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ADDENDA and CORRECTIONS

None

(ALL TIMES IN THIS BULLETIN ARE UTC)

ACCIDENT

Aircraft Type and Registration:	EC225 LP Super Puma, G-REDW
No & Type of Engines:	2 Turbomeca Makila 2A1 turboshaft engines
Year of Manufacture:	2009 (serial no 2734)
Location:	20 nm east of Aberdeen
Date & Time (UTC):	10 May 2012 at 1114 hrs
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 2 Passengers - 12
Injuries:	Crew - None Passengers - 2 (Minor)
Nature of Damage:	Damage to be assessed following salt water immersion
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	To be advised
Commander's Flying Experience:	To be advised
Information Source:	AAIB Field Investigation

The investigation

The Air Accidents Investigation Branch (AAIB) was notified at 1112 hrs on 10 May 2012 that the helicopter was preparing to ditch in the North Sea approximately 20 nm east of Aberdeen. Preparations were made for the deployment of an investigation team. The team deployed to Aberdeen that afternoon and commenced the investigation.

In accordance with established International arrangements, the Bureau d'Enquetes et d'Analyses pour la Securitie de l'Aviation Civile (BEA), representing the State of Manufacture of the helicopter, and the European Aviation Safety Agency (EASA), the Regulator responsible for the certification and continued airworthiness of the helicopter, were informed of the accident. The BEA has appointed an Accredited

Representative to lead a team of investigators from the BEA and Eurocopter, the helicopter manufacturer. The UK Civil Aviation Authority and the aircraft operator are also providing assistance to the AAIB team.

The investigation into the circumstances of this accident is being conducted under the provisions of the Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996, Annex 13 to the ICAO Convention on International Civil Aviation and Regulation EU 996/2010.

Because of the importance of helicopter operations in support of the offshore oil and gas industry it is considered appropriate to disseminate the results of the initial investigation as soon as possible. No analysis of the facts has been attempted.

Synopsis

The crew of the helicopter carried out a controlled ditching following indications of a failure of the main gearbox (MGB) lubrication system and, subsequently, a warning indicating failure of the emergency lubrication system. All passengers and crew evacuated the helicopter into a life raft and were subsequently rescued. Two passengers sustained minor injuries. The investigation has identified a 360° circumferential crack in the bevel gear vertical shaft in the main gearbox, in the vicinity of a manufacturing weld, causing disengagement of the drive to both mechanical oil pumps.

History of the flight

The helicopter was on a scheduled flight from Aberdeen Airport to the Maersk Resilient platform, in the North Sea 150 nm east of Aberdeen. On board were two flight crew and twelve passengers. The helicopter was in the cruise at 3,000 ft with the autopilot engaged and at an approximate speed of 143 KIAS. 34 nm east of Aberdeen Airport, the crew were presented, almost simultaneously, with the following indications:

- WARN red light and aural gong
- MGB.P[1] caption illuminating on the Central Warning Panel (CWP)
- CAUT amber light
- XMSN caption illuminating on the CWP
- M.P[2] and S/B.P[3] illuminated on the vehicle monitoring system (VMS)
- SHOT illuminated on the MGB control panel
- Zero indication on the main gearbox oil pressure gauge.

In addition, CHIP illuminated on the VMS and the MGB oil temperature started to increase.

The commander assumed control of the helicopter, reduced speed towards 80 KIAS, turned back towards the coast and initiated a descent. The crew activated the emergency lubrication system.

During the descent, the MGB EMLUB[4] caption illuminated on the CWP, for which the associated procedure is to land immediately. The commander briefed the passengers and carried out a controlled ditching. The total flight time was 27 minutes.

Footnote

[1] The MGB.P caption indicates a pressure drop in the MGB oil distribution manifold.
[2] Pressure drop in the main lubrication system.
[3] Pressure drop in standby lubrication system.
[4] The MGB EMLUB caption indicates loss of emergency MGB lubrication.

The helicopter remained upright, supported by the emergency flotation gear. After shutting down the engines and stopping the rotors, the crew and passengers evacuated the helicopter into one of the life rafts via the starboard cabin door. Six of the occupants were rescued from the life raft by a search and rescue helicopter, eight were transferred to a RNLI lifeboat.

