 m for level, wet grass on firm soil. Moreover, the initial upslope on Runway 22 would slightly reduce the length required but only if the wheel brakes were applied immediately after touchdown, which they were not. No factors are offered for a flooded runway surface or standing pools of water because the predicted increase in landing rollout is unquantifiable. Consequently, it was probably the partially 'flooded' condition of the strip that was the prime causal factor in this accident.

ACCIDENT

Aircraft Type and Registration:	DH82A Tiger Moth, G-ANEN
No & Type of Engines:	1 De Havilland Gipsy Major 1H piston engine
Category:	1.3
Year of Manufacture:	1942
Date & Time (UTC):	13 July 2005 at 1041 hrs
Location:	Goodwood Aerodrome, West Sussex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Engine shock loaded. Propeller and engine cowlings damaged. Underside of right wing punctured
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	72 years
Commander's Flying Experience:	18,522 hours (of which 47 were on type) Last 90 days - 16 hours Last 28 days - 11 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft over-pitched during the take-off run, resulting in the propeller striking the runway.

History of flight

During the take-off run, on Runway 24, the pilot raised the tail as normal; however, the aircraft then over-pitched and the propeller struck the grass runway. The pilot assessed the runway surface as smooth and the wind as 5 kt along the runway. The majority of the pilot's recent experience had been on aircraft equipped with a nose wheel. The pilot had flown approximately five hours on tail wheeled aircraft since the beginning of the year and his last flight on the Tiger Moth took place six weeks prior to the accident.

The pilot attributed the accident to his not centralising the elevator after the tail was raised.

ACCIDENT

Aircraft Type and Registration:	DH82A Tiger Moth, G-ANSM
No & Type of Engines:	1 De Havilland Gipsy Major 10 Mk1-1 piston engine
Category:	1.3
Year of Manufacture:	1942
Date & Time (UTC):	27 June 2005 at 1312 hrs
Location:	Peterborough (Sibson) Airfield, Cambridgeshire
Type of Flight:	Private (Training)
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Burst tyre, compression damage to right fuselage side frame
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	43 years
Commander's Flying Experience:	642 hours (of which 21 were on type) Last 90 days - 224 hours Last 28 days - 74 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Following an uneventful flight, the aircraft landed heavily with sufficient force to burst the tyre and damage the fuselage side frame.

History of flight

The pilot, who had been a flying instructor for 18 months, was instructing a student on a trial lesson in a Tiger Moth at Peterborough (Sibson) Airfield. The flight was uneventful and the pilot made a normal approach onto Runway 15 at a speed of around 55 to 60 kt. However, following the initial touch down, the aircraft bounced before landing heavily with sufficient force to burst a tyre and cause major compression damage to the right side fuselage frame. The wind at the time was assessed as light and variable.

The pilot had approximately 27 hours experience on tail wheeled aircraft, which he had gained in the previous three months and felt that the accident occurred because, on this occasion, his landing technique let him down.

ACCIDENT

Aircraft Type and Registration:	Europa XS, G-RMMT
No & Type of Engines:	1 Rotax 914 Turbo piston engine
Category:	1.3
Year of Manufacture:	2004
Date & Time (UTC):	21 May 2005 at 1200 hrs
Location:	1/4 nm north east of Tollerton Airport, Nottinghamshire
Type of Flight:	Test flight for Permit issue
Persons on Board:	Crew - 2 Passengers Nil
Injuries:	Crew - None Passengers N/A
Nature of Damage:	None
Commander's Licence:	Private Pilot's Licence
Commander's Age:	70 years
Commander's Flying Experience:	4,831 hours (of which 15 were on type) Last 90 days - 9 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot, examination of the aircraft by AAIB Inspector, further information supplied by UK agents for engine, examination of defective component by AAIB

Aircraft

The aircraft was built using a kit developed in, and supplied from, the UK. It was built by the owner at a dedicated kit aircraft completion centre in the USA, under their supervision, before being shipped back to the UK. The engine is a version of a widely used type, versions being available in both certificated and non-certificated form. The aircraft required a Permit to Fly in order to operate in the UK and although a certificated engine is not required it should be of a type and to a standard approved by the PFA.

The aircraft was being flown by a PFA approved test pilot, on conditions imposed by a 'Permit To Fly for Test Purposes', in order to carry out those tests required for the issue of a PFA Permit to Fly. The observer was the owner/ builder of the aircraft.

Flight Details

The pilot reported that he checked the documents and completed a thorough pre-flight inspection before briefing the observer. He decided to conduct two short circuit details for the purpose of familiarising himself with the aircraft and its onboard computer displays. Start up followed the procedure displayed on the onboard computer which was also referenced for the vital actions. The first sortie consisted of five uneventful circuits between 1000 hrs and 1035 hrs. The aircraft was then parked and the turbo-charger allowed to cool. The engine was shut down and the aircraft vacated before a walk around visual inspection was carried out.

A second circuit detail was then commenced; the first circuit was entirely normal. Whilst on the downwind leg of the second circuit power was reduced and the aircraft slowed, 10° of flap was selected and the aircraft turned onto the base leg at 70 kt in the approach configuration. The extended centre-line was intercepted at 500 ft and the aircraft was allowed to pass through it to enable an aircraft on the runway to commence its take-off roll. The Europa was then turned back onto finals as the other aircraft began its take-off roll and the throttle was opened to command more power in order to adjust the descent rate. The engine did not respond. The pilot instructed the observer to change the fuel selector onto the reserve position and switch on the secondary fuel pump. A MAYDAY was declared and although the engine continued to run, it did not respond to the throttle. A successful forced landing was carried out into a field.

Subsequent actions

The aircraft was de-rigged and recovered to Tollerton Airfield. It was noted that the temperature/humidity conditions at the time of the incident were highly conducive to carburettor icing although the possibility of such an occurrence, given the heating effect of the turbo-charger on the materials of the induction system, was considered to make such icing an unlikely cause for the problem.

A detailed examination was carried out and extensive ground running undertaken by the UK agent for the engine manufacturer. No fault could be reproduced. The PFA was contacted and the results of the tests fully described and discussed. Additional checks were conducted before further flying took place. In the absence of any defects being detected, a further test flight of one hour duration was completed. The engine functioned satisfactorily throughout this flight.

A series of further flights then took place. On returning to Tollerton from a subsequent flight, with the same two occupants aboard, the pilot was again unable to restore power following a period in the descent. He therefore carried out another successful forced landing into a field. The aircraft was de-rigged and moved to Tollerton.

Further investigation

During a more extensive examination, involving considerable dismantling of the engine, the UK agent for the engine type determined that the unit in question was equipped with an obsolete standard of stator for the dual ignition system. This had been the subject of a Service Bulletin described as Mandatory by the manufacturer and issued a number of years ago. It had been applied to all engines supplied to UK customers by the UK agent and to all other operators of the type known to be operating in the UK. The requirements of the Bulletin are understood to have been applied to all engines built and supplied subsequently.

The Bulletin was issued following the discovery that a particular insulated cable in the stator assembly was deteriorating in service allowing the two conductors within to short and leading to ignition failure at high power. The two conductors in question are routed to the two ignition cut out switches. It appears that the loss of insulation effectiveness occurs on engines after extensive running has allowed parts of the engine to sustain a significantly higher temperature than is normally reached during shorter engine runs. Cables of this type have been found, in service, to have soft, pliable insulation, differing considerably from their firm condition when new; the cable in G-RMMT was found to be in this condition. The reason for this deterioration is not fully understood.

The Bulletin required all stators to be replaced with a modified design supplied free as an exchange component. The later design uses two separate individually insulated cables having a different insulation material.

Turbocharged versions of the Rotax 914 engine used in Europa aircraft kits supplied to the USA must be sourced from suppliers/agents in that country; they do not form part of the kits shipped from the UK. The precise history of the engine in G-RMMT before it was installed in the airframe during build and before being shipped to the UK from the USA has not been established.

ACCIDENT

Aircraft Type and Registration:	Jabiru UL-450, G-LEEE
No & Type of Engines:	1 Jabiru Aircraft Pty 2200A piston engine
Category:	1.3
Year of Manufacture:	2000
Date & Time (UTC):	8 June 2005 at 1230 hrs
Location:	Private airstrip, Burton-on-Wirral, Cheshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Left and right main landing gear, nose leg, propeller, engine and cowling, fuselage and left wing
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	41 years
Commander's Flying Experience:	636 hours (of which 30 were on type) Last 90 days - 7 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

History of the Flight

The aircraft was taking off from a private airstrip whose runway was orientated east-west. The runway was 550 m long, 5 m wide and its grass surface was dry. The airstrip was surrounded to the east, west and south by woods, which encroached to within 50 m of the upwind end of Runway 27; the trees were estimated to be about 24 m high. The surface wind, assessed from the windsock at the airstrip, was 270º-300º at 6 kt; the visibility was in excess of 10 km and there were a few clouds at an altitude of 3,500 ft amsl. The temperature and dew point, as recorded at Liverpool Airport, 7 nm to the north-east, were +20º C and +8º C respectively. Before beginning the takeoff on Runway 27 the pilot carried out a power check, including the functioning of the carburettor heat control, and all the engine indications appeared to be normal.

Acceleration during the take-off roll felt normal but the pilot reported that the aircraft lifted off, at about 50 kt, further down the runway than usual. Thereafter the aircraft's acceleration and rate of climb 'did not feel right', although the engine rpm was indicating take-off power. Mindful of the trees at the upwind end of the runway the pilot decided to land immediately. He reduced the power to idle but reported that he misjudged the flare and the aircraft, having drifted to port, landed on its left main landing gear in long grass at the side of the runway. The left main landing gear collapsed as the aircraft ground looped to the left and the nose leg detached in the process. The propeller struck the ground and the aircraft came to a stop facing south. The pilot exited through the left door, uninjured. The grass on the runway had been cut about three days before and was reported to be about three inches long. The grass at the side of the runway was estimated to be about nine inches in length.

The pilot commented that G-LEEE was usually airborne at an indicated airspeed of about 50 kt after a take-off roll of approximately 150 m and that, from his perspective, it had to 'feel' established in the climb by about 300 m. He considered that, on this occasion, the surface wind speed may have dropped giving rise to the aircraft's seemingly reduced rate of climb. He concluded that his concern about this, coupled to misjudgement of the flare and lack of appreciation of the drift to the left, had caused the accident.

Civil Aviation Publication (CAP) 428, entitled '*Safety Standards at Unlicensed Aerodromes*' states, in its introduction, that it:

> *'provides guidance to the owners and operators of unlicensed aerodromes on the physical standards that should be met and the facilities that should be provided in order that the aerodrome may be used safely by those pilots wishing and permitted to use it.'*

Later, on the subject of the *'Physical Characteristics of the Aerodrome',* it states that:

> *'there are certain minimum physical characteristics which it is important to meet if potential flying hazards are to be minimised.'*

The publication gives recommended minimum dimensions for runways and runway strips. For runways less than 800 m in length (short runways), it advocates a minimum width of 18 m. It also provides guidance on obstacle clearance in the vicinity of the approach and departure flight paths. For short runways it specifies a slope of 1 in 20, originating from the end of the airstrip, out to a distance of 1,600 m on the extended centreline, through which obstacles should not penetrate. Lateral dimensions for these obstacle limitation 'surfaces', as they are described, are also provided.

Advice on factors to consider when assessing an aircraft's take-off performance is given in General Aviation Safety Sense Leaflet number 7B, entitled *'Aeroplane Performance'*.

ACCIDENT

Aircraft Type and Registration:	MCR-01 Club Banbi, G-LMLV
No & Type of Engines:	1 Rotax 912 ULS piston engine
Category:	1.3
Year of Manufacture:	2000
Date & Time (UTC):	21 May 2005 at 1030 hrs
Location:	Nayland Airfield, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Undercarriage leg and flap mount broken
Commander's Licence:	Private Pilot's Licence
Commander's Age:	55 years
Commander's Flying Experience:	370 hours (of which 73 were on type) Last 90 days - 21 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot carried out a flight between Cambridge and Nayland Airfield. On arrival at Nayland, where the forecast wind was 090/13 kt, he assessed the conditions and made an approach to Runway 32. This runway is 600 m (1,968 ft) in length, and is undulating with an overall steep upslope; the grass surface was wet.

The pilot reported that as he landed a squall in the area caused an increase in the wind speed. He was unable to stop the aircraft before the end of the runway so deliberately ground looped to avoid going through the hedge.

ACCIDENT

Aircraft Type and Registration:	MCR-01 ULC Banbi, G-NONE
No & Type of Engines:	1 Rotax 912S piston engine
Category:	1.3
Year of Manufacture:	2004
Date & Time (UTC):	26 June 2005 at 1310 hrs
Location:	Bolt Head Airfield near Salcombe, Devon
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Right landing gear leg collapsed, nose leg bent, right flap damaged and general minor damage
Commander's Licence:	Private Pilot's Licence
Commander's Age:	58 years
Commander's Flying Experience:	248 hours (of which 21 were on type) Last 90 days - 21 hours Last 28 days - 21 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

History of the flight

The pilot and his passenger took off from Branscome Airfield near Exeter at approximately 1230 hrs for a flight of about 30 minutes to Bolt Head Airfield, near Salcombe. Based on observations of the wind sock positioned on the airfield at Bolt Head, the pilot estimated the wind for landing was from the north-east at between 10 and 20 kt. The airfield consisted of a single grass runway which at the time of the accident had a tall crop of barley running along either side of the runway's edge.

The pilot landed on the into-wind runway, Runway 11, after what he described as a bumpy approach due to the windy conditions. He touched down on the centreline but the aircraft then started to veer to the left, weather-cocking into the wind. The pilot attempted to straighten the aircraft by use of the rudder but despite using full right rudder he was unable to prevent the left wing tip clipping the crops on the left-hand edge of the runway. This swung the aircraft left through about 100°, bringing it to rest just off the runway, with the engine stalled. During the rapid deceleration the right main gear collapsed, damaging the right-hand flap as the wing hit the ground. The pilot made the switches safe before he and his passenger were able to vacate the aircraft in the normal manner, with no injuries.

Meteorological information

The nearest airports to Bolt Head are Exeter and Plymouth. At 1220 hrs the METAR for Exeter Airport stated that the surface wind was 080°/08 kt and 30 minutes later it was 040°/08 kt. The equivalent recordings for Plymouth Airport were 070°/10 kt and 060°/09 kt. However, at both airports the wind direction became variable after 1150 hrs; at Exeter it varied between 060° and 130° whereas at Plymouth it varied between 010° and 120°. There was scattered cumulus cloud in the region at 3,500 ft and the 2,000 ft wind was approximately 090°/15 kt.

Pilot's assessment

The pilot believed his inability to keep the aircraft straight was compounded by it being light on its nosewheel, which possibly resulted in the steering remaining in the straight ahead locked position.

ACCIDENT

Aircraft Type and Registration:	Piper J3C-65 (Modified) Cub, G-BPVH
No & Type of Engines:	1 Continental C90-12F piston engine
Category:	1.3
Year of Manufacture:	1946
Date & Time (UTC):	17 July 2005 at 1430 hrs
Location:	Frieslands Farm Airstrip, Sussex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Minor) Passengers - 1 (Minor)
Nature of Damage:	Substantial
Commander's Licence:	Private Pilot's Licence
Commander's Age:	69 years
Commander's Flying Experience:	247 hours (of which 129 were on type) Last 90 days - 5 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot was carrying out his second flight of the day, a sightseeing trip. Weather conditions were clear, the surface wind was from 230° at 6 kt with occasional gusts. On returning to the airstrip he made an approach to Runway 06 which has a grass surface, is 650 m long and has a pronounced upslope averaging at 2·8° along its length.

The pilot was familiar with the airstrip and commented that sink can be expected at short finals on the approach to this runway. In view of this and the tailwind he allowed himself an extra margin of speed for the approach. On final approach the aircraft started to sink so he applied full throttle in an attempt to correct it, but the main wheels caught in a standing crop short of the threshold. The aircraft pitched nose down and flipped over before coming to rest some 12 m along the runway.

