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(ALL TIMES IN THIS BULLETIN ARE UTC)

SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A321-231, G-MEDJ
No & type of Engines:	2 International Aero Engines V2533-A5 turbofan engines
Year of Manufacture:	2004
Location:	At FL360 over northern Sudan
Date & Time (UTC):	24 August 2010 at 0225 hrs
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 7 Passengers - 42
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	34 years
Commander's Flying Experience:	Approximately 7,500 hours (of which approximately 1,400 were on type) Last 90 days - 165 hours Last 28 days - 61 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft suffered an electrical malfunction during a scheduled night flight between Khartoum (Sudan) and Beirut (Lebanon). The more significant symptoms included the intermittent failure of the captain and co-pilot's electronic displays and the uncommanded application of left rudder trim; the flight crew also reported that the aircraft did not seem to respond as expected to control inputs. A large number of

ECAM[1] messages and cautions were presented. The uncommanded rudder trim caused the aircraft to adopt a left-wing-low attitude and deviate to the left of the planned track. Normal functions were restored after the flight crew selected the No 1 generator to OFF in response to an ECAM 'ELEC GEN 1 FAULT' message. The aircraft landed safely at Beirut.

History of the flight

The incident occurred as the aircraft was cruising at Flight Level (FL) 360 over northern Sudan, with the commander as pilot flying and the No 1 autopilot (AP 1) and autothrust engaged. The conditions were night Instrument Meteorological Conditions, with slight turbulence. The commander reported that, without warning, his Primary Flight Display (PFD), Navigation Display (ND), and the ECAM upper Display Unit (DU) began to flicker, grey out, show lines or crosses, and go blank. Concurrently, there was a "chattering" heard coming from the circuit breaker panels behind the two pilots' seats, which was thought to be relay operation. The abnormal behaviour ceased after a short time. The co-pilot checked the circuit breakers to see if any had operated and to look for signs of overheating, but nothing was noted. The commander reviewed the ECAM electrical system page, which showed no abnormalities.

Some minutes later, the commander's PFD, ND, and ECAM upper DU began to flicker and grey out again, before blanking for longer periods. AP 1 disconnected and the commander handed control to the co-pilot, whose display screens were unaffected at this time. The abnormal condition was once again short-lived and once conditions had returned to normal, the commander reassumed control and re-engaged AP 1.

The symptoms returned shortly thereafter, with the commander's displays becoming mostly blank, or showing white lines. When the displays were visible, the airspeed, altimeter, and QNH/STD indications were erratic. The co-pilot's PFD, ND, and the ECAM lower DU began to flicker and were sometimes unreadable. The crew reported that the cockpit lights went off intermittently. The commander handed control to the co-pilot again, who flew the aircraft manually. Reference was made to the standby flight instruments, which operated normally throughout the incident.

During this period, the chattering sound resumed and was, at times, continuous. Numerous ECAM messages were presented and there were a number of master caution annunciations. Symbols indicating flight control system reconfiguration to Alternate Law[2] appeared, the flight directors were intermittent and the autothrust system went into 'thrust lock' mode. The aircraft rolled to the left and adopted an approximately 10º left-wing-low attitude, without any flight control input from the crew. The flight crew reported that the aircraft did not seem to respond as expected to their control inputs and shuddered and jolted repeatedly.

The flight crew became concerned that the aircraft was malfunctioning and that the ECAM was only sometimes visible and did not identify the root cause of the problem. Moreover, they were not aware of any procedure applicable to the symptoms experienced. The commander contemplated transmitting a MAYDAY,

Footnote

1 Electronic Centralised Aircraft Monitoring system - this comprises two centrally mounted electronic display units, which present the flight crew with aircraft systems information, warning and memo messages and actions to be taken in response to systems failures.

Footnote

2 Alternate Law is a mode of the flight control system in which certain protection features are unavailable.

but considered that his priorities were to retain control of the aircraft and identify the problem.

After several minutes, the commander saw the ECAM 'GEN 1 FAULT' message and associated checklist, which required the No 1 generator to be selected to OFF. On doing so the juddering motion ceased, the chattering noise stopped, and all displays reverted to normal operation, although the aircraft's left-wing-low attitude persisted. The checklist directed that the generator should be selected ON again, and following discussion and agreement that it would be immediately deselected should the problems return, the commander selected it to ON. This caused the symptoms to return, prompting him to select the generator to OFF again.

The APU[3] was started and its generator was selected to power the systems previously powered by the No 1 generator. Shortly thereafter, the flight crew noticed that the rudder trim display indicated several units from neutral, although they had not made any rudder trim inputs. When the rudder trim was reset to neutral, the aircraft readopted a wings-level attitude. The aircraft had deviated approximately 20 nm to the left of the intended track during the incident.

The aircraft was flown manually for the remainder of the flight and landed at Beirut without further incident.

Engineering investigation

An investigation into the cause of the technical problem has been initiated, with the objectives of establishing:

- The source of the failure in the electrical system
- Why both the captain's and co-pilot's electronic instrument displays were affected
- The effects of electrical power interruptions on the flight control system

The aircraft manufacturer has indicated that a reset of the Flight Augmentation Computer (FAC), caused by an electrical power interruption, may cause a small incremental offset in the rudder trim. Multiple electrical power interruptions can result in multiple increments which could, cumulatively, produce a significant rudder trim input.

Flight recorders

Due to the late notification of the event to the AAIB, both the Cockpit Voice Recorder (CVR) and the Flight Data Recorder (FDR) data for the incident were overwritten. Flight data was obtained from the operator's Flight Data Monitoring (FDM) programme, which recorded a similar set of parameters to the FDR.

An initial review of the data has confirmed some of the crew reports, including the unusual behaviour of the aircraft in yaw. A detailed review of the aircraft performance data is underway with the aircraft manufacturer to gain a better understanding of the flight control behaviour.

Discussion

The symptoms experienced during the incident are believed to be attributable to an electrical power generation system fault. The incident appeared to have posed a number of challenges for the flight crew, in that they were presented with numerous and significant symptoms, including malfunctioning electronic displays and uncommanded rudder trim input, the cause of which was not evident. The ECAM did not clearly annunciate

Footnote

[3] Auxiliary Power Unit.

the root cause of the malfunction and no information or procedures were available to assist the flight crew in effectively diagnosing the problem.

The following Safety Recommendation is therefore made:

Safety Recommendation 2010-092

It is recommended that Airbus alert all operators of A320-series aircraft of the possibility that an electrical power generation system fault may not be clearly annunciated on the ECAM, and may lead to uncommanded rudder trim operation.

Published 5 November 2010

Safety Action

Airbus intends to notify A320-series aircraft operators of this incident and associated ongoing actions.

Progress

The AAIB is continuing to investigate this incident with the co-operation of the manufacturer, the Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile and the operator. A final report will be published when the investigation is complete.

SERIOUS INCIDENT

Aircraft Type and Registration:	Boeing 737-33A, G-CELC
No & Type of Engines:	2 CFM56-3B2 turbofan engines
Year of Manufacture:	1987
Date & Time (UTC):	7 February 2010 at 1154 hrs
Location:	On approach, Chambery Airport, France
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 103
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	43 years
Commander's Flying Experience:	3,446 hours (of which 2,696 were on type) Last 90 days - 94 hours Last 28 days - 33 hours
Information Source:	AAIB Field Investigation

Synopsis

The flight crew were carrying out an ILS approach to Chambery Airport, in IMC, with the autopilot engaged and the LOC (localiser) and VS (vertical speed) modes selected. The crew reported that they had observed some anomalies with the ILS and DME information before and during the approach. Final descent, at a high rate of descent, was initiated from an altitude of 5,000 ft, with the aircraft established on the localiser but two dots below the glideslope. At a range of 8.6 nm from the runway and at 1,125 ft agl, an EGPWS Mode 2 Terrain and Pull Up warning activated. The co-pilot had just initiated a go-around and the pitch attitude was increased to a maximum value of 32.7° nose up. The aircraft climbed clear of terrain, returned to the holding fix and a second approach was carried out successfully.

History of the flight

The flight departed from Leeds Bradford Airport on a service to Chambery Airport, France. The TAF for Chambery, available before departure, was:

> '070500Z 0706/0806 36008kt 9999 BKN024 OVC 033 BECMG 0710/0712 BKN033 TEMPO 0706/0715 360/15kt'

The co-pilot was designated as the Pilot Flying (PF) for the sector because, with a northerly wind forecast, a circling approach to Runway 36 might have been required and the right hand seat pilot would have been better placed to maintain a clear view of the runway.

En-route, the crew received Chambery's ATIS information 'C', which reported a surface wind from 340° at 9 kt. The aircraft was directed by ATC to the VIRIE holding pattern and at 1148 hrs was cleared for the ILS to Runway 18 with a circling approach to Runway 36, which the commander acknowledged. (The approach chart is included at Figure 1.) At 1150 hrs, as the aircraft crossed over the VIRIE initial approach fix to start the approach, ATC advised the commander that the wind was from 360° at 7 kt and asked if he could accept a landing on Runway 18. The commander replied that he could if the wind remained the same. The aircraft was cleared to continue the approach.

The aircraft left the hold at VIRIE, in IMC, at an altitude of 6,500 ft, with the autopilot engaged, and proceeded in accordance with the published approach procedure. The commander selected the CY ILS (he previously had the CBY VOR beacon tuned for the earlier part of the procedure) and observed that it was indicating correctly. The FDR recorded a valid 13 DME CY (nm) signal. At a distance of 12 nm from the airfield, and level at an altitude of 5,000 ft, the aircraft captured the localiser in VOR/LOC mode and turned to track about one dot to the right of the localiser, before gradually adjusting towards the centreline. As the aircraft approached 11 DME CY (nm), the autopilot VS mode engaged and the aircraft started to descend at about 2,200 fpm (see Figure 2).

The commander noticed a loss of ILS information on his electronic attitude indicator (EADI) and looked across the flight deck to see if the co-pilot's ILS indications were still available. They appeared to be, so, trying to resolve the problem, he looked down at the AUTO/MAN selection switch for the navigation frequency, on his side of the aft electronic panel on the centre pedestal, to check that the ILS frequency was set correctly. He cycled the switch to ensure that it had properly engaged and his ILS indications then returned to view. ATC then contacted the aircraft with a frequency change instruction, which the commander acknowledged. However, before he checked in on the new frequency he noticed that the aircraft was below the glideslope and descending at a rate of more than 2,000 fpm.

The commander queried this with the co-pilot by saying "are you happy". The co-pilot responded that he was not and commenced a go-around. As he did so, an EGPWS Mode 2 TERRAIN TERRAIN, PULL UP warning activated and he increased the pitch angle to achieve a maximum rate of climb. The commander called "positive climb" and then selected the gear up in response to a call from the co-pilot.

The aircraft broke out of the cloud layer at an altitude of 6,000 ft with a pitch attitude in excess of 20° nose up and an airspeed of 110 kt. The co-pilot levelled the aircraft to accelerate and then continued the climb to FL90. During the climb, the aircraft's track was adjusted towards the CY NDB, a point of reference which the crew considered reliable, being uncertain of the aircraft's true position and the reliability of their other navigation systems.

The commander contacted ATC again and asked about the serviceability of the ILS. On being assured that it was serviceable the crew discussed their options and the commander decided on a second approach. That approach was completed successfully.

Airport information

Chambery Airport has an ILS installed on Runway 18, the glideslope for which is set at 4.45°. There are two published ILS approach procedures. One is a straight-in procedure, with descent from an altitude of 6,500 ft commencing at a range of 12.1 DME (nm). The second is via the VIRIE initial approach fix and CBY

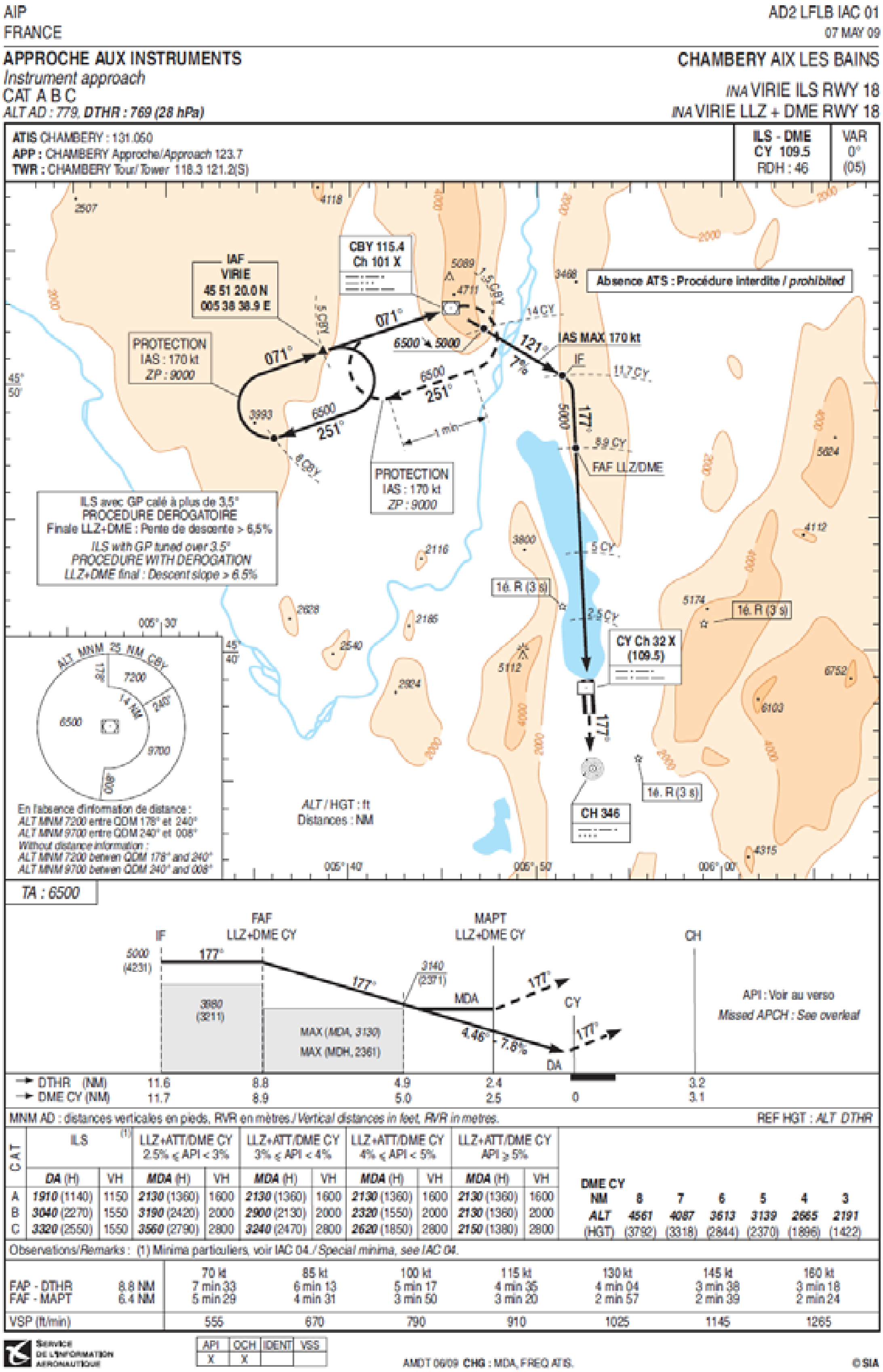


Figure 1

ILS RWY 18 approach via VIRIE

VOR beacon, with descent from an altitude of 5,000 ft commencing at 8.9 DME (nm). There is no instrument approach for Runway 36 but there is a circling procedure with prescribed flight tracks. The operator's circling minimum was 2,200 ft amsl or greater, according to the missed approach climb gradient. The airport is in a valley, with high terrain all around, and the final 8 nm of the ILS approach is over a lake. (See Figure 1.)

The most recent flight inspection of the ILS at Chambery Airport was conducted on 26 November 2009. The ILS was found to conform with the requirements for a Category 1 ILS. No reports were found concerning the serviceability of the ILS or the DME at Chambery.

The airport is designated Category C and there is a state requirement for commanders of commercial flights to receive special training from the operator before they are allowed to fly there. The commander had received this training four years earlier and since then had complied with the annual recency requirements. At the time of his initial training he had been a co-pilot; no further training was given when he was promoted to Captain. His most recent visit to the airport was on the day preceding the incident and the co-pilot's most recent visit was one week prior to the incident. The operator also provided its crews with a special brief for Chambery. The brief was comprehensive and included the following note:

> *'Beware of possible false glide-path indications. The glide path should not be used until within 12.1 DME "CY".'*

Aircraft information

The aircraft had a single Flight Management Computer (FMC) installation, without GPS, and an EGPWS with its own dedicated GPS. The EGPWS caution 'GLIDESLOPE', to alert the crew that the aircraft is more than 1.3 dots below the glideslope, is active below 1,000 ft agl and with the landing gear extended.

An ILS approach with the autopilot(s) engaged would usually be flown using the APP (approach) mode. However, when a circling approach is carried out following an ILS approach, the manufacturer recommends using the VOR/LOC and VS modes. The operator had adopted this as a Standard Operating Procedure. This method is used for two reasons. Firstly, in APP mode the Autopilot Flight Director System (AFDS):

> *'does not level aircraft at Mode Control Panel (MCP) altitude' and, secondly, 'exiting the APP mode requires either initiating a go-around or disconnecting the autopilot and turning off the flight directors.'*

The AUTO/MAN switch for the navigation frequency is located on the aft electronic panel on the centre pedestal. With the switch in AUTO the associated VHF navigation aid is selected by the FMC, and in MAN it is selected by rotating the manual frequency selector. The frequency is manually tuned to receive an ILS.

The autothrust go-around mode is armed when the aircraft descends below 2,000 ft agl.

The aircraft was inspected following the incident. No fault was found with the navigation system and none has been reported, to date, since the aircraft returned to service.

Recorded information

Recorded radar information and ATC communications at Chambery were available for the investigation. The radar recording allowed the position of the aircraft to be determined accurately, whereas the Flight Data Recorder (FDR) information recorded the FMS position, which is susceptible to errors.

Flight recorders

The aircraft was equipped with a 25-hour duration FDR and a 120-minute Cockpit Voice Recorder (CVR). The FDR contained a complete record of the incident flight. However, the CVR record of the incident had been overwritten due to the aircraft being flown from Chambery to the UK before the CVR was removed. In addition to the flight recorders, the EGPWS computer was also downloaded. This provided thirty seconds of flight data, recorded during the aircraft's first approach to Chambery when an EGPWS Mode 2[1] warning was activated. Salient parameters from the FDR included the commander's ILS glideslope, localiser and DME indications. The DME parameter recorded by the FDR was recorded once every 64 seconds and the ILS parameters were recorded once every two seconds. The co-pilot's ILS and DME indications were not recorded by the FDR or the EGPWS.

The flight was uneventful until the latter stages of the first approach, as the aircraft was being positioned for a landing on Runway 18. The approach was being conducted with the autopilot engaged and 14 nm from the runway the flight crew commenced the first of two published step descents, from an altitude of 6,500 ft to 5,000 ft. Levelling at 5,000 ft, the aircraft closed the localiser from the right before making a gentle turn to intercept it – the autopilot ALT and VOR/LOC modes were selected.

Approaching a range of 11 nm, the autopilot VS mode was engaged. At this stage, the aircraft was about 850 ft below the glideslope. The aircraft started to descend at about 2,200 fpm (see Figure 2). About ten seconds later, the commander's localiser and glideslope signals were both briefly recorded as non computed data (NCD) – indicative that the raw data was no longer reliable or not available. Recorded at almost the same time, the DME indicated 10.5 nm, which was accurate. Due to the low recording frequency of the DME parameter, the reliability of the data in the seconds prior to the descent could not be established. As the aircraft descended, two further recordings were made of the commander's localiser and glideslope signals temporarily being NCD.

Approaching the airport from the north, the aircraft is required to overfly a ridge of high ground to the east of Lake Bourget. As the aircraft descended, the terrain closure rate progressively increased to about 6,000 fpm. When the terrain clearance reached 1,125 ft, the EGPWS Mode 2 warning was activated. Almost simultaneously, the autopilot was disconnected and a go-around was carried out (due to the recording rates, it could not be determined if the go-around had been initiated before the EGPWS warning). The minimum terrain clearance was 1,112 ft.

During the go-around, the rate of climb was stabilised at about 3,800 fpm. The maximum nose up pitch attitude was 32.7° (which occurred shortly after the EGPWS warning) and the minimum airspeed was 109 kt (when the aircraft was levelled, following the go-around).

During the subsequent approach and landing, no anomalies in the recorded ILS or DME data were observed.

Footnote

[1] An EGPWS Mode 2 warning is generated when an excessive closure rate with terrain is detected.

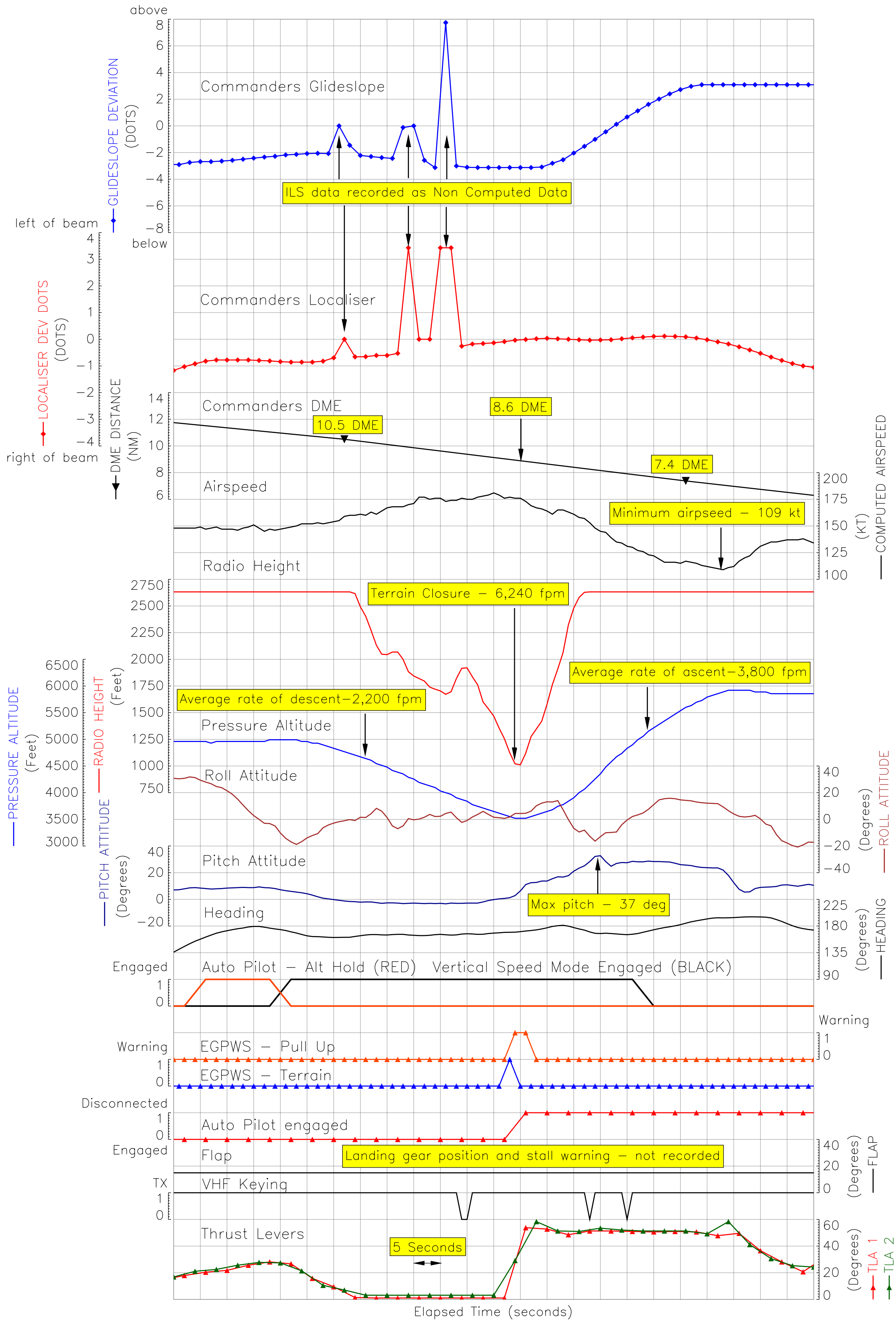


Figure 2

Recorded FDR data for the (first) ILS approach to Chambery Airport

Flight crew information

The co-pilot reported that the aircraft satisfactorily established on the localiser but that the DME was intermittent. The aircraft was configured with flap 15° and the landing gear extended, in anticipation of the final descent. He saw the glideslope pointer move rapidly down the scale and, in response, he engaged the VS mode and selected a rate of descent that he intended to be 1,200 fpm. He recollected hearing the commander say "its operating in the reverse sense" and took this to mean the localiser indication. To check the tracking he selected his expanded VOR/ILS display (the switch is located on the aft pedestal) and observed that the beam bar was displaced slightly to one side. The co-pilot commented that this action briefly distracted his attention from monitoring the descent profile.

The co-pilot caught a glimpse of a mountain ahead through a break in the cloud and noticed that the aircraft was well below the glideslope, with a rate of descent that was too high. He heard the commander say "are you happy" and, recognising that the flightpath differed from previous approaches, he disconnected the autopilot and commenced a manual go-around. He did not use the TOGA (takeoff go-around) switch because he thought the aircraft was above 2,000 ft agl and that it would not be available. When the co-pilot heard the EGPWS warning he increased the pitch attitude as much as possible. The aircraft climbed clear of cloud, at which point he flew level and accelerated before continuing the climb to FL90. He commented afterwards that the control column needed a strong push to recover the aircraft to a level attitude.

The commander reported that the final decision as to the landing runway was to be decided once visual contact had been established. He selected the ILS frequency when the aircraft was 1.5 DME (nm) outbound from the CBY VOR beacon and saw and announced that the localiser had been captured, although he noted that the aircraft was slow to establish on the centreline. He called out "12 DME with descent at 8.9", which was intended as a crosscheck and a reminder to the co-pilot about the descent point. After passing 11.7 DME from the airfield he noticed that the ILS indications on his EADI had disappeared. There was no DME indication and there were ILS fail flags on the standby Attitude Indicator. He checked across to the co-pilot's instruments where they still appeared to be available. He then checked and cycled the AUTO/MAN switch, after which his indications reappeared.

The commander recalled that his attention then returned to the flight instruments, where he saw that the aircraft was descending at a high rate and was below the glideslope. He questioned the situation with the co-pilot who, in response, initiated a go-around.

The commander reported that he had called "positive climb", in error, as a matter of habit. The manufacturer recommends that the configuration should not be changed during a terrain avoidance manoeuvre.

Analysis

There was no evidence of any signal interruption or failure of the CY ILS or DME at Chambery. A routine flight inspection two and a half months prior to the incident showed the ILS to be serviceable at that time and there had been no reports of any failures since then. The aircraft's navigational equipment was found to be serviceable when tested after the event. Thus, while an onboard or ground-based malfunction or interruption is possible, it would probably only have been of short duration.

The reason for the loss of the commander's localiser and glideslope signals could not be determined. However, the second and third recorded events of NCD during the descent were probably as a result of him cycling the AUTO/MAN switch.