Helicopter information – lubrication of the main gearbox

The main gearbox lubrication system includes two mechanically-driven oil pumps and a crew-activated emergency system. The gearbox normally contains 22 litres of oil. The oil pumps (a main pump and a standby pump) are driven by the oil pump drive pinion located on the lower part of the bevel gear vertical shaft (part no 332A32510100) within the main gearbox. This particular vertical shaft is fitted to all EC225 and some AS332 L1 and L2 helicopters. The bevel gear vertical shaft is manufactured from two sections welded together.

The emergency system includes an 11 litre tank of glycol and an electric pump. When selected, the glycol is pumped into the main gearbox with engine bleed air to form a spray. This spray is designed to provide a minimum of 30 minutes of main gearbox cooling and lubrication in the event of total loss of oil lubrication. The MGB EMLUB caption illuminates if there is a failure of this system.

Recorded data

The helicopter was equipped with a combined digital voice and data recorder (DVDR). It was also equipped with a HUMS[5] system which included two vibration sensors that monitored the drive to the main gearbox oil pumps. These sensors had recorded increasing vibration levels during the previous few flying hours prior to the accident flight and were being monitored, in accordance with the manufacturer's maintenance manual.

The combination recorder and other items of the helicopter's avionics have been recovered and are being analysed by the AAIB.

Preliminary engineering investigation

The main gearbox was drained and was found to contain about 14 litres of fluid, which was predominantly oil but with evidence of some glycol. An initial visual inspection of the main gearbox has identified a 360° circumferential crack on the bevel gear vertical shaft, in the vicinity of the weld that joins the two sections. As a consequence of this failure, the main and standby oil pump gears ceased to be driven. During this inspection it was observed that the lower part of the vertical shaft was displaced downwards by 6 mm.

Further investigation

Detailed examination of the failure to the bevel gear vertical shaft in the main gearbox and the reason for the indication of a failure in the emergency lubrication system continues.

Footnote

[5] HUMS – Health and Usage Monitoring System which monitors and records vibration levels at various locations on the helicopter.

Published 13 May 2012

SERIOUS INCIDENT

Aircraft Type and Registration:	Antonov An-12BK, UR-DWF
No & Type of Engines:	4 Ivchenko AI-20M turboprop engines
Year of Manufacture:	1968 (Serial no 8345802)
Date & Time (UTC):	9 February 2012 at 1620 hrs
Location:	Birmingham Airport
Type of Flight:	Commercial Air Transport (Cargo)
Persons on Board:	Crew - 7 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Right wing suffered scratch damage
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	41 years
Commander's Flying Experience:	8,070 hours (of which 7,700 were on type) Last 90 days - n/k Last 28 days - 87 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot, an Occurrence Report by Birmingham ATC and a Ground Incident Report by the Airport Authority

Synopsis

Whilst negotiating a gap between parked aircraft under the guidance of a marshaller and two assistants, the aircraft's right wing struck the tailplane of one of the parked aircraft. The aircraft did not follow marshalling signals precisely and the marshaller and his assistants, one of whom was not trained in his assigned role, did not stop the aircraft before the collision had taken place. The gap provided less than the recommended minimum wing tip clearance.

Description of the event

The aircraft had just landed after a flight from Graz in Austria and was taxiing to its parking position. A marshaller and two assistants who were allocated to guide the aircraft had arrived on the apron in good time. The marshaller identified a suitable parking position although it entailed the aircraft taxiing through a gap between two parked aircraft, a Piaggio P180 to the left and a Lockheed L-100-30 Hercules to the right. There were no ground taxi markings on the apron.

As the aircraft entered the apron, the marshaller positioned himself between the two parked aircraft to attract the An-12 crew's attention and indicate the intended parking stand. Having done so, he turned and walked back to the head of the stand to continue marshalling. One assistant was placed on each side of the gap; the assistant on the right stood directly under the tail of the Hercules. The subsequent events were described in the Airport Authority's report, which drew on information from CCTV cameras, ATC surface movement radar and the marshaller.

As the marshaller indicated for the aircraft to taxi straight ahead towards the gap, it started to deviate to the right. The commander of the An-12 later stated that his initial concern was clearance from the P180 to his left. The assistant standing by the P180 signalled safe wingtip clearance, while the assistant under the tail of the Hercules made no gestures, which the crew took also to mean safe clearance also. Once the commander was satisfied with clearance to the left he straightened the aircraft.