The pilot and his passenger were both able to escape from the aircraft unassisted and with only minor injuries.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-140 Cherokee, G-BRPL
No & Type of Engines:	1 Lycoming O-320-E3D piston engine
Category:	1.3
Year of Manufacture:	1972
Date & Time (UTC):	5 March 2005 at 1438 hrs
Location:	Blackpool Airport, Lancashire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Nosewheel and propeller damaged.
Commander's Licence:	Commercial Pilot's Licence with Instructor Rating
Commander's Age:	40 years
Commander's Flying Experience:	510 hours (of which 411 were on type) Last 90 days - 16 hours Last 28 days - 8 hours
Information Source:	Aircraft Accident Report Form submitted by the commander and subsequent enquiries by the AAIB

History of flight

The instructor arrived at Blackpool Airport at about 0800 hrs where he worked part-time for a flying club. He stated that he checked the weather forecast before undertaking about four or five training flights with various students. The last of these flights landed at about 1350 hrs.

The instructor then departed at 1410 hrs on a further training flight with another student who was on about his sixth training flight. The instructor stated that at the time of departure, the weather information broadcast on ATIS gave a wind of 330°/15 kt. The instructor was the handling pilot and after takeoff, he became aware of a heavy shower in the vicinity, which he avoided until it had passed the airfield. Due to the absence of a suitable visible horizon to conduct the intended exercises, the instructor decided to curtail the lesson and return to the airport.

Blackpool ATC reported the wind for landing was "northerly at 21 kt gusting to 38 kt". The instructor believed that this referred to the wind being generally northerly; he did not appreciate that the wind was from 360°, the information that ATC had intended to convey. He continued the approach but when he flared the aircraft for touchdown, he reported that a gust carried the aircraft across the runway, at which point he initiated a go around. Almost immediately the left wing touched the runway and the aircraft landed heavily on its nosewheel, causing it to collapse. The propeller struck the ground and the aircraft veered to the right coming to rest on the runway.

Neither pilot was injured and both vacated the aircraft normally having first switched off the fuel and electrics.

Weather

Reproduced below (Table 1) are the encoded actual and forecast weather conditions for Blackpool Airport on the day of the accident.

Wind limits

The flying club placed a maximum wind limit for flying operations of 40 kt with a maximum demonstrated cross wind published for the aircraft type of 17 kt.

Analysis

Throughout the day the weather forecast included a surface wind of 18 kt from a direction between 330° and 340°, gusting to between 28 and 30 kt. The actual conditions revealed by the METARs are of a wind speed of between 13 and 21 kt from a direction of between 310° and 360°. Gusts of between 26 to 30 kt were recorded at 1150 hrs, 1350 hrs and 1450 hrs. These are, however, only snapshots of the weather every half hour and do not reveal to what extent, if any, the wind was gusting between these reports.

Having checked the morning's forecast the instructor then relied upon his personal observation of the weather throughout the morning, together with listening to the airport ATIS to remain updated. Because the wind was generally not as gusty as forecast, the instructor was happy to continue with the training flights. Runway 31 was in use which also meant that the forecast wind direction of 330° to 340° would not present an excessive crosswind, even in gusts of up to 30 kt.

However, at the time he landed prior to the accident flight, the METAR gave the wind as 350°/19 kt gusting to 29 kt. It might well be expected that at this point the instructor was aware of the strong wind conditions and that the wind direction had veered towards the north. The turn round time before his next departure was short and not long after his reported take off time the wind had veered even further to the north, presenting a crosswind only 2 kt below the maximum demonstrated capability of the aircraft.

METAR
0750Z 31014KT 9999 FEW030 SCT050 04/M03 Q1013
0820Z 33013KT 9999 FEW030 SCT050 05/M03 Q1013
0850Z 33015KT 9999 FEW030 SCT050 05/M04 Q1013
0920Z 32017KT CAVOK 05/M03 Q1013
0950Z 33017KT CAVOK 05/M04 Q1013
1020Z 32016KT 9999 FEW035 SCT050 06/M03 Q1012
1050Z 32018KT 9999 FEW035 SCT050 06/M03 Q1013
1120Z 32016KT 9999 FEW035 SCT050 06/M04 Q1012
1150Z 32016G26KT 9999 FEW035 SCT050 06/M03 Q1012
1220Z 32015KT 9999 FEW035 SCT050 06/M03 Q1012
1320Z 34020KT 9999 VCSH FEW035 BKN045 07/M03 Q1012
1350Z 35019G29KT 9999 -RA FEW035 BKN045 07/M04 Q1012=
1420Z 36021KT 9999 FEW035 SCT045 07/M03 Q1013=
1450Z 35019G30KT 9999 VCSH FEW035 SCT045 06/M01 Q1013=

TAF
050716 33018G28KT 9999 SCT025 BKN050 PROB30 TEMPO 1316 6000 SHRA=
051019 34018G30KT 9999 SCT030 TEMPO 1518 6000 –SHRASN=
051322 34018G30KT 9999 SCT030 TEMPO 1518 6000 -SHRASN=

Table 1

Encoded actual and forecast weather conditions for Blackpool Airport on the day of the accident

The heavy shower reported by the instructor was not forecast and sensibly he chose to avoid it. On returning to the airfield the instructor misinterpreted the wind information passed to him by ATC, believing the term "northerly" was a general indication rather than a precise direction of 360°. At the time he missed the fact that the crosswind in gusts potentially exceeded the maximum demonstrated figure by some 10 kt. It was unfortunate that the aircraft was subject to just such a gust as it was about to touchdown. The decision to go around, whilst prudent, possibly compounded the problem due to the yawing effect of applying full power acting in the same direction as the wind.

Conclusion

The instructor did not fully appreciate the weather conditions in which he was operating and he did not fully understand, or properly interpret, the surface wind information available to him. He attempted to land in crosswind conditions that were most probably beyond the maximum demonstrated for the aircraft type and in so doing he forfeited full control of the aircraft.

ACCIDENT

Aircraft Type and Registration:	Rans S6-ESD XL (Modified), G-MZNV
No & Type of Engines:	1 Rotax 503-2V piston engine
Category:	1.3
Year of Manufacture:	1998
Date & Time (UTC):	8 May 2005 at 1645 hrs
Location:	1 mile NE of Kingsclere Mast, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Right cockpit door detached in flight, minor damage to right wing and tailplane
Commander's Licence:	Private Pilot's Licence
Commander's Age:	53 years
Commander's Flying Experience:	350 hours (of which 303 were on type) Last 90 days - 8 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The lock nut on the right door forward attachment/hinge bolt came off, allowing the bolt to migrate out and the door to fall from the aircraft. The door struck the airframe damaging the underside of the right wing and leading edge of the tailplane.

History of flight

Ten minutes after departing Brimpton Airfield, the pilot heard a loud bang and the right door disappeared. The aircraft was slowed to 60 mph and, as the handling felt normal, the pilot informed Brimpton of the situation and returned to the airfield where he made an uneventful landing.

Inspection

The aircraft is constructed from a tubular frame covered in fabric. Two tears were discovered in the fabric after this event, one approximately 50 mm in length on the underside of the right wing, the other approximately 20 mm long in the fabric covering the leading edge of the right tailplane. The forward door hinge (Figure 1), which is welded to the tubular airframe, was undamaged, whereas the rear door hinge had broken off. Whilst the lock nut for the door forward attachment bolt was found on the cockpit floor, the attachment bolt itself, the right door, its rear hinge, attachment bolt and lock nut were never recovered. The aircraft owner stated that the door attachment bolts, which had been supplied by the manufacturer with the aircraft construction kit, had never been disturbed since the aircraft was built 322 flying hours prior to the incident. The owner, however, did recall that he had fitted additional washers between the hinge and door assembly in order to reduce excessive sideways movement of the door.

Following the incident the owner checked the security of the door attachment bolts on the left door and discovered that the protruding part of the bolt was almost flush with the end of the lock nut. The owner further stated that the door attachment bolts on three other Rans S6 aircraft at Brimpton were in a similar condition. The Popular Flying Association (PFA) subsequently undertook a random check of 10 aircraft and established that on nine, the correct door attachment bolts had been used with the thread protruding through the lock nuts by approximately six mm. Shorter bolts had been used on the tenth aircraft; however, the bolts still protruded through the lock nut by approximately one and half threads, which the PFA considered to be acceptable.

Analysis

The presence of the nut on the cockpit floor, and undamaged front door hinge, indicated that the nut had come off the door attachment bolt thereby allowing the bolt to migrate from the hinge and door assembly. As the door would not now be attached at the forward position, air pressure would most likely have caused the door to move upwards and outwards, allowing the front door catch to unlatch. The door would then have continued to pivot about the rear hinge and latch, until the hinge failed and the door fell from the aircraft.

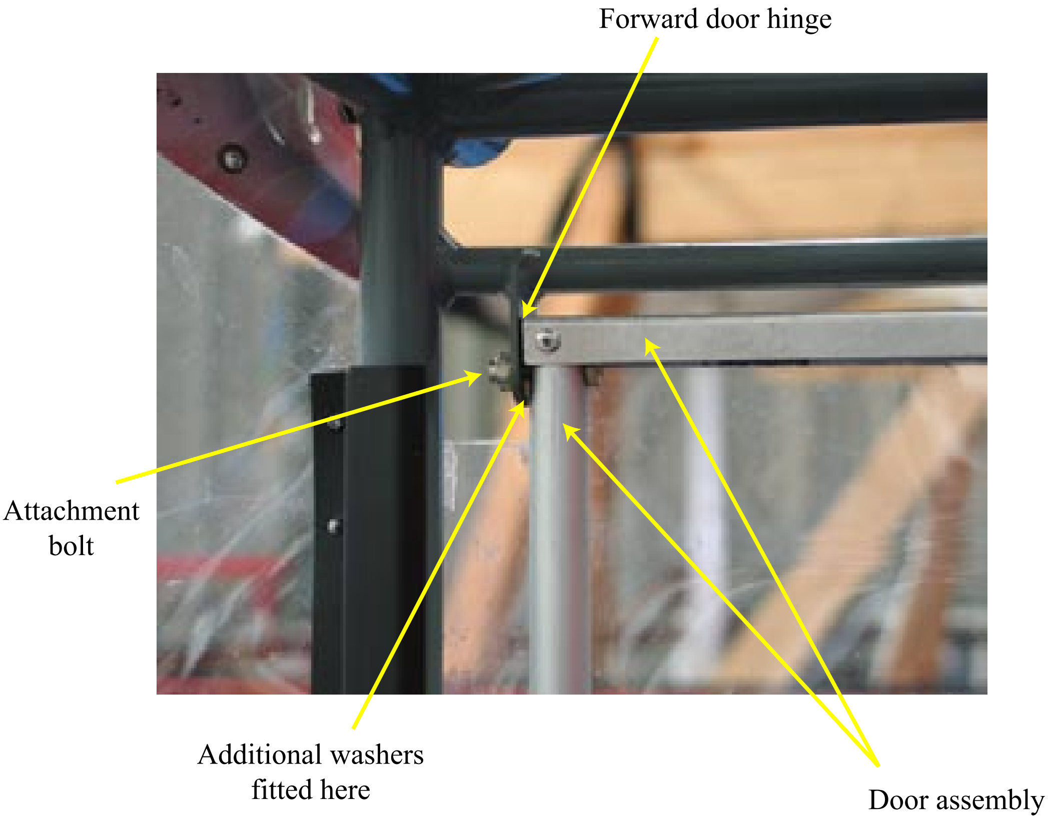

Figure 1
Door attachment arrangement on a similar aircraft

It was not possible to determine why the lock nut came off the front attachment bolt. The condition of the bolts on the left door suggests that the front attachment bolt on the right door might not have protruded through the lock nut sufficiently to ensure positive locking. Assuming that the correct length bolts were used, the need to fit additional washers to take out excessive sideways movement of the door suggests that the accumulation of manufacturing tolerances was such that the distance between the front and rear hinges might have been close to the acceptable limit, reducing the amount of thread that would protrude through the lock nuts. Nevertheless, it was still incumbent on the individual assembling the aircraft and the Inspector undertaking the stage inspections to check that the bolts were 'in safety'. Since this incident, the PFA has authorised the owner to fit longer bolts that are secured with a castellated nut and split pin. The PFA has also taken action to advise its members, via the Association's magazine, of the dangers of not ensuring that nuts and bolts are fitted correctly.

ACCIDENT

Aircraft Type and Registration:	Reims Cessna F152, G-IBRO
No & Type of Engines:	1 Lycoming O-235-N2C piston engine
Category:	1.3
Year of Manufacture:	1985
Date & Time (UTC):	3 March 2005 at 0905 hrs
Location:	1 km north of Runway 04, Leicester Airport, Leicestershire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 2 (Minor) Passengers - N/A
Nature of Damage:	Damage to right main and nose landing gear, propeller, tail fin, elevator, wings, both forward door posts and engine cowling
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	64 years
Commander's Flying Experience:	5,724 hours (of which 3,626 were on type) Last 90 days - 117 hours Last 28 days - 33 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

The training flight was to commence with a demonstration, by the instructor, of the procedure for an engine failure after takeoff (EFATO). He had briefed that after closing the throttle he would carry out touch drills for the exercise rather than complete the actual selections, with the exception that he would operate the carburettor heat and the flaps. The student, who was sitting in the left seat, had been pilot flying (PF) for the takeoff and the instructor had taken control during the climb out. Before taking control the instructor advised ATC of the practice 'fan stop' and that he would call 'climbing away'. The demonstration then commenced when the aircraft was at about 700 ft above airfield level (aal).

The instructor closed the throttle, selected the carburettor heat to 'hot' and, with the aircraft descending at 65 kt IAS, carried out the touch drills, announcing each item out loud. He reported that he then selected full flap because the aircraft was slightly high for an approach to the field which he had nominated. The speed was reduced to 55 kt IAS; the instructor selected the carburettor heat to 'cold' and opened the throttle to commence a go-around, however the engine did not respond. The instructor operated the throttle gently twice more, without success, and checked the correct setting for the mixture control. He transmitted a MAYDAY call and carried out a forced landing into the ploughed field that had already been nominated, avoiding a set of telegraph wires in the process. The aircraft bounced about 10 ft into the air, landed again on its nose wheel, flipped forwards and came to rest inverted.

Having checked that the student was alright, the instructor asked him to turn off the master switch and ignition switch, because he, the instructor, was unable to reach them from his position. The instructor turned off the electrics and the fuel cock. They then exited the aircraft through the doors, which they had opened prior to striking the ground, having sustained only minor injuries. The aircraft was extensively damaged but did not catch fire. The crew borrowed a mobile telephone from the driver of a car parked nearby and informed their flying club of the accident. The instructor later recalled that when he exited the aircraft he did not have to climb over the flaps, indicating that they had remained retracted and not travelled to the fully extended position, as selected.

During a subsequent discussion about the accident the student informed the instructor that he had switched the ignition switch to OFF during the touch drills. The instructor had not seen the student take that action but he believed that the master switch may also have been switched off at the same time, because the flaps had not travelled to the selected setting before the forced landing and his MAYDAY transmission had, apparently, not been heard by Air Traffic Control. The student's recollection was that he had not turned the master switch off until they were on the ground, hanging upside down in their seats.

Two days before the accident the instructor had given the student the flying club handouts for the exercises which they were due to complete during the flight and had briefly run through what they would entail. He reported that immediately prior to the flight he gave the student a comprehensive briefing on EFATOs and Go Arounds as well as reviewing the handouts for these exercises. He also explained that after the student had completed the takeoff he would take control and demonstrate an EFATO, before handing control back to the student, who would fly a normal circuit until late on the approach when the instructor would again take control and demonstrate a 'Go Around'. The instructor stated that he fully briefed the EFATO emergency procedure, clearly indicating that these would be touch drills, so that the student would subsequently get practice at touching the appropriate controls. The exceptions were that the carburettor heat and flaps would be operated.

The student, who had completed just under eight hours of instruction before the flight, commented that he had found it hard to fly the aircraft and listen to the instructor at the same time and that he had not been clear what to do during the exercise. He had not understood that the exercise would only involve touch drills, which was why he had turned off the Ignition Switch during the EFATO. The instructor stated that it was his intention for the student to carry out the EFATO exercise and associated touch drills after the go around at the end of the first circuit.

It seems that after the briefing for the exercise, which the instructor described as comprehensive, the student, who was at a very early stage of his flying training, was still unclear about the intended procedures during the flight.