Standard operating procedures are designed to assist with identifying and managing navigation interruptions and failures. On this occasion, the commander's attention was diverted for a short time while he resolved his ILS display problem and responded to a call from ATC. During this time, the co-pilot initiated a descent, at an excessive rate, before the aircraft had reached the final approach fix, possibly in response to a movement of the glideslope pointer. The commander remained unaware of the descent profile until his attention returned to monitoring the flightpath. At that point he questioned the situation with the co-pilot. The discrepancy was acknowledged between the pilots and the co-pilot initiated a go-around. As the EGPWS warning sounded, the co-pilot increased the pitch attitude to achieve a maximum rate of climb.

At its minimum height the aircraft was crossing a ridge of high ground. This gave rise to a very high terrain closure rate and generated the EGPWS warning. The terrain clearance was never less than 1,100 ft.

Safety action

After the incident the operator issued an Operating Staff Instruction to its flight crews which stated:

> *'In the case of Chambery, the final approach is not to be commenced unless both pilots are able to crosscheck both glide slope indication and DME distance appropriate to the approach plate in use.'*

ACCIDENT

Aircraft Type and Registration:	DHC-8-402 Dash 8, G-JEDN
No & Type of Engines:	2 Pratt & Whitney Canada PW150A turboprop engines
Year of Manufacture:	2003
Date & Time (UTC):	22 April 2010 at 0600 hrs
Location:	Southampton Airport, Hampshire
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 40
Injuries:	Crew - None Passengers - None
Nature of Damage:	Right wing leading edge damaged
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	48 years
Commander's Flying Experience:	6,086 hours Last 90 days - 167 hours Last 28 days - 39 hours
Information Source:	AAIB Field Investigation

Synopsis

During the takeoff roll the No 2 engine inboard forward access door detached from the aircraft, colliding with and damaging the leading edge of the right wing. The lower latches of the door were found in the fully open position, indicating that the door had not been secured following maintenance.

History of the flight

The aircraft and crew were due to operate four sectors beginning at Southampton, where the aircraft had been parked overnight. The flight crew arrived in good time and carried out their normal pre-flight activities. The aircraft was parked facing north, nose-in towards the airport terminal. The crew walked to the aircraft about forty minutes before the scheduled departure time of 0545 hrs. The commander removed the engine blanks and stowed them in the forward hold before beginning a walk-around inspection of the aircraft, moving clockwise round the aircraft from the forward passenger door. The sun had risen at 0457 hrs and although the sun was low in the sky, the commander stated that conditions were quite light and that he was able to carry out his inspection without a torch. He reported that he checked, amongst other things, that all engine panels were secure, and added that he took care to inspect each engine from the front as well as from both sides.

After completing the walk-around, the commander boarded the aircraft, and, having noted a very small amount of melting frost on the aircraft, ordered de-icing. The passengers embarked and the aircraft was de-iced. Although the de-icing crew moved round the aircraft as they worked, and a member of ground crew also walked round the aircraft before pushback, no abnormalities were identified. The aircraft was then pushed back and departed.

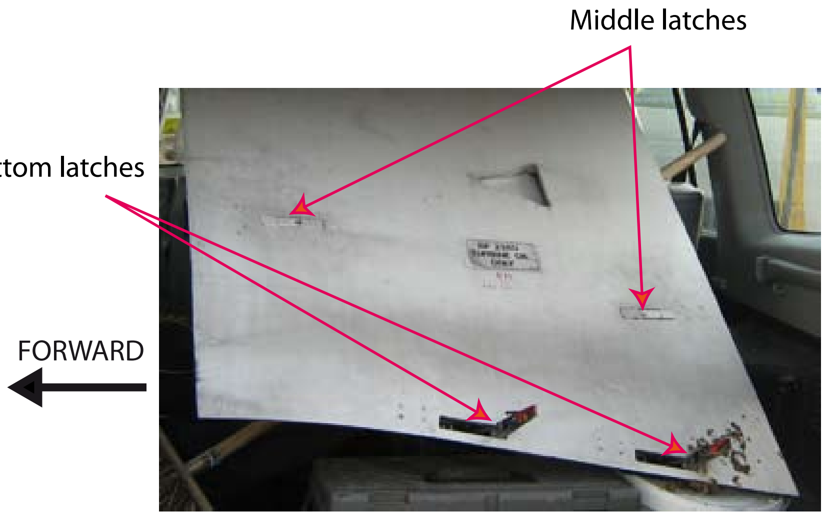
A pilot sitting in a parked aircraft saw a panel thrown upwards from G-JEDN during its takeoff roll. He reported this to ATC, who passed the information to the flight crew.

Other than the report from ATC, the flight crew of G-JEDN were not aware of anything unusual; the aircraft appeared to behave normally. ATC then advised the flight crew that a panel and some other debris had been found on the airfield. The commander decided to return to Southampton, and the aircraft landed without further incident.

Engineering examination

The No 2 engine inboard forward access door was found by airport staff in the grass area approximately halfway along and to the east of the runway. It was found with the two centre latches closed and locked but with the two lower latches fully open (Figure 1).

The lower latches had grass and dirt embedded within the lever mechanism indicating that they were in the open position when the door impacted the ground. Examination of the latch pin receivers in the nacelle structure showed no evidence of the pins having been forced out of their locked positions. All four quick-release positive-lock pin latches were found to be serviceable and showed no evidence of the latch pins having been engaged immediately prior to the engine bay door becoming detached from the aircraft.



Courtesy of BAA Southampton

Figure 1

No 2 engine inboard forward access door following recovery

Engine bay access doors

The main engine bay has two large forward access doors, one inboard and one outboard. These access doors are made from a carbon/epoxy composite material with integral foam filled stiffening ribs. Each door is hinged at the top and is held in the closed position by four quick release positive-lock pin latches. Each latch, when closed, engages a pin into a receiver mounted within the engine nacelle structure (Figure 2).

The inside of each latch is coloured Day-Glow orange.

The outboard door on the No 1 engine and the inboard door on the No 2 engine allow access to service the engine oil system.

Other information

The aircraft was based at Southampton where it had been parked overnight. A Daily Check and an unscheduled maintenance task were carried out during the night. One of the first tasks specified on the Daily Check was to check the engine oil quantities. This task required the No 1 engine forward outboard and the No 2 engine forward inboard access doors to be opened. The evidence suggested that the No 2 forward inboard access door had not been fully latched following the maintenance work.

Safety action taken by the operator

Following this event the operator launched a safety campaign to highlight to aircrew, engineering and ground staff the importance of securing and checking of engine access doors on all its aircraft types.

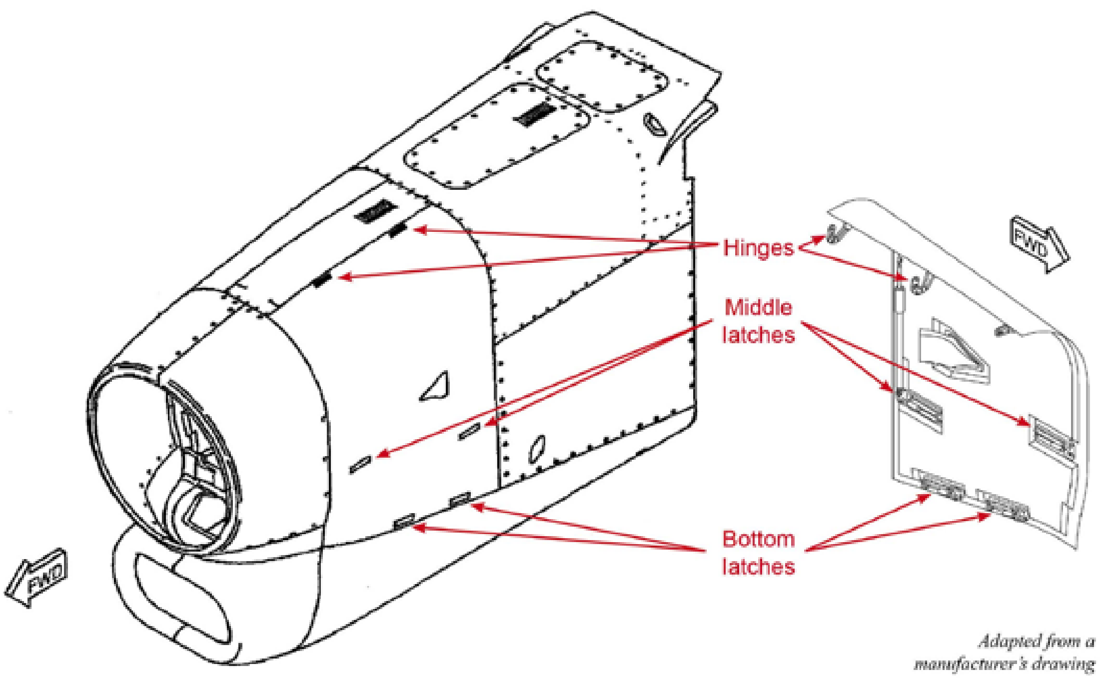


Figure 2

Forward engine bay access door

INCIDENT

Aircraft Type and Registration:	Falcon 2000, CS-DFE
No & Type of Engines:	2 CFE 738-1-1B turbofan engines
Year of Manufacture:	2003
Date & Time (UTC):	11 November 2009 at 1259 hrs
Location:	Biggin Hill Airport, Kent
Type of Flight:	Maintenance
Persons on Board:	Crew - 3 Passengers - 3
Injuries:	Crew - None Passengers - None
Nature of Damage:	Fire damage to tyres, fuselage, landing gear and wing
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	37 years
Commander's Flying Experience:	4,152 hours (of which 575 were on type) Last 90 days - 30 hours Last 28 days - 5 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft had been undergoing a technical investigation to identify the cause of a braking defect. A flight crew were requested by the on-site maintenance team to carry out high-speed taxi trials as part of the troubleshooting process. The crew conducted a series of seven accelerate/stop runs along the main runway, at gradually increasing reject speeds. At the commencement of the eighth run, the crew felt that a tyre had deflated and brought the aircraft to a stop. They were informed by ATC that there was a fire under the left wing; the crew and passengers then abandoned the aircraft safely. The fire was caused by damage to the brakes from excessive temperature, this released hydraulic fluid under pressure, which then ignited. Four Safety Recommendations have been made as a result of the investigation.

History of the flight

General

The crew of the aircraft, which comprised a commander, co-pilot and cabin attendant, travelled to the UK on 9 November 2009. They had been tasked to be available to collect CS-DFE from Biggin Hill Airport where it was undergoing maintenance. They would then crew the aircraft on whatever flight it was allocated. At this stage the crew members were unaware of the nature of the maintenance.

In the evening 10 November 2009, the commander received a text message from the operator notifying her to be at Biggin Hill Airport at 1130 hrs for a "miscellaneous activity" to include "high-speed taxi requested by maintenance department". The intended activity was not designated as an Operational Check Flight (OCF) or Test Flight (TF), which have specific meanings and requirements.

Incident manoeuvres

The crew arrived at Biggin Hill Airport at about 1100 hrs and the commander contacted the operator's Maintenance Control to establish the whereabouts of the aircraft and what was required. She was told that the aircraft was still at the maintenance organisation on the south side of the airport and that the maintenance team would brief her there.

On arrival at the maintenance organisation, the maintenance team were with the aircraft on the parking area ready for the test. The flight crew were briefed that the aircraft was reported as pulling to the left when the toe brakes were applied. The maintenance team had carried out low speed taxi tests and another flight crew had conducted tests up to 50 kt, as a result of which the left brake units had been changed with the right brake units to see if the problem still occurred. The maintenance team requested high-speed tests, which the crew agreed to but advised they would adopt an incremental approach starting at 50 kt and increasing to 80 kt.

The crew carried out performance calculations to ensure the runway length was adequate for the task to be performed. The main runway at Biggin Hill is orientated 03/21 and is 5910 ft long by 147 ft wide (Figure 1) and has a tarmac surface which was dry. They estimated that the balance field length required for an abandoned takeoff at V_1 for the weight and ambient conditions was 3,000 ft. The crew decided that it would be possible to carry out two low-speed runs, one after the other, in the full runway length available.

The commander then carried out a full crew briefing for the conduct of the trials which included the maintenance team. The three crew members boarded the aircraft, along with the maintenance supervisor and two technicians. The maintenance supervisor occupied the jump seat between the two pilots and the two technicians were seated in the rear of the passenger cabin. The cabin attendant gave a passenger brief to remind them of the main exits and wearing of seat belts.

Having completed the normal external and internal checks, the engines were started at 1226 hrs and the aircraft was cleared to taxi for Runway 21 at 1231 hrs, entering the runway at 1239 hrs.

The crew commenced a series of accelerate/stop runs along the runway by selecting takeoff thrust, accelerating to the target IAS, then retarding the thrust levers and applying the brakes positively, bringing the aircraft to a stop. The first two runs were up to 50 kt IAS using Runway 21 before turning around and performing two 60 kt runs along Runway 03. The aircraft cleared the runway at holding point A3, in order to allow another aircraft to depart, and then taxied back to the threshold of Runway 21. The aircraft was cleared to enter Runway 21 to commence the next taxi test at 1248 hrs. The aircraft was accelerated to 80 kt and the commander had to apply full left brake in order to keep the aircraft straight. A second run was carried out to 50 kt and this was normal in maintaining runway alignment, but as with the other runs, the anti-skid system was activating at the lower speeds.

The aircraft was turned around and another 80 kt run was carried out along Runway 03, but this time the aircraft veered to the left. The maintenance supervisor on the jump seat and the flight crew discussed the findings and it was agreed to carry out one more run

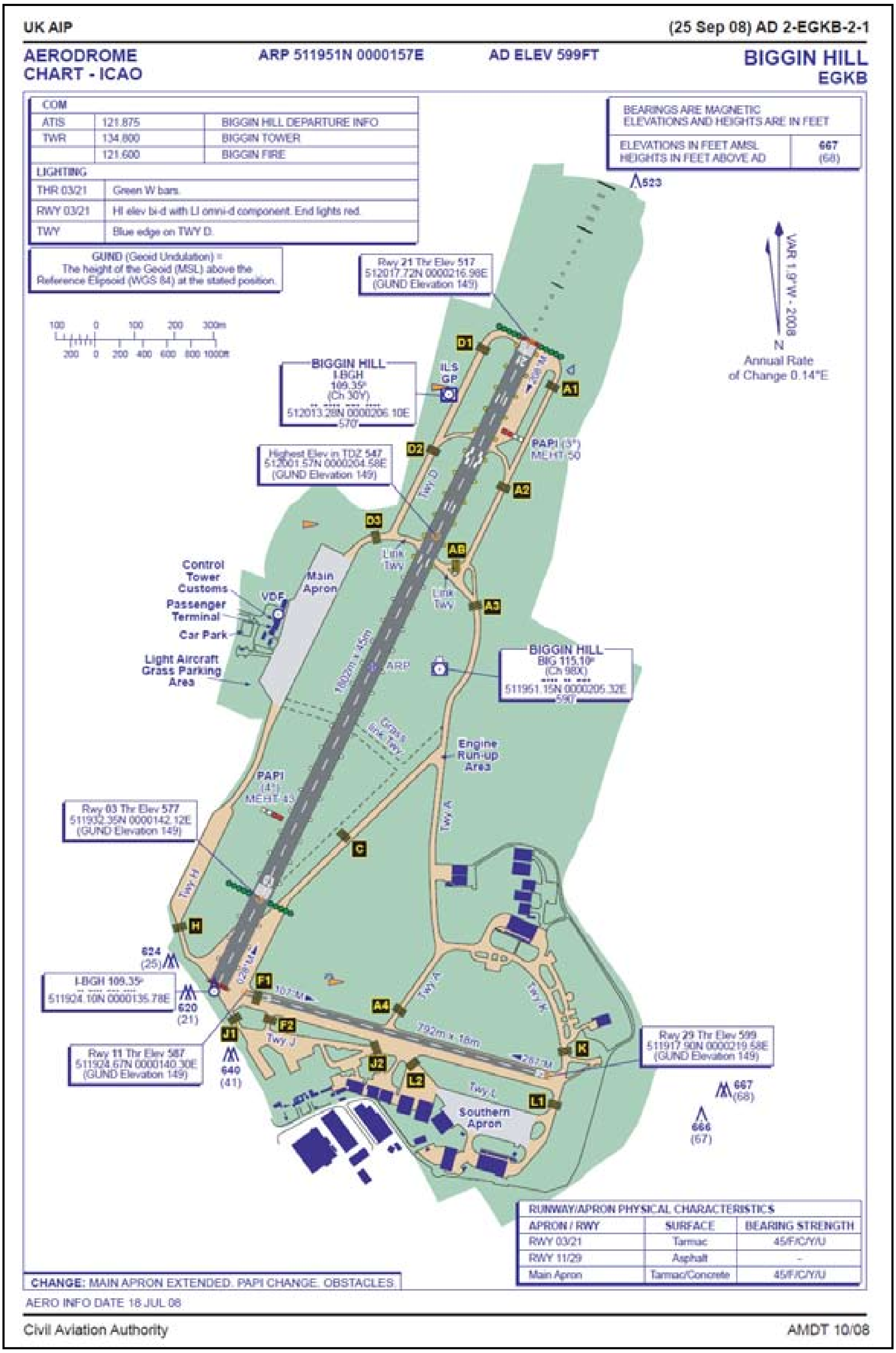


Figure 1

Biggin Hill airport layout

along Runway 21. The aircraft was taxied to the end of Runway 03 and turned around onto Runway 21 in order to perform another 80 kt test. The commander accelerated the aircraft, but before 30 kt, the test was abandoned as the crew believed they had a flat tyre on the left Main Landing Gear (MLG). They informed ATC and requested a tug, but shortly after, the pilot of another aircraft holding at D2 informed ATC that there was a fire on the left MLG of CS-DFE. ATC confirmed this visually and at 1257 hrs advised CS-DFE that there was a fire and to evacuate the aircraft. The crew carried out the evacuation drills and all those on board left the aircraft without difficulty through the normal airstair door. The Airport Fire and Rescue Service (AFRS) responded immediately and extinguished the fire.

Flight Recorders

The aircraft was fitted with a 25-hour Flight Data Recorder (FDR) and a 2-hour Cockpit Voice Recorder (CVR). These were both removed from the aircraft following the incident to be downloaded and then analysed by the AAIB.

The parameters recorded on the FDR were of limited value to the investigation; however, it was possible to determine the timing and maximum speed of each high-speed taxi run. The regulations at the time the aircraft type was first certified did not require brake pressures and temperatures to be recorded.

The salient FDR parameters are presented at Figure 2 and show that in total, eight high-speed taxi runs were completed over a period of just under 16 minutes. The first seven runs achieved speeds of between 60 kt and 90 kt. The final run was aborted at just over 35 kt[1] when the crew (verified on the CVR recording) realised that the aircraft had a flat tyre.

The duration of each of the runs was between 20 and 25 seconds. A number of runs were conducted one after the other on the same runway, with a gap of about 45 seconds between runs. Others required a change of runway which took between 90 and 200 seconds to complete.

Aircraft description

The Dassault Falcon 2000 is certified as a 19-seat, 16.5 tonne maximum takeoff weight business jet, powered by two turbofan engines. It is equipped with a retractable landing gear with two main gears and a nose gear. Each MLG is fitted with two wheels, radial tyres and hydraulically operated, carbon disk brake units. The aircraft is fitted with a wheel well overheat warning system, but there is no measurement or indication of brake temperatures. The aircraft has two main hydraulic systems, both of which supply the braking system (Figure 3).

Initial aircraft inspection

Prior to notification of the incident to the AAIB, the operator replaced the aircraft's mainwheels and tyres. The aircraft was towed clear of the runway and parked on an adjacent taxiway. The removed wheels, tyres and bearings were retained and made available to the investigation. All the tyres had deflated by way of the thermal fuses releasing and the sidewalls on both tyres from the left MLG had been partially consumed by fire.

An initial inspection of the aircraft was carried out on the taxiway which confirmed severe fire damage. A significant section of the lower skin of the left wing, rear of the landing gear bay, was burnt away, as was the

Footnote

[1] Airspeed is normally unreliable below 30-40 kt; however, a calculation of groundspeed, based on the acceleration of the aircraft, showed this figure of 35 kt to be accurate.

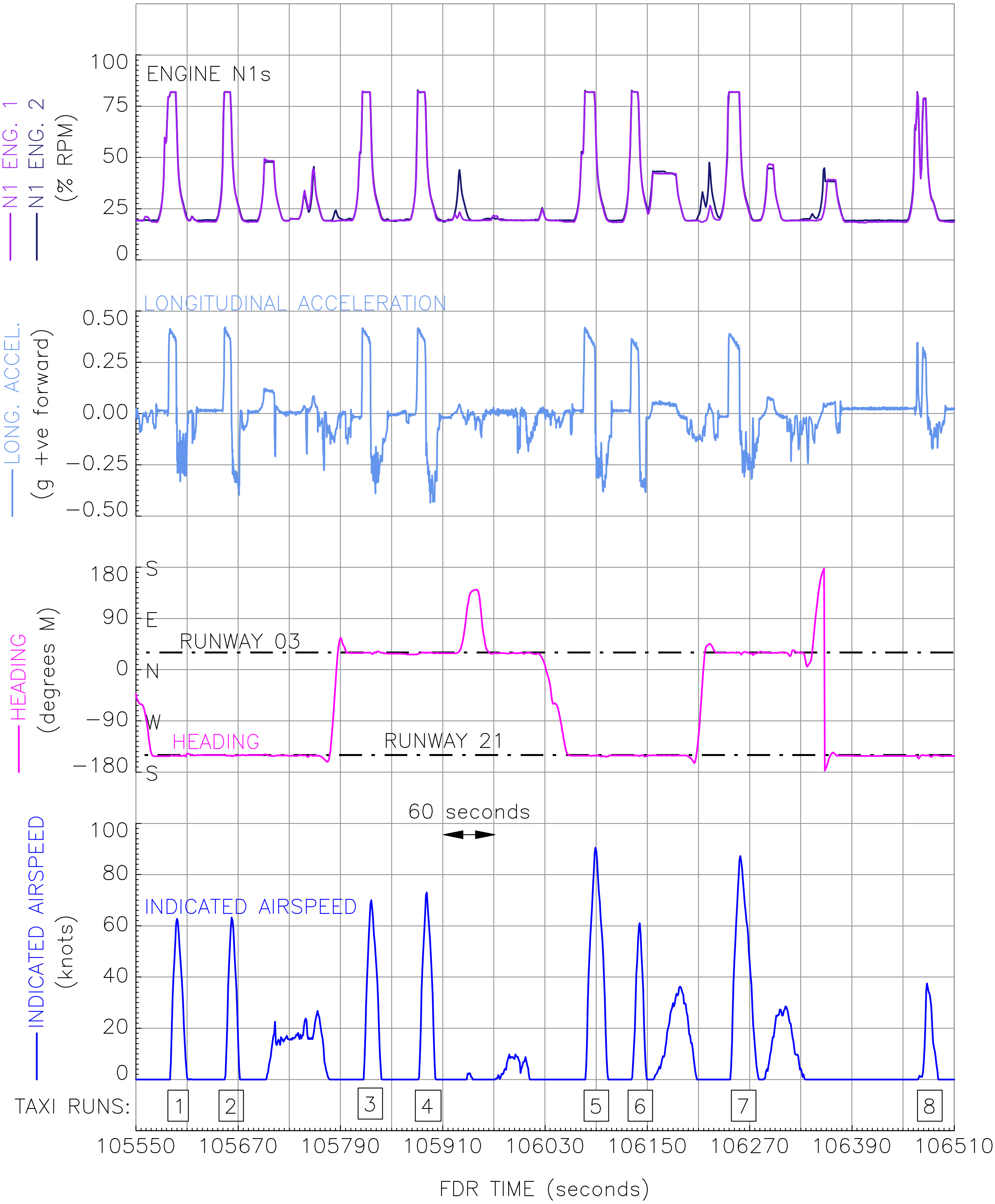


Figure 2

Salient FDR parameters from CS-DFE of high-speed taxi runs

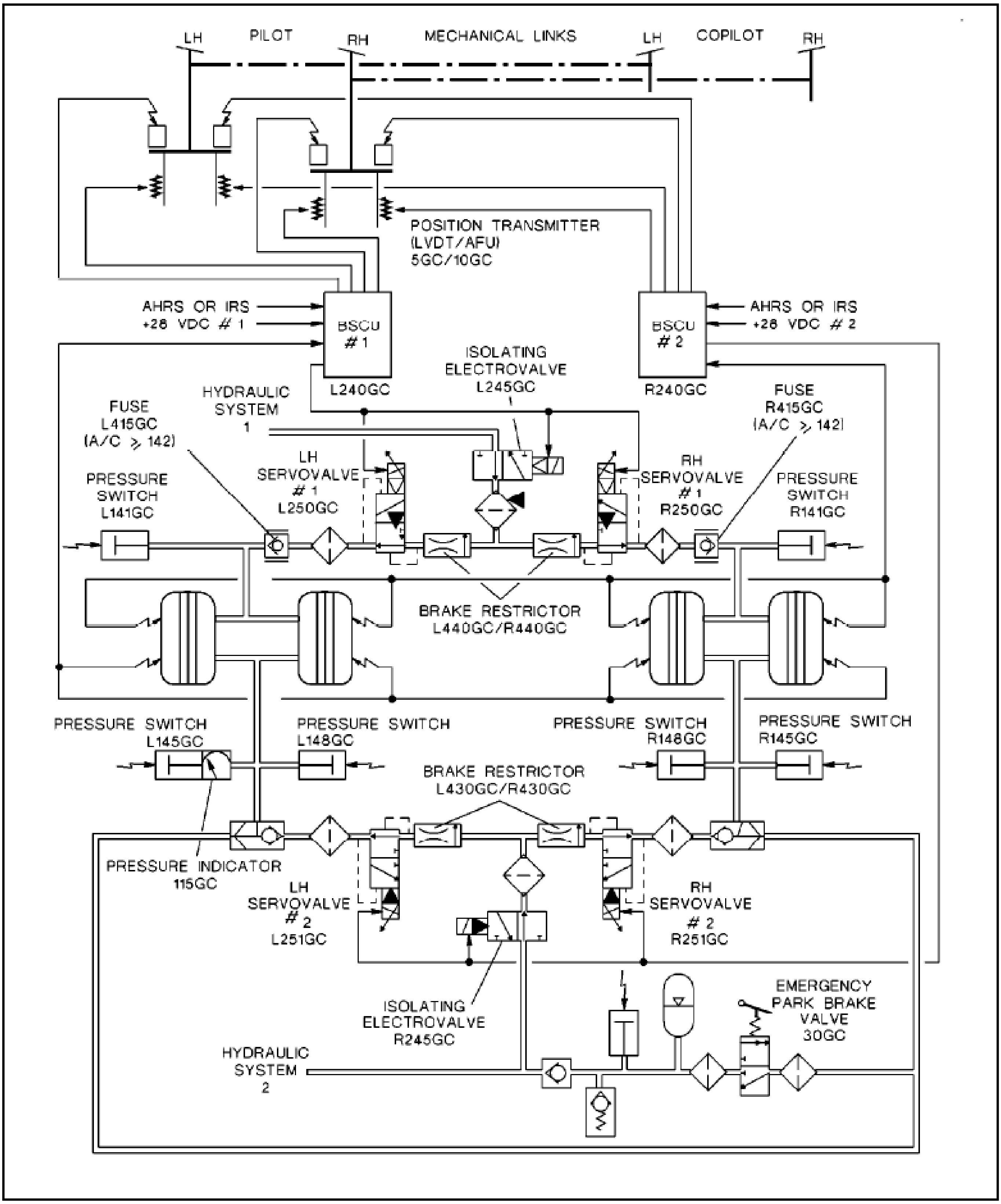


Figure 3

Aircraft braking system

lower skin of the adjacent flap, which had been partially deployed at the time (Figure 4). The landing gear bay within the wing was heavily sooted with extensive heat damage evident to the upper wing skin and the electrical wiring looms running along the rear of the wing. The fuselage panels adjacent to the left MLG bay were severely heat damaged and the whole of the fuselage, rear of the wings, was heavily sooted. The number two hydraulic system reservoir level indicator showed that the system contained no hydraulic fluid; the number one hydraulic system reservoir was indicating just over half full. There was no evidence of fire around the right MLG.