The marshaller realised the close proximity of the An-12's right wing to the Hercules, and started giving signals to turn left, about 6 to 10 seconds before the An-12's wing struck the tail of the Hercules. The assistant under the tail of the Hercules had remained passive until immediately before the collision. The marshaller gave a 'stop' signal to the aircraft, but then after a short pause continued marshalling the aircraft ahead towards its parking position. Subsequent inspection revealed scrape marks on the under surface of the outer part of the An-12's right wing, where it had come into contact with the upper surface of the Hercules's horizontal tailplane. The Hercules suffered scratch damage to the upper surface of its left horizontal tailplane and was subsequently ferried, with specific approval, to a maintenance facility for repair.

The gap between the parked aircraft was subsequently measured at 42.4 m, while the wingspan of the An-12 was 38 m, giving a clearance of only 2.2 m each side. However, the marshaller had been confident that the aircraft could safely pass through the gap. As the Airport Authority's report observed, Civil Aviation Publication 168, *Licensing of Aerodromes*, suggests a minimum clearance between a manoeuvring aircraft and any obstruction of 20% of wingspan, equivalent to 7.6 m each side in this case[1].

The Airport Authority's report revealed that the assistant under the tail of the Hercules was not trained for the wing tip guide role and acknowledged that the crew of the An-12 could reasonably expect both assistants to be trained wing tip guides. It was observed that, while the aircraft could have passed through the gap, the clearance was less than ideal.

Footnote

[1] CAP 168 actually states that the apron should be of such dimensions as to allow the stated clearance.

SERIOUS INCIDENT

Aircraft Type and Registration:	Boeing 757-21B, G-LSAI
No & Type of Engines:	2 Rolls-Royce RB211-535E4 turbofan engines
Year of Manufacture:	1987
Date & Time (UTC):	7 September 2011 at 1135 hrs
Location:	In the cruise, in Bulgarian airspace
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 7 Passengers - 219
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	38 years
Commander's Flying Experience:	10,232 hours (of which 3,611 were on type) Last 90 days - 178 hours Last 28 days - 53 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent AAIB enquiries

Synopsis

Whilst cruising at FL390 the aircraft's left AC electrical bus lost power, resulting in multiple flight instrument failures. After the flight crew completed the Quick Reference Handbook (QRH) drill for loss of power from the left generator, a thin haze of smoke and electrical fumes entered the flight deck. An attempt to power the aircraft's left AC electrical bus from the APU bus was unsuccessful and the aircraft diverted to Kavala Airport in Greece, where a normal landing was carried out. The source of the electrical fault with the left AC power generation system was traced to a corroded crimp terminal at the D1114J connector at the left pylon bulkhead. The source of the smoke that entered the flight deck was not positively identified.

History of the flight

The aircraft was on a flight from Leeds-Bradford Airport to Larnaca Airport, Cyprus and was established in the cruise at FL390. At 1135 hrs, approximately 2 hours and 50 minutes into the flight and whilst in Bulgarian airspace, the crew recalled observing L AC BUS OFF and L GEN OFF warning captions on the lower EICAS display, along with multiple failures of flight instruments. The commander completed the QRH drill for the L GEN OFF caption, which included resetting the left bus tie, after which power was momentarily restored before being lost again. The second power loss was associated with a thin haze of smoke and a strong smell of electrical burning in the flight deck. The crew responded by donning their oxygen masks and goggles. The commander declared a MAYDAY to ATC and an immediate descent and diversion was carried out to the nearest suitable airport, Kavala Airport in Greece, which was approximately 38 nm to the south. Two minutes after the left AC bus initially lost power the commander started the APU, which then powered the left AC electrical bus for a further 17 seconds before it lost power again. No additional attempts to supply power to the left AC bus were made and aircraft landed without further incident at 1156 hrs. During the final approach it was apparent that the fumes had dissipated and the passengers were disembarked normally.

Previous maintenance actions

The aircraft had experienced an 'L AC BUS OFF' event 13 flights prior to the incident flight and following inconclusive troubleshooting actions, the left integrated drive generator (IDG) was disconnected and the defect was transferred to the list of deferred defects in the aircraft's Technical Log. Subsequent investigations by the operator's maintenance personnel included wiring continuity checks in accordance with the aircraft's Fault Isolation Manual, replacement of the left Generator Control Unit (GCU) and the Bus Power Control Unit (BPCU), in addition to replacement of the circuit breakers for the left generator and the left bus tie. None of these actions were successful in resolving the defect.