ACCIDENT

Aircraft Type and Registration:	Tri-R-Tech Tri Kis, G-BVZD	
No & Type of Engines:	1 Continental IO-240-B1B piston engine	
Category:	1.3	
Year of Manufacture:	1995	
Date & Time (UTC):	10 July 2005 at 1400 hrs	
Location:	Boscombe Down Airfield, Wiltshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Nosewheel burst, propeller damage, engine cowling distorted, tail skid broken, lower rudder damage	
Commander's Licence:	National Private Pilot's Licence	
Commander's Age:	64 years	
Commander's Flying Experience:	405 hours (of which 113 were on type) Last 90 days - 10 hours Last 28 days - 3 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

Returning from a flight to Leicester the aircraft was on approach to Runway 05 in good weather with a wind from 060° at 10 kt. During the flare the aircraft stalled at approximately two to three feet above the runway resulting in the aircraft touching down heavily on its tail and main gear. The aircraft bounced twice resulting in the nosewheel bursting and the propeller tips striking the runway surface. Despite the damage the pilot was able to taxi the aircraft off the runway and back to the flying club.

In a candid report the pilot admitted that he allowed the airspeed to reduce too low during the flare.

ACCIDENT

Aircraft Type and Registration:	Tucker DG Taylor Titch, G-VIVI
No & Type of Engines:	1 Continental Motors Corp O-200-A piston engine
Category:	1.3
Year of Manufacture:	1999
Date & Time (UTC):	2 July 2005 at 1045 hrs
Location:	Great Oakley Airfield, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	1,400 hours (of which 200 were on type) Last 90 days - 25 hours Last 28 days - 15 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot prepared to take off for a local flight by backtracking and then positioning the aircraft on the right hand side of grass Runway 22. The surface wind was estimated as varying between 220° and 260° at a maximum of 15 kt. After a very short take-off roll, the aircraft became unexpectedly airborne, possibly as a result of a gust of wind from the right. In response to this the pilot pushed the control column forward to raise the tail and thereby allow forward vision. The aircraft was drifting to the left and although full right rudder and some aileron was applied, directional control could not be established. At this point the aircraft was flying at less than 45 mph and started to roll right so the pilot reduced the amount of right aileron and rudder. The aircraft continued to drift left at about 5 ft above the ground until the left wheel caught in the tops of a rape crop which was growing to the side of the runway. The aircraft then descended rapidly nose first into the crop and flipped inverted. The pilot, who was wearing a lap and diagonal harness, was able to escape uninjured by climbing out of the left hand side where the fuselage had been destroyed.

ACCIDENT

Aircraft Type and Registration:	Yak C11, G-YCII
No & Type of Engines:	1 ASH 21 piston engine
Category:	1.2
Year of Manufacture:	1945
Date & Time (UTC):	1 June 2005 at 1150 hrs
Location:	North Weald Aerodrome, Essex
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - Nil
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	One propeller blade badly damaged; engine shockloaded. Damage to left wing leading edge and left flap
Commander's Licence:	UK Basic Commercial Pilot's Licence with Instructor Rating
Commander's Age:	26 years
Commander's Flying Experience:	882 hours (of which 1 was on type) Last 90 days - 12 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and telephone enquiries by the AAIB

Synopsis

Whilst conducting his first flight on type with an experienced Yak pilot in the rear seat, the aircraft ended up low on final approach on three successive circuits, on each occasion shortly after selecting the flaps. On the last approach, the aircraft clipped the top of a tree, causing the left flap linkage to fail, but the aircraft landed safely.

History of the flight

The pilot was on his first flight in a Yak C11 and, prior to flight, had been briefed by an experienced Yak pilot who would fly with him. The aircraft is a descendant of a World War 11 Russian fighter aircraft having tandem seating and a tailwheel configuration.

It was agreed that the pilot on his first flight would sit in the front seat for the flight from a private site in Kent to North Weald Airfield; both pilots had previously flown from North Weald. The front seat pilot was the commander for the flight. The initial part of the flight was uneventful with the commander carrying out some slow speed handling, including stalls. However, he was aware that the aircraft felt very different to any he had flown before and he was finding it a high workload; he commented as such to the other pilot.

On arrival at North Weald Airfield, the commander joined the circuit for Runway 20. The weather was good with a surface wind of 210°/ 14 kt. There are no visual approach aids at North Weald and pilots need to rely on familiarity and runway perspective. During the first circuit, the commander considered that the aircraft was too low during his base leg and went around from finals. On the next circuit for a planned touch-and-go, shortly after selecting flap, he found himself low again. His approach was relatively flat but he achieved a normal landing. Then, after taking off for the next circuit he experienced a sink rate close to the ground just after retracting flap; the flap on the Yak C11 has only two positions, fully up or fully down. At this stage, the commander was not comfortable with the way he was flying the aircraft and expressed his intention to the other pilot that he would land off the next approach. However, this initiated a short discussion about the need to gain as much experience as possible from each flight and the commander decided to carry out another touch-and-go; the recollection of the rear seat pilot was that the commander was going to complete a full stop landing. After turning from base leg to final approach, the commander selected flap and was again aware that he was getting low on approach. He added power but not enough to arrest a developing sink rate and, on short finals there was a loud noise and the aircraft started to drift to the left. The rear seat pilot had seen leaves coming over the top of the left wing and took control. He regained the runway heading and then passed control back to the commander, who carried out the landing. It appeared that the aircraft had struck the top of a tree on short finals and, amongst other damage, this had caused the left flap linkage to break resulting in asymmetric flap.

Additional information

On reflection, the commander considered that he should not have continued with the flight after his misgivings. Additionally, he had expected that he would have received more input from the rear seat pilot. However, the rear seat pilot stated that he was not an instructor and that this was his first flight in the rear seat of the aircraft. The visibility from the rear seat of the Yak C11 is very poor. The rear seat pilot also commented that he had previously flown with the commander on the commander's early flights on a Harvard aircraft and had been favourably impressed. On reflection, he considered that this may have influenced his approach to the conduct of the flight.

The CAA produce an Aeronautical Information Circular (AIC) 4/2003 titled 'Piloting old aircraft and their replicas'. The final paragraph provides the following good advice:

> *'Before you start to fly any aeroplane with which you are not familiar, and especially when the design is that of an earlier generation than the one on which you were trained, find out all that you can about it. The flying qualities, the feel of the controls, the unusual cockpit arrangement and unexpected operation of the systems, all conspire to unnerve and reduce the effectiveness of an unfamiliar pilot. Talk first to someone who is used to flying the aeroplane. Finally do not be too proud to arrange, whenever possible, a proper flight demonstration and check by someone who is competent on a strange type. Such aeroplanes can be unforgiving towards pilots who are insensitive to their peculiarities.'*

Analysis

It was apparent that the commander was surprised by certain aspects of the handling qualities of the YAK C11. For example, on three successive circuits he ended up low, shortly after selecting flap. This probably resulted from not applying sufficient power to counter the effect of flap. However, the use of a rectangular circuit rather than an oval circuit, together with the limited forward visibility from the cockpit, may have affected his visual perception of the correct approach angle. Additionally, he appeared surprised by the effect of retracting flap after a touch-and-go.

Although the commander was accompanied by an experienced Yak pilot, the ability of the rear seat pilot to provide assistance in the air was very limited by the rear seat view, particularly during circuits. This effectively meant that the rear seat pilot was not in a position to land the aircraft when the commander expressed his concern about his performance. The rear seat pilot did take control, but only when he became aware that the aircraft had struck a tree and then handed control back for the landing.

While the pilots had taken some sensible precautions for the flight, it appeared that the commander did not have sufficient information on the aircraft and related operating procedures to safely complete the flight. Notwithstanding the poor visibility from the rear seat, a flight in the rear seat to observe a type experienced pilot would have been a more sensible option prior to making his first flight on the type.

ACCIDENT

Gyroplane Type and Registration:	Ken Brock KB-2, G-BUYT
No & Type of Engines:	1 Rotax 582 piston engine
Category:	2.3
Year of Manufacture:	1993
Date & Time (UTC):	15 December 2004 at 1410 hrs
Location:	Sutton Bank, Thirsk, North Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Extensive
Commander's Licence:	Private Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	3,350 hours (of which 33 were on gyroplanes and 12 were on type) Last 90 days -12 hours (0 on type) Last 28 days - 3 hours (0 on type)
Information Source:	AAIB Field Investigation

Synopsis

Shortly after takeoff from a grass strip at Sutton Bank Airfield, the gyroplane developed a nose low attitude and descended over the edge of an escarpment. Its engine noise was heard to reduce and a 'crunch' noise was heard by witnesses as it began its descent. The wreckage of the gyroplane was discovered at the base of the escarpment where the pilot had been fatally injured.

History of flight

The gyroplane had been flown to the Yorkshire Gliding Club's site at Sutton Bank by its co-owner on the morning of the accident. After this 12 minute flight, the gyroplane was shut down and parked outside. During the morning, the pilot had flown one gliding instructional flight and three aero towing flights. After lunch, the co-owner started the gyroplane's engine whilst the pilot prepared himself for his flight, the purpose of which appears to have been to maintain currency. The gyroplane was not refuelled and it is estimated that there was 2.5 gallons of fuel on board. Prior to takeoff, the pilot was observed to check full and free control movement and perform a normal pre-rotate on the rotorblades. A witness also noticed the rotor moved to full aft; the normal position at the start of the take-off roll. The gyroplane took off from the south-westerly grass strip, becoming airborne after approximately 200 m and maintained a very low height for a short period before climbing away. It appeared that the gyroplane had climbed no higher than 20 ft when its pitch attitude abruptly changed to nose low and it began to descend. There was no sign of any pilot induced oscillation. This descent continued below the upper edge of the escarpment at the end of the grass strip and out of site of witnesses. One witness reported hearing a 'crunch' as the gyroplane began its descent and several witnesses believed they heard the engine noise reduce at about the same time. The gyroplane crashed on a footpath below the escarpment shortly afterwards, fatally injuring the pilot.

Meteorology

An aftercast from the meteorological office indicated that at the time of the accident there was a light north-westerly wind, excellent visibility and little cloud cover. There would have been rising air coming up the face of the escarpment but this was unlikely to have been of sufficient strength to give the pilot handling problems with the gyroplane.

Pathology

The pathological examination of the pilot revealed that he died from multiple injuries. No evidence was found of any disease, alcohol, drugs or toxic substances which could have caused or contributed to the cause of the accident. The pilot weighed in excess of 100 kg.

Accident site

The accident site was located between Roulston and Ivy Scar, which are just on the south-western side of the Yorkshire Gliding Club's airfield which is located on the top of Sutton Bank. The gyroplane had crashed on a footpath approximately 205 ft below and 100 m from the Cleveland Way, a National Trail public footpath which runs along the upper edge of Sutton Bank ridge. The area between the accident site and the almost vertical cliff that leads up to the Cleveland Way is gently sloping undulating land sparsely covered with small to medium sized trees, bushes and rock outcrops. The land in the area to the south and west of the accident site slopes downwards and is densely covered with substantial trees for approximately 1.2 km. Approximately 350 m to the north-west of the accident site and 320 ft below it are open cattle grazing fields.

Impact parameters

The gyroplane's initial impact was with the top of a medium sized tree located approximately 15 m to the east-north-east from where the wreckage finally came to rest. It was not possible to determine, with any degree of confidence, which part of the gyroplane made initial contact with the tree. At the time of this contact, it is estimated that the gyroplane was on a heading of about 250°M, flying at a speed of about 20 mph and descending at around 150 ft per minute. After the initial tree contact, it continued descending on a general heading of 250°M and struck the trunks of two more medium sized trees, which caused major damage to the structure of the gyroplane. It then impacted the ground with a high decent rate, slow forward speed, banked to the right and pitched nose down. The force of this ground impact failed both the lateral and longitudinal beams which, together with the rotor mast, form the main structural elements of the airframe. A small tree was dragged by the tail of the gyroplane, which came to rest on top of the wreckage. All the parts of the gyroplane, except the fixed horizontal stabiliser, were present at the accident site but photographs taken during the takeoff on the accident flight showed that the horizontal stabiliser had not been fitted. Evidence indicated that the propeller was being driven at low power by the engine at the time of the ground impact. The morning following the accident, when the wreckage was examined by the AAIB, there was a smell of fuel around the wreckage, but the seat/fuel tank was empty. This had been ruptured during the ground impact sequence, the rupture being located at the lowest point of the tank in its as found attitude, and hence any fuel contained prior to the accident would have drained away. The fuel cock fitted between the seat/fuel tank and the engine was found to be selected in the ON position.

Wreckage examination

The wreckage was inspected both on-site and at the AAIB facility at Farnborough. Examination of the flying control system found no evidence of disconnections but there was evidence, in the form of witness marks, of a restriction to the motion of the left cyclic control rod, in the area where this rod runs next to the left-hand end of the seat frame support crossbar. This is located at the lower rear edge of the seat, see Figure 1. These marks had the appearance of having recently occurred, but it was not possible to determine if the restriction came about before or during the impact sequence.

The main rotor blades showed that, at impact, they were rotating with low energy and there was no evidence to indicate that they had struck the rear of the gyroplane or the propeller.

The engine was taken to the manufacturer's UK agents facility for examination and testing. External and internal examination showed no evidence of a major failure, disconnect or partial seizure between the pistons and their cylinder bores. Both carburettor bowls contained fuel and, together with the fuel filter, were free of contamination. The engine was installed onto an airframe mounting, a replacement propeller was fitted and a successful engine test run was carried out.

Seat installation, (Figure 1)

The pilot's seat on this gyroplane was a 31.4 ltr (7 imp gallons, 23 kg) capacity Ken Brock seat/fuel tank combination kit, empty weight 4.4 kg, made from a moulded plastic material. The weight of the seat/fuel/pilot is supported by a horizontally mounted U shaped tubular frame bolted, at the rear, to a support crossbar which itself is attached by two bolts to the aluminium alloy square section tube rotor mast. The frame is supported at the front by two simple struts to the longitudinal structural beam. The top of the seat is also attached to the mast by a 16 gauge aluminium alloy bracket, which was supplied with the seat kit, designed to restrain or stabilise the seat in the fore/aft and lateral planes. This bracket does not transmit any significant vertical loads between the seat and the mast. It is secured to the top of the seat back by three bolts, and to a fitting clamped around the mast by two bolts (left and right) through two integral lugs.

The pilot is restrained in the seat by a four point harness. The upper torso restraint is connected to a fitting on the rotor mast, the lap strap, to the seat frame support crossbar.

Seat examination

Examination of the seat revealed that the left side lug of the attachment bracket at the top of the seat, at its connection to the clamp around the mast, had failed by a fatigue cracking mechanism, prior to the first impact with the trees. The right side lug had also partially failed in fatigue and then failed completely in a one-off overload mechanism. It was not possible to determine if the overload failure had occurred before the first impact or during the impact sequence. There was very good evidence of fretting between the attachment bolt washers and both the left and right lugs of the attachment bracket, indicating that there had been relative movement between the attachment bracket and the mast clamp over a period of time. Examination of the seat frame support crossbar, at its attachment to the rotor mast, found it to be loose and able to be 'rocked' laterally. There was very good evidence of fretting of the crossbar steel attachment bolts and ovalisation, in a downward direction, of the bolt holes in the aluminium rotor mast, indicating that this damage had occurred over a period of time. It was also found that the cross section of the hollow square section rotor mast had reduced in the immediate area of the attachment bolt holes, deformation being present on both the front and rear faces, in a manner consistent with excessive torque tightening of these attachment bolts. It was not established when this deformation occurred.