Detailed aircraft inspection

The aircraft was recovered to a hangar for detailed inspection of the damage.

Left main landing gear

The MLG leg displayed extensive heat damage and sooting. The wiring looms located on the leg were significantly charred and fire damaged. The hydraulic pipe work attached to the MLG leg was also severely heat damaged. The coating on both the brake units had changed from silver to dull bronze indicating that they had been subjected to temperatures in excess

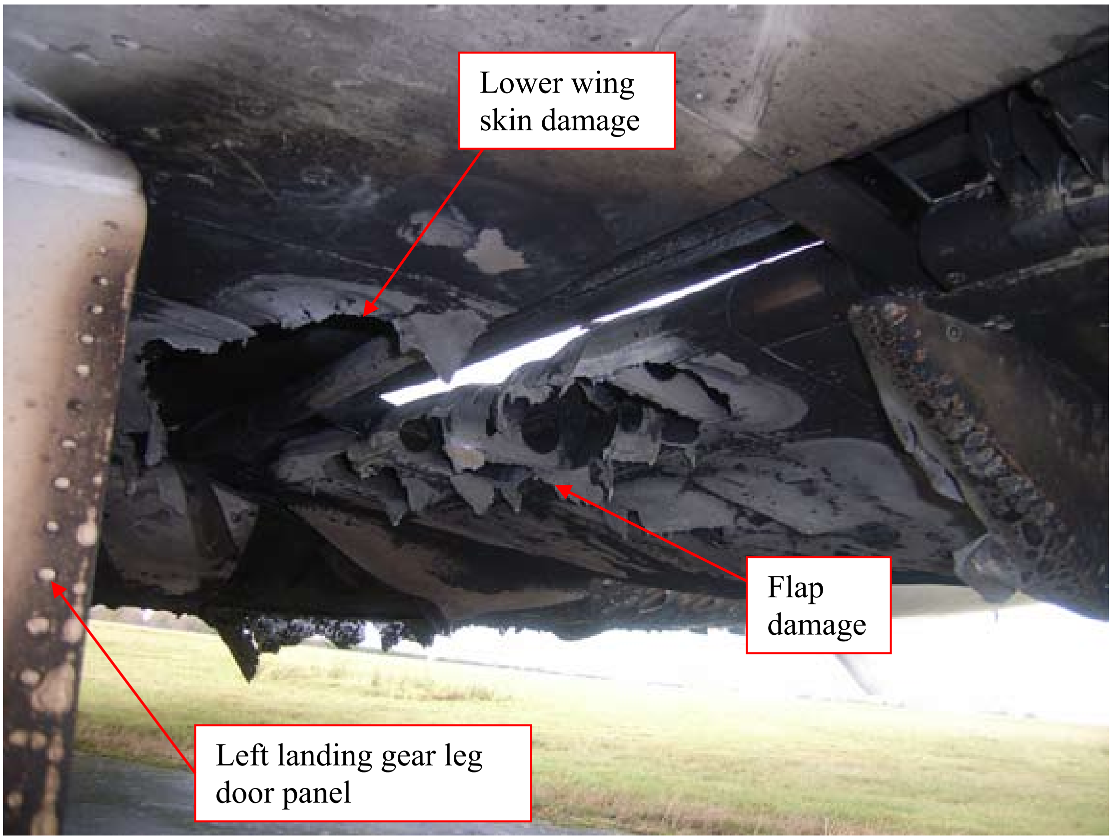


Figure 4

Lower wing skin and flap fire damage

of 150°C. The cadmium coating on the left MLG axles had blistered suggesting temperatures in excess of 400°C. The hydraulic system pipes between the servo valve and the brake units were refilled with fluid and pressurised using a hand pump. Fluid leaks were identified in the flexible hoses at the base of the MLG leg as they joined the brake unit and in the brake unit pistons.

Right main landing gear

No evidence of fire was found on the MLG, however, the coating on the number three brake unit housing (inboard wheel of the pair) had also changed from silver to bronze. The hydraulic system pipes were also filled and pressurised and leaks were identified around the number three brake unit pistons.

Brake unit inspection

Both the left MLG brake units and the number three brake unit from the right MLG were removed and sent for disassembly and inspection at the manufacturer's overhaul facilities.

The inspection found that all three units displayed severe heat damage after experiencing 'exceptionally' high brake energies. The elastomeric static and dynamic piston seals were completely destroyed (seal degradation would have started at a temperature of 183°C). The aluminium alloy housings within the brake piston assembly had melted, indicating temperatures in excess of 200°C and the pistons themselves were significantly deformed (Figure 5). The protective coating on the carbon discs had been removed indicating temperatures in excess of 1,200°C.

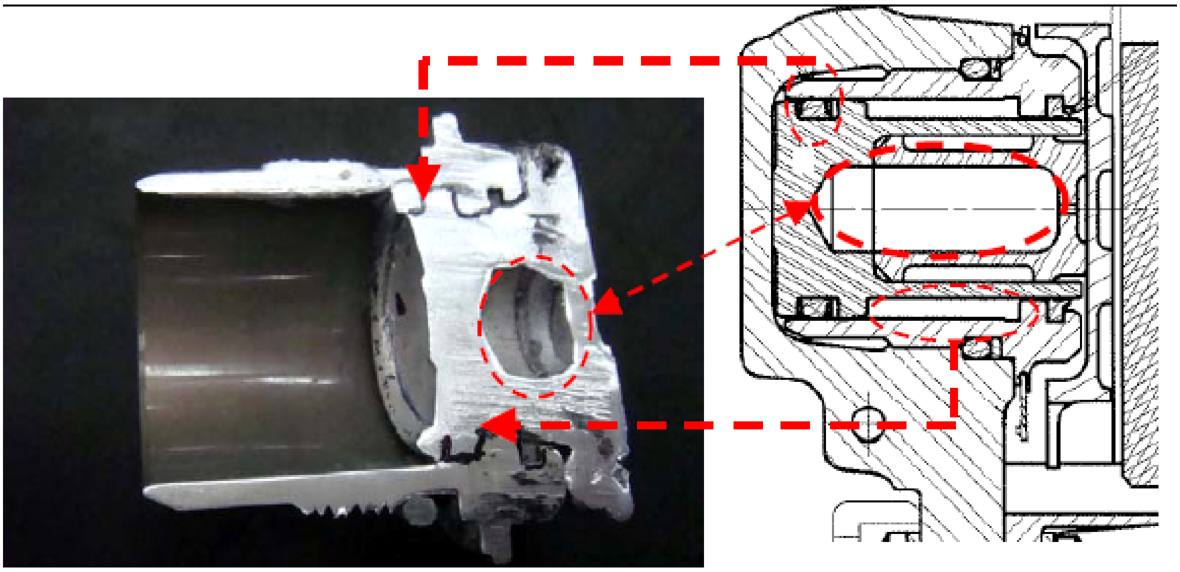


Figure 5

Brake piston deformation

Brake energy calculation

Using the recorded flight data, the manufacturer assessed that each of the left brakes had absorbed just under 18 MJ of energy and each of the right brakes just over 11 MJ[2] from the cumulative effect of eight braked runs conducted during the incident.[3] During certification the brakes had been tested up to 15 MJ on the aircraft and 16.4 MJ during brake qualification tests. Based on the data obtained from development testing with a fully worn heat sink, 16 MJ of brake energy was assessed to elevate the brake temperature by approximately 1,600°C.

The wheel fuse plugs are designed to melt at 199°C. It was assessed that the level of brake energy which would result in the wheel thermal fuses releasing was achieved during run five for the left brakes. Maximum energy rejected takeoff tests during aircraft certification showed that a period of five minutes or more, after the point where sufficient brake energy is achieved, could be required, depending on ambient conditions, for the heat to transfer from the brake unit to the area where the wheel thermal fuses are positioned. The incident was consistent with this experience, as the tyres started to deflate prior to run eight, some five and a half minutes later.

Brake life

The number one and two brakes had achieved 786.6 hours and 535 cycles. The number 3 brake unit had 642.8 hours, 403 cycles and the number four unit 453.1 hours and 310 cycles. The average number of cycles achieved by a Falcon 2000 brake unit prior to removal is 1,100.

Footnote

2 During run five the handling pilot applied only the left brake pedal, thus retarding the aircraft using the left brakes only. Brake energies were calculated based on an estimated aircraft weight of 25,674 lbs.

3 Whilst these calculations required a number of assumptions to be made and therefore may underestimate the actual energy levels experienced, it is unlikely that the estimates vary sufficiently to affect the relative exceedence or otherwise of the approved limit.

Hydraulic fuses

In 1999 a Falcon 2000 aircraft experienced a total loss of hydraulic fluid event. This was a result of foreign object damage to a bracket on the MLG that supported the brake hydraulic hose connections for both systems. As a consequence of this incident the No 1 hydraulic system was modified to include fuses which isolate the MLG hydraulic fluid pipes when an excessive flow rate is detected. The manufacturer did not apply the modification to the No 2 system due to the lack of service experience of the fuses on Falcon aircraft and to avoid the risks associated in modifying both systems with the same design change simultaneously. The fuses successfully activated during this event retaining a significant amount of fluid in the No 1 system. As there were no fuses fitted in the No 2 system, the entire fluid contents was lost through the leak paths identified in the brake pistons and supply pipes.

A sustained fire resulting from an uncontrolled loss of hydraulic fluid has been identified as a significant risk by airworthiness authorities for many years and has been addressed by the introduction of specific wording within the design regulations. The current amendment (8) of CS 25, paragraph 25.735 states:

> *'(b) Brake system capability.*
>
> *The brake system, associated systems and components must be designed and constructed so that:*
>
> *(2) Fluid lost from a brake hydraulic system following a failure in, or in the vicinity of, the brakes is insufficient to cause or support a hazardous fire on the ground or in flight.'*

The aircraft was certified to JAR 25 Amendment 13, which did not include the wording of paragraph (b). However, the intent was still present within the requirement, as the guidance material in the ACJ issued for compliance with 25.735 at the time stated:

> ***'Protection against fire***
>
> *Unless it can be shown that hydraulic fluid which may be spilt on to hot brakes is unlikely to catch fire, the hydraulic system should be protected so as to limit the loss of fluid in the event of a serious leak. The precautions taken in the latter case should be such that the amount of fluid lost in the vicinity of the brakes is not sufficient to support a fire which is likely to hazard the aeroplane on the ground or in flight.'*

The manufacturer provided the following response when this was discussed with them:

> "During the event, the braking energy absorbed by the brakes of the F2000 205 is much higher than the maximum certified energy: The document DGT 341504[4], which estimated the absorbed braking energy, shows an energy of 17.9 MJ per brake. Furthermore, the energy was absorbed by 8 RTO [Rejected TakeOffs] performed along 15 minutes. This scenario is very different from the usual single RTO were [sic] the energy is absorbed in less than 1 minute. The longer duration in the case of the event has lead to more heat diffusion from the heat pack to the torque tube and hydraulic housing which explains the important deformation of pistons, seal pistons destruction and consequently leakage from pistons towards the heat pack. In the case of the F2000 205, we consider that the fire on ground did not lead to a hazardous situation as it did not jeopardize the aircraft evacuation."

Footnote

4 This refers to a document supplied by the manufacturer which detailed the calculated brake energy based on recorded flight data.

Operator's Operations Manual

The operator's Operations Manual (OM) Part A, contains the relevant information with regards to TFs. The text is set out below:

> ***'8.7.1.4 Test Flights***
>
> ***8.7.1.4.1 Reason for Test Flights***
>
> *A test flight must be performed after special maintenance and/or repair work on an aeroplane and on special request of the authority.*
>
> ***8.7.1.4.2 Test Flight Programmes***
>
> *Test flights shall be performed in according to programmes issued by the responsible technical department, in agreement with the flight operations department.*
>
> ***8.7.1.4.3 Test Flight Crew***
>
> *Those flights shall be performed by the minimum flight crew according to AOM. Only experienced pilots should be assigned by flight operations for test flights.*
>
> ***8.7.1.4.4 Other Crew***
>
> *If it is required by the nature of the test flight, there may be, in addition to the minimum crew, engineers, mechanics or inspectors on board who were directly involved in the preceding work/inspection of the aeroplane. They must be recorded in the flight log as additional crew members.*

8.7.1.4.5 Briefing

The responsible engineer shall give the flight crew a briefing on:

- *The reason for the test flight;*
- *The test programme; and*
- *How the preceding work may influence the airworthiness of the aeroplane.*

8.7.1.4.6 OCF (Operational Check Flight)

An OCF is a flight where one or more aircraft systems need to be checked for proper operational functioning. No passengers can be carried on OCFs except for crew members and maintenance engineers required for observation.

8.7.1.4.7 Conditions Requiring an OCF

- *Engine maintenance*
- *Flight control maintenance*
- *Pressurisation maintenance*
- *Landing gear maintenance after a failure of the landing gear to extend or retract*
- *When required after phase inspections*
- *When so required by the maintenance and/ or Flight Operations Department'*

The OM provided information regarding weather, runway and performance requirements all of which were complied with on the incident flight. The OM specifies the operating crew requirements.

'8.7.1.4.10 Operating Crew Requirements

None of the operating crew may be inexperienced (as defined in paragraph 4.1.5 or on training except during PIC line training.

Any PIC with less than 500 hours on type requires FM/AFM (Fleet Manager/Assistant Fleet Manager) approval.'

The definition of inexperienced is found at paragraph 4.2.2 which is set out below.

'4.2.2 Crewing of Inexperienced Flight Crew Members

A flight crew member is considered inexperienced, following completion of a type rating or command course and the associated line training, until he has achieved 100 hours and/or 30 sectors on the type.'

The operator had set out a procedure for flight crew to become qualified to carry out an Operational Check Flight (OCF). It was contained in the company Flight Operations Procedures, NJFOP 1.02 '*OCF Pilot Qualifications Procedure*', extracts of which are set out below:

'The respective Fleet Manager invites interested pilots to submit a brief description of relevant factors. Interested pilots are then assessed based on, but not limited to, technical background, experience and any other additional roles. If selected, pilots are then shortlisted to undergo OCF training.'

The procedure sets out the method of training which is a briefing by the Fleet Manager covering a comprehensive range of subjects set out in the document and self study by the pilot. On successful completion of the training, the pilot's name and qualification are entered into the electronic crew scheduling system.

The operator had differentiated between OCF and TF. The OCF is "a flight used to verify component/ system/ or aircraft performance to determine correct operation after maintenance" while a TF is performed to "verify component/ system/ or aircraft performance to determine certification". Whilst the operator had defined the OCF and TF, as well as the crew composition and qualification to conduct the flights, the brake test troubleshooting taxi runs had not been placed into either category.

Aircraft manuals

The Approved Maintenance Manual (AMM) for the Falcon 2000 does not specify taxi trials to be conducted as part of any defect troubleshooting activity. There is no test schedule published by the manufacturer in any of the aircraft manuals for conducting the kind of braking tests attempted by the operator. As such, there was no specific guidance regarding cumulative brake energies and brake cooling times. The Airplane Flight Manual (AFM) does, however, have three sections which can be considered relevant:

1) Within the limitations section of the AFM, under the section heading '*Tires and Brakes*' the following limitation is published:

> *'Brake kinetic energy limit: 15,000 kJ per brake'*

2) Within the performance section of the AFM, graphs are provided showing how the maximum brake energy speed in takeoff configuration varies for a range of parameters such as ambient temperature, pressure altitude and takeoff weight. This allows the pilot to calculate, for the prevalent conditions, the speed from which the braking effort in the event of a rejected takeoff would result in the maximum brake energy being achieved. When the combination of the various parameters present on the day of the incident was assessed, the chart showed that the calculated maximum brake energy speed was off the scale of the graph, well in excess of the 160 KIAS highest value.

3) Within the AFM performance section is guidance on minimum turnaround time. This includes graphs for calculating brake energy and brake cooling times following a rejected takeoff or landing. The charts themselves require a degree of interpretation and cannot be used in the 'quick reference' style of a checklist. An example calculation is also provided in this section of the manual to assist in understanding the use of the graphs. It uses the scenario of two sequential rejected takeoffs with a period of taxiing between.

The start of this AFM section on minimum turnaround time explains the way in which brake energy and cooling time is calculated from the graphs. It explains that energy from a previous RTO or landing should be calculated, an approximate energy figure to take account of further taxiing should be added to this and then the energy of a further RTO at V_1 added. The manual then states:

> *'If the sum of the energies absorbed per brake is below 12.09 x 10^6 ft.lb (16.4 MJ), no cooling time is required.'*

This quoted figure of 16.4 MJ exceeds the brake energy limitation of 15 MJ that is stated in the limitations section of the AFM. Also, a note in these charts states that energies of 10.6 MJ (new brake) and 9.5 MJ (worn brake) will cause the wheel thermal fuses to '*blow*'.

The aircraft manufacturer advised that the maximum energy of 15 MJ quoted in the AFM was demonstrated with an initial heat sink temperature of 246°C, which is equivalent to 16.4 MJ given an initial temperature of 20°C. Therefore, 16.4 MJ was the qualification maximum energy demonstrated during bench testing by the brake manufacturer.

15 MJ per brake was the maximum energy demonstrated during the maximum energy RTO certification test and hence was used for the limitation, but benefit of the 16.4 MJ figure was taken for the determination of the minimum turnaround time.

Although not directly applicable to the tests conducted prior to the incident, the AFM would have provided an approximate figure for brake energy and the appropriate cooling times to remain below the published limit. The operating crew during the incident reported that they were unaware of any limitations and had not consulted this section of the AFM prior to embarking on the tests.

Flight crew training

During the type rating raining for the Falcon 2000, the use of the '*Minimum Turnaround Time*' subsection of the performance section of the AFM was included in the course. The commander recalled that during the flight phase of her training, whilst carrying out circuits and roller landings, she had been told that brake energy was not a problem on the Falcon 2000.

Operator/Maintenance actions prior to the event

The aircraft flew into Biggin Hill on 1 November 2009. The commander recorded a defect in the aircraft technical log stating:

> *'A/c pulls left with even application of the brakes. Evident from both pilots brake pedals and through emeg. brake. Problem is worse as brakes heat up, therefore not noticeable on pre flight brake check.'*

A work package was raised by the operator's maintenance provider on 2 November 2009 and a maintenance supervisor and two technicians were despatched from their base at Northolt the same day to troubleshoot the defect on the aircraft.

Initially, the aircraft was raised on jacks and an inspection of the wheels carried out; this determined that they were free to rotate and there were no obvious defects. The maintenance team then taxied the aircraft at low speed along Runway 03, and whilst applying the brakes at speeds of between 5 and 10 kt they reproduced the pull to the left. These tests were eventually abandoned due to a suspected flat tyre. An inspection confirmed that this was not the case, but the left MLG tyres had extensive flat spots and large skid marks had been left on the runway surface, predominantly from the left MLG, but occasionally from the right.

The left wheels (No 1 and No 2) were replaced and the Brake System Control Units (BSCU) were interchanged. However, further low speed taxi trials confirmed the defect was still present along with a number of fault codes on the BSCU. At this point the manufacturer's helpdesk was contacted and after consultation, the No 1 and No 2 tachometers were replaced. Based on guidance provided by the helpdesk, the aircraft was then subjected to further rig checks, including brake function using a hydraulic rig and a function check of the anti-skid system; no defects could be identified. Further low speed taxi trials were conducted during which the defect was not present. The maintenance team reported that as the helpdesk could provide no further troubleshooting guidance, they requested a flight crew to carry out high-speed taxi trials to assess whether the defect reoccurred as the brakes heated up.

Correspondence with the manufacturer's help desk showed that the manufacturer was aware that high-speed taxi trials were being proposed and were to be conducted by the operator and their maintenance team, although as the content of these trials was not decided until the day of the test, they would not have been aware of any specific details. The help desk staff also suggested, in email correspondence, that taxi trials were necessary to prove the defect had been cleared, although the nature of any such trial was not elaborated on.

A flight crew arrived on 6 November 2009 and they conducted a number of RTO stops, which showed that the aircraft still pulled to the left and that the anti-skid was active as the aircraft decelerated from 40 to 20 kt IAS. The maintenance team returned to the aircraft on 9 November 2009 and were instructed by the operator's maintenance manager to interchange the brake units from position 1 to position 3 and from 2 to 4. This work was completed and a further high-speed taxi test was scheduled for 11 November 2009. Hydraulic leak checks, system function checks and general walk round inspections were performed prior to the day of the taxi trial, which did not identify any issues or leaks.

As laid out in the history of the flight section of this report, the crew which arrived to conduct the maintenance tests were not aware of the history of the problem and were told that a full brief would be provided by the maintenance supervisor on-site. When interviewed after the event, the maintenance supervisor reported that he believed he could hand the aircraft over to the crew and they would carry out the taxi trials in accordance with their own procedures. The maintenance team opted to be in the aircraft during the trials for the experience, but did not consider it their role to influence the way in which the test was conducted. Following further discussion between the commander and the maintenance supervisor, a rough plan to conduct a series of RTO stops along the runway at gradually increasing reject speeds was agreed between the crew. However, no formal test schedule was written and no pre-test assessment of the potential risks or actions in the event of a problem were considered. The maintenance supervisor sat directly behind the crew during the test, but did not wear a headset. This was the first time he had been present in the aircraft for any form of high-speed taxiing or braking tests.

Engineering organisation, management procedures and oversight

The operator's headquarters were based in Portugal. Due to the nature of their operation, this was an administrative hub representing the Part M organisation only, with maintenance subcontracted to a number of Part 145 approved Maintenance Repair Organisations (MRO) at locations around Europe. These MROs operated to a set of procedures issued by the operator, who regularly audited their compliance. The UK based MRO was a wholly owned subsidiary of the parent company of the operator and worked exclusively on the operator's aircraft, though they were still tasked with work requests in the same manner as the other MROs. Operational control of aircraft, flights, crewing and maintenance was done by means of a computer based system called I Jet. This allowed the location of the aircraft to be tracked, maintenance inputs, flights and operating crew to be scheduled and also identified the aircraft's serviceability status. It was linked to maintenance, such that outstanding work packages had to be signed off as complete before the status could be updated and the aircraft released to operate. Only the operator could amend the status of the aircraft on the system. The request from the maintenance team for high-speed taxi trials was forwarded by the MRO's maintenance manager to the operator's duty maintenance manager, who authorised the test and requested the crew scheduling team to allocate a crew. He did not discuss the requirement with the flight operations duty fleet manager and had not considered that any specialist crew would be required. The crew were allocated and their names were entered into the I Jet management system. Had the tests required the aircraft to be released for flight, the open status of the work package may have prompted the test to be classified as an Operational Check Flight (OCF) and the appropriate flight crew allocated, as the aircraft status was still 'undergoing maintenance'; this did not take place.

In addition to the top level flight crew requirements for OCF and TF in Part A of the operator's Operations Manual, specific instructions at a working level were published by the operator in a procedure called NJMP 1.15. A copy of this procedure was available in the aircraft's onboard technical document library, as well as at the headquarters where the duty maintenance manager was based. It listed a number of requirements relating to allocation of flight crew, pre-test paperwork and briefings and post-test debriefing and recording of findings. There were no procedures in place to document the roles of either of the maintenance managers involved and no guidance as to when procedure NJMP 1.15 became applicable. However, based on custom and practice the operator's maintenance manager would decide when to apply NJMP 1.15 and request an OCF qualified flight crew as necessary. In this case he did not consider the check flight procedure was applicable to high-speed taxi test activity, as the tests were only for the purpose of maintenance defect troubleshooting on the ground.

Safety action

The operator's safety investigation highlighted concerns about the lack of procedures to cover the engineering and operations interface regarding aircraft test activity. In response to this, procedure NJMP 1.15 was amended to cover high-speed taxi trials and engine ground runs. The Operations Manual was also updated.

Analysis

Flight crew

The crew were properly licensed and qualified to operate the aircraft. Whilst the commander had met the 500 hours on type minimum requirement for OCFs, she had not carried out the training to conduct an OCF and was not included as such on the I Jet system. The high-speed taxi trials had not been identified as an OCF and no test schedule was available.

Following the briefing by the maintenance supervisor, the flight crew carried out a risk assessment of the test activity. They considered the greatest hazard was overrunning the end of the runway whilst carrying out the accelerate/stop manoeuvre. This was addressed by carrying out the appropriate performance calculations. By incrementally increasing the target speed for stopping the aircraft they also addressed the possibility of significant lateral departure from the runway centreline. However, the risks associated with exceeding the brake energy limit were not identified by the crew or the maintenance team.

The composition of those persons onboard was not governed by the requirements of a TF or an OCF which would probably have required only the maintenance supervisor being present in addition to the minimum flight crew of the two pilots. On the incident flight, two technicians were also present and for this reason the cabin attendant also boarded the aircraft.

On the final manoeuvre, when the crew suspected that they had a deflated tyre on the left MLG they stopped the aircraft on the runway in order to assess the situation. At this stage, they received the information regarding the fire and carried out the emergency evacuation drill which concluded in the safe evacuation of all those onboard.

Aircraft fire

Whilst attempting to troubleshoot a braking defect, the crew conducted eight high speed rejected takeoffs, within a 15 minute period, with limited distance travelled at taxiing speeds and no significant periods of cooling between runs. The cumulative effect of this was to subject the left gear brake units to energy levels in excess of what they were designed to accommodate and the certified limits demonstrated during aircraft development. This raised the temperature of the brake components to the point where the hydraulic fluid seals failed and significant structural damage occurred. Consequently, hydraulic fluid was released at high pressure which rapidly ignited on the hot brake surfaces, resulting in a sustained fire around the left MLG.

The crew were not aware of the fire until another aircraft crew in the vicinity relayed a warning to the air traffic controller, who in turn advised the crew to abandon the aircraft. Consequently, they were able to evacuate the occupants safely, whilst a rapid response by the professional and fully equipped AFRS allowed the fire to be brought under control.

The extent and duration of the fire and the associated level of damage were directly attributable to the amount of hydraulic fluid which was lost from the hydraulic systems. The No 1 hydraulic system was fitted with fuses which activated to limit the loss of fluid from this system. Had the No 2 system also been fitted with similar protection, the amount of fluid loss would have been reduced, with an associated reduction in the duration and severity of the fire.

The leak was caused by operation of the aircraft beyond its approved limits, which is an issue that cannot necessarily be mitigated by the manufacturer. However, the subsequent events demonstrated that regardless of the cause, the current design allows an uncontrolled loss of hydraulic fluid from the No 2 system, which will result in a significant and sustained fire when in the proximity of an ignition source, such as hot brakes. It should also be noted that the right main gear No 3 brake unit was leaking hydraulic fluid despite having potentially absorbed an energy level well within the approved limits. The risk from leaking hydraulic fluid was acknowledged by the airworthiness authorities prior to certification of the Falcon 2000 and although the aircraft was certified to JAR 25 Amendment 13, without protection to limit the loss of hydraulic fluid from a leak, the circumstances of this incident have highlighted that this represents a safety risk. Therefore, the following Safety Recommendation is made:

Safety Recommendation 2010-061

It is recommended that the European Aviation Safety Agency review the Falcon 2000 landing gear and hydraulic system design with a view to ensuring that, in the event of a leak, the system is protected so as to limit the loss of fluid in the vicinity of the brakes.