On the morning of the incident flight, further maintenance troubleshooting was performed which revealed an open circuit at pin 12 between the D1014P plug, which mates with the D1114J bulkhead connector at the left pylon bulkhead, and the left IDG. The wiring loom between the D1014P plug and the left IDG was replaced and following a successful operational check, the left AC generator system was declared serviceable.

Post-incident maintenance actions

Following the incident, visual inspection of the circuit breaker for the left generator and the left bus tie was carried out, with no defects found, and the source of the smoke was not determined. Examination of the BPCU's built-in test equipment revealed that the fault messages LH GEN DP TRIP and MAIN BUS/OVERLAP ZONE had been recorded in the BPCU memory, indicating that the current demanded by the loads on the aircraft's left AC bus had not been detected to be in balance with the current output from the left IDG. The left GCU and the BPCU were replaced and the aircraft's engines were ground run for 45 minutes, during which the left and right AC power generation systems operated correctly and no electrical burning or smoke was apparent.

The aircraft was then ferried back to Manchester Airport with just a flight crew and two of the operator's maintenance personnel on board. Approximately 2 hours and 20 minutes into the flight, whilst cruising at FL380, the left AC bus again lost power and the crew observed L AC BUS OFF and L GEN OFF messages on the EICAS display. The crew reported no smoke or fumes following this event. They performed the QRH actions, which included starting the APU, and on this occasion the left AC bus remained powered from the APU bus and the aircraft was able to continue to Manchester Airport, where it landed uneventfully. Following this landing the crew attempted to reconnect the left AC generator to the left AC bus, and were successful. The BPCU's built-in test equipment was interrogated and once again it had recorded LH GEN DP TRIP and MAIN BUS/OVERLAP ZONE fault messages, as was the case for the previous incident.

Additional maintenance troubleshooting actions followed, which identified that pin 12 at the 30-way D1114J left pylon bulkhead connector was open circuit, and the central area of the connector's rear face was coated with soot. Disassembly of the connector revealed that the crimp terminals at pins 11 and 12 on the connector had parted from their wiring and the connector's backshell was loose, due to stripped threads. Pin 11 connects an earth shield to the left IDG's exciter field wiring, whilst pin 12 connects a winding around the 'A' output AC phase to the left generator differential protection current transformer, for use in fault sensing logic.

All the crimp terminals were renewed, the D1114J bulkhead connector was replaced with a new component and the electrical continuity of the associated wiring looms was checked, with reference to the Wiring Diagram Manual, and determined to be satisfactory. Following this maintenance action there was no further recurrence of a fault with the aircraft's left AC power generation system.

Inspection of the D1114J bulkhead connector

The D1114J bulkhead connector was sent to the AAIB for detailed examination. The connector holes at the pin 11 and 12 positions were blocked by crimp terminals that were pushed to the bottom of the connector; they were withdrawn (Figure 1) and examined using visual and scanning electron microscopy. Both crimp terminals showed that the multi-strand wire had completely parted within the crimped portion of the terminal and the exposed surface of the wire was heavily contaminated with black corrosion products. The wire end's surface had a rounded appearance, with no evidence of ductile overload. A significant quantity of dark-coloured powder was removed from inside the connector's holes by tapping the body of the connector. Analysis of the chemical composition of this powder revealed high levels of copper, carbon, silicate and oxygen, consistent with corrosion of the connector's internal components.

Figure 1

D1114J connector,
showing the detached crimp terminal at pin 12

Analysis

The cause of the intermittent disconnection of the left IDG from the left AC electrical bus was traced to a corroded crimp terminal at pin 12 of the left pylon's D1114J bulkhead connector. The backshell of the connector was loose due to stripped threads, probably caused during previous over-tightening and this defect allowed moisture to enter the connector, causing corrosion of the connector's internal components. The loose backshell also prevented support of the connector's wiring loom, which allowed the loom to vibrate during flight, promoting mechanical damage of the individual wires at their point of attachment to the crimp terminals.

Loss of electrical continuity at pin 12 caused the left IDG's differential protection current transformer to erroneously sense that the 'A' output AC phase carried zero current, causing the left GCU, via logic within the BPCU, to disconnect the left IDG from the left AC bus. The intermittent nature of the connection, due to corrosion within the crimp terminal, made isolation of the defect difficult to diagnose and following two occurrences of an in-flight loss of left AC power, the defect cleared and the aircraft produced left AC power during subsequent ground running.