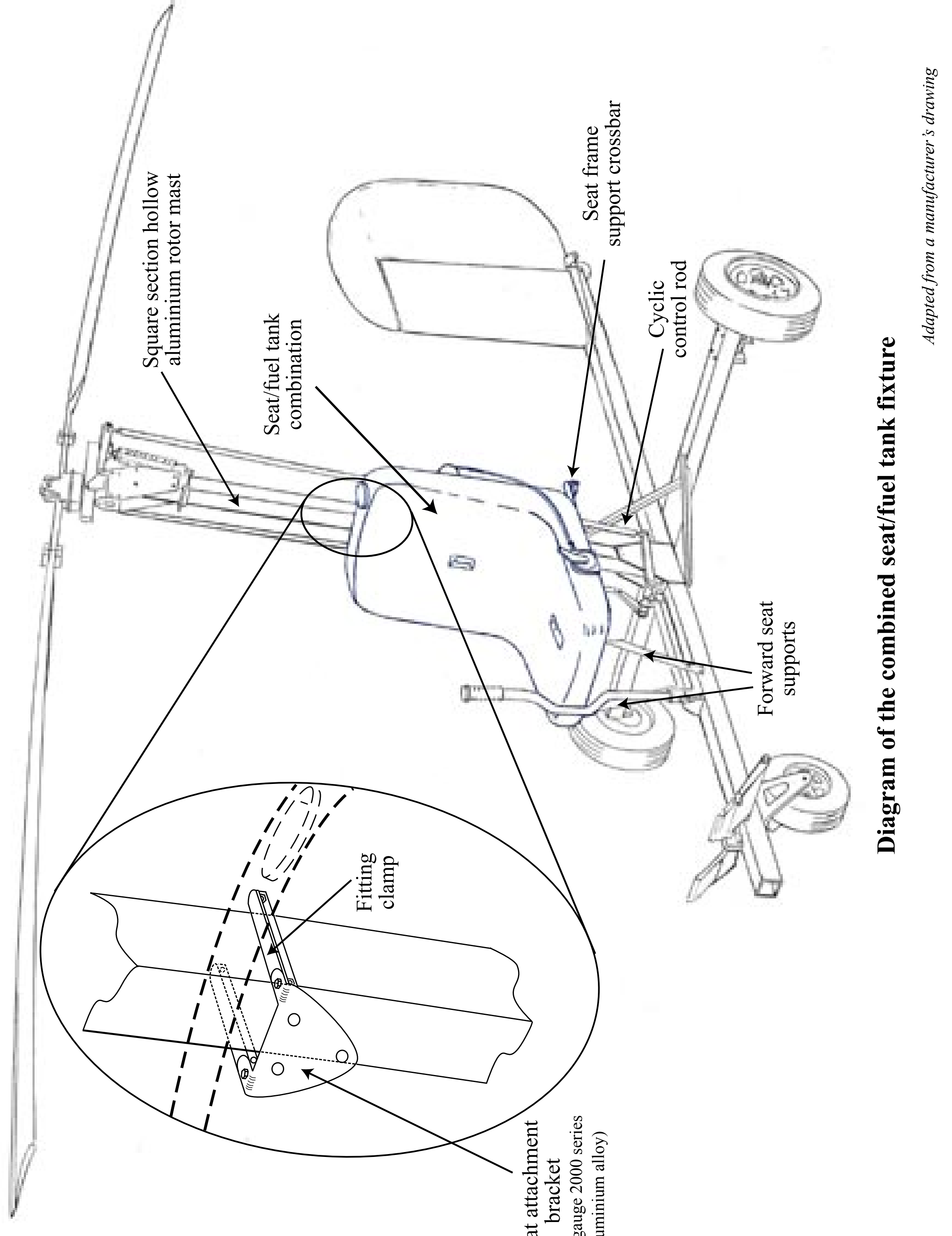
Square section hollow aluminium rotor mast
Seat/fuel tank combination
Seat frame support crossbar
Cyclic control rod
Forward seat supports
Fitting clamp
Seat attachment bracket
(16 gauge 2000 series aluminium alloy)
Diagram of the combined seat/fuel tank fixture
Adapted from a manufacturer's drawing

Figure 1

Pilot experience

The pilot was a very experienced glider and aero-tow pilot, but had little flight time on gyroplanes. He gained his Private Pilot's Licence (Gyroplanes) in October 2000 but had achieved only 33 hours on gyroplanes since then. Although his personal flying logbook was incomplete, analysis of the accident gyroplane's logbook shows that it is unlikely he had more than two hours flying gyroplanes within the last 12 months.

Other information

The weight, under 1g conditions, that the seat support structure was required to withstand with the accident pilot on board could potentially have been in the region of 128+ kg if the fuel tank were full (pilot 100+ kg, seat 4.4 kg and fuel 23 kg). If, on takeoff, the autogyro fuel tank contained only the reported 2.5 gallons, then this figure reduces to 113 kg, as a minimum. The empty weight of the autogyro is stated as 150 kg, the maximum take-off weight 272 kg, and so it appears that the gyroplane was, at most, only 10 kg below its maximum weight at takeoff. However, no maximum limit was quoted in any of the documentation for seat loading and, therefore, it is not known what effect upon the seat support structure a combined load of at least 113 kg would induce.

The investigation identified that a horizontal stabiliser had not been fitted to this gyroplane throughout the period of current ownership. In July 2004, the gyroplane community conducted tests in an attempt to determine the effectiveness of horizontal stabilisers on similar types of gyroplanes. They concluded that, at high speeds, there was a small improvement in pitch stability with the addition of a horizontal stabiliser but, at low speed, the effect was negligible. This accident occurred in a low speed flight regime.

Discussion

Although no fuel was discovered in the seat/fuel tank after the accident, it had been ruptured in the impact and this, together with the smell of fuel around the wreckage and evidence that the propeller was being driven, suggested that some fuel had been contained within the tank at the time of the accident. Therefore, fuel exhaustion was not considered a causal factor.

The only significant evidence found during the examination of damage that was inconsistent with having occurred during the accident, was the failure of the seat top attachment bracket. The left side lug of this bracket was found to have failed by fatigue cracking prior to the first impact with the trees. The right side had partially failed in fatigue. It was not possible to determine if the final overload failure of the right side occurred prior to, or as a consequence of, the impact. There was good evidence of long term fretting in a number of areas of the seat attachment points, looseness of the main load bearing rear crossbar for the seat, and vertical ovalisation of the crossbar attachment holes in the rotor mast.

Within the gyroplane's airframe, there is no provision for load/vibration damping to smooth the loads experienced by the airframe during taxiing, takeoff and landing, except for that provided by the pneumatic tyres. It is probable, because of the looseness of the seat frame support crossbar, that such loads induced damaging vertical and lateral cyclic loading in its attachment holes to the rotor mast which, over time, produced the ovalisation seen in these holes. As this ovalisation increased, an increasing vertical load would have been placed on the seat top attachment bracket, for which it was not designed, and this loading, combined with vibration and normal in-service loading, almost certainly initiated and propagated the fatigue cracking found in the bracket. At some point, possibly on the accident flight, the un-cracked portion of the right attachment lug could no longer support the vertical loads, and the bracket failed completely. It is possible that this failure then allowed the left-hand end of the crossbar to contact and restrict the movement of the left cyclic control rod which, together with the seat becoming insecure, could have led to the loss of control. Should the restriction have been present prior to the final flight, then it remains to be explained why on the previous flight, and prior to takeoff on the accident flight, it was not noticed by either pilot. However, it is also possible that the right lug, which was only partially fractured by fatigue, finally failed during the impact sequence. In that case, no technical explanation for the loss of control was discovered during the investigation.

From an operational perspective, it is difficult to forecast the effect a loose, unstable seat would have on the handling characteristics of the gyroplane, aside from the fact that it would have been distracting. On encountering a control problem, it would appear that the pilot's first response was to throttle back to idle as a first attempt to resolve the situation. Lack of witness evidence prevents further analysis of the events in flight. However, the pilot's lack of recency on this gyroplane type may have hindered his ability to diagnose and respond to an emergency in a timely and correct manner.

Safety Recommendations

This gyroplane had been issued with a Permit to Fly, and was overseen by the Popular Flying Association. At the time of the accident there were four similar gyroplanes on the UK register, but none were reported to be in an airworthy condition. As it would appear that the failure of the seat top attachment resulted from a combination of looseness of the lower crossbar attachment bolts, in combination with in-service loading/vibration, concern is raised over the security of seat attachments on other gyroplanes of this, and similar, designs. The following safety recommendation is therefore made.

Safety Recommendation 2005-064

It is recommended that the Popular Flying Association (PFA) emphasise to all PFA Inspectors, and owners of Brock KB-2 and similar gyroplanes, the particular importance of checking the security of all seat attachments and fittings and, where looseness is found, that no cracking or deformation of the airframe or seat attachments is present.

Conclusions

No definitive cause of this accident was established as a result of the investigation. However, the possibility that the pilot lost control of the gyroplane, due to control difficulties precipitated by the seat attachment bracket failure occurring on the accident flight, could not be dismissed.

ACCIDENT

Aircraft Type and Registration:	Robinson R22 Beta, G-TGRR	
No & Type of Engines:	1 Lycoming O-320-B2C piston engine	
Category:	2.3	
Year of Manufacture:	1989	
Date & Time (UTC):	11 November 2004 at 1533 hrs	
Location:	Cophams Hill Farm, Bishopton, Stratford-upon-Avon, Warwickshire	
Type of Flight:	Training	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - 1 (Fatal)	Passengers - N/A
Nature of Damage:	Aircraft destroyed	
Commander's Licence:	Student pilot	
Commander's Age:	57 years	
Commander's Flying Experience:	118 hours (of which 117 were on type) Last 90 days - 26 hours Last 28 days - 12 hours	
Information Source:	AAIB Field Investigation	

Synopsis

The student pilot was returning to Shobdon from Wellesbourne Mountford on the second leg of a cross country navigation exercise. His instructor had become concerned that the weather might not be suitable for the student to return, and had flown to Wellesbourne in another helicopter with the intention of leading him back in loose formation. During the return flight to Shobdon, and shortly after establishing radio contact on a previously agreed enroute frequency, the student told his instructor that he was having difficulty following him, and subsequently, that he had lost sight of the lead helicopter. Despite numerous attempts, the instructor was unable to make further contact. The student's helicopter had crashed in a field 2 nm north-west of Stratford-upon-Avon, fatally injuring the pilot.

History of the flight

The student pilot had been authorised by his instructor to fly a solo cross country navigation exercise from Shobdon to Wellesbourne and return. Wellesbourne was approximately 45 minutes flying time to the east of Shobdon. Prior to departure the student and his instructor both signed a "Solo Navigation Briefing Certificate". This confirmed that the student had been briefed on a list of issues relevant to the exercise, including consideration of current and forecast weather conditions and action to be taken in the event of weather deterioration. At approximately 1230 hrs the student pilot departed in G-TGRR. The instructor took off shortly afterwards in another helicopter to carry out a radio navigation exercise with another student.

Whilst operating in the Redditch area, north-west of Wellesbourne, the instructor became concerned that the visibility was reducing and called Wellesbourne Radio to request that G-TGRR be kept on the ground. The instructor advised Wellesbourne Radio that he would return to Shobdon and then fly to Wellesbourne to lead the cross country student back.

On his return to Shobdon, the instructor contacted the pilot of G-TGRR at Wellesbourne by telephone to discuss the plan. The pilot of G-TGRR is reported to have said that he was happy to return to Shobdon without assistance, but the instructor insisted on carrying out his plan, because the visibility in the Redditch area was expected to be poor. The instructor departed for Wellesbourne shortly after 1400 hrs in another Robinson R22, G-TGRE, flown by a student who had originally planned to conduct another cross country flight. During the flight he noted that the visibility was good between Shobdon and Worcester, half way along the route, but that it deteriorated east of Worcester in conditions similar to those encountered on his earlier flight.

When he arrived at Wellesbourne the instructor met the pilot of G-TGRR and explained that the return flight to Shobdon would be flown at 85 kt at an altitude of 1,200 ft on the Wellesbourne QNH of 1024 hPa. He briefed that the two aircraft were to make contact on frequency 123·45 MHz, when passing north of Stratford, in order that they could converse freely without blocking any nearby aerodrome frequencies, but that otherwise the instructor would carry out all radio transmissions for both aircraft. The instructor intended that G-TGRR should follow 200 to 300 m behind G-TGRE, and indicated this distance by reference to a hangar at the airfield boundary.

Shortly before 1530 hrs, the aircraft departed in a loose line-astern formation and proceeded as planned to the north of Stratford. Approximately one mile north of Stratford, the instructor switched to frequency 123·45 MHz and made contact with the student pilot in G-TGRR at the second attempt. The student pilot said that he was having difficulty keeping up with G-TGRE, and shortly afterwards that he had lost sight of it. The instructor replied that they should slow down to 75 kt while maintaining an altitude of 1,200 ft. The instructor reported that the pilot of G-TGRR repeated the new speed, and shortly afterwards said "I can't see a thing".

The instructor asked the student to clarify whether he meant that he couldn't see the lead helicopter or that he had lost all visual reference, but there was no reply. The instructor made numerous further attempts to contact G-TGRR on 123.45 MHz, on the Shobdon and Wellesbourne Airfield frequencies, and by mobile telephone, but without success. During this exchange Wellesbourne Radio informed the instructor of reports that a light helicopter had landed in a field 1 nm north-west of Stratford. When G-TGRE arrived at the scene, 27 minutes after losing radio contact with G-TGRR, the fire brigade and air ambulance were already in attendance.

Pilot information

The student pilot of G-TGRR had completed 118 hours of flight instruction towards the issue of a Private Pilot's Licence for Helicopters (PPL (H)), of which 22 hours were cross country and six hours were solo. He had also completed four hours flying on instruments. The accident flight was his second solo cross country involving a landing away from Shobdon. Although training records revealed that the student had made slow and unremarkable progress, the instructor commented that he had reached a standard typical of students carrying out solo cross country exercises. A survey of helicopter training organisations in the UK suggests that, on average, students take approximately 70 hours to gain a PPL (H).

Commenting on his decision to lead the student back to Shobdon, the instructor told the AAIB that he did not want the student to return on his own in the prevailing conditions. He was concerned that the student might become unsure of his position, particularly in relation to a 984 ft mast and an area of laser activity at Pershore, 3 nm south of his intended track. The instructor hoped to reduce the student's workload by having him follow at a range of a few hundred metres.

Wreckage and impact information

The accident site was an area of soft, ploughed field. The direction of the short wreckage trail was on a magnetic heading of approximately 275°. Impact marks indicated that the helicopter struck the ground tail first, banked to the right by approximately 110° with a slight clockwise rotation and no horizontal motion. The right side of the helicopter was extensively damaged and perspex from the canopy had been thrown up to 2 m forward and approximately 8 m to the right of the cockpit. Both fuel tanks had ruptured and at least five gallons of fuel had pooled under the wreckage. The rotor mast was bent and had fractured at the gearbox interface. A number of the control rods had also bent or fractured. There was no evidence of damage to the leading edge of either of the main rotor blades, both of which had bent on impact. The rivets securing the tail pylon had failed at the frames in Bay 4 and 5, and there was also evidence of two low energy blade strikes on the top and the left side of Bay 5. The tail pylon had failed aft of Bay 5 and the tail rotor and stabiliser assembly were found lying on the left side of the pylon facing the opposite direction.

In the cockpit the mixture control was selected to fully RICH, the carburettor heat control was out by 25 mm, the fuel cock was set to ON, the primer was locked in, the cyclic right trim was out and the magneto switch was set to BOTH. The governor switch on the end of the collective was in the OFF position. Both emergency landing circuit breakers were in the 'pulled', (ie out) position; the remaining circuit breakers were all in the in position. The pilot was wearing an intact three point inertia seat harness.

Medical and pathological information

The pilot held a current JAA Class II medical certificate with limitations requiring him to fly by day only and to have near vision lenses available while flying. A spectacle lens was recovered from the crash site, suggesting that he was complying with the latter limitation.

The post mortem examination carried out by a consultant aviation pathologist revealed no evidence of natural disease or the presence of any substance which may have caused or contributed to the accident. The severity of the crash was such that the provision of additional or alternative safety equipment would not have altered the fatal outcome.

Recorded information

Secondary radar returns corresponding to the flight paths of G-TGRE and G-TGRR were recorded at Clee Hill, 33 nm west-north-west of the crash site. These indicate that G-TGRR followed approximately 1/3 nm behind G-TGRE, while maintaining an average ground speed of 75 kt. This corresponds to an air speed of approximately 85 kt in the prevailing 10 kt wind from the west. G-TGRR and the lead helicopter appeared to maintain a generally constant altitude, although the altitude of G-TGRR fluctuated briefly between 900 and 1,400 ft amsl during a ten second period approximately one minute prior to the final radar return. The final recorded position of G-TGRR coincided with the accident site.