Systemic contributory factors

There were numerous systemic factors relating to the manner in which the operator conducted this test activity which contributed to the incident. Many of these, such as appropriate crew selection, the need for an approved test schedule and a detailed brief and debrief of the test activity with all involved personnel, are common to other recent incidents and accidents involving operators conducting maintenance or customer demonstration check flights. These issues have been highlighted and analysed in detail in the AAIB report into a serious incident involving a B737, G-EZJK, in the UK (reference: EW/C2009/01/02 AAIB Bulletin 9/2010) and a Bureau d'Enquêtes et d'Analyses (BEA) report into a fatal accident involving an A320, D-AXLA, in Perpignan, France (Report d-la081127). Recommendations to address these issues have already been made in the referenced reports and are equally applicable to conducting high-speed taxi trials; as such they are not repeated in this report.

Test preparation

Whilst the crew had been shown the brake energy graphs and calculations during their type conversions, they had not used them since. The brake energy limit is rarely encountered during normal aircraft operation, which may have reinforced an understanding by both pilots that brake energy was not a concern under any circumstances and they did not recognise the cumulative effect of carrying out multiple accelerate/stop manoeuvres.

A 'flight-test' schedule would have provided structure to the activity and an opportunity for a more formal risk assessment to be conducted. This would have addressed the runway overrun and lateral runway departure issues as well as the brake energy implications. Whilst the crew might have consulted the brake energy information in the flight manual, the manufacturer emphasised that the information derived was not appropriate for the purposes of this test activity.

AFM limitations and guidance

The use of different brake energy limitation figures within different chapters of the AFM is ambiguous and confusing. Minimum turn-around time guidance should reflect the maximum brake energy limit, which has been qualified by aircraft certification testing. The No 3 brake unit on the right MLG also exhibited significant damage and was leaking hydraulic fluid, despite apparently being subject to energy levels lower than both of the quoted limitations. The following Safety Recommendation is made:

Safety Recommendation 2010-062

It is recommended that the European Aviation Safety Agency require Dassault Aviation to review and amend the Falcon 2000 Airplane Flight Manual to ensure that the brake energy limitations quoted in all sections of the manual are consistent and reflect what has been satisfactorily demonstrated on the aircraft as a safe limit.

Even for normal operations, the AFM is unclear about the mitigating actions required by the crew in the event of high brake energies being encountered, particularly given the wheel fuse plugs are set to release significantly below the published brake energy limit. This means there is a likelihood that the plugs will release and the tyres deflate, regardless of brake performance. Clear and unambiguous guidance for the operating crew is particularly important given the lack of brake temperature indication or a brake overheat warning system[5]. Therefore, the following Safety Recommendation is made:

Safety Recommendation 2010-063

It is recommended that the European Aviation Safety Agency require Dassault Aviation to review and amend the Falcon 2000 Airplane Flight Manual to ensure that the guidance provided to flight crews relating to accumulated brake energy and minimum turnaround times is clear, consistent and takes account of all aspects of the aircraft's operation.

Maintenance

From a maintenance perspective there were a number of significant contributory factors. The practice of operating an aircraft with a significant problem for the purpose of replicating the defect can be a high-risk maintenance activity and as such it should only be considered once all other appropriate troubleshooting options have been exhausted.

If operational aircraft testing becomes necessary, then the risks need to be identified and addressed to ensure the tests are completed safely. One possible means of reducing risk would have been the use of a test procedure, or AMM task, approved by the manufacturer. In this case high-speed taxi trials were not a recognised AMM test and no additional guidance was sought from or offered by the manufacturer in support of the test activity.

The operator's maintenance manager had approved the request for the aircraft trial to take place. However, there was a lack of clear procedures or guidance available to advise him of his role and responsibilities for this type of activity and that procedure NJMP 1.15 for conducting operational check flights was relevant to a high-speed taxi trial. Although the procedure was not comprehensive and has been significantly updated by the operator since the incident, it did provide some elements of risk mitigation which may have prompted the maintenance manager or the flight crew to delay the test until it had been properly planned and organised.

Having been presented with the taxi test requirement, the aircraft commander contacted the operator's maintenance control in order to establish the exact nature of the task and question if it fell within the OCF category, which would have required her to contact her fleet manager. The operator's duty maintenance manager instructed the commander to discuss the activity with the maintenance supervisor on-site, which devolved control of the activity to the aircraft commander and the maintenance supervisor, neither of whom had the necessary knowledge or experience of aircraft operational testing.

The lack of training and guidance for subcontracted maintenance organisations, and specifically the on-site maintenance supervisor and his team, regarding their roles and responsibilities in the preparation, briefing and conduct of taxi trials meant that the necessary engineering support was not provided to assist the crew to conduct the tests safely. This lack of training and guidance also meant the on-site maintenance team was unaware of the roles and responsibilities of the operator's maintenance and operations departments with regard to the trial. As such, they had no appreciation of the level of support they and the crew should have expected to receive.

These issues were identified in part by the operator's internal safety department investigation and a recommendation was made in their report to develop

Footnote

5 The wheel bay overheat warning is only relevant when the gear has been retracted after take-off. There is no brake overheat warning system available on the ground.

and implement specific additional procedures. The operator's response has been to amend the applicability of the OCF procedure NJMP 1.15 to include high risk ground test activities, such as high-speed taxi trials and engine ground runs. The amended procedure also adds definition to some elements of the role of the operator's maintenance manager when OCF activities take place. Whilst this is a positive improvement, further changes are recommended to fully address the maintenance issues highlighted. These should include separate and additional maintenance procedures for both internal and sub-contract maintenance participants to document the tasks, roles and responsibilities when requesting and participating in these high risk test activities and to highlight when procedure NJMP 1.15 should be referred to. The following Safety Recommendation is made:

Safety Recommendation 2010-064

It is recommended that NetJets Transportes Aéreos introduce maintenance procedures which document the tasks, roles and responsibilities of all maintenance personnel when requesting and participating in operational/functional check flights or flight crew operated ground tests.

Safety action

The operator carried out an in-depth internal safety department investigation into this incident. Their report included nine Safety Recommendations addressing the operational and engineering issues identified.

ACCIDENT

Aircraft Type and Registration:	Aero AT-3, G-UKAT
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2005
Date & Time (UTC):	9 May 2010 at 1324 hrs
Location:	North Weald Airfield, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Landing gear and wings damaged on impact; aircraft destroyed by post-crash fire
Commander's Licence:	Private Pilot's Licence
Commander's Age:	46 years
Commander's Flying Experience:	464 hours (of which 258 were on type) Last 90 days - 19 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot, wreckage examination by AAIB and weather aftercast by the Met Office

Synopsis

On short finals at North Weald, the pilot initiated a go-around, increasing the throttle setting to full power and raising the flaps to 15º. During the climbout the aircraft entered a turn to the left and headed off the runway centre line by around 45º. The pilot was unable to level the wings and stop the turn to the left. As the aircraft approached tall trees the pilot made a very tight left turn and the stall warning begun to sound at approximately 70 ft agl. The pilot put the aircraft nose down and pulled the throttle to idle, to reduce the turn motion to the left, preventing the crash from being onto parked aircraft.

History of the flight

The pilot was returning to North Weald after a short local flight, where he had climbed to 2,800 to 3,000 ft near Chelmsford and spent about 15 minutes practising a series of turns and other general handling manoeuvres.

He descended in stages, due to the Stansted airspace restrictions, called North Weald Radio Air/Ground (A/G) for joining information at North Weald and joined the aerodrome circuit on the downwind leg for a landing on Runway 13, "13 left hand", flying a wide circuit to avoid overflying the car racing event taking place on Runway 02/20. The pilot reports that at about three-quarters of the way along the downwind leg, at a height of 800 ft agl, he slowed the aircraft to 75 kt, lowered the flaps to 15° and then trimmed the aircraft for 70 kt. The pilot made the base leg a continuous manoeuvre to the left, descending from 800 to 550 ft and called "Golf Alpha Tango finals 13" to A/G, who acknowledged and advised that the wind was still northerly at 8 kt. Due to the northerly wind over the nearby trees and buildings the pilot expected a bumpy approach and decided that if the landing approach "was not perfect" he would initiate a go-around.

At approximately 400 ft the pilot lowered the flaps from 15° to the maximum setting of 40°, trimmed the aircraft for 60 kt and removed the carburettor heat. He carried out the approach with the left wing slightly low, due to the crosswind, and felt that the approach was good. However, on final approach, at a height of approximately 20 ft and a speed of 55 kt, the aircraft was affected by strong turbulence and the pilot detected the onset of a high rate of sink. He applied some power and maintained the runway centre line at a height of approximately 10 ft and then decided to initiate a go-around.

In the go-around the pilot applied full power and raised the flaps from 40° to 15° for the climbout and, with no passenger onboard, the pilot considered the engine was giving a decent rate of climb. At this point the pilot glanced down at the instruments for what he considered was a very short period but, looking up, was amazed to find the aircraft was in a turn to the left, heading off the runway centre line by around 45° towards buildings and maintenance hangars.

With the aircraft still climbing, the pilot felt that he could hold the heading and continue to climb. However, he found he was not able to level the wings and stop the turn to the left, as application of right aileron and rudder appeared to be ineffective - even with full power, the pilot felt that he should have been able to turn the aircraft to the right with the application of both rudder and aileron. The aircraft climbed over a line of parked aircraft, still turning to the left. At this point, the pilot believes he was at approximately 100 ft and was still unable to level the wings. He was concerned that the aircraft would not be able to clear the tall trees, behind a large hangar, which he was very rapidly approaching. He made the decision to make a very tight left turn to avoid hitting the trees, making sure that the aircraft cleared the hangar. He realised that by making such a steep turn the aircraft might stall, but at that point he considered that he had no other option available to avoid the trees.

At this point the aircraft was heading in a westerly direction, still turning left and losing airspeed. The stall warning was now sounding and to avoid crashing into parked aircraft the pilot put the aircraft nose down and pulled the throttle to idle, calculating that this action would help reduce the turn motion to the left, putting the inevitable crash onto the grass between the perimeter track and the runway, rather than on top of the parked aircraft. At this point, the pilot realised that he had little control of the aircraft as it was in a stalled condition with a nose down attitude and with the left wing still very low.

As the aircraft hit the ground the pilot saw the rear of a car directly in front of him and watched the propeller and front cowling breaking up on impact with the vehicle. He recalled that the side of his head hit hard on part of the airframe, causing a loss of vision in that eye. From his right eye the pilot could see smoke rising from the top of the cowling; he tried to turn the master and ignition switches off, but noticed that the key and instrument panel were distorted. Hearing someone shouting urgently for him to get out, he unclipped the seat belt. The pilot was unable to climb out of the aircraft due to a broken left leg, but was dragged out by the driver and passenger of the vehicle the aircraft had struck. He was able to talk to the various workers and other pilots who came to his assistance.

The pilot was then taken by ambulance to the Princess Alexandra Hospital in Harlow, Essex.

Wreckage examination

Following the removal and transportation to a secure storage facility, the AAIB carried out an examination of the wreckage, finding no evidence of a pre-impact structural failure or disconnect or restriction of the flying control system. However, the extent of the impact and fire damage was such that a pre-impact anomaly could not be entirely excluded.

Weather aftercast

Following the accident, the Met Office estimated that for North Weald at the time of the accident, the surface wind would have been about 040º, steady at 8 to 12 kt.

.**Discussion**

Since the accident the pilot had time to think about the event and, on reflection, considered that having applied full power at the initiation of the go-around he should not have looked down at the instruments, and instead concentrated on keeping the aircraft flying straight, knowing the prevailing turbulent conditions and having just experienced a downdraft. He further considered that he should also have opened the throttle more slowly, to accommodate the distinct leftward torque effect from this engine.

However, the pilot was still surprised that he could not stop turning to the left in the climb, even with the application of right aileron and rudder, given that the stall warning did not start until after he made the final steep turn to the left, to avoid the high trees. He considered that there might have been a subtle mechanical cause for this difficulty in stopping the continuing turn to the left.

ACCIDENT

Aircraft Type and Registration:	Cessna 152, G-BNUS
No & Type of Engines:	1 Lycoming O-235-L2C piston engine
Year of Manufacture:	1982
Date & Time (UTC):	9 May 2009 at 1605 hrs
Location:	Clacton Airfield, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to the nose landing gear, propeller and firewall
Commander's Licence:	Private Pilot's Licence
Commander's Age:	34 years
Commander's Flying Experience:	115 hours (of which 50 were on type) Last 90 days - 12 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot, Occurrence Report submitted to the CAA by the airfield manager and subsequent AAIB enquiries

Synopsis

A bounced landing led to the collapse of the nose landing gear.

History of the flight

The pilot reported that he landed on grass Runway 18 in good weather and a surface wind of less than 5 kt. He reported holding the nose landing gear off the runway as, in his opinion, the surface was "rough". As he lowered the nosewheel the aircraft passed over a public footpath that crosses the runway, 180 m from the threshold. The pilot reported that there was a loud thump and the nose of the aircraft dropped as the nose landing gear collapsed. The pilot and passenger, who were uninjured, vacated the aircraft normally after it had come to a stop and been shut down. There was no fire.

Airfield operator's inspection

The morning after the accident a runway inspection was carried out by the airfield operator. This showed a single mark, consistent with the nose landing gear, 10 m before the footpath then no ground marks for 38 m until all three landing gear appeared to have contacted the runway, with some evidence of scuffing by the nose landing gear, suggesting it had partially collapsed. A further 10 m on there were marks from all three landing gear, and the propeller, on the runway surface. The marks then continued to the point where the aircraft had stopped. There had been no aircraft movements in the time between the accident and the inspection, and the operator commented that the runway, including the footpath, was inspected daily.

CAA Aerodrome Standards

CAA Aerodrome Standards confirmed that Clacton is a licensed airfield, that the runway is considered fit for purpose with the runway to footpath transition being appropriately managed.

Comment

The ground marks recorded by the airfield operator are indicative of a bounced landing leading to the collapse of the nose landing gear.

SERIOUS INCIDENT

Aircraft Type and Registration:	Cessna 172Q, G-CFSM
No & Type of Engines:	1 Lycoming O-360-A4N piston engine
Year of Manufacture:	1983
Date & Time (UTC):	5 June 2010 at 1615 hrs
Location:	Cowley Drive, Woodingdean, East Sussex
Type of Flight:	Aerial work
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	No damage to aircraft; damage to house roof tiles
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	53 years
Commander's Flying Experience:	1,511 hours (of which 1,473 were on type) Last 90 days - 42 hours Last 28 days - 10 hours
Information Source:	AAIB Field Investigation

Synopsis

Whilst returning from a banner towing detail, the banner detached from the aircraft and fell onto a house, causing damage to roof tiles. Evidence of pre-existing damage to the cable was found, but the cause of this damage could not be determined.

Engineering examination

The banner tow cable was constructed of stranded steel surrounded by a plastic sheath. Examination of the fracture faces of the two halves of the failed cable revealed that the sheathing had been damaged in a plane at right angles to the cable axis and that the damaged cable had been in use for some time before the final failure. Most of the steel strands of the cable had failed in overload and all failures were at points close to the plane of the damage to the sheath. The failure was consistent with sequential strand failure following initial cable damage. The cause of the damage to the sheath could not be determined.

The operator reported that the cable was supplied by a specialist American company that is no longer trading.

ACCIDENT

Aircraft Type and Registration:	DH82A Tiger Moth, G-ADGT
No & Type of Engines:	1 de Havilland Gipsy Major 1F piston engine
Year of Manufacture:	1935
Date & Time (UTC):	18 July 2010 at 1031 hrs
Location:	Lashenden (Headcorn) Aerodrome, Kent
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 2 (Minor) Passengers - N/A
Nature of Damage:	Wings and landing gear separated from aircraft, forward fuselage and propeller damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	50 years
Commander's Flying Experience:	450 hours (of which 97 were on type) Last 90 days - 4 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Whilst landing in crosswind conditions the aircraft bounced to the right of the runway centreline and despite the commander taking control, he was unable to prevent the aircraft colliding with the airfield boundary hedge.

History of the flight

The purpose of the flight was for the commander, who was a club check pilot, to endorse a club pilot for crosswind operations in the aircraft, using Runway 29 at Headcorn Aerodrome. Surface wind conditions were estimated to be 12 kt from 220°; however, meteorological conditions were favourable for generation of thermals, causing gusts in the surface wind.

After completing a series of circuits, during which the commander described the club pilot as being slightly 'behind' the aircraft, the club pilot positioned the aircraft for final approach to Runway 29. The aircraft drifted right of the runway centreline and was too high during the approach. The club pilot attempted to correct the drift by lowering the into-wind wing. However, the sink rate increased and the aircraft touched down at approximately 60 kt, resulting in a bounce to the right of the runway centreline. During the subsequent go-around the aircraft continued to drift further right of the runway in a nose-high attitude. Despite the commander taking control and applying full power, the right wingtip contacted the ground, causing the aircraft to ground loop to the right and subsequently collide with the airfield boundary hedge. The wings, landing gear and forward fuselage were extensively damaged in the ensuing impact, however both occupants were able to leave the aircraft having only sustained minor injuries. A fuel leak occurred due to disruption of the fuel lines upstream of the fuel shutoff valve but there was no fire.

ACCIDENT

Aircraft Type and Registration:	1) DH82A Tiger Moth, G-AKUE 2) Cessna 152, G-BMTB
No & Type of Engines:	1) 1 De Havilland Gipsy Major I piston engine 2) 1 Lycoming O-235-L2C piston engine
Year of Manufacture:	1) 1939 2) 1977
Date & Time (UTC):	15 August 2010 at 1440 hrs
Location:	Redhill Airfield, Surrey
Type of Flight:	1) Private 2) N/k
Persons on Board:	1) Crew - 2 Passengers - None 2) Crew - 2 Passengers - None
Injuries:	1) Crew - None Passengers - N/A 2) Crew - None Passengers - N/A
Nature of Damage:	1) Propeller 2) Right aileron
Commander's Licence:	1) Airline Transport Pilot's Licence 2) N/k
Commander's Age:	1) 73 years 2) N/k
Commander's Flying Experience:	1) 25,131 hours (of which 1,031 were on type) Last 90 days - 50 hours Last 28 days - 18 hours 2) N/k
Information Source:	Aircraft Accident Report Form submitted by the pilot

After clearing the runway and confirming that there were no obstructions in the aircraft's path, the pilot of G-AKUE taxied towards the apron. As he approached the apron, the pilot became aware of the presence of another aircraft a short distance in front of him, so he switched off the engine in an effort to stop his aircraft. The Tiger Moth, which is not fitted with wheel brakes, continued to roll forward and its propeller struck the right aileron of G-BMTB. The occupants of both aircraft were uninjured. The pilot of G-AKUE attributed the accident to a combination of the restricted forward visibility from the Tiger Moth on the ground and confirming that his aircraft's path remained clear of obstructions too late to prevent the collision.

ACCIDENT

Aircraft Type and Registration:	Pioneer 300, G-IPKA	
No & Type of Engines:	1 Rotax 912 ULS piston engine	
Year of Manufacture:	2005	
Date & Time (UTC):	25 August 2010 at 1055 hrs	
Location:	Battleflat Farm Strip, Leicestershire	
Type of Flight:	Training	
Persons on Board:	Crew - 2	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Landing gear, propeller, fuselage, engine cowl	
Commander's Licence:	National Private Pilot's Licence	
Commander's Age:	64 years	
Commander's Flying Experience:	1,896 hours (of which 140 were on type) Last 90 days - 26 hours Last 28 days - 12 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The pilot was undertaking a licence revalidation check flight with an LAA coach. Shortly after touchdown, the left mainwheel ran into a narrow rut parallel to and adjacent to the edge of the grass strip. The pilot applied full right rudder, but was unable to turn the aircraft to the right. As the aircraft decelerated, the left landing gear leg collapsed. The nose then swung 60° to the right and the nose gear collapsed, causing the propeller to strike the ground, stopping the engine.

ACCIDENT

Aircraft Type and Registration:	Pioneer 300 Hawk, G-JDRD
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2010
Date & Time (UTC):	31 July 2010 at 1335 hrs
Location:	Dunkeswell Airfield, Devon
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Propeller, aerial beneath fuselage
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	57 years
Commander's Flying Experience:	5,081 hours (of which 8 were on type) Last 90 days - 17 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The nose landing gear could not be raised after takeoff and could not be locked down. A successful wheels-up landing was performed and a broken universal joint in the nose gear actuating mechanism was found to be the cause.

History of the flight

After takeoff, the pilot retracted the tricycle landing gear but received an 'unsafe' warning for the nose landing gear, whilst the two main gears indicated normally. The same indications occurred when the gear was recycled and it appeared that the nose gear would not fully retract or lock down. The pilot tried to wind the gear down manually but with the same result – the nose gear continued to give an unsafe indication.

A pilot in another aircraft visually confirmed that the nose gear was not locked down so the pilot of G-JDRD elected to perform a landing on the grass parallel to Runway 23 at Dunkeswell; he chose to do this with the main gears retracted as he feared that the nose of the aircraft might 'dig-in' and invert. The landing was successful and resulted in minimal damage.

Examination of the aircraft

The aircraft was lifted and all three landing gears were extended and manually placed into the down and locked condition. The nose gear was found to be swinging freely as it did not appear to be connected to its extension/retraction mechanism. The electrical landing gear actuator is connected to a gearbox which outputs to three shafts, one to each landing gear; for the nose gear two universal joints are fitted at each end of the actuating shaft. The joint at the gearbox end of the shaft was found to have failed in overload, leaving no drive to the nose gear either electrically or manually.

The Light Aircraft Association (LAA) have advised that similar failures have resulted from the electric motor continuing to drive the actuating shaft against jams or extreme stiffness of the mechanism. A 7 amp circuit breaker (CB) is specified in the motor circuit and G-JDRD was found to have a 10 amp CB fitted. It is currently unknown whether fitting the lower-rated CB would have resulted in it tripping and preventing mechanical damage; although it is thought that fitment of the 10 amp CB is fairly common. The LAA has embarked on trials with the manufacturer to assess the effect of fitting a 10 amp CB instead of the originally specified 7 amp. Results of the trials will be promulgated by the LAA.

ACCIDENT

Aircraft Type and Registration:	Piper PA-32RT-300 Cherokee Lance II, G-BRHA
No & Type of Engines:	1 Lycoming IO-540-K1G5D piston engine
Year of Manufacture:	1978
Date & Time (UTC):	23 June 2010 at 1409 hrs
Location:	Earls Colne Airfield, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Propeller, engine shock-loaded, fuselage, flaps
Commander's Licence:	Private Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	675 hours (of which 511 were on type) Last 90 days - 2 hours Last 28 days - None
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

On returning from a local flight the pilot decided to conduct a Practice Forced Landing (PFL) from overhead the airfield. After completing this, he elected to continue the approach to land and in doing so omitted to select the undercarriage down. The aircraft sustained damage but the pilot was uninjured.

History of the flight

The pilot had not flown for some time, and planned a flight to the north-east of Earls Colne Airfield to conduct some general handling practice. On returning, as the weather was fine and there were no other aircraft in the circuit, he decided to carry out a PFL from overhead the airfield. He commenced the PFL at approximately 2,500 ft above the airfield, moving the throttle lever back to idle to simulate an engine failure. Following completion of the PFL, while close to the ground, the pilot considered the aircraft to be in an ideal position to continue the approach to Runway 24, and so he elected to land rather than go around, as he had originally intended. Instead of touching down normally, the propeller and lower fuselage struck the runway surface and it became apparent that the undercarriage was not extended. The aircraft slid along the asphalt runway before veering off to the left, coming to rest in the grass area adjacent to the runway. The pilot was uninjured and vacated the aircraft via the normal exit.

The aircraft is equipped with an undercarriage warning horn which activates if engine power is reduced below approximately 14 inches of manifold pressure and the undercarriage is not locked down. The pilot recalled hearing the warning horn activate, as expected, when he reduced power to idle at the commencement of the PFL and it continued to sound until the aircraft landed. However, as he had become accustomed to hearing the warning horn by the time he decided to land, he did not appreciate its significance.

During subsequent recovery of the aircraft by the maintenance company, the undercarriage lever was observed to be in the 'UP' position. The aircraft was placed on jacks and the undercarriage operated satisfactorily when tested.

The pilot attributed the accident to his last minute decision to land, rather than go around.

ACCIDENT

Aircraft Type and Registration:	Yak-52, G-YAKH
No & Type of Engines:	1 Ivchenko Vedeneyev M-14P radial piston engine
Year of Manufacture:	1989
Date & Time (UTC):	31 May 2010 at 0910 hrs
Location:	Runway 03, White Waltham Airfield, Berkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Minor damage to left wing tip, left aileron and tail skid
Commander's Licence:	Private Pilot's Licence
Commander's Age:	37 years
Commander's Flying Experience:	405 hours (of which 81 were on type) Last 90 days - 6 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

After landing and turning right off the grass runway the aircraft 'lurched' to the left. The pilot reached for the landing gear selector to ensure that it was DOWN, and in doing so may have inadvertently briefly selected it UP. The left main gear leg retracted, and during recovery the right main gear leg also retracted. Retraction and extension tests of the gear after the incident did not reveal any mechanical faults.

History of the flight

The pilot had completed three successful touch-and-go landings. After his fourth landing on Runway 03 (grass) he vacated it to the right and started taxiing towards the fuel pumps. He reduced the engine power to 40% and retracted the flaps while the aircraft slowed on an upslope. Shortly thereafter he felt a 'lurch' to the left. He looked left and saw the left wing dropping so he pulled the throttle back to IDLE and reached for the landing gear selector; in doing so he believes he may have briefly selected UP before reselecting DOWN. The left wing continued to drop until its wing tip hit the ground, whilst the aircraft was rolling forwards at a walking speed. The pilot shut down the engine, but because the nose gear leg and right main gear leg had remained extended, the propeller did not strike the ground. After he called for assistance some ground handlers arrived and lifted the left wing; this caused the right main gear leg to retract. When the aircraft was later recovered both main gear legs were extended and locked into place.

Examination of the landing gear

The main landing gear legs on the Yak-52 retract forwards and are operated by a pneumatic system. The landing gear legs do not retract into the fuselage or wings, but remain protruding beneath them, thus protecting the aircraft underside in the event of a gear-up landing, gear collapse or inadvertent UP selection on the ground (Figure 1). The maintenance organisation that recovered the aircraft carried out a number of landing gear extension and retraction tests, and each time all three main landing gear legs locked into the DOWN position. The main gear downlocks are integral to the actuators and a strip examination of the actuators revealed a small amount of internal corrosion, but it was not deemed sufficient to cause a malfunctioning of the locking mechanism.

Pilot's assessment of the cause

The pilot stated that the aircraft's lurch to the left was very prominent and might have been caused by the left wheel dropping into a hole. Without any evidence of a mechanical fault the pilot concluded that he might have caused the gear to unlock when he reached for the landing gear selector.