During the initial loss of left AC power 13 flights prior to the incident flight, no electrical smell was apparent to the flight crew, nor was it on the return flight to Manchester Airport. It is therefore probable that the presence of an additional factor was required to cause the electrical overheating fumes experienced prior to the diversion to Kavala Airport. Following the incident, inspection of the components associated with the left AC power generation system, other than the D1114J connector, did not reveal any visible electrical overheating damage that would indicate a component fault. However, loss of electrical continuity at pin 11 of the D1114J connector, as determined from examination of the crimp terminal, disconnected the earth shield from the left IDG's exciter field power supply wiring. It is therefore possible that electromagnetic interference could have affected the exciter field voltage and, in turn, the left IDG output AC voltage. The aircraft manufacturer confirmed that a reduction in AC voltage can cause fuselage-mounted electrical motors and transformers to overheat, resulting in a hot electrical smell and possibly light smoke, but without leaving any visible evidence once these components have subsequently cooled.

SERIOUS INCIDENT

Aircraft Type and Registration:	DHC-8-402 Dash 8, G-JECF
No & Type of Engines:	2 Pratt & Whitney Canada PW150A turboprop engines
Year of Manufacture:	2004
Date & Time (UTC):	11 September 2010 at 1845 hrs
Location:	On approach to Exeter Airport, Devon
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 49
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	44 years
Commander's Flying Experience:	3,050 hours (of which 1,560 were on type) Last 90 days - 77 hours Last 28 days - 20 hours
Information Source:	AAIB Field Investigation

Synopsis

During approach the aircraft experienced a failure of the number 1 Input Output Processor (IOP 1). The flight crew became distracted with this failure and were unaware that the altitude select mode of the flight director had become disengaged and that the aircraft had descended below its cleared altitude. Descent continued until, alerted by an EPGWS warning, the pilots climbed the aircraft and re-established the glidepath. The investigation found that the IOP 1 failure was caused by intermittent electrical contact arising from cracked solder on two pins of a transformer on the IOP power supply module. It was further determined that there was a lack of appropriate operational guidance available to flight crews to deal with such avionics failures. Three Safety Recommendations have been made.

History of the flight

The crew reported for duty at 1135 hrs to fly four sectors, beginning and ending at Exeter Airport. The first three sectors passed without incident and the aircraft took off at 1727 hrs for the last sector, from Bergerac. There were no apparent defects and the commander was the handling pilot.

After an uneventful flight the crew began their approach to Exeter Airport. They were cleared by ATC to descend to an altitude of 2,600 ft, the sector MSA, and given radar vectors to position the aircraft for an ILS approach to Runway 26. The crew reported that the aircraft was being flown with the autopilot engaged, the approach mode of the flight director armed and descending in the vertical speed mode. When passing an altitude of approximately 3,300 ft the flight crew noticed that the IOP1 FAIL annunciator on the engine display (ED) was illuminated. They also noticed that the commander's speed bugs and minimum descent altitude setting on his primary flight display (PFD) had been replaced with white dashes, whilst the co-pilot's PFD indications remained normal. The commander attempted to regain indications on his PFD by switching the air data computer (ADC) source selector from the NORM position to ADC 2. When this had no apparent effect he reselected NORM. The commander realised that by changing ADC selection the approach mode had become disarmed and so, on re-selecting NORM, he also re-armed the approach mode. Having no speed bug information on his side, the commander then decided to hand control to the co-pilot for the landing. The horizontal situation indicator selector (HSI SEL), which is normally selected to the handling pilot's side, remained selected to the commander's side. The pilots considered this would not affect the operation of the aircraft at that stage of the flight. The crew commented, after the event, that when the HSI selection is changed it requires the lateral and vertical navigation modes of the flight director (FD) to be re-selected.

Shortly after the co-pilot took control, a GPWS 'CAUTION TERRAIN' alert sounded. Both pilots had been trying to resolve the IOP 1 failure and on hearing the caution looked up. They stated that they were in VMC and could see clearly the runway ahead. Within a few seconds of the initial caution a GPWS 'TERRAIN TERRAIN, PULL UP' warning sounded. The co-pilot stated that he disengaged the autopilot and advanced the power levers to about 80% power and began climbing the aircraft at a pitch angle of approximately five degrees. He commented that he was confident that this pitch angle would be adequate to provide terrain clearance under the circumstances.