Witnesses on the ground

Eyewitness statements were obtained from six individuals who saw the final moments of the flight, from three distinct viewpoints on the ground. All reported seeing the helicopter flying straight and level for some distance, then pitch nose up and cease all forward motion, before pitching nose down into its final descent. During this almost vertical descent, the helicopter was seen to yaw slowly in a clockwise direction and develop a slight roll to the right. Shortly before impact the main rotor appeared to have stopped or to be rotating unusually slowly, with the blades bent upwards at an extreme angle. Those closest to the accident also recalled an absence of engine noise. Each of the eye witnesses reported being able to see the helicopter continuously, clear of cloud, from the first moment they became aware of it, until the moment of impact or very shortly beforehand.

Meteorological information

1) Information available during the pre flight briefing

The UK low level forecast issued at 0835 hrs on 11 November 2004 showed a warm front moving southeast across central England and forecast to pass over the route between Shobdon and Wellesbourne at or shortly after 1500 hrs.

Birmingham International Airport (elevation 325 ft), 17 nm north-north-east of Wellesbourne, is the nearest station to the destination for which forecast information was obtained. The most recent forecast available during the pre-flight briefing was recorded at 1204 hrs. It predicted visibility greater than 10 km and broken cloud at 2,500 ft, but temporarily between 1300 and 2200 hrs, broken cloud at 1,400 ft with a 30% probability, in the same period, of 8 km visibility in light rain and broken cloud at 900 ft.

The operator's Flying Order Book stated that:

> *"Cross country flights will not be flown without a clearly discernable horizon, and weather minima in accordance with (relevant extract reproduced below - Table 1), expected along the whole of the route to be flown:"*

Wellesbourne Airfield is situated 159 ft amsl, and Shobdon is 318 ft amsl. The highest terrain on a direct track between the two airfields is high ground approximately 827 ft amsl, 5 nm east of Leominster. The aeronautical chart used by the student showed two masts within 5 nm of this direct track, one 984 ft amsl (886 ft agl) at Pershore and another, 900 ft amsl (700 ft agl), near Bromsgrove. Worcestershire Beacon in the Malvern Hills rises to 1,394 ft amsl and is 7 nm south of the direct track.

2) Aftercast

Archived weather reports were obtained for the period covering the return flight. At 1520 hrs Birmingham International airport reported visibility of 4,800 m in light drizzle and mist, with cloud scattered at 500 ft and overcast at 600 ft. At 1550 hrs, the reported visibility was 3,000 m in mist with cloud scattered at 500 ft and broken at 700 ft.

An aftercast produced by the Met Office for the same period indicated that the area was likely to have been generally overcast with drizzle, surface visibility of between 2,000 and 5,000 m and cloud overcast with a base between 800 and 1,200 ft. The temperature and dew point were both estimated to be 6.5°C.

3) Pilot reports

The air ambulance was tasked at 1542 hrs and took off shortly afterwards from its Strensham base, 17 nm west south west of the accident site. It arrived at the scene at 1555 hrs. The direct route between these points would have been broadly parallel to the forecast warm front.

	DAY		NIGHT	
	Cloud base above highest obstacle en-route	Visibilty	Cloud base above highest obstacle en-route	Visibility
SOLO	1500 ft	8 km	2000 ft	10 km

Table 1

The pilot of the air ambulance said that whilst enroute to the accident site he had been concerned that the lowering cloud base and failing light might restrict the choice of trauma hospitals to which he could fly a casualty. He judged that the visibility was approximately 5,000 m with the cloud base generally at 1,000 ft, but occasionally as low as 800 ft, causing him to fly at 700 ft in order to maintain good visibility. He expressed surprise that a student had been allowed to fly solo in these conditions.

Another instructor, who had flown a Robinson R22 from Gloucester Airport to Wellesbourne in the late morning, reported that the weather had deteriorated throughout the day. Later, while flying in the circuit at Wellesbourne as G-TGRR departed, he noted that the weather over Stratford was overcast, with mist in places. He commented that, throughout the day, he had used more carburettor heat than he considered normal.

The student flying G-TGRE reported that the instructor had cautioned him to monitor his application of carburettor heat, since conditions were ideal for the formation of ice in the carburettor.

At 1515 hrs another pilot departed Gloucester Airport in an MD500 turbine engine helicopter, intending to carry out a navigation exercise to Junction 14 on the M40, 5 nm east of Wellesbourne, via Billesley Manor, 1 nm west of the crash site. The pilot reported that he was able to see the hangars at Wellesbourne clearly as he commenced an orbit of Billesley Manor, but that he was unable to see them shortly afterwards as he completed the orbit in conditions of increasing drizzle. He estimated that the visibility around Stratford had reduced to 3,000 m or less with a cloud base of 800 ft, and at 1545 hrs decided to terminate the exercise. He reported that the cloud base remained at 800 ft during the return flight to Gloucester.

Carburettor icing

Carburettor icing is caused by the sudden temperature drop of the air due to fuel vaporisation and pressure reduction at the carburettor venturi. The temperature can reduce by up to 30°C which could cause any moisture in the air to freeze, with a consequent build up of ice in the carburettor throat adjacent to the butterfly valve. The subsequent reduction in cross sectional area will gradually reduce the airflow and cause the engine rpm to decrease. Carburettor icing can occur when the ambient temperature is between -10°C and +30°C and the effect is most noticeable when the butterfly valve is closed.

If an engine subjected to carburettor icing is fitted with a governor, then it will attempt to maintain the engine rpm by progressively opening the butterfly valve without the pilot being aware of what is happening. If the pilot were to then close the throttle it is possible that the build up of ice adjacent to the butterfly valve might be sufficient to cause the engine to stop.

All pilots should be trained to appreciate the dangers of carburettor icing and to apply carburettor heat when necessary. The aircraft handbook for the R22 lists conditions when carburettor icing can be expected and warns the pilot that the governor system might mask the formation of carburettor icing. Moreover, the limitations section of the pilot's operating handbook, and a placard adjacent to the carburettor heat gauge, states "Caution below 18 in MP ignore gage and apply full carb heat".

Formation flying

Flying in formation is not included in the syllabus for either PPL or Flight Instructor training. The student pilot had received no training in how to conduct the flight in formation, nor had the instructor had any formal training in briefing for, or providing flight instruction in, formation flying.

The intended cruise speed of 85 kt, nominated by the instructor, is close to the maximum level cruise speed of a Robinson R22 helicopter. In the event that the following aircraft dropped back, the student pilot would have had little margin of speed to enable him to catch up with the lead aircraft and maintain sight of it.

When flying in line astern formation it is difficult to judge relative position and closing speed, even in good visual conditions. The closer that the formating pilot is to the lead aircraft, the easier it is to identify changes in relative position and closing speed. At distances of 200 m or more, this becomes more difficult and requires high levels of concentration, which would have reduced significantly the student's capacity to carry out normal monitoring actions. In this regard flying in loose formation is as demanding a task as flying in close formation.

Significant features of the aircraft

The R22 is a two seat, single engine helicopter powered by a four cylinder Lycoming air-cooled engine. Filtered induction air is supplied to the carburettor via an airbox. Ambient air enters the airbox via a duct connect to the right hand side of the aircraft and hot air is ducted from around the exhaust pipes. A slider valve in the airbox, operated by the carburettor heat control in the cockpit, regulates the proportion of ambient and hot air entering the carburettor. The normal procedure is for the pilot to monitor the carburettor air temperature gauge and apply sufficient carburettor heat to prevent the temperature in the carburettor orifice, which is sensed upstream of the throttle butterfly valve, falling below +10°C.

Engine rpm is controlled either manually, by a twist-grip control located on each collective lever, or automatically by the governor system. The main components of the governor system are: a toggle switch, control unit and actuator. The governor is switched on by the toggle switch mounted on the end of the right hand collective lever and operates between 80% and 115% engine rpm. Engine rpm is measured by mechanical points mounted in the right hand magneto and the electrical output is sensed by the control unit, which sends a signal to the actuator causing the throttle connecting rod between the two collective levers to move. Movement of the throttle connecting rod causes the throttle twist grips to rotate and the butterfly valve in the carburettor to move. The pilot can over-ride the clutch in the actuator by firmly gripping the throttle twist grip.

A correlator is connected to the collective lever such that movement of the collective lever causes the carburettor butterfly valve to move without providing any feedback to the throttle twist grips. The governor is designed such that there is a dead-band between 102.5 and 105.5% rotor rpm during which the correlator adjusts the engine rpm to compensate for movement of the collective lever. However, the design of the correlator is such that it over-compensates for movement of the collective lever at the lower end of its range of movement; consequently a correcting input is required either automatically by the governor, or manually by the pilot.

The rotor system consists of a two-bladed teetering main and tail rotor driven by two pairs of vee-belts connected between the output of the engine and a clutch assembly fitted between the tail rotor drive shaft and main rotor gearbox. The clutch assembly allows the rotor assembly to free wheel when the engine power is reduced. As there is a direct connection between the engine crankshaft and main rotor gearbox, any reduction of the main rotor rpm will cause the engine rpm to decrease with the possibility of stalling the engine. Correct tension in the vee-belts is obtained by the operation of a linear actuator mounted between pulleys on the crankshaft and rotor drive system. After the engine is started, a clutch switch on the centre console is set to ENGAGE, which causes the actuator to operate, forcing the pulleys apart against the increasing tension in the vee-belts. Once the correct tension is reached, microswitches operate breaking the power supply to the actuator. Should one of the vee-belts fail, tension in the remaining belt would be insufficient to operate the microswitches; therefore an over-travel microswitch is fitted, which breaks the power supply once the actuator has extended by 1·7 inches. An amber caution CLUTCH light illuminates whenever the actuator or the over-travel microswitch operates. Although it is normal for the CLUTCH light to come on momentarily as the belts warm up and stretch, the Operating Handbook states:

> *"if the light comes on in flight and does not go out within 6 or 7 seconds, pull the CLUTCH circuit breaker, reduce power, and land immediately".*

Detailed examination of wreckage

1) General

The magnetic plugs in the main and tail rotor gearboxes were clear and, with the exception of minor damage to the rotor head and strike marks on the tail cone, all the damage was consistent with the helicopter impacting the ground. The primary droop stops were intact and there was minor damage to the pads on the secondary stops; there was also some chipping of the paint on the up-coning stops. Only 4·15 kg (60%) of the canopy was recovered from the crash site. Overall the helicopter appeared to be well maintained and serviceable prior to the upset that resulted in the accident.

2) Engine

The right side of the engine, the left magneto and the carburettor had been badly damaged in the ground impact. Despite the damage there were five independent indicators that the engine was not turning when the aircraft impacted the ground:

a the pointer on the Manifold Pressure gauge left a distinct mark at 30 inches Hg.
b distortion of the filaments in the alternator and oil pressure warning lights was consistent with the lights having been illuminated at impact.
c the engine rpm needle was bent against the bottom of its scale.
d the fan-wheel slippage indicators were still aligned.
e the oil radiator had been forced onto the engine starter ring and the resulting damage could only have been caused if the engine had not been rotating.

The engine was partially stripped and there was no evidence to suggest that a mechanical engine failure had occurred prior to the crash. There were signs that it had been running slightly on the lean side, but this was not considered to be unusual.

3) Carburettor Heat

The carburettor heat control knob in the cockpit was found in a position 25 mm towards the selection of maximum available hot air; this represented 1/3 of its available travel. However, movement of the engine during the impact caused the air box slider control cable to be pulled off the bottom of the control knob and the slider to be partially pulled off its backing plate. It is, therefore, possible that the pilot had selected more than 25 mm and that the control knob had been pulled back into this position during the impact. In comparison with another R22 helicopter, 1/3 movement of the control knob corresponds to a 22% opening of the hot air port by cross sectional area.

4) Throttle and Governor System

The governor components were tested, under AAIB supervision, and found to be serviceable. Score marks from the throttle linkage were found on the structure in the passenger's luggage compartment. Comparison with other R22 helicopters indicates that at the point of impact the throttle was closed and that the score marks were the result of the throttle connecting rod being pulled into the engine compartment as the luggage compartment distorted and the engine moved during the impact. The movement of the throttle linkage back into the throttle system would have been accommodated by distortion of the over-travel spring. The impact also caused the right hand collective lever to fracture, thereby freezing the position of the hand throttle on the collective levers. A comparison of the position of the hand throttle, and the collective throttle connecting rod, with the controls of other R22 helicopters confirms that at impact the hand throttle was closed and pressing against the over-travel spring.

5) Clutch and Vee Belts

Distortion of the clutch light filament was consistent with the light being illuminated when the helicopter impacted the ground. The aft vee belt was intact and the forward belt had been cut by the wreckage. However, there was no evidence that the belts had been slipping, or that the forward belt had failed whilst the engine was turning. The clutch actuator had distorted and fractured in overload consistent with the direction in which the helicopter impacted the ground. The length of the exposed actuator rod was measured as between 41·7 mm and 44·7 mm. At the time of the accident the vee belts had consumed 1,961 of their 2,200 hour life.

Analysis

There was no evidence of a mechanical failure that could have caused the engine to stop, or explain the loss of control of the helicopter. The presence of a large amount of fuel at the crash site indicates that there was sufficient fuel available for normal operations. Damage to the rotor system, low impact strikes on the tail cone, missing perspex and witness statements are all consistent with a loss of rotor rpm and stalling of the main rotor blades. Such a situation could arise if the pilot failed to respond quickly to an unexpected reduction in engine rpm. The position of the throttle is consistent with the pilot carrying out a forced landing with power available, as demonstrated in training, during which he would have been taught to close the throttle twist grip through a spring stop to overcome the tendency of the governor to apply more power at the conclusion of the manoeuvre. On relaxing his grip, the hand throttle would move, under spring pressure, to the position in which it was discovered. This would not be an appropriate technique in the case of low rotor rpm, because closing the throttle would make carburettor icing more likely for the reasons described earlier.

The clutch vee belts were nearing the end of their life and it is possible that the accumulated wear was sufficient for the actuator to go into an over-travel position. The pilot's initial reaction to the warning light would have been to reduce power by lowering the collective lever and land immediately. Alternatively, the clutch actuator might have been close to over-travel, and severe vibration resulting from the main rotor blades stalling caused the actuator to go into over-travel.

At the top of climb the pilot would normally be expected to engage the cyclic right trim by pulling it out, as it was found after the accident. It is possible that in undertaking this operation he may have inadvertently interfered with the governor switch on the end of the collective lever, causing it to move to the OFF position. In cruising flight, the action of the correlator in response to movement of the collective lever would be sufficient to trim engine speed. However, a build-up of ice in the carburettor could cause the engine and rotor rpm to decay until the low warning horn operated. The pilot's training required him to respond to the low rpm warning by opening the throttle and lowering the collective lever. If the pilot's initial reaction had been to lower the collective lever without manually opening the throttle then the correlator would act to close the butterfly valve thereby exacerbating the situation. However, tests undertaken on another helicopter to assess the likelihood of inadvertently interfering with the governor switch established that this was unlikely.

The investigation explored the possibility that the observed pitch up was initiated by the pilot as part of a "quick stop" manoeuvre, perhaps because he was concerned about continuing in poor visibility while unsure of the position of the other aircraft, which had declared it would be slowing down. A quick stop involves an application of aft cyclic, which induces a pitch up to reduce forward speed, and lowering of the collective to avoid gaining height. However, this is a highly unusual manoeuvre to execute from cruising flight and, having previously established radio contact, the pilot might have attempted to advise his instructor of his intention not to continue. Since neither the instructor nor the student accompanying him in G-TGRE recalls such an exchange, and given the unusual nature of the manoeuvre, it is possible that the pitch up manoeuvre itself was not a deliberate action by the pilot.

The witnesses stated that the aircraft was clear of cloud and in steady level flight prior to the initial pitch up. Nevertheless, in the degraded visual environment the student pilot may have had limited visual references, especially whilst in a nose up attitude, and may have become disorientated.