Figure 1

G-YAKH with its landing gear retracted

(photograph courtesy CAA G-INFO)

ACCIDENT

Aircraft Type and Registration:	Robinson R22 Beta, G-RIDL	
No & Type of Engines:	1 Lycoming O-360-J2A piston engine	
Year of Manufacture:	2001	
Date & Time (UTC):	15 November 2009 at 1530 hrs	
Location:	Pinfold Farm, Macclesfield, Cheshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - 1 (Fatal)	Passengers - N/A
Nature of Damage:	Aircraft destroyed	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	69 years	
Commander's Flying Experience:	476 hours (of which 130 were on type) Last 90 days - 0 hours Last 28 days - 0 hours	
Information Source:	AAIB Field Investigation	

Synopsis

The pilot was undertaking a local flight in his helicopter when witnesses heard an unusual noise and saw the helicopter descend. It crashed in a field, fatally injuring the pilot. Evidence suggests that the pilot may have been attempting a precautionary landing and that the tail of the helicopter contacted the ground, leading to a loss of control. Corrosion was found in the left magneto, which could have caused an increase in engine vibration and noise, and possibly led the pilot to attempt a precautionary landing.

History of the flight

The pilot, who was also the owner of G-RIDL, kept the helicopter outside at a private site located close to Manchester Airport and normally only used it for pleasure flights in the local area. On the afternoon of the accident he decided to undertake such a flight, intending to return after about an hour flying around the Macclesfield area.

There were no witnesses to the pilot preparing the helicopter for flight, but a witness, who had seen the helicopter operating before, watched as the pilot started the engine. He twice saw the helicopter lift off and rise a few feet above the ground before landing again. It then took off and departed normally. He was not aware of anything otherwise unusual regarding the helicopter or its operation.

Manchester ATC recorded the helicopter taking off at

1517 hrs and cleared the pilot to fly to the south-west, to a rural area a few miles to the north of Macclesfield. The helicopter remained flying in this area and at 1519 hrs ATC advised the pilot that another helicopter, G-CKCK, an Enstrom 280FX, was taking off from a nearby site. The pilot of G-RIDL replied that he would descend to 200 ft and later reported that he had the other helicopter in sight. The pilot of G-CKCK did not see G-RIDL.

Shortly before the accident, G-RIDL was seen by witnesses who described it flying at a height of between 500 and 1,000 ft above the ground, with no apparent signs of anything being wrong. The helicopter had been circling near the crash site for a few minutes when one witness heard a noise described as a "bang" or "clatter" and saw the helicopter rock from side to side. He reported that the engine continued to sound as if it was running normally but that the helicopter then slewed to one side so that its nose was pointing to the left of the direction of travel.

Other witnesses saw the helicopter as it descended but, due to the nature of the terrain and surrounding trees, no one saw it strike the ground. Witnesses reported hearing the engine running as the helicopter descended. Other people close to the accident site, who had not seen the helicopter, were alerted to its presence by the noise it was making. One described it as "struggling as if it were under load". There was then a heavy thud and the noise stopped, prompting two people to investigate. They found the helicopter lying on its side in a nearby field, with the pilot having sustained serious injuries. They notified the emergency services who attended the scene but the pilot subsequently died from his injuries.

Air Traffic Control

When Manchester ATC did not receive responses to their calls to G-RIDL they requested the assistance of the pilot of G-CKCK in trying to locate it. The pilot flew over the last known position of G-RIDL, but was unable to locate it. ATC also guided him to the normal landing site for G-RIDL to see whether it had returned. When it could not be found ATC activated their lost aircraft response procedure. This was quickly suspended, however, when they were informed by the emergency services that G-RIDL had crashed.

Weather

Reports from Manchester Airport covering the time of the accident indicated that weather conditions were good, with a light southerly wind and no cloud likely to have affected the flight. The temperature and dew point of 11°C and 8°C, respectively, were conducive to serious carburettor icing.

Recorded data

The helicopter was not equipped with a crash-protected recorder, nor was it required to be.

A GPS receiver capable of recording the helicopter's flight path was recovered from the wreckage. This type of GPS receiver records the track in a memory that is dependent on an internal battery. An attempt to download the data revealed that the battery did not have sufficient charge to maintain the memory; therefore no GPS track data was available.

The flight path of the helicopter was, however, captured by Manchester Airport's radar (Figure 1). The helicopter's transponder was not set to report its altitude, so only its ground track could be assessed.

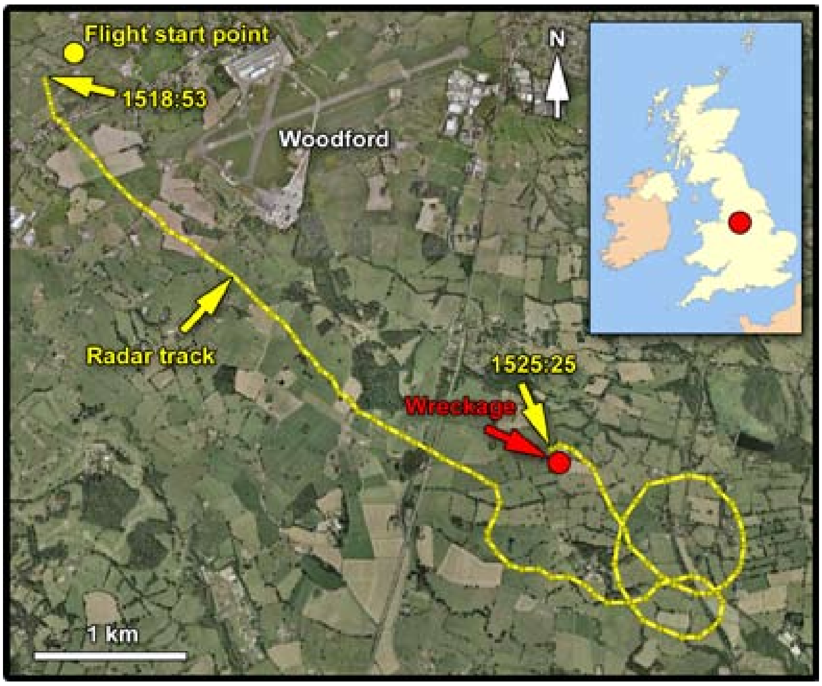


Figure 1

G-RIDL radar track

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Accident site and initial examination

The helicopter struck the ground approximately 50 metres from the north-west corner of a field near the top of an elevated area of ground (Figure 2). The first ground mark consisted of a shallow scrape together with two associated angled slash marks, consistent with the helicopter's tail rotor blades striking the ground whilst rotating. A second ground mark was found three metres beyond the first and contained a portion of the tail rotor gearbox mounting bracket. These markings showed that the helicopter was on a heading of approximately 147º(M)when it first struck the ground. The tail rotor gearbox, including the roots of both tail rotor blades, and the tail assembly of the helicopter had detached and were found close to the second ground mark. The tail rotor blades had failed at approximately 25% of their span; one detached blade section was found 20 metres beyond the first ground mark and the second was recovered from an adjacent field, 115 metres to the left of the first ground mark.

A third ground mark was identified 15 metres beyond the second, which was consistent with the right skid striking the ground. The final ground mark was produced when one of the main rotor blades struck the ground. This had resulted in the fuselage of the helicopter rotating 180º around the rotor head and landing heavily on its right side. The helicopter came to rest in a low-lying, waterlogged area of the field, 53 metres beyond the point of first ground contact. There was no evidence that the helicopter had made contact with any of the trees surrounding the field, or the overhead electricity cables which crossed the field.

Figure 2
Accident site

The impact sequence resulted in the right side of the cockpit being deformed inwards. This also caused deformation of the cockpit bulkhead on the right side and crushing of the right side of the pilot's seat mounting structure. The magneto switch was found in the OFF position but it was later confirmed that the emergency services had turned the key from the BOTH position to the OFF position during their rescue attempt. The carburettor heat selector was also found in the OFF position, although it could not be established whether it had been moved after the accident.

The right skid had failed in bending just behind the forward mounting strut. The rear mounting strut had failed where it attached to the right side of the rear fuselage/engine mounting framework which had also been distorted. Both main rotor blades were intact and showed no leading edge damage. The blades had been bent upwards when they struck the ground during the impact sequence. The tail rotor pitch control rod had also become wrapped around the tail rotor driveshaft.

A significant quantity of fuel was drained from the fuel tanks prior to recovering the helicopter from the field.

Helicopter description

The R22 Beta is a two-seat, single engine helicopter powered by a four-cylinder Lycoming air-cooled engine. The engine is rated at 145 hp at 2,700 rpm.

The rotor system consists of a two-bladed teetering main rotor and a tail rotor driven by a pair of vee-belts. The vee-belts are fitted between a lower pulley mounted on the end of the engine crankshaft and an upper pulley located on the driveshaft of the combined tail rotor and main rotor gearbox (combined gearbox). The belts are tensioned via a clutch system which displaces the upper pulley relative to the engine crankshaft pulley. The clutch assembly consists of an electrically-driven actuator connected to the engine crankshaft and the combined gearbox driveshaft by a pair of bearing assemblies. The upper bearing is fitted with a freewheel unit which allows the rotor system to continue to rotate in the event of an engine failure. When the clutch is engaged via the cockpit-mounted switch the actuator extends, tensioning the belts. A light illuminates on the instrument panel to indicate that the clutch actuator is operating. As the belt tension increases a pair of leaf springs bow outward, operating two microswitches when the correct operating tension is achieved, switching off the actuator motor. The tension in the vee-belts can vary during normal operation and the clutch actuator operates periodically to compensate and maintain the correct belt tension.

Robinson Helicopter Safety Notice SN-2B, dated July 1988, and revised in June 1994, gives information on the clutch warning light. It states that if it flickers, or remains illuminated for longer than usual, it can indicate a belt or bearing failure in the vee-belt drive. It instructs that should this occur whilst airborne the pilot should immediately pull the CLUTCH circuit breaker, select the closest safe landing site and make a normal power-on landing. During the landing the pilot should be prepared to enter autorotation if a failure of the drive system occurs. The CLUTCH circuit breaker on G-RIDL was not found to be pulled when the helicopter was examined.

Ignition system

The engine is fitted with a dual ignition system incorporating two magnetos, each of which supplies high voltage to one of the two spark plugs in each of the four cylinders. Within the magnetos the high-energy electrical power is fed from the coil via its outlet tab to the distributor by a rotating carbon brush. Environmental sealing of the magneto relies on the tight face to face contact of the two magneto case halves and the application of a coat of paint to the assembled unit. The magnetos are turned ON and OFF by a key-operated, five-position, rotary ignition switch mounted on the lower instrument panel. The five switch positions are:

OFF -	Both magnetos off
R -	Right magneto on, left magneto off
L -	Left magneto on, right magneto off
BOTH -	Both magnetos on
START -	Operates the starter motor, both magnetos on

The left magneto was a TCM type S4LSC-200 unit, with part number 10-600614-1 and serial number I180D19E. The right magneto was a TCM type S4LSC-204T unit, with part number 10-600644-201 and serial number I250027E.

Loss of engine power

A loss of engine power in an R22 is evident by a nose-left yaw, change in engine noise and a rapid decay in main rotor rpm. If there is a delay in lowering the collective lever the rotor rpm can decrease to a level where the rotor blades stall. In forward flight the retreating blade will stall before the advancing blade. This will cause the rotor disc to tilt backwards, a phenomenon known as rotor blow-back. With a reducing rotor rpm the helicopter will start to descend and the airflow impinging on the tail surface will cause the helicopter to pitch nose-down. If the pilot moves the cyclic control rearwards to prevent the nose from dropping, then the combination of rotor blow-back and pilot input can cause the main rotor blades to strike the tail cone.

Maintenance history

Examination of the helicopter's maintenance records confirmed that it had been maintained in accordance with the approved maintenance program for the Robinson R22 Beta and was in compliance with all mandatory requirements in force at the time of the accident.

Teledyne Continental Motors (TCM) Service Bulletin 643B provides the maintenance intervals for TCM and Bendix aircraft magnetos and related equipment. SB 643B includes a requirement for the magneto to be inspected every 500 flying hours, which includes inspections of the carbon brush for unusual wear and the outlet tab on the coil for the presence of a depression. The SB also requires that the magneto be overhauled or replaced either at the expiration of five years since the date of manufacture, or four years since the magneto was placed in service, whichever occurs first. The maintenance records for G-RIDL confirmed that both magnetos were removed in July 2009 for overhaul in accordance with SB 643B.

On 6 November 2009, a flying instructor had arranged to use the helicopter, but after starting the engine he observed that the clutch actuator warning light was flickering. He shut down the helicopter and reported the problem to the owner, who replied that this was an ongoing issue. The owner, who had a mechanical engineering background, explained to the instructor that he did not believe the problem was serious. Nevertheless, the instructor provided the owner with a copy of Robinson Helicopter Safety Notice SN-2B, and arrangements had been made for the helicopter to be examined by a maintenance organisation the week commencing 16 November 2009, the week following the accident.

Detailed examination

Analysis of the fuel recovered from the helicopter showed that it conformed to the specification for Avgas and that there were no significant contaminants present. Examination of the rotor head and the cyclic and collective control circuits revealed no evidence of control restriction or pre-impact disconnection. The fracture surfaces of the tail rotor gearbox mounting were consistent with a failure in overload and both tail rotor blades had failed as a result of overload in bending. The tail rotor driveshaft coupling to the tail rotor gearbox had failed in torsional overload and the tail rotor pitch control rod had become wrapped around the tail rotor driveshaft.

Given the reports regarding the flickering rotor clutch light, the rotor drive system was examined in detail. Both rotor drive vee-belts were found to be in good condition with no evidence of wear or deterioration. The tension of both belts was measured and found to be within the limits defined in the Robinson R22 Maintenance Manual and the extension of the clutch actuator was within the expected operating range. In order to test the operation of the clutch actuator, both rotor drive belts were removed and electrical power was applied to the helicopter. With the clutch selected to ENGAGED the clutch light remained illuminated but the clutch motor did not operate. The clutch assembly was removed and damage was found to the outer sleeve of the clutch actuator which was consistent with the actuator being struck by the rearmost, engine-mounted drive belt pulley during the impact sequence. Disassembly of the actuator confirmed that the inner diameter of the outer sleeve had been distorted, jamming the moveable portion of the actuator. The clutch motor was then reconnected to the helicopter wiring loom and electrical power restored. During this test the clutch motor operated intermittently. Examination of the wiring loom confirmed that the insulating sleeve of one cable had been damaged and would, when moved, 'short out' against the adjacent structure, causing the clutch motor to stop intermittently. The damage was consistent with having been caused during the impact sequence. When the wire was repaired, the clutch motor operated normally. The upper and lower clutch bearings were disassembled and no evidence of bearing distress or deterioration was noted. The clutch system tension microswitches were tested and found to operate normally.

The engine, serial number L-39266-36A, was removed for a series of operational tests in an instrumented test cell under AAIB supervision. After starting and a warm-up period to confirm that the engine appeared to operate normally, it was accelerated to 1,500 rpm to carry out a functional check of each magneto. The decrease in engine speed was 80 rpm and 76 rpm when operating on the left and right magnetos respectively.

Both magnetos were reselected and the speed of the engine was increased to 1,800 rpm, with no abnormalities identified with the engine's performance or parameters. After stabilising at 1,800 rpm a second magneto check was carried out, which showed a drop of 271 rpm when operating on the left magneto, compared to a 112 rpm drop when operating on the right. The test was repeated and this time, when operating on the left magneto, the speed drop was 101 rpm.

The engine speed was then increased to 2,700 rpm with both magnetos operating. The engine produced 145.4 hp at this speed, with all of the parameters within the engine manufacturer's prescribed limits. However, there was an intermittent misfire on the number four cylinder with associated engine vibration. The engine speed was reduced to 1,800 rpm and the test was then repeated using the right magneto only. The engine was able to maintain 2,700 rpm and produced 140 hp without misfiring. Once again the engine speed was decreased to 1,800 rpm and the test repeated using just the left magneto. As the engine speed reached 1,950 rpm the number four cylinder was observed to misfire intermittently and the engine could not be accelerated above 2,300 rpm. The engine was shut down and the magnetos removed for further investigation.

A bench test of both magnetos confirmed that sufficient energy was being produced to generate a spark across a representative air gap. On disassembling the magnetos, no defects were observed in the right magneto; however, when the left magneto was opened, clear evidence of water ingress was found. Examination of the mating faces of the magneto case halves failed to identify the location of water ingress. Removal of the distributor gear revealed evidence of arcing damage to the number four cylinder contactor and the presence of a layer of oxide on the contactor. The copper outlet tab on the magneto coil was coated in a layer of oxide and a depression had formed in the middle of the tab (Figure 3).

Measurement confirmed that the depression had been formed as a result of a loss of material from the tab. The carbon brush in the distributor gear was measured and found to be 10.7 mm long (the minimum permitted length is 9.53 mm), but the surface of the brush that touched the magneto coil tab was pockmarked as if material had been plucked from its surface. The formation of oxide on the conducting surfaces would have resulted in an increase in the electrical resistance and also accelerated the rate of wear of the components. The damage to the number four cylinder contactor confirmed that arcing had occurred between the

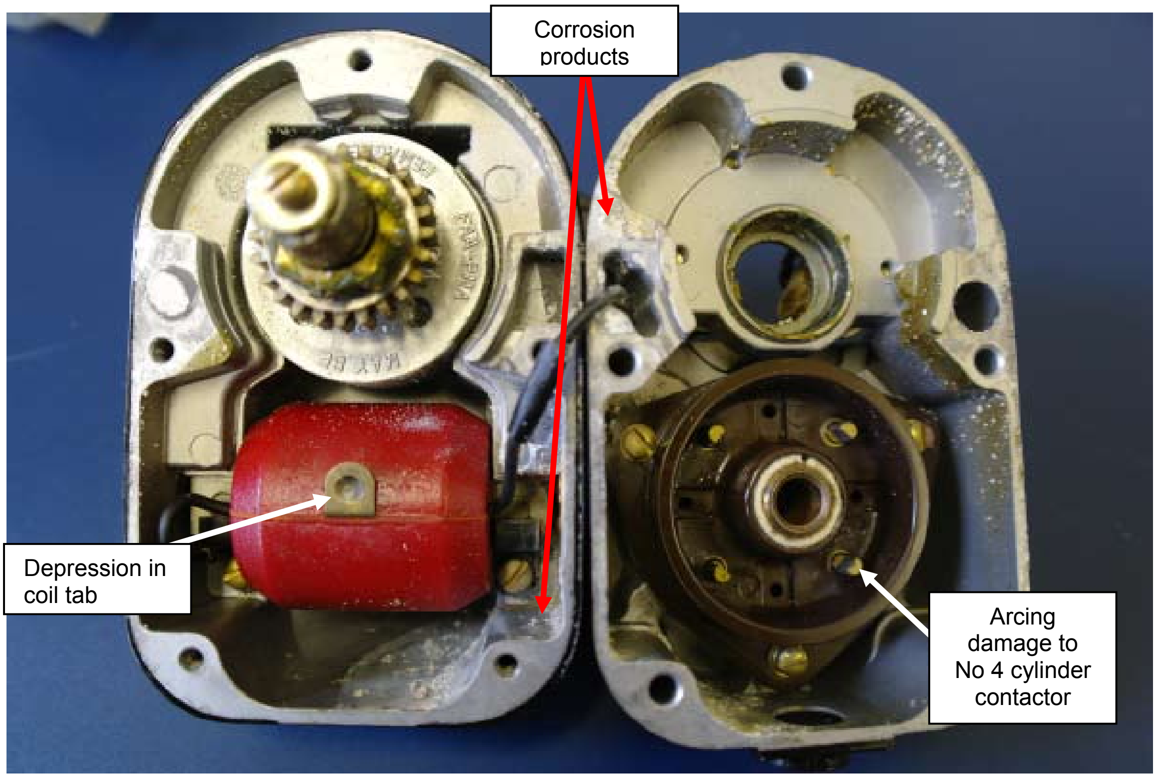

Figure 3

Left magneto showing corrosion and contactor damage

distributor gear and the contactor. Such arcing would have the effect of delaying the generation of a spark from the number four cylinder spark plug connected to the left magneto. This delay would change the speed of combustion within the cylinder resulting in burning fuel passing out of the exhaust valve and an engine misfire.

Previous events

In February 2009 the AAIB investigated a fatal accident to a Robinson R22, registration G-TTHC (AAIB report number EW/C2009/02/04). The investigation identified one of the contributory factors to be the failure of the left magneto due to the failure of the magneto coil tab. Whilst the left magneto fitted to G-RIDL had not failed completely, the abnormalities observed showed significant similarities to the failure mechanism observed on G-TTHC.

Medical aspects

The pilot had a medical history which he had not declared to the CAA and which would have been at least temporarily disqualifying. Post-mortem toxicology tests also revealed that he had been flying whilst taking undeclared medication capable of producing a range of side effects of significance when flying an aircraft.

Analysis

The damage to the helicopter and distribution of the wreckage indicated that the helicopter had first struck the ground in a tail-down attitude, close to the top of a slope in the field, causing the tail rotor blades to fail. The tail-down attitude and the damage to the tail rotor blades indicate that there was sufficient main rotor rpm to maintain pitch control of the helicopter at impact. The failure of the tail rotor blades would have resulted in a loss of directional control of the helicopter in the final stages of the landing, resulting in an accident sequence sufficiently severe to cause fatal injuries to the pilot.

The ground markings indicated that when it struck the ground, the helicopter was travelling on a track of 147º(M), although no accurate estimate of its forward speed could be made. There was no evidence of any pre-impact damage or restriction to the flying controls, nor any evidence of a pre-impact defect within the main rotor drive system.

Tests identified that the engine was capable of generating its maximum rated power despite the number four cylinder misfiring intermittently at high power settings. The misfire, caused by the defect within the left magneto, could have resulted in an increase in engine vibration and noise. The presence of moisture in the magneto would have accelerated the formation of oxides on the electrical contacts within the magneto, resulting in a deterioration in its performance. Whilst the method of moisture ingress could not be identified, the exposure of the helicopter to the elements, whilst parked outside, may have been a contributory factor.

Given the prevailing weather conditions, it is possible that the engine had suffered carburettor icing. The carburettor heat control was found in the OFF position, although it remains possible that this had been moved inadvertently during the rescue attempts. However, witness observations, indications of the powered state of the rotors at impact, and the condition of the left magneto makes it seem more likely that the helicopter was operating normally during most of the flight, but that the problem with the left magneto had then manifested itself to the pilot. A transient loss of engine power could account for the rocking of the helicopter and the yaw to the left observed by one of the witnesses.

The pilot was aware of the issue with the clutch warning light and of Robinson Helicopter Safety Notice SN-2B, with its requirement to carry out a precautionary landing without delay, should a bearing or vee-belt failure be suspected. The investigation revealed no fault with the clutch mechanism, vee-belts or drive bearings, nor could it determine the cause of the flickering warning light. It is considered, however, that the pilot might have incorrectly associated the symptoms of the failing magneto with the clutch warning light issue. Whether or not this is the case, it is believed that the increase in engine vibration and noise due to the deterioration of the left magneto could have caused the pilot to attempt a precautionary landing.

In attempting to land, the pilot was either unaware of the downslope of the field, or was flying at a speed which required a sufficiently large pitch-up to slow down, that the tail struck the ground. This situation might have been exacerbated by the proximity of the electricity pylons ahead. The pilot's lack of recent flying experience, and possible physiological effects due to his medical condition and medication, might also have affected his handling abilities at the time.

ACCIDENT

Aircraft Type and Registration:	Robinson R22 Beta, G-NWDC
No & Type of Engines:	1 Lycoming O-360-J2A piston engine
Year of Manufacture:	2005
Date & Time (UTC):	8 August 2010 at 1550 hrs
Location:	Londonderry Eglinton Airfield, Co Londonderry
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Landing gear, tail boom and rotor blades
Commander's Licence:	Student
Commander's Age:	51 years
Commander's Flying Experience:	82 hours (of which 82 were on type) Last 90 days - 4 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Following a satisfactory dual circuit, and after checking that the student pilot was happy to continue with a solo exercise, the instructor vacated the helicopter. The student then performed two takeoffs and landings on the spot, before hover taxiing to a practice area on the other side of the main runway. Whilst turning into wind, the left skid unexpectedly touched the ground, destabilising the helicopter. The student was unable to maintain control and the helicopter then struck the ground, rolled on to its side and was substantially damaged. The student sustained only minor injuries.

He candidly commented that, during the debrief with the instructor, they identified that the initial ground contact may have been due to hovering at too low a height and/or allowing the helicopter to sink slightly due to insufficient power being applied during the left pedal turn into wind.

ACCIDENT

Aircraft Type and Registration:	Schweizer 269C-1, G-LINX
No & Type of Engines:	1 Lycoming HIO-360-G1A piston engine
Year of Manufacture:	2006
Date & Time (UTC):	22 September 2009 at 1103 hrs
Location:	East bank of River Wyre, near Stalmine, Lancashire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Fatal) Passengers - 1 (Fatal)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	38 years
Commander's Flying Experience:	1,524 hours (of which 894 were on type) Last 90 days - 59 hours Last 28 days - 12 hours
Information Source:	AAIB Field Investigation

Synopsis

The helicopter, which was on a training flight, suffered an in-flight emergency and subsequently crashed, fatally injuring both occupants. Examination of the wreckage revealed that the main rotor was turning at low speed on impact, but the reason for this could not be established. The investigation concluded that the most likely cause of the accident was a loss of control during an attempted forced landing downwind. The helicopter was being flown at 400 ft immediately prior to the emergency, which would have reduced the probability of a successful outcome.

One Safety Recommendation is made as a result of this investigation.

History of the flight

The helicopter took off from Blackpool Airport at 1042 hrs with a student and instructor aboard. The purpose of the flight was not recorded but the student had flown with the instructor on several previous occasions in the course of his training for a Private Pilot's Licence (PPL). The helicopter departed to the west before turning north to follow the Blackpool coastline and climbed to approximately 1,400 ft. On passing Bispham, about 2 nm north of Blackpool Tower, it turned towards the town of Knott End-on-Sea.

A witness in Blackpool reported that, shortly before 1100 hrs, he saw a helicopter similar in appearance to G-LINX flying inland to the north of the town at a height of approximately 1,500 ft. He stated that the helicopter appeared to emit five or six "puffs of black smoke", then flew on without further incident until out of his view. There were no other reports of this event.

At 1050 hrs, the helicopter crossed the coast at Knott End-on-Sea and commenced a descending left turn onto a westerly heading. A witness in Knott End watched as it operated above the sands approximately 1 nm north of the coast, manoeuvring for several minutes as though in a right hand circuit. He saw it twice climb to a height of a few hundred feet before descending again to a height consistent with having either landed or entered a low-level hover. At 1100 hrs, the helicopter flew south towards the mouth of the River Wyre, initially at about 200 ft, before climbing to approximately 400 ft as it passed south-west of Knott End, behind buildings and out of view of the witness. It then continued along the east bank of the river.

At 1102:23 hrs the Blackpool Approach controller (APC) received a MAYDAY transmission, later identified as spoken by the instructor, which included the aircraft call sign, its approximate location and the word "FAILURE". The APC acknowledged the call and requested further details. He received a further transmission from the helicopter at 1102:31 hrs, consisting mainly of background noise, which did not contain any verbal clarification of the nature of the emergency.

At 1104 hrs, after several unsuccessful attempts to contact the helicopter, the APC initiated emergency procedures. Several agencies joined the search for G-LINX, which was located by a police air support helicopter at 1152 hrs. Both occupants of G-LINX had received fatal injuries.