The co-pilot's reaction to the GPWS warning coincided with ATC asking the crew to confirm they were descending with the glideslope. The commander had by then realised that the ALT SEL function of the FD had become deselected, allowing the aircraft to descend below the selected altitude. He informed ATC that the aircraft had had an instrument failure and that it was climbing to capture the glideslope. The aircraft climbed to 2,200 ft and captured the glideslope before landing without further incident at 1851hrs.

Weather

The crew reported that the weather had been "good" at the time of the incident and VMC prevailed throughout the approach. Official night was at 1909 hrs, about 25 minutes after the GPWS warning, and the crew described the light conditions at the time as dusk, with the ground clearly visible.

Exeter ATIS, timed at 1820 hrs, reported the following conditions:

Wind:	290º/10 kt
Visibility:	in excess of 10 km
Cloud:	FEW at 2,500 ft
Temperature/dew point:	17/13ºC
QNH:	1016 Mb

Flight recorders

The aircraft's flight data recorder (FDR) contained information from the incident flight. Recordings of the flight on the cockpit voice recorder (CVR) had been overwritten with more recent recordings because it had not been isolated.

Figure 1 shows the salient parameters recorded on the FDR during the incident flight. The figure starts at 1849 hrs with the aircraft descending and the autopilot engaged with HEADING, ALTITUDE SELECT and VERTICAL SPEED modes of the FD selected. The selected altitude was 2,600 ft and the selected vertical speed was -500 ft/min.

At 1849:31 hrs the FDR recorded an ADC reversion in which all the selected FD modes disengaged and the FD reverted to PITCH HOLD AND ROLL HOLD[1]; the selected vertical speed also reset to zero. Five seconds later HEADING mode was reselected.

Approximately 15 seconds later the power levers were retarded, causing the airspeed to start reduce while the aircraft continued to descend. As the aircraft passed through 2,600 ft the HEADING mode was deselected for 2 seconds and, as the bank angle was now less than 6º, the autopilot reverted to WINGS LEVEL mode. The HEADING mode was then reselected again followed by flap 5.

After a further 25 seconds, at 1850:37 hrs, during which the aircraft had descended to 2,185 ft amsl (1,680 ft agl) and slowed to 162 kt CAS, the flight director mode changed from HEADING to LOCALISER. It remained in LOCALISER mode for 37 seconds, during which the aircraft continued to descend and slow down. During this descent, at 1851:00 hrs, a GPWS "CAUTION TERRAIN" aural alert sounded for 1 second. The aircraft was passing 1,759 ft amsl (1,066 ft agl), and indicating a deviation of approximately ¾ of a dot below the glideslope. At 1851:09 hrs the HSI SEL button was selected to the right side, resulting in the localiser mode being cancelled. The aircraft then reverted to WINGS LEVEL mode for 2 seconds until the HDG mode was selected. The aircraft maintained a continuous deceleration during the decent, with the power lever position remaining unchanged for approximately 55 seconds until the GPWS 'pull up' warning sounded. The minimum airspeed recorded was 146 kt CAS[2]. Shortly afterwards the power was increased and the aircraft started to accelerate but continued to descend.

At 1851:14 hrs the GPWS "TERRAIN TERRAIN, PULL UP" aural warning sounded and continued for 12 seconds. The aircraft started to climb within 9 seconds of the initiation of this warning. The flaps remained extended at flap 5 throughout the climb and the minimum altitude recorded was 1,417 ft amsl (700 ft agl), when the aircraft was approximately 8 nm from touchdown.

Aircraft information

The aircraft experienced an IOP failure during the approach. There are two IOPs installed on the aircraft, and these are part of the Flight Data Processing System (FDPS), which is responsible for acquiring data from various aircraft systems and sensors and routing this data to other aircraft systems. These include the Electronic Instrument System (EIS) (which displays primary flight data, navigation, engine and system parameters on five liquid crystal Display Units (DU) in the cockpit), the Flight Data Recorder (FDR), the Autopilot (A/P), the Stall Warning and the Traffic Collision Avoidance System (TCAS). A failure of one or both IOPs can result in a loss of some cockpit indications.

Footnote

[1] Flight director mode reversion is described in the section '*Flight director control*'.