The atmospheric conditions prevailing at the time of the accident were conducive to serious carburettor icing at any power setting and it is likely that the pilot made some attempt to apply carburettor heat. However, with his attention focused on following the lead helicopter, he may have been unable to monitor the carburettor temperature gauge regularly enough to ensure that sufficient carburettor heat was applied at all times. Normal operation of the governor would have compensated for any build-up of ice in the carburettor by opening the throttle, until sufficient ice accumulated to stop the engine, even at full throttle. Furthermore, any lowering of the collective lever to reduce height, slow down, land or react to the low warning horn would result in closure of the butterfly valve via the correlator, and increase the risk of engine stoppage. It is also possible that the pilot, in this tense situation, gripped the collective sufficiently tightly to override the governor, or that, contrary to standard training, his instinctive reaction to a gradual loss of power was to raise the collective to maintain height. This would eventually lead to a critical reduction in main rotor rpm in the absence of sufficient engine power.

Following a power loss, the rotor blades would slow down and the low rpm warning horn would operate at 97%. The pilot would need to enter autorotation quickly to avoid a further reduction in rotor rpm. Below 76%, rotor rpm would be unrecoverable and the blades would stall. Increased drag from the rotor blades would then cause the engine to stall and the blades would flap, striking the tail cone and canopy.

AAIB bulletin EW/C98/3/1 describes a fatal accident involving a Robinson R22 helicopter. The report discusses research into the time available, following a range of failures, for the pilot to initiate an autorotation before rotor rpm decays to a value below which recovery is no longer possible. Although the Robinson R22 meets current certification criteria, these studies suggest that the time taken to intervene successfully is typically greater than the time that must be demonstrated to satisfy the certification criteria. It is therefore highly likely that, in the stressful and unfamiliar circumstances arising from the need to follow another aircraft in deteriorating weather, the pilot was unable to react in a timely manner to the engine failure, however caused.

Discussion

Training organisations and their instructors have a duty of care to students flying under their supervision. When authorising a student for any solo flight the instructor must satisfy himself that the actual and forecast conditions, including any transient conditions, are suitable for the flight and not expected to fall below the minima published in the training organisation's Flying Order Book or operations manual at any time during the exercise. If a subsequent deterioration in weather conditions causes the exercise to be curtailed, recovery of the aircraft must not involve the student in any further solo flying until conditions exceed the relevant minima. If the conditions are suitable for the student to fly solo then there is nothing to be gained from requiring him to follow another aircraft.

The student pilot was attempting to fly in loose formation whilst in poor visibility. He had not been trained to conduct this task and his briefed position and speed allowed no margin for error. The instructor had intended to reduce the student pilot's workload, but had inadvertently increased it, thus reducing significantly the student's capacity to carry out normal monitoring actions.

Conclusion

The student pilot was attempting to follow his instructor's aircraft in loose formation, despite having received no training in this demanding task. The student was, nevertheless, flying solo in weather conditions which, the available evidence indicates, were below the training organisation's minima. In the absence of sufficient carburettor heat, the helicopter probably encountered a severe build up of carburettor ice which either significantly reduced the available power or caused the engine to stop. The student probably acted in accordance with his training, but, faced with the added stress of having to follow another aircraft in reducing visibility, did not react quickly enough to prevent a critical reduction in rotor rpm. Consequently the main rotor stalled, causing the helicopter to fall to the ground with no possibility of recovery.

ACCIDENT

Aircraft Type and Registration:	i) Robinson R22 Beta, G-CDBG ii) Robinson R44 Astro, G-OLOW
No & Type of Engines:	i) 1 Lycoming O-360-J2A piston engine ii) 1 Lycoming O-540-F1B5 piston engine
Category:	2.3
Year of Manufacture:	i) 2004 ii) 1994
Date & Time (UTC):	24 April 2005 at 1010 hrs
Location:	Sherburn-in-Elmet, Leeds
Type of Flight:	i) Training ii) Training
Persons on Board:	i) Crew - 2 Passengers - None ii) Crew - 2 Passengers - None
Injuries:	i) Crew - None Passengers - N/A ii) Crew - None Passengers - N/A
Nature of Damage:	i) Main rotor blades damaged and engine shock loaded ii) Main rotor blades damaged and engine shock loaded
Commander's Licence:	i) Airline Transport Pilot's Licence with Instructor rating ii) Private Pilot's Licence with Instructor Rating
Commander's Age:	i) 62 years ii) 47 years
Commander's Flying Experience:	i) 16,500 hours (of which 8,000 were on type) Last 90 days - not known Last 28 days - not known ii) 2,500 hours (of which 990 were on type) Last 90 days - not known Last 28 days - not known
Information Source:	Aircraft Accident Report Forms submitted by the pilots

History of the flights

On the morning of the accident an instructor parked an R22, G-CDBG, at the refuelling area. After he parked the R22 another instructor parked an R44, G-OLOW, next to the R22. Later in the morning the instructor, who had earlier parked the R44 next to the R22, briefed a student to go out and pre-flight and start-up the R22 in preparation for a local training flight. After the student had started the R22 the instructor joined him and just prior to lift off there was a sudden bang and a massive vertical vibration. As the instructor was closing down the helicopter he realised that the main rotor blades of his helicopter had collided with those of the R44 which had just started up.

The instructor, who had parked the R22 earlier in the morning, was tasked to fly the R44 with another pilot for type conversion training. When the instructor and conversion pilot arrived at the R44 it was found that the check list was missing. The instructor returned to the flying club to find the check list whilst the conversion pilot carried out the external pre-flight check. As part of the external check the conversion pilot rotated the main rotor blades through 180° to ensure that there was sufficient tip clearance from the adjacent R22. At this time the R22 had not been started. The instructor returned with the check list, completed the internal checks and proceeded to start the R44. As he did so its main rotor blades contacted those of the now running R22. The R44 was shutdown. The instructor of the R44 wrongly assumed that the pilot who had previously parked the R44 had left adequate clearance between it and the R22.

Safety action taken

Since this accident the operator has painted measured parking spots in the refuelling area

ACCIDENT

Aircraft Type and Registration:	Robinson R22 Beta, G-RICE
No & Type of Engines:	1 Lycoming O-320-B2C piston engine
Category:	2.3
Year of Manufacture:	1995
Date & Time (UTC):	19 July 2005 at 0815 hrs
Location:	Swansea Airport, West Glamorgan
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Slight bend to lower left hand frame and undercarriage cross tube
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	6,655 hours (of which 550 on type) Last 90 days - 104 hours Last 28 days – 43 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During a practice autorotation the helicopter landed with left drift sufficient to bend the lower left hand frame and undercarriage cross tube.

History of flight

The pilot was an experienced helicopter pilot and instructor, who was carrying out practice autorotations to the threshold of Runway 22 prior to undertaking a Line Proficiency Check. Whilst his second autorotation was carried out into wind, at touch down the pilot felt that the helicopter was slightly misaligned with the direction of the wind and he landed with a slight amount of left drift. Consequently, the left skid made contact with the ground fractionally before the right skid, which resulted in the slight bending of the lower left hand frame and undercarriage cross tube. Whilst the bend in the cross tube was within the acceptable limits defined by Robertson Helicopter Company, the operator took the opportunity to replace both parts.

The pilot assessed the wind as 270°/14 kt gusting 17 to 18 kt and believes that the accident happened because he encountered a gust of wind close to the ground, which precipitated the left drift.

ACCIDENT

Aircraft Type and Registration:	Kolb Twinstar Mk 3 (Modified), G-MYMI
No & Type of Engines:	1 Rotax 582 piston engine
Category:	1.4
Year of Manufacture:	1995
Date & Time (UTC):	29 May 2005 at 1620 hrs
Location:	Netherthorpe Airfield, Nottinghamshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Serious) Passengers - None
Nature of Damage:	Left main landing gear leg collapsed
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	43 years
Commander's Flying Experience:	99 hours (of which 9 were on type) Last 90 days - 4 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

History of the flight

The pilot and his passenger were on a cross country flight from Horsley Brook Farm (Staffordshire) to Netherthorpe Airfield. The surface wind for the area near Netherthorpe had been reported as 10 mph (8.6 kt) from the south-west and visibility greater than 10 km. The pilot carried out an overhead join into the Netherthorpe circuit and was descending 'dead side' when another aircraft called 'long finals'. The pilot saw this other aircraft whilst on the base leg to Runway 24 grass and decided to initiate a go-around. During his second circuit he was lined-up on final approach when he experienced a 'huge lump of turbulence' that caused his aircraft to roll left to approximately 45° of bank. He rolled the wings level and because he was then a little low on the

approach he also applied some power. As the aircraft crossed the runway threshold the aircraft experienced more turbulence and sank. The pilot applied full power but it was insufficient to arrest the high rate of descent resulting in a heavy landing that caused the left main landing gear leg to collapse. The engine continued to run with no damage to the propeller but the aircraft came to rest quickly. The pilot and his passenger were able to exit the aircraft unassisted but it was later revealed that the pilot had suffered a serious back injury.

The approach had been carried out without flaps at the pilot's normal approach speed of 55 mph (48 kt). The flaps-up stall speed was 38 mph (33 kt). The elevator trim was full nose-down as was normal in this configuration. Due to the engine's high thrustline, the aircraft has a tendency to pitch nose-down when power is applied.

Downloaded GPS data

A download of the onboard GPS, which recorded the aircraft's position approximately every 10 seconds, revealed that the average groundspeed of the aircraft during final approach was 51 mph. The average groundspeed during the downwind leg was 53 mph and on the base leg it was 49 mph. The pilot stated that he flew the entire circuit at the same indicated airspeed, approximately 55 mph. The GPS data can, therefore, be interpreted to show that his average true airspeed was 52 mph and that there was less wind than the reported 10 mph from the south-west.

Discussion and conclusions

There were some houses and trees to the north of the short-final centreline and the pilot thought he might have experienced a 'rotor' of wind from that direction. However, the light wind as evidenced by the GPS data indicated that this was unlikely. The preceding landing aircraft had vacated the runway by the time G-MYMI was on short finals. The preceding aircraft type was not known but was similar in size to a Cessna 152 or Cessna 172. The distance from this aircraft and its low weight would suggest that a wake turbulence encounter was unlikely although not impossible. The pilot described the weather as 'thermic' because during the flight he had experienced many updrafts and downdrafts. Consequently the turbulence and sudden left roll experienced by G-MYMI during the approach was probably caused by a thermally induced updraft or downdraft. The high sink rate and heavy landing were probably a result of a loss of airspeed, possibly aggravated by the turbulent conditions.

ACCIDENT

Aircraft Type and Registration:	Pterodactyl Ptraveller Microlight, G-MBLN
No & Type of Engines:	1 Fuji-Robin EC-34-PM piston engine
Category:	1.4
Year of Manufacture:	1981
Date & Time (UTC):	11 December 2004 at 1310 hrs
Location:	Prospect Farm, Wollaston, Northants
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	700 hours (of which at least 45 minutes were on type[1]) Last 90 days - 1 hour Last 28 days - 1 hour
Information Source:	AAIB Field Investigation

Synopsis

During a Check Flight for revalidation of a Permit to Fly the aircraft entered a left turn at about 150 ft agl, the angle of bank increased and the nose pitched down; the aircraft then impacted the ground. The manner in which the flight was conducted had caused concern to witnesses before the accident. Investigations revealed that the pilot had made claims of experience to the British Microlight Aircraft Association (BMAA) in order to obtain ongoing qualification as a Check Pilot, that were not substantiated by evidence in his log book.

History of the Flight

The aircraft owner, an experienced microlight pilot, had acquired the aircraft in the summer of 2004 and had re-built it. An Inspector from the British Microlight Aircraft Association (BMAA) had inspected the aircraft and assessed it as fit for revalidation of its Permit to Fly, as the previous Certificate of Validity had expired in 1994. The BMAA's procedures required that the aircraft pass a Check Flight, and a BMAA Check Pilot, known to the aircraft owner, had agreed to conduct this flight.

The owner had provided regular information to other members of the local flying club on the rebuilding process since he was aware of interest in this project to restore

Footnotes

[1] The pilot's logbooks prior to 1998 were not available. Between 1998 and the accident date, 45 minutes flying on type are recorded.

a 'vintage' microlight aircraft. He had informed other members of the proposed Check Flight and a number of them arrived by air and road to observe the flight.

The owner arrived at the airfield some time before the pilot and carried out a pre-flight check before running the engine and completing some taxi tests; these were assessed as satisfactory: another pilot also taxied the aircraft. The owner then carried out a further pre-flight check in anticipation of the pilot's arrival, and later stated that both pre-flight checks were "very thorough" and revealed nothing amiss.

The pilot arrived at the airfield in his own flex-wing microlight, and made a normal approach and landing. He carried out a brief pre-flight inspection of the aircraft, strapped in and started the engine. The strip's slope and the weather conditions favoured taking off from the opposite end of the strip, towards the hangar area where the spectators were gathered, and the pilot taxied to the take-off position. However, the engine then failed and the aircraft was man-handled back to the hangar area. The owner carried out remedial work on the carburettors. The pilot and owner then agreed that the problem had been resolved, and the pilot strapped himself into the aircraft once again. He taxied the length of the strip, turned the aircraft towards the hangar end, and commenced the takeoff. The acceleration and lift off appeared to be normal.

Once airborne, the pilot flew the aircraft level with the runway for a short distance whilst accelerating, before pitching up into a climbing attitude. He flew a series of manoeuvres close to the airfield including flight at various airspeeds, turns both to the left and right at various angles of bank, and stalls and their associated recoveries. During these manoeuvres the aircraft's height did not exceed approximately 500 ft and much of the time was spent at lower heights. Witnesses described being surprised at the manner in which the aircraft was flown and its low height.

The final moments of flight were described by a number of witnesses. Although their recollections were not entirely consistent their statements suggest that the aircraft entered a left turn at about 150 ft agl, the angle of bank increased and the nose pitched down; the aircraft then impacted the ground.

The spectators ran to the aircraft, which had been destroyed, and rendered first aid to the pilot. One of the spectators called for an ambulance using his mobile telephone. The pilot was treated by the ambulance crew and then evacuated to hospital by air ambulance. He had sustained minor cuts to his head, a punctured lung, and serious injuries to both legs.

Meteorology

An aftercast provided by the Meteorological Office showed that an area of high pressure was centred over Europe, with a weak warm front north of the area of the accident. A slack west to south-westerly air flow covered central England. The weather was hazy with a surface visibility of around 5,000 m, there were a few cumulus clouds at 2,500 ft and scattered to broken stratocumulus clouds with a base of 3,000 to 3,500 ft. The mean sea level atmospheric pressure was 1028 hPa and the surface wind was assessed as 240° at less than five knots.

Witnesses, most of whom were microlight pilots, consistently reported good weather with still air, good visibility and a cloudless sky at the time of the accident.

The pilot's recollection

As a result of his injuries the pilot was not interviewed until a month after the accident. When interviewed he was able to talk clearly and coherently about the events of the day up to a short while before the accident occurred, when his memories failed. He remembered preparing for flight, carrying out a power check and taking off before carrying out a left hand circuit, left and right turns, and stalls. He reports that he did not attempt an evaluation of the aircraft's handling at V_{NE} (the aircraft's

Never Exceed speed), as he believed that achieving this speed is difficult.

He described electing to fly the Check Flight at a low altitude, because he felt confident in the aircraft's handling characteristics. He recalled that the aircraft "flew normally", although he did believe that the aircraft's rigging seemed a little more taut than he expected, and he had made a mental note to suggest to the owner that it should be slackened. He recalled that he had decided that the aircraft was fit for revalidation of its Permit to Fly, and that he had concluded his check and was preparing to land when his memories cease. His last recollection is of making a final circuit at between 150 and 200 ft agl.

The pilot

The pilot had obtained a Private Pilot's Licence for microlight aircraft in 1983. He was considered by his peers to be an expert on 'vintage' and 'interesting' microlight aircraft, such as the Ptraveller. He had been appointed as a BMAA Check Pilot in 1986, and had been re-authorised on an annual basis to continue as a Check Pilot.

The owner

The owner had known the pilot for some years prior to the accident, and knew him to have some previous experience on the Ptraveller aircraft. The owner had acted as a Safety Officer at microlight flying events and had, on occasion, reprimanded the pilot for flying in a manner which caused him concern. However, he had asked the pilot to carry out this Check Flight on the basis of his expertise.