Meteorological information

When issuing taxi instructions to G-LINX at 1037 hrs, the aerodrome controller reported that the wind was from 270° at 15 kt, gusting to 26 kt. Meteorological conditions reported at Blackpool Airport at 1050 hrs included: surface wind from 260° at 20 kt, visibility of 10 km or more and scattered cloud with a base at 2,000 ft. The air temperature was 16°C and dew point 11°C. A further report at 1120 hrs indicated that conditions had not changed significantly.

Recorded Information

Accident protected flight data recorders

G-LINX was not equipped with an accident-protected data or voice recorder, nor was it required to be.

Radar information

Recorded radar information was available from two radar sites, located at Great Dunn Fell and St Annes. St Annes radar is located approximately 8 nm south of the accident site and Great Dunn Fell approximately 50 nm to the north-east. Primary and secondary radar information was recorded approximately once every four seconds by the radar at St Annes and approximately once every eight seconds by the radar at Great Dunn Fell. Both radars recorded G-LINX manoeuvring in the vicinity of Knott End-on-Sea before tracking south to follow the River Wyre. About 1.5 nm south of Knott End, 1.2 nm west of the village of Stalmine, it altered track towards the east and descended, disappearing from radar shortly thereafter. The final radar positions were within 45 metres of the accident site. Figure 1 shows the helicopter's radar track.

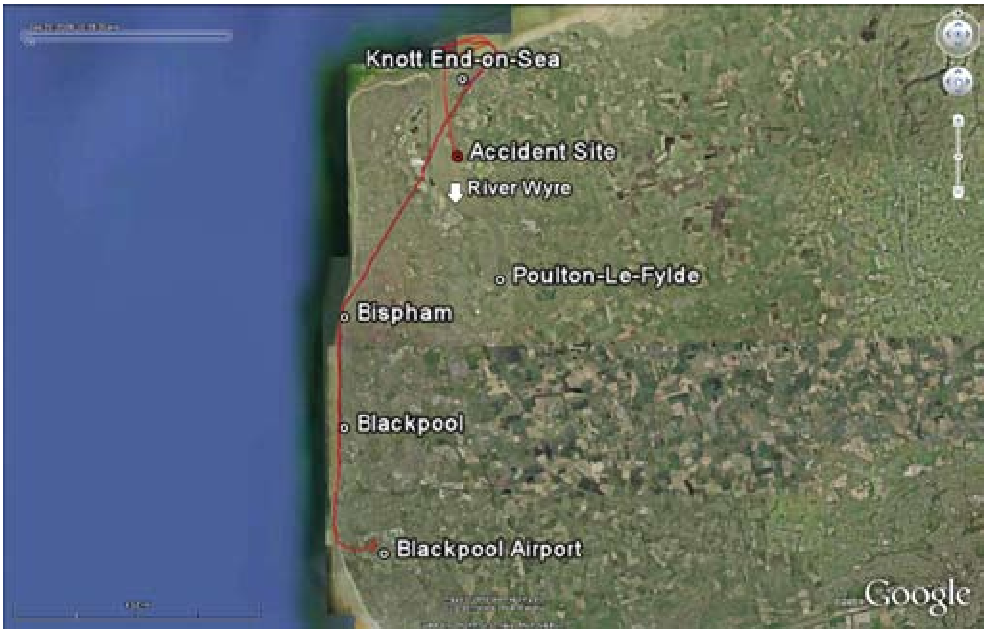

Figure 1

G-LINX –Radar track

Transponder[1] Mode A and Mode C information was available for most of the flight. Analysis of the departure from Blackpool Airport indicated that the transponder altitude was within approximately +/- 50 ft of the aircraft's actual altitude.

The helicopter was also equipped with a Garmin GNS 430 combined GPS, navigation and VHF communications unit. The final GPS position recovered from the unit coincided with the accident site, indicating that the unit was electrically powered at the time of impact. The VHF communication frequency was tuned to the Blackpool Approach frequency, with Blackpool Tower set as the standby frequency. No GPS routes had been activated and the unit did not record the helicopter's GPS track.

Footnote

[1] When interrogated by ATC radar, the transponder transmits data which can be decoded by ATC radar to display specific information on the aircraft, including a four-digit identity code and its altitude, on the radar screen. Pressure altitude is based upon the International Standard Atmosphere (ISA), which assumes a barometric pressure of 1013.25 millibars at sea level. Mode C (altitude) information transmitted by the transponder is quantized to the nearest 100 ft increment.

Interpretation

All altitudes are above mean sea level unless stated otherwise.

During the flight along the Blackpool coastline, the average ground speed was 65 kt, and from Bispham to Knott End it was 80 kt. Allowing for the winds as reported at Blackpool Airport, the average airspeed during the flight from Blackpool Airport to Knott End would have been approximately 70 kt, which is consistent with normal operation of the helicopter.

At 1050 hrs, the helicopter approached the coastline near Knott End. From a height of about 1,400 ft it made a descending left turn onto a westerly track, heading into wind. Its descent stabilised at about 975 ft/min +/- 75 ft/min at an average ground speed of 35 kt. About 0.5 nm north of the coastline, above an area of sand exposed at low tide, the helicopter descended to a height consistent with either touching down or flying at low level. During the next eight minutes, it flew in a predominantly right-hand circuit direction, at heights not above about 400 ft. During this period the helicopter climbed and descended twice (Figures 2 and 3). Both descents occurred whilst heading into wind. During the first descent, the average descent rate was 1,570 ft/min +/- 786 ft/min and the second was 1,570 ft/min +/- 524 ft/min. The average ground speeds during both descents were similar, at about 35 kt, giving an airspeed of approximately 50 to 55 kt in the prevailing conditions.

At 1100:25 hrs, G-LINX routed to the south, tracking along the east bank of the River Wyre. Initially flying at about 200 ft, it then climbed to about 400 ft as it passed to the south-west of Knott End. Approximately one third of a mile from the accident position there was a momentary 100 ft increase in transponder altitude, indicating that G-LINX was at about 430 ft. The ground speed remained stable at about 60 kt after departing the area near Knott End (Figures 4, 5 and 6).

At 1102:23 hrs, the instructor transmitted a MAYDAY on the Blackpool Approach frequency. At that moment the helicopter was at a height of approximately[2] 280 ft +/- 50 ft, and its average ground speed had reduced from 60 kt to 45 kt. During the next 13 seconds, its ground speed stabilised at about 30 kt and the helicopter altered track to the east and descended. It was then approximately 0.5 nm east of the west (upwind) bank of the River Wyre. The final radar point, recorded at 1102:36 hrs, indicated the helicopter was at a height of about 180 ft +/- 50 ft. The average descent rate during the final nine seconds of data was 1,311 ft/min +/- 656 ft/min.

Figure 2

G-LINX - Flight in the vicinity of Knott End-on-Sea

Footnote

[2] The nominal alignment error between the radar and RTF information was +/- one second.

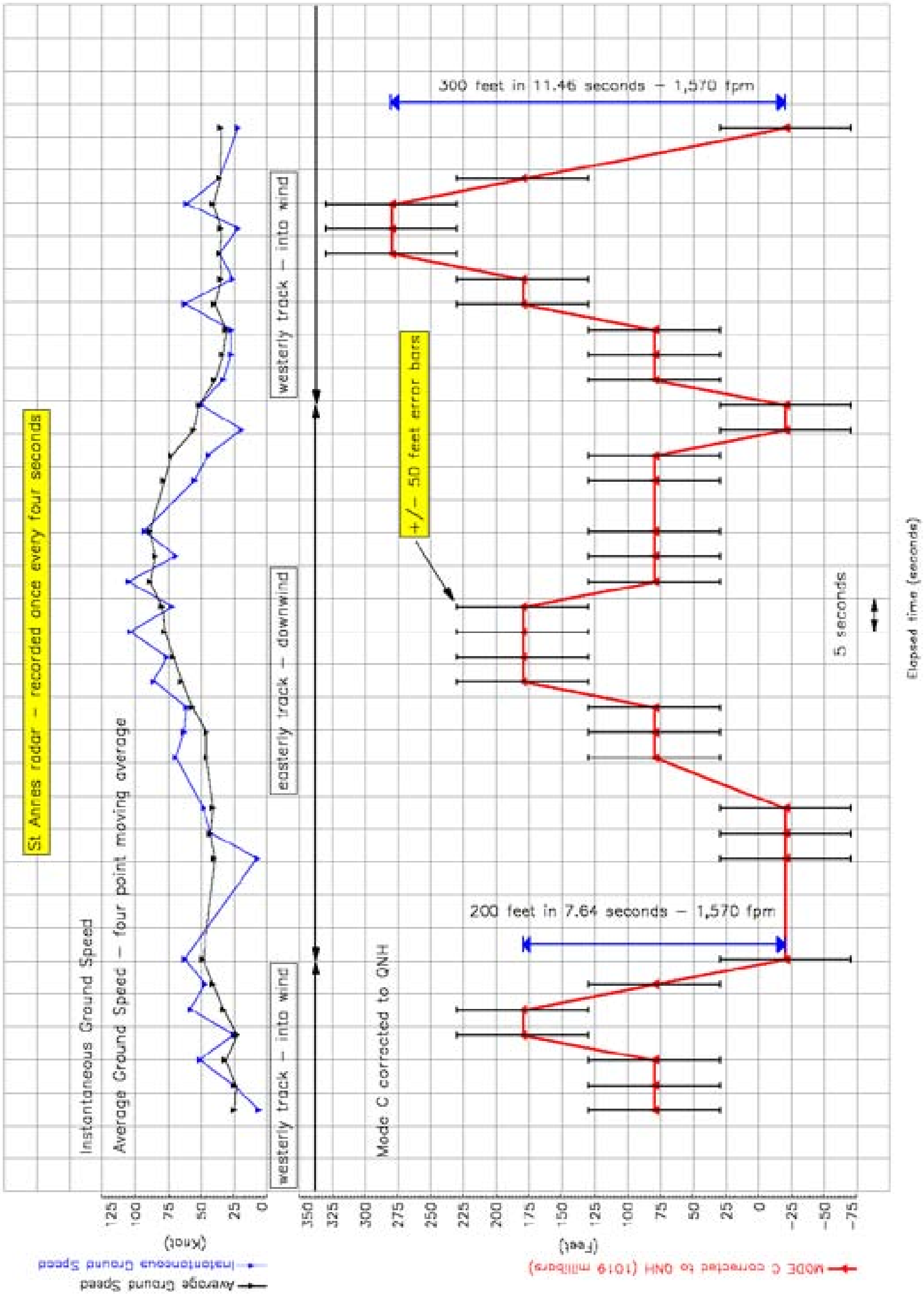

Figure 3

G-LINX - Flight in the vicinity of Knott End-on-Sea

Figure 4

G-LINX - Flight from Knott End-on-Sea

Radio Telephony (RTF)

Five radio transmissions from G-LINX were recorded on the Blackpool Radar frequency. Three were made in short succession at 1042 hrs, as the aircraft climbed through 780 ft on departure from Blackpool Airport. The final two transmissions were made 20 minutes later, at 1102:23 hrs and 1102:31 hrs. The first of these was a MAYDAY, followed by an open microphone transmission. Both lasted about three and a half seconds and were separated by an ATC acknowledgement lasting four and a half seconds. During the MAYDAY transmission, the instructor is believed to have said "FAILURE", but it could not be determined if he was referring to a component or system on the aircraft. A family member who assisted with interpretation of the transmission commented that the instructor sounded calm and that his voice held no sense of panic during the MAYDAY call.

Frequency spectral analysis of the first three radio transmissions identified the presence of sounds generated by the rotation of the main rotor gearbox and the main rotor. Sounds generated by the operation of the engine could not be identified. However, mathematical correlation with the rotational speed of the main rotor gearbox, which is driven by the engine, indicated that the engine was operating at about 2,515 rpm at the time of the radio transmissions.

Analysis of the MAYDAY call identified that during the final second of the transmission, the rotational speed of the main rotor gearbox was reducing. This reduction equated to a main rotor speed of approximately

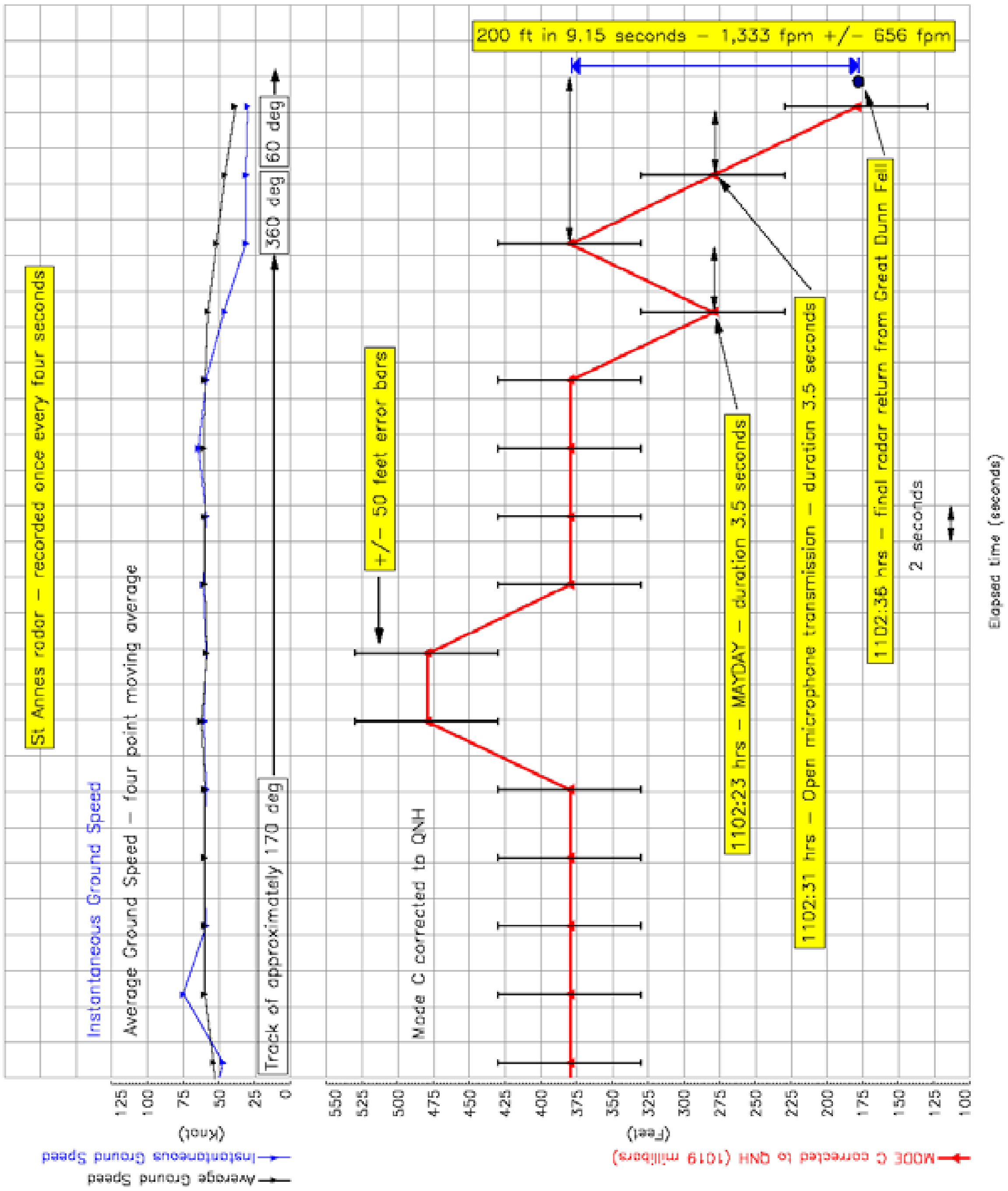

Figure 5

G-LINX - Flight from Knott End-on-Sea

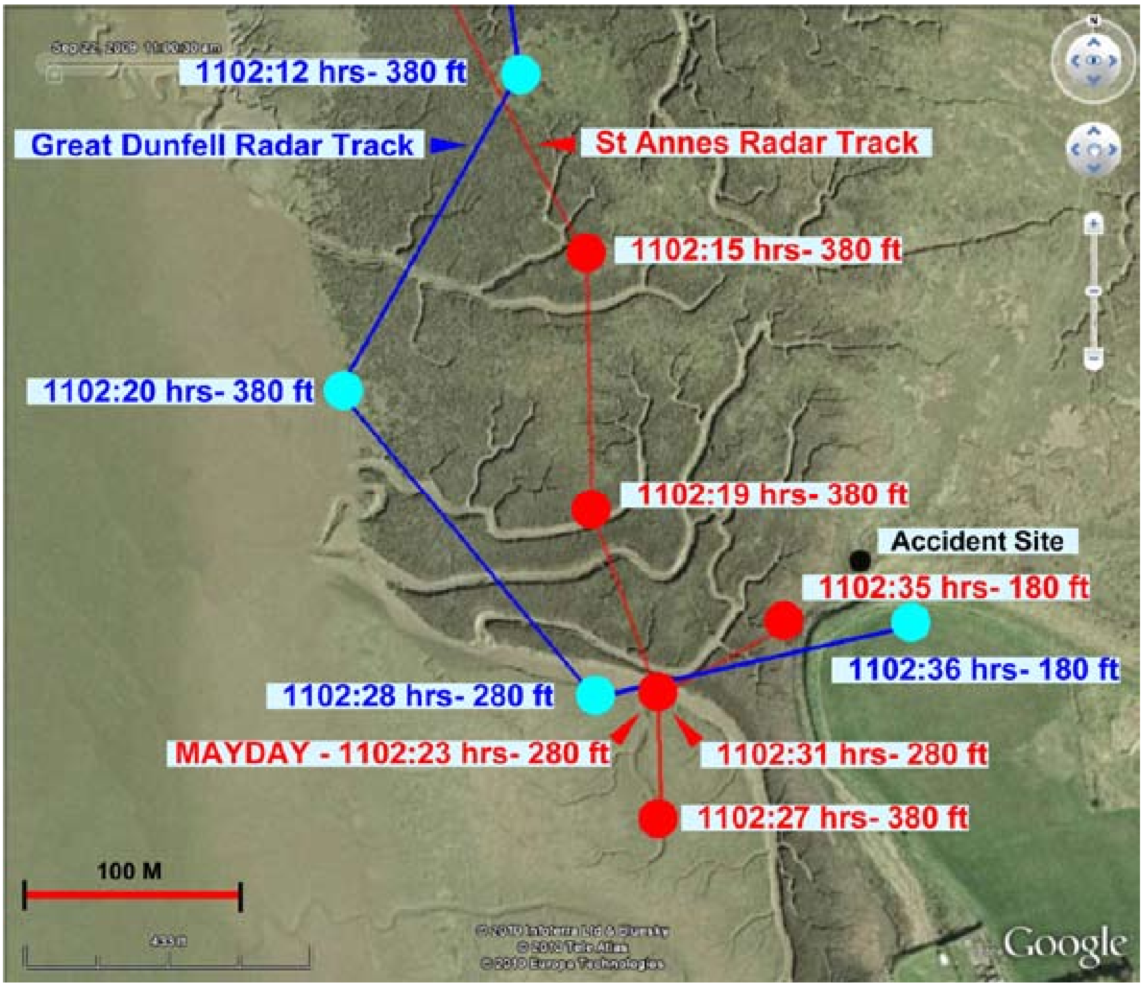

Figure 6

G-LINX – Final radar positions

445 rpm, reducing to 438 rpm. As with the first three transmissions, engine-related sounds could not be identified.

During the final open-microphone transmission, a steady 3,063 Hz tone was recorded; this was determined to be the main rotor low speed audible warning. The helicopter manufacturer stated that no other systems would produce an audible tone of similar frequency. This tone was not present in the four previous transmissions. The tone was recorded throughout the duration of the final transmission, and was of sufficient amplitude to be heard above the background noise.

During the later stages of the final transmission, a rhythmic pulsing sound was identified. Although the source of the sound could not be established, had the sound originated from the rotation of the main rotor blades, it would be indicative of a main rotor speed of about 340 rpm, some 50 rpm below the activation point of the main rotor low speed warning system.

RTF tests at Blackpool Airport

A series of audio tests were conducted at Blackpool Airport using a helicopter of the same type, and having the same model of headsets and VHF communication equipment as G-LINX. It was established that whilst in the cruise, at engine speeds of about 2,600 rpm and above, sounds generated by the operation of the engine could be recorded by the RTF system at Blackpool Airport. At an engine speed of 2,530 rpm, (similar to that at the time of the first three radio transmissions from G-LINX) sounds generated by the engine could not be detected in the recording. Two practice autorotations were also carried out, with the engine speed set to about 1,500 rpm. Analysis of the recordings could not detect any sounds generated by the engine.

Previous flights

The instructor flew G-LINX on 14 occasions between 23 July 2009 and 20 September 2009. Radar data indicated that six of the flights had been circuits flown within the Blackpool aerodrome traffic zone and eight were local flights, departing and returning to Blackpool Airport. All but one of the local flights operated to the north of Blackpool Airport. Transponder Mode A information was available for all the flights, but only four - all local - contained Mode C altitude information: two flights on 23 July 2009, one flight on 24 July 2009 and one flight on 20 September 2009.

Each of the four flights containing Mode C altitude information included descents consistent with carrying out practice autorotations. During the flights on 23 July 2009 and 24 July 2009, the helicopter descended from 1,500 ft to about 500 ft before climbing. On the 20 September 2009, the practice autorotation continued to a landing or low-level hover above a field. Radar information indicates that G-LINX then tracked slowly across the field for about two minutes, before climbing to 1,600 ft. The field itself was situated near to the east bank of the River Wyre, just over 0.5 nm south of the accident location.

The four flights for which altitude information was available provided no evidence of G-LINX having been flown consistently at heights similar to those during the latter stages of the accident flight, except during takeoff, landing or the aforementioned practice autorotations.

Medical and pathological information

A post-mortem examination, conducted by an aviation pathologist, revealed that both occupants had died immediately of severe injuries sustained in the accident. There was no evidence of pre-existing medical conditions that could have caused or contributed to the accident and toxicology revealed no evidence of drugs or alcohol.

Autorotation

Autorotation in helicopters is said to occur when the main rotor is turned by the action of airflow rather than engine power and is the means by which a helicopter can be landed safely in the event of an engine failure[3]. The rate of descent in an autorotation is affected by forward airspeed. In the Schweizer 269C-1 it is relatively high at zero airspeed, reducing to a minimum at approximately 50 to 60 kt and increasing again as airspeed increases. The speed specified by a manufacturer for conducting the manoeuvre is usually chosen to give the best combination of minimum rate of descent and most shallow glide angle. Accordingly, the absolute minimum rate of descent may be achieved at a slightly slower airspeed than that specified but any further decrease in airspeed will result in an increased rate of descent.

When landing, the rotational energy stored in the main rotor is converted into thrust to decrease the

Footnote

3 U.S Department of transportation, *'Rotor Flying Handbook'*, 2000, p.30.

rate of descent and achieve a soft landing. More energy is required to decrease a high rate of descent. Consequently, descents at very low or very high airspeeds are more critical than those performed at the airspeed giving the minimum rate of descent, because the rotor may have insufficient stored energy to reduce the resulting high rate of descent before landing.

The stabilised rate of descent in a typical practice autorotation is between approximately 1,500 and 2,000 ft/min. The average rate for the whole manoeuvre from initiation in level flight to recovery is lower depending on the duration of the manoeuvre, because it includes a period at the start of the manoeuvre during which the rate of descent increases from approximately zero.

Effects of controls

Collective

Lowering the collective lever reduces the pitch of all the main rotor blades. Following an engine failure this will result in a descent and an upward flow of air that can produce sufficient thrust to maintain main rotor rpm for autorotation. Conversely, raising the lever increases the pitch of all the main rotor blades. To a certain extent this will increase the lift of the main rotor but in the absence of engine power will also result in a reduction of main rotor rpm. It is therefore important not to raise the lever to such an extent that the rpm falls below the normal operating range until a safe landing is assured. Given sufficient height it may be possible to increase rpm by lowering the collective again but this will result in an increased rate of descent.

Cyclic

The cyclic control changes the pitch of each main rotor blade according to its position in the rotor cycle and, all else being equal, results in the rotor disc tilting in the direction of the control input. Forward movement of the cyclic control will, in the absence of other influences, tend to tilt the disc forwards, resulting in the nose of the aircraft pitching down and an increase in forward airspeed. Likewise, aft movement of the cyclic will tend to raise the nose and reduce forward airspeed. During an autorotation a descent of several hundred feet may be required before a forward cyclic input will result in a significant increase in airspeed.

Procedures

The Pilot's Flight Manual contains *'emergency and malfunction procedures'*. The first five items of the procedure entitled *'Engine failure – altitude above 450 feet*' are as follows:

'1. Lower collective pitch.

2. Enter normal autorotation.

3. Establish a steady glide of 52 kt (60 mph) IAS approximately.

4. At an altitude[4] of approximately 50 feet, initiate a flare.

5. At approximately 10 feet, coordinate collective pitch with forward movement of cyclic stick to level aircraft and cushion landing. Make ground contact with aircraft level.'

The procedure entitled *'Engine failure – altitude above 7 feet and below 450 feet'* states:

'In the event of power failure during takeoff, lower the collective pitch (altitude permitting), in order to maintain rotor speed. The amount

Footnote

4 Strictly, the word "altitude" indicates height above sea level, but in this context is understood to mean height above ground level.

> *and duration of collective reduction depends upon the height above ground at which the engine failure occurs. As the ground is approached, use aft cyclic and collective as needed to decrease forward speed and vertical velocity.'*

Training

The requirements for the licensing of helicopter pilots are set out in the Joint Aviation Requirements Flight crew licensing (Helicopter), known as JAR-FCL 2. Appendix 1 to JAR-FCL 2.125 – *'PPL(H) training course – Summary'* states that the PPL(H) flight instruction syllabus shall cover, among other items, emergency procedures, basic autorotations and simulated engine failure.

Appendix 1 to JAR-FCL 2.320D – *'Flight Instructor rating (Helicopter) (FI(H)) course'* states the following course objective:

> *'The aim of the FI(H) course is to train helicopter licence holders to the level of proficiency necessary for the issue of a FI(H) rating and, for that purpose, to:*
>
> *a. refresh and bring up to date the technical knowledge of the student instructor;*
>
> *b. train the student instructor to teach the ground subjects and air exercises;*
>
> *c. ensure that the student instructor's flying is of a sufficiently high standard; and*
>
> *d. teach the student instructor the principles of basic instruction and to apply them at the PPL level.'*

The United Kingdom CAA no longer produces formal guidance on the conduct of this training but conventions remain based on the withdrawn document Civil Aviation Publication (CAP) 421 – *'Basic flying instructor (helicopter) handbook'*, which previously served this purpose. In particular, instructors are usually taught that when conducting a practice autorotation or engine-off landing the aircraft should be positioned into wind at the correct speed no lower than 300 ft agl.

During the investigation the AAIB consulted several instructors, the CAA Flight Operations Inspectorate and Staff Flight Examiners. All commented that, whilst a successful downwind landing is possible in favourable circumstances, it is always preferable to land into wind, especially in the event of engine failure. To do so requires sufficient height to reposition the helicopter if it is not already heading into wind and the existence of suitable terrain in the landing direction. If forced to land downwind a pilot would be presented with an unfamiliar situation and might be tempted to reduce the high apparent ground speed by applying aft cyclic control. This could result in an airspeed below that for minimum rate of descent.