Footnote

[2] The *'Normal procedures – approach and landing'* section of the Operations Manual stated that the normal speed for flap 5 at that stage of the approach was 170 kt. It also stated that the minimum manoeuvring speed should be V_{REF} FLAP 5 +10 kt, which at the estimated aircraft weight was 143 kt.

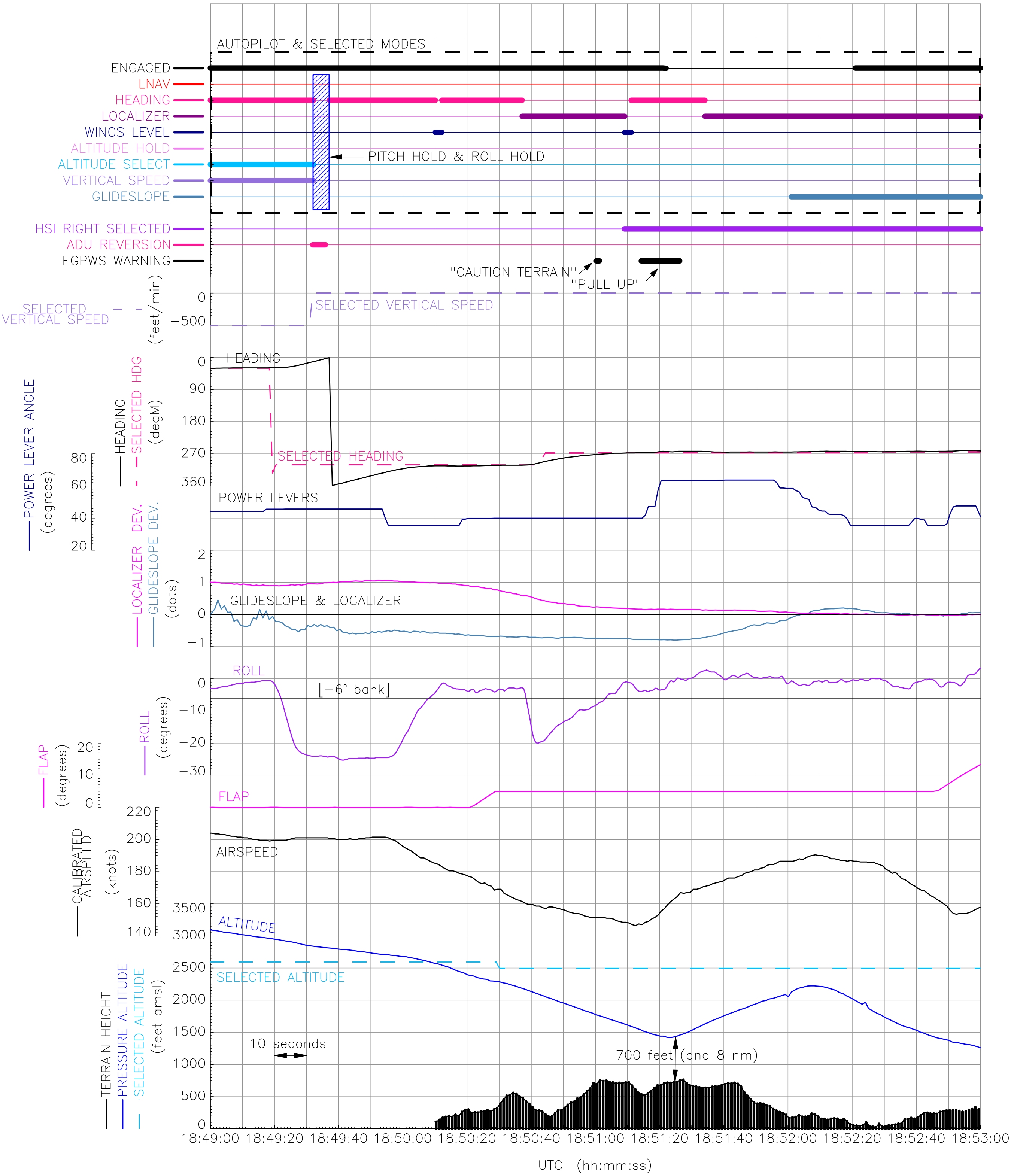

Figure 1

Salient FDR parameters

IOP failure modes

When an IOP is confirmed failed the caption IOP 1 FAIL or IOP 2 FAIL is displayed as an advisory message on the Engine and System Integrated Display (ED) (IOP S FAIL is displayed if both are failed). This caption is generated if there is a loss of transmission between the IOP and the active ED greater than 10 seconds duration, due to a wiring malfunction or automatic shutdown of the IOP upon an internal error. It also displays if the IOP status is set to FAIL by the opposite IOP due to failure of the IOP input / output interface. The AVIONICS CAUTION light will also illuminate on the overhead warning and caution panel, but only when the aircraft is on the ground and aircraft speed is less than 50 kt. There are no flight crew procedures for ED advisory messages relating to avionics failures such as an IOP failure, but maintenance action is required prior to dispatch of the next flight.