Check flights

When a microlight aircraft, of a type already subject to Type Acceptance or Type Approval, was to be granted revalidation of its Permit to Fly the BMAA required it first to be inspected by a BMAA Inspector. He would then evaluate the aircraft's fitness for flight before it was flown by a Check Pilot. There was no requirement for this Check Flight to be reported to the BMAA, unless it was successful and would then form part of the application for the revalidated Permit.

The BMAA Check Pilot Scheme and the Pilot's Check Pilot Qualification

The BMAA Check Pilot scheme was established to ensure that when a microlight required a new or revalidated Permit to Fly the owner would be able to locate a suitably qualified pilot within a reasonable distance. Pilots involved in testing and checking were categorised into three categories, A, B and C. A Category C pilot was referred to as a Check Pilot and was responsible for flights assessing the continued eligibility of an aircraft for a Permit.

The BMAA Guide to Airworthiness procedures described a Check Pilot as:

> *'Qualified to fly aircraft on which they have sufficient experience for validation of a permit to fly, or for assessment of certain modifications, where this is approved by the Chief Technical Officer.*
>
> *'A Category C pilot is a competent microlight pilot, approved by the Chief Check Pilot… A Category C pilot would normally have 150 hours as captain of microlight aircraft or experience considered by the Chief Check Pilot to be equivalent to this and no recent record of dangerous or illegal flying.'*

The BMAA Check Pilots Handbook included extracts from the British Civil Airworthiness Requirements Section S, relevant to microlight aircraft airworthiness, as well as Guidance Notes and a Flight Test Schedule detailing the required manoeuvres. It also described the Acceptance of Pilots for Airworthiness Flight Tests stating that:

> *'Recent experience on the particular type or similar aircraft types, amounting to at least 10 hours in the last 12 months is a requirement of acceptance…'*

Check Pilots were authorised for one calendar year at a time and, in order to receive on-going authorisation, were required to detail their flying activities and experience to the Chief Check Pilot each year on a BMAA 'Check or Test Pilot Update for Annual Renewal' form. Authorisation was granted to fly one or more specific types, or specific classes, of microlight aircraft. The Chief Check Pilot evaluated the stated experience on the renewal forms and granted authorisations on that basis. The BMAA's procedures did not require any check of the accuracy of such information.

A comparison of the pilot's annual forms from 1998 until 2004 and his Log Book showed inconsistencies between his experience as logged, and that claimed on the returns. In particular, he claimed a total of seven hours experience on Pterodactyls between 2001 and 2004, whereas his log book showed none. His last logged Pterodactyl flight was in 1999, when he flew 30 minutes on an aircraft with an expired Permit to Fly: the aircraft owner reported that this was not a Check Flight. The pilot claimed to have carried out a total of 21 Check Flights in the years 1998 to 2003, whereas his log book for that period showed evidence of just one Check Flight, in 2002.

Conduct of Check Flights

Check Pilots were advised on the conduct of Check Flights by various means, including a telephone brief from the Chief Check Pilot, a letter from him and the BMAA Check Pilots Notes.

The Notes stated that before a Check Flight 'A very thorough Pre-flight inspection should be carried out', and regarding the 'Stall – wing level' that 'This check should be carried out at a minimum height of 2500 ft AGL' (Above Ground Level).

Analysis of the video recording

One spectator made a video recording on the day of the accident. It showed the accident flight from the time at which the aircraft taxied out until shortly before the accident. Unfortunately, at that moment the camera operator ceased filming.

Analysis of the video evidence indicated that the aircraft was flown close to or within the boundaries of the airfield throughout the recorded part of the flight. The flight appeared to have been conducted at a low or very low height. The aircraft appeared to be under control throughout the recording.

Significant features of the aircraft

The Pterodactyl Ptraveller was one of a family of unusual aircraft produced in the early 1980s, developed from the Pterodactyl Pfledgeling, which was designed to meet then current United States regulations requiring such aircraft to be foot launchable. The Ptraveller, which was unconventional in terms of both its configuration and methods of control, is most easily understood in the context of its progenitor, the Pfledgeling.

The Pfledgeling comprised a tubular trike with a 'hammock' type weight-shift pilot's seat, a tricycle landing gear, and a rear mounted engine directly driving a pusher propeller; the whole suspended beneath a moderate sweep, constant chord, double skinned, fabric covered wing. The wing employed conventional microlight construction techniques and comprised an articulated front and rear spar framework, which allowed the wing structure to be folded for transportation by road. When rigged for flight, the spars were braced apart by tubular compression struts, and the whole wing was further braced by a conventional system of wires and a king post. The wing profile was maintained in the conventional way by means of tubular battens inserted into pockets on the wing upper surfaces. The outboard series of battens incorporated a significant reflex profile, necessary to provide the tail-less aircraft with the required longitudinal stability. Short-term changes in the aircraft's pitch attitude were effected by means of weight shift, with the aircraft's long-term pitch attitude being controlled primarily by the secondary effect of power, due both to the offset thrust line (below the wing) and to the nose up pitching moment from the reflex profile in the outer wings. Although some variants of the Pfledgeling were equipped with spoilers for roll control, the majority had no directly acting roll control devices. Instead, roll attitude was changed as a secondary effect of yaw, induced by the outward deflection of rudder-like vertical flying surfaces (winglets) mounted at each wing-tip, controlled an via open-loop cable system linked to a side-stick control column. The longitudinal moment arm of the winglets was insufficient to generate any significant yaw in the conventional manner, ie by acting as rudders. Rather, they acted as tip-mounted drag inducing devices: movement of the side stick control column to the right resulted in deflection of the right winglet surface only - the resulting yaw to the right causing the aircraft to roll to the right in response; and vice-versa.

The Ptraveller was essentially a direct development of the Pfledgeling, incorporating an all-flying canard control surface mounted on a pair of extension tubes projecting forward of the trike, connected by a push-pull rod to the side-stick control column. The canard's sole purpose was to provide an additional means of controlling the aircraft in pitch: it was not intended to provide any contribution to lift per se, and with the aircraft in a trimmed condition was designed to fly at zero incidence. However, the hammock type seat was retained and was capable of influencing the aircraft pitch attitude via weight shift. The long-term pitching moments variations with power also remained.

It is understood that in excess of a thousand Pterodactyl aircraft kits have been sold worldwide.

History of G-MBLN

G-MBLN's log book shows that it was assembled in the United Kingdom in 1981 as a Pterodactyl Ptraveller, powered by a direct-drive Cayuna 430D engine. In May 1989, after the aircraft had changed ownership four times and accumulated some 187 hours flying time, the original engine was replaced by a Fuji Robin unit incorporating a reduction drive. Subsequent log book entries recorded (to the nearest hour): 226 hrs total time as of August 1991; 236 as of 31 October 1993; and 241 hrs as of 2 October 1994, when the exemption scheme under which G-MBLN (and other microlights unable to meet the requirements of BCAR Section S) was operated, was rescinded by the CAA. It is understood that thereafter the aircraft remained unused and un-maintained until it was purchased in June 2004 for restoration by a BMAA inspector with a special interest in 'vintage' microlights. He had also inspected G-MBLN prior to the issue of its last Permit to Fly under the 'exemption' scheme in 1993.

In the period between its purchase in June 2004 and the accident, G-MBLN was completely dismantled, inspected, and, after replacement of damaged spars, reassembled. Minor modifications were also made to improve the undercarriage suspension and the electrical system and flight instruments were revised and updated. All fabric was renewed, together with the rigging wires, cable attachment fittings and other sundry items. All type-specific hardware was purchased new from the United States, from a company which took over the provision of spares and support from the original manufacturer and has extensive experience of building, maintaining, and flying the Pterodactyl family of aircraft. The rebuild was carried out following advice contained in a comprehensive "builders manual" for the structurally identical Pterodactyl Ascender II aircraft, compiled and supplied by the same company, which also provided advice and guidance via e-mail on specific issues arising during the course of the restoration. No major problems were encountered, but several minor issues did arise due to a combination of lack of information specific to G-MBLN and minor design changes and production variations affecting the Ascender/Ptraveller types over the years. A particular issue, which could not be fully resolved prior to the Check Flight, was the rigging tension of the winglet control cables. These could not be finally adjusted until it had been determined whether, with the structure loaded and the wing flexed in flight, there was any tendency for the winglets to deploy from their neutral position. It was therefore decided that installation of the swaged backup collars onto the protruding tails of the winglet operating cables, at their attachments to the control surfaces, would be postponed until after completion of the Check Flight, when the cable tension could be set definitively and the cables locked down into their final position.

Upon completion of the restoration work on 9 December 2004, the aircraft was inspected by an independent BMAA inspector, using the appropriate approved Schedule, and an application was made by the owner to the BMAA for an annual validation of a microlight Permit to Fly for the purpose of carrying out a Check Flight. In the week preceding the accident, the aircraft was also examined independently by the pilot designated by the BMAA to conduct the Check Flight. On both occasions the aircraft was deemed to be in a fit condition.

Examination of the wreckage at the crash site

The distribution of wreckage and ground impact marks at the accident site indicated that the aircraft was in a steep, approximately 70°, nose down attitude at impact and slightly left wing low.

The impact resulted in major disruption and break-up of the trike's tubular framework, but the wing survived the crash without significant damage except for a single fracture of the inboard section of the right wing front spar, fractures of the forward and rear sections of the keel member and a failure of the bracing wire between the trike frame and the right wing at its swaged connection to the underside of the wing spar. All of these structural failures were a direct consequence of the impact.

The propeller had fragmented and the broken pieces scattered in the immediate vicinity of the impact point. The character and distribution of these fragments was consistent with rotation under significant power at the time of impact, but it was not possible to assess accurately the degree of power being developed by the engine at that time.

The canard control surface suffered direct damage in the impact which resulted in both hinge fittings been torn from their mountings, but the canard's control horn, together with the connecting rod linking it to the pilot's side stick control column, was present and its connections had survived the impact intact. The orientation of the ground witness mark produced by the leading edge of the canard, relative to witness marks produced by the leading edges of the wings, indicated that the canard's attachment to the rest of the aircraft was intact at the time of impact. Examination of the aircraft's yaw/roll control system revealed that both of the winglet operating cables had pulled away from their clamped connections to the operating horns on their respective control surfaces. The nature of the impact was such that both cables would have been subject to a heavy snatch-loading during the impact which would have tended to pull the cables from their end attachments; however, the possibility of a prior disconnection during flight could not be ruled out on the basis of the evidence available at the accident site.

Detailed examination of the wreckage

Structure

A detailed study of the structure confirmed the assessment made at the scene: that all of the structural damage was entirely consistent with the impact; nothing was found to suggest that there had been any pre-impact failure of the primary structure or of the fabric covering of the wing.

Yaw/roll controls

The clamps securing the outer ends of the winglet operating cables to the control horns on the winglet surfaces were examined in detail in an effort to establish whether any disconnection may have occurred prior to impact with the ground.

Each clamp comprised an over-length bolt which passed through a loose-fit hole in the outer end of the tubular fitting forming the control horn at the winglet. This bolt was installed with the head uppermost, leaving an extended length of the threaded section of the bolt protruding beneath the horn. The tail of the control cable passed through a hole in this threaded section of the bolt, and was clamped between a pair of hard plastic washers, each backed by steel washers and a jam-nut. Each of the jam-nuts was of the nylock stiff-nut type, which necessitated the upper nut being installed onto the bolt with its nylon lock collar on the underside of the nut acting as the clamping face, ie abutting the upper of the two steel backing-washers.

Examination of the plastic clamping washers under high magnification revealed clear evidence of deep indentation resulting from the clamping force applied to the cable on both of the washers from the left clamp, and on one of the washers from the right hand clamp. The other washer from the right hand clamp displayed less clearly defined indentation markings than was evident on the other washers, but it was noted this washer was of a slightly different type from the others. Although the cable indentation was less clearly defined, localised crushing and tearing of the surface in contact with the cable was clearly evident, consistent with the cable having been pulled through the fitting against significant resistance provided by the clamping. It was also noted that the plastic nylock collar of the top backing-nut of the clamp assembly from the right winglet was longer than that from the corresponding nut on the left clamp, and protruded slightly beyond the end of the swaged section of the nut proper and as a consequence the steel backing washer from the right clamp was bearing against the end of the plastic collar, which had crushed back slightly on one side as the lower jam-nut was tightened to clamp the cable. 'As found', the separation distance between the interfacing surfaces of each of the clamps was equal (0.6 mm), and the number of turns applied to each of the lower jam-nuts in order to secure the cable was also equal.

Based on the available evidence, it was not possible to rule out totally the possibility that post-installation creep (crushing) of the plastic lock collar in the backing nut from the right clamp assembly may have occurred, relaxing the clamping action on the right hand cable and allowing it to pull free of its fixing in flight. However, it was considered more likely that the cables had pulled out during the impact, when very large snatch forces would certainly have been applied to both cables.

Wing profile

A comparison of the batten profiles from the left and right wings showed that, post accident, the outermost batten (No 7) from the right wing exhibited approximately 30 mm greater reflex at the trailing edge than the corresponding batten from the left wing. The No 6 batten profiles were identical for all practical purposes; the No 5 batten from the right wing exhibited approximately 8 mm more reflex at the trailing edge than that from the left wing. The remaining battens exhibited minor variations only.

A check of the batten profiles against the manufacturer's drawings revealed that the apparent variations in reflex profile were in fact the result of a combination of relatively minor deviations in both the leading and trailing edge regions of the affected battens. Overall, the observed variations in batten profile would have had the effect of reducing both the camber (in the leading edge region) and also the reflex of the right wing in comparison with the left wing.

With the exception of a discrete bend in the inboard batten of the right wing, which was clearly the result of the impact, it was not possible to establish whether the more uniform deviations in batten profile were present before the accident or, alternatively, whether they were the result of induced loadings of the battens caused by abnormal tensions in the fabric as the wing flexed in the impact.

Analysis

Technical issues

The available evidence leaves little doubt that the aircraft struck the ground in a steep spiralling descent to the left from low-altitude, with the engine running.

At the time of impact the aircraft was structurally intact, and the canard and is associated control linkages intact and connected. However, although both winglet control surfaces were also securely attached, the operating cable for each had pulled out from its clamped in fixing at the control surface – consistent with the forces that would have been induced in both cables at the time of impact. Whilst it was not possible to rule out totally the possibility of a control cable disconnection in flight, microscopic examination of the clamping hardware revealed evidence to show that both yaw cables had been subject to significant clamping pressure in their fixtures, and the probability of a pre-impact disconnection was assessed as low.

Because the system controlling the winglets is open loop – each surface being deflected only outwards in response to tension applied to its associated control cable – a disconnection in-flight is unlikely to have precipitated the steepening turn to the left which developed subsequently into the spiral into the ground. Rather, its effect, as prior instances of cable disconnects on Pterodactyl series aircraft in the United States attest, would be to inhibit the pilot's efforts to restore the aircraft to level flight from an already banked condition. Not withstanding the physical evidence suggesting that both cables were effectively clamped in their fittings, the effect of a right winglet cable disconnecting in-flight is likely to have been to prevent the pilot from levelling the aircraft from the turning manoeuvre to the left that he had apparently initiated in preparation for landing.

Had the batten profile variations noted during the post accident inspection of the wreckage been present prior to impact, then their effect would probably have been to predispose the left outer wing to stall in advance of the right. Such stalling characteristics may not have been manifest with the aircraft being stalled conventionally in level flight, but could potentially be significant in the event of the aircraft stalling whilst in a turn to the left, when any tendency to drop the left wing could precipitate a spiral/incipient spin to the left.

Operational issues

The purpose of the flight was to check the 'continuing' safe flying characteristics of the aircraft.

Evidence from the pilot's log book showed that he lacked recent experience on the aircraft type and in conducting Check Flights. There was also a marked discrepancy between the pilot's claimed experience, in his applications to the BMAA for continuing status as a Check Pilot, and the hours recorded in his log book

The manner in which the flight was conducted prior to the accident caused concern to the aircraft owner and to other witnesses. Furthermore, the aircraft owner had previously expressed concerns regarding the manner in which the pilot had flown.

The witness accounts of the flight being conducted at a height of less than 500 ft were consistent with the video evidence. Good airmanship requires that the testing and checking of aircraft should be carried out at a height from which the pilot may recover from any unexpected or unplanned excursions from normal manoeuvres without hazard to the aircraft or crew. The BMAA's Check Pilots Handbook required that stalls should be carried out at a minimum height of 2,500 ft agl, and it is clear that the height at which the stalls were conducted did not satisfy this requirement.