The instructor who operated the registered facility from which the flight originated commented that when flying along the River Wyre he would do so approximately half a mile east of the high tide line to allow sufficient space for a dry landing into wind in the event of an engine failure. In common with the other instructors consulted, he stated that a practice autorotation would not normally be initiated below 1,500 ft. To do so would limit its training value by providing insufficient opportunity to explore the manoeuvre, whilst reducing the margin for correcting errors.

When conducting a practice autorotation the normal procedure is to lower the collective lever fully whilst closing the throttle progressively to avoid excessive engine speed. It is not necessary to close the throttle abruptly but instructors commented that students sometimes did so and that on occasion this had resulted in the engine stopping.

Organisational information

In the UK, training for the issue of a PPL is conducted at Registered Training Facilities (RF). RFs are required to register with the CAA and to certify that they comply with certain required conditions but no approval is required. No inspections are carried out, no training or operations manuals are required and it is not necessary for the RF to maintain formal training records, although some choose to do so. Registration remains valid until either the CAA is informed that PPL training is to cease or the CAA establishes that training is not being carried out safely or is not in compliance with JAR-FCL[5]. The AAIB explored the potential disadvantages of this system and made recommendations intended to improve oversight in its report of the accident on 26 January 2008 to Gazelle helicopter YU-HEW[6].

The RF from which the accident flight originated did not have training or operating manuals and did not maintain formal training records for each of its students. Consequently it was not possible to determine the minimum height at which its instructors were expected to operate the aircraft in cruising flight or when initiating practice autorotations.

Aircraft information

G-LINX (Figure 7) was type certified as a 'Model 269C-1', but its commercial designation was 'Schweizer 300CBi'. The helicopter type is a development of the Hughes 300C. G-LINX was manufactured in 2006 and the airframe and engine had accumulated 307 hours at the time of the accident. The helicopter was powered by a fuel-injected Lycoming HIO-360-G1A piston engine which drove the main rotor gearbox and tail rotor driveshaft via a belt-drive transmission assembly. It had a three-bladed, fully articulated, main rotor and a two-bladed tail rotor. The helicopter's flight controls were mechanically actuated via a series of tubular push-pull rods and cables, without any hydraulic assistance. The helicopter was fitted with two seats and dual flying controls and had a maximum takeoff weight of 794 kg.

Figure 7

Accident aircraft, G-LINX

(photo courtesy CAA website G-INFO)

The helicopter was equipped with the optional AES/STAR system (Automatic Engagement System/Startup RPM Limiter/Rotor Low RPM Warning Installation). The low rotor rpm warning part of this system includes a red light on the instrument panel and a horn. If the rotor rpm drops below the minimum normal operating range of 442 rpm (equivalent to 2,530 engine rpm when the engine is engaged to the rotor) the red light flashes

Footnote

5 Joint Aviation Requirements – flight crew licensing.

6 Published in the AAIB Bulletin 11/2009.

and the horn emits a pulsing tone at 2,900 ± 500 Hz. If the rotor rpm drops below 390 rpm (the minimum safe autorotation rpm) the red light indicates steady ON and the horn emits a steady 2,900 ± 500 Hz tone.

Maintenance history

The helicopter was maintained by an EASA Part-145 approved maintenance organisation. Its last annual maintenance inspection was completed on 21 July 2009 when the helicopter had accumulated 289 flight hours (18 hours prior to the accident). The annual inspection included work on the main rotor and tail rotor drive systems and was, therefore, followed by an air test. The helicopter's last maintenance input before the accident was a main rotor mast torque check on 11 September 2009 at 305 flight hours. There were no open deferred defects recorded in the technical log. There were no entries in any of the maintenance worksheets of an adjustment having been made to the engine's idle rpm setting or idle mixture setting.

Accident site and initial wreckage examination

The helicopter had struck the ground on the eastern bank of the River Wyre, 1.2 nm west of Stalmine. It was located in a grassy area of soft ground that sometimes floods at high tide. On the day of the accident the high tide occurred at 1320 hrs (UTC) at which time the river came to within a few metres of the wreckage but did not reach it. The evidence at the accident site indicated that the helicopter had hit the ground with a high vertical speed and a very low foward speed, on a heading of approximiately 173°(M). There was a very limited spread of wreckage, mostly consisting of broken pieces of perspex, in the direction of 107°(M) (Figure 8), which indicated that the helicopter had some sideways travel to the left at the time of impact. The furthest piece of wreckage, a piece of perspex, was located 16 m east of the main wreckage. The left skid had broken, the right skid had splayed outwards and both seat pans had been crushed, indicating that the helicopter had not initially struck the ground on its left side, but that it had rolled onto its left side after impact in a moderate left bank.

The three main rotor blades were intact with no damage to their leading edges, trailing edges or tips, indicating that they had little rotational energy at impact. One rotor blade was bent upwards, one was bent downwards, and the third had multiple bends and wrinkles from impact with the ground. Chordwise mud splatter on the tips of the blades indicated that some rotation was present at impact. The tail rotor gearbox had remained attached to the tail boom and both tail rotor blades were attached to the gearbox. One tail rotor blade was undamaged, and the other, which was buried, had a damaged tip. The

Figure 8

Accident site - parts of the cabin structure have been removed and the green tarpaulin was placed on the ground after the accident horizontal stabiliser was undamaged. The tail boom had bent and split about 70 cm forward of the tail rotor gearbox, and the tail rotor driveshaft had sheared at the same location, although it did not exhibit evidence of a high-energy torsional failure. The eight transmission drive-belts were intact, although they had lost their tension as a result of failure of the H-frame supporting the upper and lower pulleys.

Detailed wreckage examination

Flying controls

The cable control between the tail rotor and the pedals was continuous. The cyclic pitch and roll, and collective controls to the main rotor head were continuous apart from some control rod overload failures beneath the cockpit floor.

Rotary drive components

The main rotor gearbox was driven by the engine through a transmission assembly consisting of a lower pulley attached to the engine driveshaft and an upper pulley attached to the main rotor gearbox input drive shaft (Figure 9). The lower pulley directed power to the upper pulley through a set of eight drive-belts. An 'idler' pulley, running against the belts, and actuated electrically by the pilot, operated as a clutch to engage the upper pulley after engine start. The tail rotor driveshaft was driven directly by the upper pulley. The upper pulley incorporated an over-running clutch (freewheel unit) to permit the main rotor to autorotate without back-driving the belts or engine, in the event of an engine failure. Examination of the main rotor head, main rotor driveshaft, main rotor gearbox, upper pulley, tail rotor driveshaft and tail rotor gearbox revealed that they were all free to rotate. The over-running clutch was also found to be operational. The lower pulley was connected to the engine driveshaft, and once the driveshaft was disconnected the lower pulley rotated freely on its bearing. The eight belts were intact and in good condition, but tension had been lost as a result of overload failure of the H-frame between the upper and lower pulleys. Failure of this H-frame was consistent with the high vertical loads experienced at impact. The linear actuator which drove the 'idler' pulley was measured to be in the fully retracted position, corresponding to full belt tension having been applied. The main rotor gearbox and tail rotor gearbox chip detectors were found to be clean.

Fuel system

The single fuel tank (32.5 USG usable capacity) on the aircraft was found to be intact and contained 11.7 USG of fuel. Fuel samples taken from the fuel tank and the fuel lines were tested and found to conform with

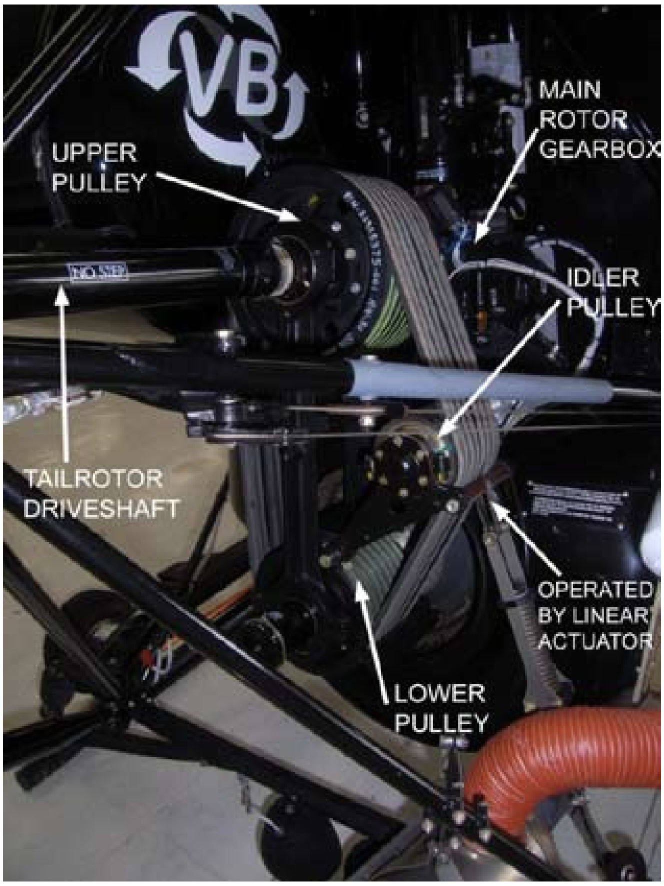

Figure 9

Schweizer 269C-1 transmission assembly

the properties of Avgas 100LL with no evidence of contamination. The fuel tank breather tube was clear. The pilot-controllable fuel shutoff valve, located near the outlet of the fuel tank, was found in the ON position. The fuel lines were continuous between the fuel tank and the engine apart from a separation at the outlet of the fuel strainer. The hose between the outlet of the fuel strainer and the engine-driven fuel pump had separated at the strainer fitting end, but this appeared to be the result of impact damage to the fitting. Residual fuel was found throughout the system, including in the fuel strainer, the engine-driven fuel pump and the fuel injector servo. The electric fuel boost pump motor was tested with a 24 VDC power supply and operated normally, and the pump was stripped with no defects found. The engine-driven fuel pump was also stripped with no defects found.

Instruments and switches

The lower portion of the instrument panel was severely disrupted which rendered the position of unguarded switches unreliable. The guarded clutch switch was in the normal ENGAGE position. The magneto switch was in the BOTH position but the key had broken off. The fuel mixture control lever was found in the normal 'full rich' position, but bent almost 90°. There were no witness marks on the faces of the flight or engine instruments that might have given an indication of a pre-impact reading. The altimeter was found set to a QNH of 1019 mb. The filaments from the warning and caution bulbs were examined for indications of stretch that might indicate a hot/illuminated bulb at impact, but none of the filaments had stretched or broken.

Air intake

The engine air intake duct, at the front of the helicopter beneath the cockpit floor, was crushed. The intake duct was cut open and the air filter was found to be clear with no evidence of obstructions within the intake system.

Engine examination

The throttle and mixture controls to the fuel injector servo on the engine were continuous apart from some overload failures within the throttle linkages. The engine was removed from the aircraft for a strip examination. The engine had suffered some impact damage to its exhaust pipes and intake manifold pipes, which were attached to the base of the engine, but the engine was otherwise intact. When the spark plugs were removed the engine could be rotated freely by turning the fan attached to the crankshaft. A complete teardown of the engine cylinders and crankcase did not reveal any mechanical failures or defects, or any evidence of heat distress. All the cylinder bores, pistons and piston rings were in good condition, although oil had collected inside cylinder No 1 and No 3 (the left side of the engine[7]), probably due to the engine's orientation at the accident site. The spark plugs were in good condition apart from oil deposits on the lower plugs from cylinders No 1 and No 3. The components of the oil scavenge pump were in good condition and the oil filter was clear.

The fuel injector lines were all connected and free of internal obstructions, and a flow test of the fuel injector nozzles found them to be operating within specification. The engine-driven fuel pump was intact and ejected some fuel during removal. The fuel injector servo was bench tested after cleaning its venturi assembly which had ingested some mud. The fuel injector servo passed the flowmeter limit specifications, except for the fuel

Footnote

7 Compared to a fixed wing aircraft with a tractor-propeller configuration, the engine on the Schweizer 269C-1 is mounted backwards, so the No 1 and No 3 cylinders are on the aircraft's left side.

flow measurement with 0 lb/hr airflow and the mixture control set to RICH. During this test a fuel flow rate of 32.25 lb/hr was observed, while the specification range was 23.0 lb/hr minimum to 31.0 lb/hr maximum.

Both the left and right magnetos were securely attached to the accessory gearbox with no witness marks indicating slippage. The magnetos were removed and bench tested. The left magneto passed the specification test which required it to produce a consistent steady spark at 255 rpm[8]. At speeds above this it also operated normally. The right magneto failed the specification test. At 255 rpm the right magneto barely produced a single spark; at 500 rpm it produced sparks at all four points but firing erratically; at 750 rpm it was still missing some sparks on occasions; at 1,000 rpm it produced near steady sparks; and at 1,500 rpm and above it produced consistent steady sparks. The right magneto was opened up which revealed that the contact points were worn more than normal, and the position at which the contact points opened was 7° out. The contact points were replaced with a used set and rigged correctly. The right magneto was then retested and it produced a consistent steady spark at 255 rpm and above. At a later date, the original contact points were reinstalled in the magneto and set to their as found position. The magneto was then installed on a different Lycoming IO-360 engine which was mounted to a dynamometer testbed. The magneto installed in the 'left' position was a new magneto. The engine was warmed and then operated at varying engine rpms while operating on both magnetos, the left magneto only and the right magneto only. The engine operated normally at 700 rpm and above while selected to the left, right or both magnetos. At 500 rpm and 600 rpm, the engine ran continuously but roughly on the left magneto only. At 500 rpm and 600 rpm, the engine ran down and stopped when on the right magneto only. The idle stop was set to 500 rpm as this was an engine intended for a fixed-wing aircraft. The engine fitted to G-LINX would have had its idle-stop originally set to a minimum of 1,400 rpm with the rotor disengaged.

Adjustment of engine idle rpm and idle mixture

The Schweizer 269C-1 Pilot's Flight Manual (Revision 24 October 2002) contains a procedure in section 4.14 entitled '*Pilot's Check of Idle Mixture, Idle Speed, and (Helicopters with Fuel Injected Engine – HIO-360-G1A) Fuel Boost Pump*'. The procedure states that:

> *'this check of idle mixture and idle speed shall be accomplished at the end of the last flight each day, prior to engine shutdown.'*

The idle mixture check involves rapidly rotating the throttle to the closed (normal idle stop, not override) position, and then smoothly moving the mixture control towards the IDLE CUTOFF position and noting the engine rpm, before moving the mixture back to FULL RICH before the engine stops. The engine rpm should rise between 25 and 100 rpm, before dropping during this check. If the rpm rise is not within these limits then the idle mixture setting needs to be adjusted by maintenance personnel.

The idle mixture procedure is followed by the idle speed check. During this check the throttle is rapidly rotated closed to the full override position, and the rpm should be checked that it does not drop below 1,400 rpm. A second check involving rapidly rotating the throttle to the normal idle stop should produce an engine rpm no greater than 1,600 rpm. If the engine idle speed is not within these required limits then it needs to be adjusted by maintenance personnel.

Footnote

[8] In this installation magneto rpm is equivalent to engine rpm.

The checklist found in G-LINX did not contain either of the above checks as part of the post-flight engine shutdown checks. However, in its pre-takeoff '*After Engagement*' section, a check similar to the idle speed check was included which stated:

> *'Lower lever – close throttle. Observe needle split and check ground idle rpm (1400 +/- 100 rpm).'*

The checklist did not make it clear whether the throttle should be closed to the normal idle stop or the override position. The checklist also permitted a ground idle rpm of 1,300 rpm, whereas the Pilot's Flight Manual specified a minimum of 1,400 rpm.

Discussions with six different Schweizer 269C-1 flight instructors from different training organisations in the UK revealed that only one of them was aware of the idle mixture check. They all carried out some variation of the idle speed check as part of their pre-takeoff checks, although some just checked for a needle split and that the engine did not stop, but did not check for a specific rpm. The aircraft manufacturer stated that it was important to carry out the idle speed check and idle mixture check because if either the idle speed or idle mixture were set incorrectly, it could lead to engine stoppage in flight if idle were selected. The manufacturer also stated that it was important to perform the idle speed check at the end of the flight, rather than only prior to flight, because the engine response was different when the engine was at normal operating temperature.

Post-maintenance engine ground runs

G-LINX was maintained in accordance with the Light Aircraft Maintenance Schedule (LAMS), which later became the Light Aircraft Maintenance Programme (LAMP). Both LAMS and LAMP required that an engine ground run be carried out after every 50-hour, 150-hour, or annual check. The only LAMS/LAMP requirements for the engine ground run were that the powerplant, liquid, air and gas systems be checked for leaks, and that the instruments, systems and services be checked for operation, and that following the ground run a check of cowling, panel and door security was carried out. There was no specific requirement to check engine idle speed or idle mixture setting. The Schweizer 269C-1 maintenance manual did not specify such a check either, unless the settings had been adjusted. The maintenance organisation that maintained G-LINX had carried out engine ground runs in accordance with LAMS/LAMP, and no check of the idle speed or idle mixture setting was carried out. The maintenance organisation employed pilots to perform the engine ground runs, and these pilots were not aware of the idle mixture setting check or the pre-shutdown idle speed check in the Pilot's Flight Manual, and therefore had not performed them. The maintenance organisation that had previously maintained G-LINX had completed an 'engine run record' after some of its maintenance checks. These included an entry for '*Slow Running RPM*' (although not defined) and for '*ERPM Rise at Mixture Check*'. The last engine run record was completed on 11 April 2007 and noted a '*Slow Running RPM*' of 1,430 rpm and a '*ERPM Rise at Mixture Check*' of 50 rpm. Assuming the '*Slow Running RPM'* check was done with the throttle in the override position and the needles split, then these figures were within the specification limits in the Pilot's Flight Manual.

Analysis

Engineering issues

The evidence at the accident site was consistent with the aircraft having struck the ground with a high vertical speed, travelling sideways to the left with little or no forward speed. The aircraft's attitude at impact was probably slightly nose-up with some left bank. The minimal damage to the main rotor and tail rotor blades indicated that the rotors probably had insufficient rotational energy to sustain flight. This evidence was consistent with the presence of the steady low rpm warning tone in the pilot's final radio transmission, which indicated that the rotor rpm was below a safe speed for autorotation. There was no evidence of a pre-impact failure to any of the rotary drive components, so an engine problem or stoppage was suspected as a factor in the loss of rotor rpm. A witness who may have observed G-LINX shortly before 1100 hrs reported seeing puffs of black smoke from a helicopter. Black smoke from an exhaust can result from incomplete combustion of the fuel. However, apart from a weak right magneto and a slightly out-of-tolerance fuel injector servo, no anomalies with the engine powerplant system could be found. At the normal minimum engine idle rpm of 1,400, the problem with the right magneto's contacts would not have been apparent and therefore was probably not a factor in affecting the engine's operation. Even if the engine idle rpm had been set 200 rpm below the 1,400 rpm minimum, the right magneto would probably still not have affected the engine's operation.

The slightly rich setting of the fuel injector servo might have contributed to a rich cut if the throttle was rapidly reduced to idle, but the idle mixture setting would normally have been adjusted by the aircraft manufacturer after installing and ground-running the engine; this idle mixture setting is adjusted by turning a thumbwheel which shortens or lengthens the idle mixture link and could compensate for an over-rich setting internal to the fuel injector servo. There were no entries in any of the maintenance worksheets of an adjustment having been made to the engine's idle rpm setting or idle mixture setting post aircraft construction. So the possibility existed that the settings had drifted outside the required limits, and this could have caused an engine stoppage if idle had been selected in flight. There was no requirement for the maintenance organisation to check the idle speed or idle mixture settings during the post-maintenance engine ground run, but according to the Pilot's Flight Manual, pilots should have been performing this check at the end of the last flight of the day. Among the Schweizer piloting community in the UK the awareness of these procedures appeared to be low. Therefore the following Safety Recommendation is made:

Safety Recommendation 2010-089

It is recommended that the Civil Aviation Authority highlight to owners and operators of Schweizer 269C-1 helicopters the importance of performing the idle speed and idle mixture checks in section 4.14 of the Pilot's Flight Manual.

Operational issues

With the exception of the single report of black puffs of smoke emanating from the helicopter as it flew north from Blackpool, the flight appears to have proceeded unremarkably until the helicopter descended over the sands north of Knott End. Radar resolution was insufficient to determine the exact nature of the manoeuvres north of Knott End, but indicated average rates of descent that are typically achieved during practice autorotations. From that point until the end of the flight there is no record of the helicopter having climbed above 500 ft, although there were no reported cloud or airspace restrictions that would have prevented it from doing so.

After these manoeuvres the helicopter turned south to follow the east bank of the River Wyre at approximately 400 ft. There were no indications of flight control or other difficulties until the MAYDAY call shortly before the final descent. Transmission of the MAYDAY indicates that the instructor had identified an emergency situation and, although it was not possible to determine what this was, the MAYDAY itself was delivered in a voice that, according to family members, sounded calm and held no sense of panic. Analysis of the final transmission, however, suggests that the helicopter was by then no longer in controlled flight.

The engineering investigation found that a loss of power might occur if the throttle was rapidly reduced to idle, such as might occur if it was closed too abruptly at the start of a practice autorotation. If the manoeuvres north of Knott End seen by the witness and recorded on radar were practice autorotations then they appear to have been completed without incident. The instructor had previously used the area in which the accident took place to conduct practice autorotations. It is therefore possible that immediately prior to the accident one of the occupants of G-LINX initiated a practice autorotation. If this involved abrupt closure of the throttle then this might have caused the engine to lose power. This would have been cause for the instructor to transmit a MAYDAY and attempt a forced landing and is a possible mechanism for the helicopter entering its final descent. However, there is no record of the instructor having conducted practice autorotations from heights of 500 ft or less on previous flights and there is no obvious training value in doing so. There is therefore no reason to presume that this is what happened.

Having identified an actual emergency, particularly if he believed the engine had failed, the instructor would probably have initiated an intentional autorotation in order to land under control. However, at the time of the MAYDAY, the location of the helicopter was such that he would have been constrained to complete a forced landing either downwind or into the river. There would have been insufficient height to reposition the helicopter with enough dry land ahead to complete the manoeuvre into wind. At a height of approximately 400 ft the instructor would have had very little time in which to make a decision, but the location of the wreckage suggests that he attempted a landing downwind.

Information provided by the manufacturer and experienced pilots indicates that a landing downwind without power is likely to be difficult to accomplish safely. A pilot faced with this situation might try to reduce the apparent high ground speed by applying aft cyclic control, which could result in an airspeed below that for minimum rate of descent. There might then be insufficient energy stored in the rotor to reduce the resulting high rate of descent, such that the impact would not be survivable. Having elected to land downwind, normal control could be maintained by maintaining the correct airspeed throughout the descent and allowing the helicopter to touch down with high forward ground speed. However, the outcome would then depend on how smooth and level the terrain was over which the aircraft would then slide to a halt.

Whatever caused the instructor to make a forced landing, the location of the helicopter at low level over the downwind river bank limited the options for a successful outcome. Operation of the helicopter at greater height, further downwind of the river bank, would have provided more opportunity to complete an autorotation into wind and onto land.

Conclusion

The pilot responded to an emergency situation, apparently associated with a loss of power, the cause of which the investigation was unable to identify. The subsequent manoeuvres, initiated from a height of approximately 400 ft, were accompanied by a loss of rotor rpm and did not result in a safe landing. Operating the helicopter at greater height and in a position from which an into-wind landing could have been accomplished would have increased the opportunities for a safe outcome.

ACCIDENT

Aircraft Type and Registration:	Jabiru UL, G-OMHP
No & Type of Engines:	1 Jabiru Aircraft Pty 2200A piston engine
Year of Manufacture:	2000
Date & Time (UTC):	23 July 2010 at 1645 hrs
Location:	Kingsmuir Airfield, Fife
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to fuselage, left wing, nose leg, propeller
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	63 years
Commander's Flying Experience:	68 hours (of which 18.5 were on type) Last 90 days - None Last 28 days - None
Information Source:	Aircraft Accident Report Form submitted by the pilot and additional AAIB inquiries

Synopsis

The pilot had rigged the aircraft prior to being inspected and test flown by a Light Aircraft Association (LAA) inspector. Whilst awaiting his arrival the pilot decided to conduct a "practice takeoff" - essentially an accelerate-stop manoeuvre on the runway. However, at about 50 kt the aircraft started to drift to the right and the pilot was unable to prevent the aircraft from departing the runway and striking an earth bank. It was subsequently found that a safety pin, which retained a pin attaching the right-hand flap to its operating linkage, was missing. However, it could not be determined whether this was a factor in the accident.

Circumstances of the accident

The aircraft had been inspected by an LAA inspector on 30 May 2010 for the renewal of its Permit to Fly. However, it was not possible to conduct the necessary flight test on that day due to bad weather. A combination of continued bad weather and the owner/pilot working away from home caused further delays in arranging a test flight within the requisite 30-day period from the inspection. The owner then arranged for a repeat inspection, together with a test flight, to be carried out by a different LAA inspector who happened to be visiting Kingsmuir Airfield on 23 July to work on another aircraft.

On the day of the accident, the owner, took the aircraft out of the trailer in which it had been stored since 30 May. After rigging the aircraft, he checked the engine oil and put 55 litres of fuel in the tank. At this time the LAA inspector was working in a nearby hangar, so the owner decided to conduct a power check, followed by a 'practice takeoff', prior to the inspection on his aircraft. The owner subsequently stated that it was not his intention to leave the ground and he intended simply to carry out an accelerate-stop procedure on the runway, with his son on board as a passenger.

After checking the magnetos, full power was applied and the aircraft accelerated along the grass runway, with zero flap selected. At a speed of around 50 kt the aircraft started to veer to the right; the pilot reduced power and applied the brakes. However, this appeared to exacerbate the situation; the aircraft ran onto rough ground on the right-hand side of the runway before spinning round so that the left wing contacted an earth bank and a fence. At some point during this process, the nose leg collapsed and the propeller contacted the ground. The aircraft came to rest with the left wing partially torn off and its associated wing strut separated close to its attachment to the fuselage. The occupants were uninjured and left the aircraft via the doors.

Subsequent examination of the aircraft

The LAA inspector later commented that he had heard the sound of the aircraft engine but was not initially aware of the accident. When he arrived at the scene, he noted that the right flap was hanging in its fully down position; it was apparent that a pin that connected the flap to the operating linkage in the fuselage had become disengaged. This in turn was due to the absence of a 'Terry-clip' type safety pin that normally would be inserted through a hole in the flap connecting pin.

The aircraft was removed to a repair organisation, who conducted an examination with a view to repair. This included an examination of the brake system components, which revealed no evidence of disc roughness or any other feature that could have led to the right brake 'grabbing' or dragging.

The nose landing gear leg was sent to the AAIB, where it was examined in conjunction with photographs of the engine firewall to which it had been attached. All the failures in the housing appeared consistent with overload, indicating that the nose leg became detached during the accident rather than being an initiator of it. The steering rod was also found to have sustained an overload failure during the process of the leg detachment.

Discussion

Whilst it was not intended for the aircraft to become airborne during this 'practice takeoff', there was an inevitable focus on the absence of the right-hand flap safety pin. The pilot stated that he had selected zero flap; thus the effect of a flap pin disengagement during the ground roll would result in the flap streaming in the approximate zero position. This would be unlikely to produce any significant directional control difficulties, although there could be some loss of lift if the flap rigging allowed the airflow to push it slightly beyond its normal retracted position.

There was insufficient evidence in this case to determine whether the missing safety pin was a factor in the accident. However there can be no doubt that a flap pin disengagement whilst airborne, with flaps deployed, would result in a flap asymmetry condition with potentially serious consequences. Whilst the LAA inspector, had he had the opportunity, would probably have found the discrepancy, the event nevertheless emphasises the necessity of a thorough pre-flight inspection after rigging any aircraft.

ACCIDENT

Aircraft Type and Registration:	Pegasus Quantum 15-912, G-EMLY
No & Type of Engines:	1 Rotax 912 piston engine
Year of Manufacture:	1999
Date & Time (UTC):	17 July 2010 at 1030 hrs
Location:	Field 1.5 nm east of Abergavenny, Monmouthshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Wing beyond economic repair and minor damage to trike
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	45 years
Commander's Flying Experience:	87 hours (of which 87 were on type) Last 90 days - 16 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

During a cross-country flight the engine lost power. The pilot made a successful forced landing into a field with a crosswind, but while slowing to a stop, the wind caused the aircraft to roll onto its side, seriously damaging the wing. The cause of the engine failure could not be determined.

History of the flight

The Pegasus Quantum 15-912 is a flex-wing microlight aircraft powered by a Rotax 912 piston engine. The pilot had filled the aircraft's 50-litre capacity fuel tank to full and departed from Old Sarum airfield for a cross-country flight to Shobdon Airfield. The visibility was greater than 10 km and the cloud base was between 3,500 ft and 4,000 ft with a westerly wind of about 10 kt at ground level.

While cruising at 2,100 feet near Abergavenny the pilot performed a LIFE (Location, Instruments, Fuel and Endurance) check and noted that the engine temperatures and pressures were normal. Shortly thereafter the engine lost power. The engine did not respond to the foot throttle so, suspecting a cable disconnect, he tried the hand throttle but this had no effect either. He also checked the magnetos and choke position, to no avail, so he decided to carry out a forced landing. The surrounding area was undulating, with small cropped fields and some grass fields, but most of these contained livestock. When he found a grass field with no livestock he initiated an approach towards it. He then realised that he was approaching the field in a southerly direction with a crosswind from his right. However, due to high-tension power lines along the western side of his selected field, he decided to continue the approach. He also did not want to manoeuvre to turn into wind and risk undershooting the field. The aircraft touched down uneventfully in the first third of the field, by which time the engine had stopped. While slowly rolling to rest the pilot felt the wind from his right lift the right side of the wing. He tried to lower the wing, but was unable to do so, and the wind rolled the aircraft over onto its left side, causing serious damage to the wing. The pilot was able to vacate the aircraft on his own and then received assistance from a nearby farmer who reported having heard the engine "coughing" when it was overhead.

According to the aircraft's 'Flydat' the engine had been running for 2 hours and 20 minutes. At a typical fuel burn rate of 11 litres/hour (for solo flight), the engine would have consumed about 26 litres, so about 24 litres should have been remaining in the fuel tank. According to the pilot this figure was consistent with his check of the fuel gauge while performing the LIFE check near Abergavenny.

Aircraft examination

The aircraft was de-rigged and transported to the aircraft manufacturer's facility for repair and examination. An examination of the engine and detailed examination of the fuel system did not reveal any faults. The engine was ground run and operated normally. Some of the wiring in one of the ignition boxes had suffered from 'fatigue' breakages in the past and had been repaired. Therefore, to err on the side of safety, this ignition box was replaced prior to a test flight. The aircraft was test flown successfully with no engine anomalies.

ACCIDENT

Aircraft Type and Registration:	Pegasus XL-R, G-MTOO
No & Type of Engines:	1 Rotax 447 piston engine
Year of Manufacture:	1987
Date & Time (UTC):	12 June 2010 at 1601 hrs
Location:	Newbridge Leisure Centre, Newbridge, Gwent
Type of Flight:	N/A
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Damaged beyond economic repair
Commander's Licence:	Pilot under Training
Commander's Age:	65 years
Commander's Flying Experience:	40 hours (of which 15 were on type) Last 90 days - n/k hours Last 28 days - n/k hours
Information Source:	Aircraft Accident Report Form submitted by the owner and subsequent AAIB telephone enquiries

Synopsis

The aircraft owner, who was not yet qualified as a pilot, had intended to conduct untethered ground runs at some playing fields following the completion of maintenance on the aircraft. During these ground runs the aircraft inadvertently became airborne and collided with goalposts. The owner sustained serious injuries and the aircraft was destroyed.

History of the flight

The microlight was transported to the accident site, some playing fields near Newbridge, on the morning of the accident. The owner, who was undertaking training for a PPL (Microlights) had previously used this site to conduct untethered ground runs and considered it suitable for his purposes due to its location and the expanse of land available. He conducted two 400 metre long ground runs of the trike unit at up to approximately 5,500 engine rpm, during which no anomalies were noted. He then rigged the wing to the trike unit and commenced a further untethered ground run, with the intent of determining at what point the wing produced lift, following recent reprofiling of the wing battens. On reaching a speed of approximately 24 mph, the owner felt the wing producing lift and attempted to bring the aircraft to a stop; however, he reported that the foot throttle had stuck in the open position. He attempted to pull the ignition kill-switch to stop the engine but was unable to reach it. In attempting to do so he believed he pushed the A-frame forward, causing the aircraft to become airborne. The aircraft subsequently collided with goalposts.

Aircraft description

The Pegasus XL-R is a two-seat flexwing microlight aircraft comprising a trike unit and wing, which are connected by a bolt through the monopole. The trike incorporates a tricycle undercarriage, powerplant and tandem seating arrangement for a pilot and one passenger. The aircraft is controlled via an A-frame, which consists of a control bar braced by fore and aft wires and two uprights attached to the wing keel tube.

The primary throttle control is foot-operated and this is complemented by a friction-damped cruise control hand throttle on the left side of the seat frame. Cables from both the foot and hand throttles enter a throttle splitter box. The splitter box is an aluminium tube with a nylon piston inside. The two throttle cables are attached to one side of the piston block; attached to the other side of the piston is a single cable which runs to the carburettor. Operating either throttle pulls the nylon block along the splitter box and controls the carburettor slide which regulates the flow of air and fuel to the engine. The foot throttle is sprung to return back to idle when pressure is removed; a friction device causes the hand throttle to remain in the selected position. If both the foot and hand throttle are actuated at the same time, the greater of the two inputs is taken by the splitter box to drive the carburettor slide.

The mixture control is located on the right side of the seat frame. An ignition kill-switch is fitted on the front seat base bracket, immediately below the pilot's knees.

Background

The owner had acquired G-MTOO in 2007 and initially flew it with his instructor while undertaking pilot training. He subsequently decided to continue his training in a club aircraft, and consequently G-MTOO was not used for a period of approximately 22 months.

In May 2010 the owner decided that he wished to fly G-MTOO again. Accordingly, it was subjected to an engineering inspection and a check flight for the purpose of revalidating the Permit to Fly, which is required on an annual basis. The inspection and check flight were carried out by the same individual, who held both BMAA Inspector and Check Pilot status. No significant defects were reported during the engineering inspection. The aircraft performed acceptably during the check flight, however the Check Pilot noted a number of minor anomalies (but not sufficient to prevent revalidation of the Permit). These included a slight tendency of the aircraft to turn to the left and a sluggish engine response. He recommended that the owner reprofile the wing battens and decoke the engine. The new Permit was issued and the recommended maintenance was subsequently carried out by the owner.

Discussion

The owner reported that the foot throttle had stuck in the open position, but he was not able to reproduce any throttle faults subsequent to the accident. Discussions with the BMAA and the aircraft manufacturer suggest that this type of throttle has been known to jam, as the nylon piston in the splitter box can swell due to moisture ingress. However, no anomalies were noted with the throttle operation during the recent Permit revalidation inspection, or during the ground runs conducted prior to the accident. In addition, the throttle splitter box had been replaced by the owner the previous year, and he reported that the nylon piston moved freely both before and after the accident.

As two ground runs had already been carried out prior to the accident, the possibility that the hand throttle may have been left partially open following an earlier ground run could not be discounted. However, the owner could not recall this being the case. Had it been so, the hand throttle would have provided an overriding command, even when foot pressure was removed from the foot throttle. Subsequent models of microlight aircraft from this manufacturer incorporate a microswitch that prevents operation of the starter if the hand throttle is open. Later designs of microlight from this manufacturer also incorporate a more accessible ignition kill-switch which is mounted on the seat frame.

The owner attributed the accident to poor selection of the test site where obstructions existed and his eagerness to conduct the ground runs, rather than waiting until his instructor was available to assist.

ACCIDENT

Aircraft Type and Registration:	Rotorsport UK MT-03, G-CEYX
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2008
Date & Time (UTC):	24 September 2010 at 1315 hrs
Location:	Kirkbride Airfield, Cumbria
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Damage to rotors, left main landing gear, fuselage pod, propeller and rudder
Commander's Licence:	Student pilot
Commander's Age:	51 years
Commander's Flying Experience:	80 hours (of which 51 were on type) Last 90 days - 34 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Whilst taking off the student pilot did not use the technique he had been taught, resulting in a loss of control and the gyroplane rolling on to its side. The pilot received minor injuries.

History of the flight

The student pilot was departing on a solo cross-country flight in fine weather. He lined up on Runway 10 and, in accordance with the normal takeoff procedure, selected full forward cyclic before he engaged the pre-rotator.

The student pilot reported that, during a normal takeoff, once the rotor has reached 220 rpm, the pre-rotator should be disengaged, the brakes released, the cyclic moved fully aft and the throttle advanced. Having carried out these actions, as the gyroplane increases speed down the runway, the relative airflow will accelerate the rotor and at about 340 rpm the gyroplane will become airborne.

On this occasion, the pilot did not select aft cyclic before he began the takeoff roll. He realised that the takeoff was not proceeding normally at the same time as hearing his instructor, who was watching from beside the control tower, say "stick back" over the radio. The pilot pulled back on the cyclic, the gyroplane became airborne, pitched nose up and rolled left. The rotor blades struck the ground and the gyroplane came to rest on its left side. There was no fire and the student, who was wearing a full harness and a helmet, received only minor injuries.

The student pilot commented that holding the cyclic in the forward position caused the rotor to decelerate during the takeoff roll and that pulling back on the cyclic resulted in retreating blade stall. He considered that he should have retarded the throttle and brought the gyroplane to a stop on the runway when he realised that he was using the incorrect technique. He could not explain why he had not pulled the cyclic back before beginning the takeoff roll but thought that he may have been preoccupied with the cross-country flight on which he was about to depart. He had not made this mistake previously, with or without his instructor.

The student's instructor commented that he recalled saying "stop" over the radio. It was also reported that rejected takeoffs had been discussed during training but not practised due to the risk of a rollover accident.

ACCIDENT

Aircraft Type and Registration:	Savannah VG Jabiru(1), G-TTAT
No & Type of Engines:	1 Jabiru Aircraft Pty 2200 piston engine
Year of Manufacture:	2009
Date & Time (UTC):	17 July 2010 at 1600 hrs
Location:	Stoke Airfield, Kent
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Propeller, left wing tip, main landing gear, nose landing gear, firewall, cockpit floor, cowlings
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	75 years
Commander's Flying Experience:	425 hours (of which 7 were on type) Last 90 days - 20 hours Last 28 days - 12 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot was flying an approach to grass Runway 24 at Stoke Airfield, Kent, an airfield with which he was familiar. The weather conditions were good but the westerly wind was reported as being gusty. The approach was flown at 50 kt with the intention of touching down a quarter of the way along the 530 m runway. The pilot stated that, at a height of approximately 10 ft, "between round-out and flare, the aeroplane stopped flying and hit the ground with a great thump." The aircraft was extensively damaged, but the pilot and his passenger were unhurt and vacated the aircraft normally. There was no fire.

In a candid report, the pilot considered that the accident was caused by his lack of experience on this type of aircraft.

ACCIDENT

Aircraft Type and Registration:	Thruster T600T 450 Jab, G-BZJD
No & Type of Engines:	1 Jabiru Aircraft Pty 2200A piston engine
Year of Manufacture:	2001
Date & Time (UTC):	4 September 2010 at 1615 hrs
Location:	Old Hay Airfield, Paddock Wood, Kent
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Right main landing gear, propeller and fuselage
Commander's Licence:	Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	264 hours (of which 15 were on type) Last 90 days - 14 hours Last 28 days - 11 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot was on his second flight of the day from Old Hay Airfield, Kent. The weather conditions were good, with a light easterly wind, and Runway 10 was in use. After a short flight in the local area, the aircraft returned to the circuit. The pilot described his approach to the runway as normal but the aircraft bounced on touchdown and began to porpoise. After the second bounce, he applied full power, in an attempt to climb away, but the aircraft contacted the ground again and the right main landing gear collapsed. The aircraft "somersaulted onto its roof" and came to a stop in the middle of the runway. The pilot and his passenger, who were uninjured, were able to vacate the aircraft and walk away.

The pilot considered that the accident was the result of too high a flare and the aircraft stalling prior to the initial touchdown.

BULLETIN CORRECTION

AAIB File:	EW/G2009/12/14
Aircraft Type and Registration:	Boeing 737-800, EI-DHD
Date & Time (UTC):	23 December 2009 at 0847 hrs
Location:	Glasgow Prestwick Airport
Information Source:	Airfield operator's investigation report and further enquiries by the AAIB

AAIB Bulletin No 10/2010, page 2 refers

In the first sentence of the seventh paragraph (near the top of the right hand column on page 2) of the **History of the flight** section of this report it stated:

> The commander recalled cancelling the autobrake at about 100 kt and selecting reverse thrust at 60 kt, before allowing the aircraft to roll to the end of the runway prior to vacating.

The word **selecting** should not have been included in this sentence and it should have read:

> The commander recalled cancelling the autobrake at about 100 kt and reverse thrust at 60 kt, before allowing the aircraft to roll to the end of the runway prior to vacating.

BULLETIN CORRECTION

AAIB File:	EW/C2010/01/01
Aircraft Type and Registration:	Piper PA-31P Pressurised Navajo, N95RS
Date & Time (UTC):	15 January 2010 at 1407 hrs
Location:	Bladon, Oxfordshire
Information Source:	AAIB Field Investigation

AAIB Bulletin No 11/2010, page 59 refers

In the 'Pilot information' section of this report, the opening sentence of the third paragraph was inadvertently displaced to the end of the paragraph. This gave the impression that the qualifications in this third paragraph referred to the pilot of N95RS, rather than to the passenger as intended.

The corrected 'Pilot information' section was placed in the report version published on the AAIB website on 11 November 2010, and is reproduced below:

Pilot information

The pilot was an airline transport pilot whose main flying activity was working for an airline as a training captain on Boeing 737-800 aircraft. For the three days prior to the accident the pilot had been conducting aircraft training with pilots new to type. When this training is being conducted a type-qualified safety pilot is seated on the jumpseat. The pilot had returned to his home on the evening of the day before the accident.

The pilot also had various general aviation interests. He was a commercial helicopter pilot with a valid instructor rating and an active fixed-wing pilot. His Multi-engine Piston (MEP) rating was renewed on 2 November 2009. No logbook record of his recent general aviation flying activities was found so it was not possible to know precisely how much of this type of flying he had done in the recent past.

The passenger was a qualified private pilot; no logbook record of his flying experience was found. He obtained his PPL on fixed-wing aircraft in November 2008 and his PPL(H) in March 2009. He was reported to have flown his own Robinson R44 helicopter on a regular basis. He carried out a full-time training course to obtain an MEP rating in November 2009 using a Piper Seneca aircraft. It was recorded on his application form for the rating that he had 93 hours of pilot in command flight time. When he had completed his MEP course he started working towards obtaining an IMC rating; at the time of the accident he had done about 4 hours dual training, also on a Piper Seneca. His instructor gave his opinion that at his stage of training and experience he would be unlikely to have been able to successfully fly a Piper Navajo aircraft in IMC.

AIRCRAFT ACCIDENT REPORT No 7/2010

This report was published on 23 November 2010 and is available on the AAIB Website www.aaib.gov.uk

REPORT ON THE ACCIDENT TO AEROSPATIALE (EUROCOPTER) AS 332L SUPER PUMA, G-PUMI AT ABERDEEN AIRPORT, SCOTLAND ON 13 OCTOBER 2006

Registered Owner and Operator:	Bristow Helicopters Limited
Aircraft Type and model:	Aerospatiale (Eurocopter) AS 332L Super Puma
Nationality:	United Kingdom
Registration:	G-PUMI
Place of Incident:	Aberdeen Airport, Scotland
Date and Time:	13 October 2006 at 1220 hrs

Synopsis

The accident was notified to the Air Accidents Investigation Branch (AAIB) by the Operator's Flight Safety Officer. The following Inspectors participated in the investigation:

Mr R D G Carter	Investigator-in-charge
Mr C A Protheroe	Engineering
Miss G M Dean	Operations
Mr P Wivell	Flight Recorders

The aircraft was departing from Runway 14 for a flight to oil platforms in the North Sea, carrying 13 passengers. Five seconds into the takeoff the crew heard a bang and an abnormal vibration started. The crew rejected the takeoff and landed back on the runway. The aircraft started to taxi but the severe vibration continued so the commander stopped and shut down the helicopter on the threshold of Runway 32.

Initial examination showed that one main rotor blade spindle had fractured, through the lower section of its attachment yoke on the leading side of the spindle. Post-fracture plastic deformation of the lug had stretched open the fracture, separating the faces by some 12 mm.

As a result of this accident the helicopter manufacturer published an Emergency Alert Service Bulletin, requiring periodic inspections, and this was subsequently mandated by the European Aviation Safety Agency (EASA) as an Airworthiness Directive. In July 2009 the manufacturer issued Service Bulletins which introduced a 'wet' assembly procedure, with new nuts, for the main rotor blade spindles. This eliminated the requirement for the repetitive inspection procedure and was made mandatory by the issue of an Airworthiness Directive (AD) by the EASA.

The investigation identified the following causal factors for the failure of the spindle yoke:

(i) Wear on the flapping hinge inner race.

(ii) Excessive clamping pre-load across the yoke, due to the tie bolt being torqued to the specified dry value in the presence of grease when it was reinstalled some 175 hours prior to failure of the yoke.

(iii) Significant hoop stresses in the bore of the yoke due to adverse tolerance stacking and the associated interference fit of the bush in the yoke.

The following were considered as contributory factors in the failure:

(i) Flight loads biased towards the high-speed level flight condition, slightly higher than those generated by normal level flight cruise conditions.

(ii) A minor deviation in corner radius profile at the inner end of the bore of the yoke, with a small increase in the attendant stress concentration.

(iii) A minor reduction, at the fatigue origin site, in the intensity of the compressive surface layer stresses from the shot-peen process.

(iv) Flight loads in the spindle yoke slightly higher than anticipated in certification fatigue testing, due to the action of the lead-lag dampers (frequency adaptors).

One Safety Recommendation is made, to the EASA, concerning HUMS detection in helicopter rotating systems.

Findings

The accident flight

1) The flight crew were properly licensed and qualified to conduct the flight.

2) The flight crew were suitably rested and held valid medical certificates.

3) Five seconds after lifting off to begin a flight to the Britannia Platform, the lower half of the lug forming the leading side of the Blue main blade spindle yoke fractured.

4) The failure was accompanied by a bang and very heavy vibration, and the crew immediately landed back on Runway 14. The aircraft was shut down and the passengers disembarked whilst still on the runway.

The fracture mechanism

5) The yoke had failed in fatigue, due to a crack that originated at the corner radius on the inner end of the bore in the lug that accommodates the flapping hinge pin. The fatigue crack propagated through some 90% of the cross-section before the remaining material became overloaded and ruptured.

6) Analysis of the fracture faces indicated that the primary fatigue crack had propagated over a period of some 90 rotor starts, with the crack breaking through the visibly accessible lower surface of the lug 15 to 17 rotor starts prior to the final rupture.

7) The aircraft's flight logs indicated corresponding flight times of 258 hrs for propagation to failure, of which 47-54 flight

hours occurred after the crack had broken through the visible lower surface of the yoke.

8) Sacrificial washers bonded to the inner faces of the lugs were also cracked along fracture lines parallel with the plane of the yoke fracture.

9) Flight loads measured in flight trials were broadly comparable to those upon which the original design and certification, including fatigue testing of the spindle, was based. The minor differences were inconsequential in any potential primary causal mechanism.

10) None of the fatigue testing had identified any potential failure of the yoke section of the spindle and failures had involved the main body of the spindle.

11) Failures of the spindle lugs had occurred in service at positions comparable to the G-PUMI failure, only on earlier designs of spindle with thinner (15 mm) yokes.

12) Initiation of earlier fractures had been attributed to fretting between the inner face of the yoke and the flapping hinge inner race with no sacrificial washer, to be introduced later specifically to prevent fretting failures of this type.

13) No significant deviations from specification or drawings were found in the failed blade spindle forging, or any of the associated components.

14) Evidence of wear was found on the end faces of the flapping hinge bearing inner race, the extent of which was close to the maximum measured across a small sample of spindles undergoing overhaul by the aircraft manufacturer.

15) Traces of grease were found on the tie bolt passing through the centre of the flapping hinge pin and laboratory testing showed that application of the specified dry torque to a lubricated tie bolt induced a pre-load substantially higher than the manufacturer intended.

16) Excessive tie bolt tension, due to grease, combined with wear gaps between the yoke inner faces and the ends of the hinge bearing inner race, will cause the yoke arms to deform inwards and adopt a reflex mode of flexure which induces significant standing (static) stresses in the yoke at the fatigue origin site.

17) It is likely that only trace amounts of grease had contaminated the tie bolt, introduced unwittingly as the tie bolt came into contact with extraneous grease in the bore of the flapping hinge pin, as the bolt was reinstalled. In such circumstances, there would have been no indication to the person installing the bolt that contamination had occurred.

18) The superposition of alternating stresses, caused by in-flight loading, onto these large standing stresses was shown to create conditions capable of fatigue crack initiation at the fracture site.

Safety Recommendation

Safety Recommendation 2010-027

It is recommended that the European Aviation Safety Agency, with the assistance of the Civil Aviation Authority, conduct a review of options for extending the scope of HUMS detection into the rotating systems of helicopters.

AIRCRAFT ACCIDENT REPORT No 8/2010

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REPORT ON THE ACCIDENT BETWEEN CESSNA 402C, G-EYES and RAND KR-2, G-BOLZ NEAR COVENTRY AIRPORT ON 17 AUGUST 2008

Registered Owner and Operator:	1) Reconnaissance Ventures Limited 2) Privately owned
Aircraft Types:	1) Cessna 402C 2) Rand KR-2
Registrations:	1) G-EYES 2) G-BOLZ
Place of Accident:	Close to Coventry NDB, approximately 3.0 nm from Runway 23 threshold at Coventry Airport
Date and Time:	17 August 2008 at approximately 1036 hrs (All times in this report are UTC, unless otherwise stated)

Synopsis

The accident was notified to the Air Accidents Investigation Branch (AAIB) by Warwickshire Police shortly after it occurred; an AAIB field investigation was commenced immediately.

Cessna 402C aircraft G-EYES was engaged in flight calibration training and was making an ILS approach to Runway 23 at Coventry Airport when it was involved in a mid-air collision with a Rand KR-2 aircraft, G-BOLZ, operating in the visual circuit. The collision occurred in Class G (uncontrolled) airspace. The four occupants of G-EYES and the single occupant of G-BOLZ received fatal injuries.

The investigation identified the following primary causal factor:

The two aircraft collided because their respective pilots either did not see the other aircraft, or did not see it in time to take effective avoiding action.

The investigation identified the following contributory factors:

1. The likelihood that the crew of G-EYES would see G-BOLZ in time to carry out effective avoiding action was reduced by the small size of G-BOLZ, its position relative to G-EYES and the high rate of closure between the aircraft.

2. Insufficient or inaccurate information was provided to the pilots, which did not assist

them in fulfilling their duty to take all possible measures to avoid collisions with other aircraft.

3. The Aerodrome Controller's sequencing plan, which was based on an incomplete understanding of the nature of G-EYES' flight, was unlikely to have been successful. By the time the risk of a collision was identified, it was too late to devise an effective method of resolving the situation.

4. There were no effective measures in place to give G-EYES priority over traffic in the visual circuit.

As a result of this accident one Safety Recommendation was made.

Findings

1 The crew of G-EYES and the pilot of G-BOLZ were properly licensed and qualified to conduct their respective flights.

2 The air traffic controllers involved held relevant Certificates of Competence for their respective roles.

3 G-EYES and G-BOLZ were correctly maintained and were serviceable for their respective tasks.

4 Both aircraft appeared to have been operating normally before the collision.

5 All relevant ATC equipment was serviceable.

6 The collision occurred in Class G (uncontrolled) airspace and outside the Coventry Airport ATZ.

7 There was no evidence to suggest that the pilots took action to avoid the collision.

8 G-BOLZ was on a constant bearing relative to G-EYES for approximately three minutes prior to the collision.

9 It was estimated that at the point of collision G-BOLZ was crossing G-EYES' track at an angle of 43º and that G-EYES was overtaking G-BOLZ at a relative speed of approximately 106 kt.

10 The sightline to G-BOLZ from the front right seat of G-EYES probably intersected the canopy behind, or slightly to the left of, the windscreen central pillar.

11 The pilot of G-BOLZ was not informed about G-EYES approaching on the ILS.

12 At the time the crew of G-EYES was advised that G-BOLZ (number 2 in the landing sequence) was turning final inside the Coventry NDB, the PA-28 (number 1 in the landing sequence) was turning final inside the Coventry NDB. G-BOLZ had not yet completed its base leg.

13 The ATC Instrument Training booking sheet for G-EYES was annotated 'ILS calibration work' but this was incorrectly transferred to the flight progress strip as 'IRT', denoting Instrument Rating Training.

14 The ADC was not aware that G-EYES was undertaking calibration training because the flight progress strip was annotated with 'IRT'.

15 The operator of G-EYES did not appear to have followed the procedures outlined in its SMS that were to be used when undertaking a new flying activity because no risk analysis was produced, and there was no evidence that the planned calibration training had been discussed at the monthly safety meetings.

16 There was no discussion between the operator and ATC managers about the planned calibration training flights and how they would be integrated with other traffic.

Safety Recommendation

The following Safety Recommendation was made:

Safety Recommendation 2010-003

It is recommended that the Civil Aviation Authority ensures that the requirement in Part 1 of the Manual of Air Traffic Services for Aerodrome Control to issue '*information and instructions to aircraft under its control to achieve a safe, orderly and expeditious flow of air traffic and to assist pilots in preventing collisions*' is suitable, sufficient and complied with.

FORMAL AIRCRAFT ACCIDENT REPORTS
ISSUED BY THE AIR ACCIDENTS INVESTIGATION BRANCH

2009

3/2009 Boeing 737-3Q8, G-THOF
on approach to Runway 26
Bournemouth Airport, Hampshire
on 23 September 2007.

Published May 2009.

4/2009 Airbus A319-111, G-EZAC
near Nantes, France
on 15 September 2006.

Published August 2009.

5/2009 BAe 146-200, EI-CZO
at London City Airport
on 20 February 2007.

Published September 2009.

6/2009 Hawker Hurricane Mk XII (IIB), G-HURR
1nm north-west of Shoreham Airport,
West Sussex
on 15 September 2007.

Published October 2009.

2010

1/2010 Boeing 777-236ER, G-YMMM
at London Heathrow Airport
on 28 January 2008.

Published February 2010.

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

Published May 2010.

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

Published May 2010.

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

Published September 2010.

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

Published September 2010.

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

Published November 2010.

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

Published November 2010.

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

Published December 2010.

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