It is appropriate to consider whether any mechanism within the BMAA's procedures could have prevented the accident. The oversight of the rebuild and the inspection of the aircraft prior to the Check Flight appeared to have been satisfactory. However, the pilot had submitted inaccurate claims of his experience, and these were not identified as such by the BMAA. Requiring pilots to submit copies of their log books to substantiate their applications would at least allow 'claimed' experience to be checked against log book details. However, introduction of such a requirement might itself be counter-productive. Experienced and able pilots might find the process onerous and be inclined to rescind their Check Pilot status, thus depriving aircraft owners of their abilities in the process. A system of occasional checks would inspire applicants to produce accurate applications but would not entirely address the problem. In any case, a pilot could falsify log book evidence, and obtain ongoing authorisation as a Check Pilot by that means (although falsifying log books carries formal penalties).

Aside from stating the requirement to conduct stalling at a minimum of 2,500 ft, the BMAA's advice to Check Pilots did not provide significant detail regarding the safe conduct of a Check Flight. However, it might be reasonable to consider that such matters as operating at a safe height should be so instilled into an experienced pilot as to make their re-iteration in such guidance superfluous.

Conclusions

The aircraft struck the ground as the result of a departure from controlled flight which occurred at a height from which recovery was impossible. The cause of the departure from controlled flight could not be determined; however, the evidence indicates that it is unlikely that structural or mechanical failure was the cause. The process by which the BMAA had accredited the pilot with Check Pilot status did not identify that he did not possess the appropriate experience to conduct the flight.

Safety Action

The BMAA has commenced a review of its Check Flying procedures and has taken action to withdraw most "all types" Check Pilot approvals, replacing them with approvals for specific handling groups where the pilot had significant (and recent) experience only. It also plans to introduce significantly more stringent requirements concerning recency on class of aircraft, increasing the minimum annual flying experience for Check Pilots from five hours to 30 hours (with some exceptions), and to introduce more formal procedures for training for new Check Pilots, including face-to-face briefing and a requirement to demonstrate appropriate skills.

The BMAA also plans to re-write the Check Pilot's Handbook, to appoint a new Chief Check Pilot and to re-write the Check Flight schedule.

Safety Recommendation 2005-067

It is recommended that the Civil Aviation Authority should conduct a thorough review of the manner in which Permit to Fly renewals are carried out by the British Microlight Aircraft Association, to ensure that persons involved in Check Flying are appropriately experienced and qualified, and receive relevant training and guidance.

INCIDENT

Aircraft Type and Registration:	Sky 90-24 Hot Air Balloon, G-VINO
No & Type of Engines:	None
Category:	3
Year of Manufacture:	1998
Date & Time (UTC):	10 June 2005 at 2046 hrs
Location:	Dog House Lane, Todmorden, Yorkshire
Type of Flight:	Private Flight
Persons on Board:	Crew - 1 Passengers - 3
Injuries:	Crew - None Passengers - 1 (Minor)
Nature of Damage:	Minor burn damage to the envelope
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	57 years
Commander's Flying Experience:	656 hours (all on type) Last 90 days - 6 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

History of the flight

The pilot and three passengers departed a large open playing field area on the east side of the village of Mytholmroyd for a one-hour pleasure flight. The balloon was climbed to 2,000 ft and it tracked in a westerly direction. The weather was CAVOK with the 1,000 ft forecast wind from 090°/09 kt. The flight was uneventful and after one hour the pilot selected a landing site in a field at the top of a steep-sided valley. The balloon passed over the valley and the wooded upslope towards the landing site, touching down in virtually calm wind conditions. Initially the balloon envelope remained inflated and upright with the main burner gas supply control lever in the spring loaded OFF position but with the pilot lights still lit. Given the calm wind conditions in the lee of the trees, the pilot intended to leave the balloon envelope inflated in order to assist his recovery crew in locating the balloon.

The envelope however, collapsed quickly on top of the basket and burners due to the downdraft created by the wind passing over the trees and valley upslope, upwind of the balloon. The balloon had landed backwards which meant that the flying wires from the collapsed envelope lay across the burners which had rotated through 90° into a horizontal position. One of the 24 flying wires which attach the burners to the balloon envelope contacted the burner gas supply control lever, briefly opening it and releasing propane gas which was ignited by the pilot lights. A ball of flame passed under the collapsed envelope singing the hair and causing a minor burn to the face of one of the passengers.

Balloon pilot's assessment

The balloon pilot considered that although the wind condition in the lee of the trees was calm, the curl-over effect was sufficient to collapse the envelope. Turning OFF all the gas supplies and extinguishing the pilot lights promptly on landing would have prevented the incident.

ACCIDENT

Aircraft Type and Registration:	Skyranger 912(2), G-CCXM
No & Type of Engines:	1 Rotax 912-UL piston engine
Category:	1.4
Year of Manufacture:	2004
Date & Time (UTC):	10 July 2005 at 1132 hrs
Location:	Redlands Airfield, Swindon, Wiltshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Extensive to airframe and propeller
Commander's Licence:	UK Private Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	639 hours (of which 58 were on type) Last 90 days - 20 hours Last 28 days - 11 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Circumstances

The Skyranger is a two seat, three axis aeroplane; G-CCXM had a tricycle undercarriage though the type is available in a taildragger configuration. The pilot, who was also the aircraft owner, had flown to Redlands Airfield from his home strip in Northamptonshire and was preparing for the return flight when the accident happened. Prior to the flight to Redlands, the aircraft battery was found to be discharged, so a 'jump start' pack was used to start the engine. The 43 minute flight to Redlands was otherwise uneventful. After a ground stop of some 40 minutes, the pilot boarded the aircraft for the return flight, but found that there was still insufficient battery power to turn the engine. As the pilot had not brought the starter pack with him he decided to hand swing the propeller.

The pilot manoeuvred the aircraft to point it in a safe direction before applying the parking brake, which consisted of a 'bungee' cord which was looped over the control column and brake lever – a common arrangement on this type. The pilot did not have any wheel chocks and none were immediately available. He considered asking someone to sit in the cockpit to guard the switches but felt that there was no-one nearby whom he could trust with this task and that it may potentially endanger them. The pilot checked that the master and ignition switches were ON and that the throttle was closed before hand swinging the three bladed propeller. The engine did not fire at the first swing, so the pilot re-checked the switches and confirmed the throttle was closed. On the next swing the engine started but ran up to a high power setting, causing the aircraft to move forward. The pilot attempted to jump clear of the propeller and to reach the cockpit to turn the switches off, but in so doing his left arm was struck by two blades of the propeller, breaking his elbow and causing a deep laceration which later required surgery.

The aircraft proceeded unmanned across a runway and into a hedge where it came to rest. The engine stopped as a result of the propeller coming into contact with the ground. The main undercarriage had collapsed, and damage had occurred to the cabin and main fuselage areas. The aircraft was subsequently examined by a BMAA inspector but the reason for the engine starting on a high power setting could not be determined; there was no pre-accident damage to throttle cables and no sign of a carburettor fault that would cause the engine to default to a high power setting. Throttle friction, which was not adjustable, was set correctly.

In his frank report, the pilot stated the following:

> *"My naïve belief was that because I had hand-started Rotax 912 engines before I could do so on this occasion without any problem. Had the engine not started at a high power setting I would probably have had no difficulty, but when it did I was caught out. The one thing I did right was to point the aircraft away from people. I quite accept that it is possible to hand-start an aeroplane safely if you take every possible precaution, though I will not push my luck by hand-swinging a propeller again."*

The pilot also commented that he should have persisted with his efforts to find some chocks; although the aircraft may well have jumped the chocks at high power, he might have avoided the propeller and may even have reached the cockpit before it did so. The pilot later felt he was wrong in thinking that a properly briefed person in the cockpit would have been subject to any unacceptable risk. He also thought that it would have been better to have obtained a 'jump start' pack or to place the battery on charge and accept that he would be a few hours late home.

The CAA issues the following advice to pilots through its General Aviation Safety Sense leaflets:

> *"**Never** attempt to hand swing a propeller (or allow anyone else to swing your propeller) unless you know the proper, safe procedure, and there is a suitably briefed person at the controls, the brakes are ON and the wheels are chocked. Check that the area behind the aircraft is clear."*

Comment

The discharged battery was a common feature to both engine starts on the day, though only one resulted in an accident. At the pilot's home base the correct equipment was available and there would have been minimal pressure to conduct the flight. On the return flight, an unexpected situation left the pilot with apparently limited options, an unfamiliar environment and a lack of the right equipment readily available. Additionally, there was an increased element of pressure to make the flight as it was to return to home base. It is the unexpected situation, probably away from base, which is more likely to lead to a degree of 'improvisation' which in turn increases the risk of a mishap.

BULLETIN CORRECTION

AAIB File No:	**EW/C2004/03/01**
Aircraft Type and Registration:	Agusta A109E, G-PWER
Date & Time (UTC):	3 March 2004 at 1939 hrs
Location:	1 mile east of Bournemouth (Hurn) Airport, Dorset
Information Source:	AAIB Field Investigation

AAIB Bulletin No 6/2005, page 58 refers

Synopsis

The pilot was flying a visual approach to Bournemouth Airport in poor weather at night; radar data indicated that the aircraft was tracking the extended centreline of Runway 26 at between 800 to 1,000 feet amsl. The pilot declared that he was visual with the airport but, shortly afterwards, the radar data indicated that the aircraft had entered a turn to the left. The aircraft turned through about 540° before striking the ground, fatally injuring both the pilot and the passenger. The pilot had probably become disorientated, and his limited instrument flying background did not equip him to cope with the degraded visual environment. There was no evidence from the wreckage recovered of any mechanical failure or unauthorised interference with the aircraft or its systems that may have contributed to the accident.

Bulletin Correction

The Civil Aviation Authority have pointed out that the flying regulations referred to in the published report were not the relevant regulations because the helicopter involved in the accident was at no time subject to these Visual Flight Rules. Since the flight was flown at night the flight was conducted as a 'Special VFR flight' whilst in the Heathrow and Bournemouth control zones, and was subject to the Instrument Flight Rules when flying outside of the control zones. The relevant regulations are produced below.

Since the basis for the Safety Recommendation has now changed the revised wording of the Recommendation itself is also presented.

Flying Regulations

The rules of the air that relate to the circumstances of the accident are contained within The Rules of the Air Regulations 1996 which can be found at Section 2 of CAP 393.

The Rules

Rule 1 of the Rules defines a special VFR flight as:

> "a flight made at any time in a control zone which is Class A airspace, or in any other control zone in Instrument Meteorological Conditions or at night, in respect of which the appropriate air traffic control unit has given permission for the flight to be made in accordance with special instructions given by that unit instead of in accordance with the Instrument Flight Rules and in the course of which flight the aircraft complies with any instructions given by that unit and remains clear of cloud and in sight of the surface;"

Rule 22 of the Rules provides:

> **Choice of VFR or IFR**
>
> (1) Subject to paragraph (2) and to the provisions of Rule 21 an aircraft shall always be flown in accordance with the Visual Flight Rules or the Instrument Flight Rules.
>
> (2) In the United Kingdom an aircraft flying at night:
>
> (a) outside a control zone shall be flown in accordance with the Instrument Flight Rules;
>
> (b) in a control zone shall be flown in accordance with the Instrument Flight Rules unless it is flying on a special VFR flight.

Rule 28 of the Rules provides:

> **Instrument Flight Rules**
>
> (1) In relation to flights within controlled airspace rules 29, 31 and 32 shall be the Instrument Flight Rules.
>
> (2) In relation to flights outside controlled airspace rules 29 and 30 shall be the Instrument Flight Rules.

Rule 29 of the Rules provides:

> **Minimum height**
>
> Without prejudice to the provisions of Rule 5, in order to comply with the Instrument Flight Rules 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 unless:
>
> (a) it is necessary for the aircraft to do so in order to take off or land;
>
> (b) the aircraft is flying on a route notified for the purposes of this rule;
>
> (c) the aircraft has been otherwise authorised by the competent authority; or
>
> (d) 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.

Effects of the Rules

Outside controlled airspace

Flight at night outside controlled airspace such as a control zone must be conducted in accordance with the applicable Instrument Flight Rules which are Rules 29 and 30. However Rule 30 – the Quadrantal rule and semi-circular rule - only applies when flying above 3000 feet. Accordingly when flying below 3000 feet at night outside controlled airspace the applicable rule is Rule 29.

This normally requires the aircraft to be flown not less than a height of 1.000 feet above the highest obstacle within 5 nm of the aircraft.

This requirement does not apply when the aircraft is flying below 3000 feet and remains clear of cloud and in sight of the surface or if the aircraft is taking off or landing.

Within controlled airspace

When flying at night within controlled airspace the applicable Instrument Flight Rules are Rules 29, 31 and 32. Rule 31 relates to the provision of a flight plan and Rule 32 relates to position reports. Rule 22 (2) (b) however provides that an aircraft may instead comply with the requirements for a Special VFR flight in Rule 1. In particular it must comply with ATC instructions and remain clear of cloud and in sight of the surface.

Licence privileges

In addition to complying with the relevant Rules of the Air a pilot must also observe the privileges of his licence.

The privileges afforded by the pilot's UK ATPL (H) meant that as a private flight he was permitted to fly in IMC outside controlled airspace and IMC within certain categories of controlled airspace even though he did not hold an IR.

Safety Recommendation

Since the flight was flown at night the flight was conducted as a 'Special VFR flight' whilst in the Heathrow and Bournemouth control zones, and was subject to the Instrument Flight Rules when flying outside of the control zones; specifically taking advantage of the alleviation in Rule 29 (d). In either case the pilot was required to "remain clear of cloud and in sight of the surface". In the deteriorating meteorological conditions the pilot of this helicopter either encountered a seriously degraded visual environment or inadvertently entered IMC and subsequently experienced spatial disorientation. The freedom for helicopters to remain clear of cloud and in sight of the surface when operating below 3,000 feet does not provide an adequate margin of safety for preventing inadvertent IMC or spatial disorientation. It is therefore recommended that:

Safety Recommendation 2005-055

The Civil Aviation Authority should review the Rules of the Air and relevant regulations in their applicability to helicopters and should consider imposing minimum visibility requirements for day and night. These minima should afford an effective safety margin to prevent inadvertent flight in instrument meteorological condition or loss of adequate external visual references. The requirement for a clearly defined horizon, particularly over water or featureless terrain should also be considered.

BULLETIN CORRECTION

AAIB File No:	**EW/G2005/02/02**
Aircraft Type and Registration:	Piper PA-23-250 Aztec, N54211
Date & Time (UTC):	5 February 2005 at 1310 hrs
Location:	Elstree Aerodrome, Hertfordshire
Information Source:	Correspondence with the commander

AAIB Bulletin No 8/2005, page 60 refers

In this report it was stated that during the recovery 'A truck was connected to the tie-down ring on the tail of the aircraft using a rope' and then 'the truck pulled the tie-down ring and surrounding skin off the aircraft.' The truck was not connected to the tie-down ring during the initial attempt to lower the nose gear. The horizontal tail was lowered solely by the weight of the people sitting on it.

After the main gear collapsed during the failed recovery, the aircraft was dragged by its nose gear to an open grass area clear of the taxiway but due to the boggy conditions, the nose leg sank into the ground. The fire service then secured a truck to the tie-down ring in an attempt to rotate the aircraft clear of the taxiway, and it was at this time that the tie-down ring and surrounding skin were torn from the aircraft.

The pilot of N54211 also wished to highlight a human factor issue that contributed to the main gear collapse during the recovery of the aircraft. He reported that after he had landed and vacated the aircraft, the fire crew were eager to remove it from the runway as soon as possible so that the runway could be re-opened. There was also an unconfirmed report that another aircraft with low fuel was requesting priority to land (this turned out not to be true). Because of these pressures the pilot said he rushed to help move the aircraft without taking the time to consider carefully the operation of the landing gear system. After the tail was lowered he tried to extend the nose gear by pulling on it with a rope. During his pull the main gear collapsed but he narrowly avoided injury.

The pilot stated that if there was a moral to the story it was that "if you have just force-landed an aircraft don't immediately get involved in its recovery."

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.

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