In the event of an IOP failure, several cockpit indications are lost. All the parameters which are only acquired by one, rather than both, of the IOPs, will be lost if the respective IOP fails. For an IOP 1 failure these include: left fuel inlet temperature (displayed on the ED); left main oil pressure (displayed on the ED); and hydraulic quantity for systems No 1 and No 3 (displayed on the MFD). For an IOP 2 failure they are: right fuel inlet temperature (displayed on the ED); right main oil pressure (displayed on the ED); and hydraulic quantity for system No 2 (displayed on the MFD). In addition to these, other cockpit indications may also be lost, depending on the precise nature of the fault that has caused the IOP to register a fail status. The associated cockpit effects may include, but are not limited to: the loss of speed bugs (displayed on the PFD airspeed indicator); loss of Decision Height (DH) and Minimum Descent Altitude (MDA) (displayed on the PFD) indications; inadvertent aural warnings; a CAT 2 FAIL advisory message; and the loss of the "MINIMUMS-MINIMUMS" callout during approach.

The FDPS system performs Power On Start-up Tests (POSTs) and performs a continuous test routine during operation. Any failures which effect the functioning of the FDPS are stored in the Built-in Test Equipment (BITE) memory and transmitted to the Central Diagnostic System (CDS).

Defect history

The IOP unit installed in position 1 at the time of the incident was Serial Number (S/N) 364. A review of the aircraft technical log and the operator's recurrent defects database shows that the recent defect history commenced on 22 August 2010 when an entry was made indicating that an IOP 1 FAIL had occurred. Maintenance troubleshooting was carried out in accordance with the manufacturer's Fault Isolation Manual (FIM) and an operational test of the IOP was performed in accordance with the Aircraft Maintenance Manual (AMM). No fault codes were generated and the aircraft was returned to service.

The next entry reporting an IOP 1 FAIL refers to the incident flight on 11 September 2010. The relevant circuit breaker was reset and an operational test of the IOP generated normal indications. The aircraft was released to service with a request for further reports from flight crew.

Two further reports of IOP 1 FAIL were made on 20 September 2010. After the first occurrence, no faults were noted in the CDS and an operational test of the IOP revealed no faults. In response to the second occurrence the IOP 1 unit (S/N 364) was swapped into the IOP 2 position for further reports. The operational test was carried out again with no findings, and the aircraft was released to service with S/N 364 in IOP 2 position.

An occurrence of IOP 2 FAIL was reported on 23 September 2010. This was not noted in the technical log because a removal and re-application of electrical power to the system, performed on the ground by the flight crew, caused the indication to disappear.

A further report of an IOP 2 FAIL was noted on 1 October 2010, after which the operational test was carried out satisfactorily and the unit was re-installed.

On 7 October 2010 an IOP 2 FAIL was reported. The IOP units were again swapped into the opposite positions for fault-finding during the troubleshooting. All tests were performed satisfactorily, and the units were swapped back again prior to release of the aircraft to service, with S/N 364 in the IOP 2 position.

On the 8 October 2010 another occurrence of IOP 2 FAIL was reported. Subsequent troubleshooting confirmed a fault and S/N 364 was removed from the IOP 2 position and replaced. The removed unit was then sent to the vendor's overhaul facility for testing and repair.

IOP reliability

The operator reported that 'IOP fail' indications are common events on their Dash 8 Q400 fleet. While they are considered to be a cause of operational delays, due to the requirement for maintenance intervention prior to dispatch of the next flight, IOP removals do not feature among the most frequent component removals on the fleet. Only approximately 20% of 'IOP fail' reports result in a confirmed failure and subsequent removal of the unit from the aircraft. In the majority of cases, the operator's experience is that resetting the relevant circuit breaker or re-installing the unit appears to solve the problem, and the unit remains in service. Many reports refer to isolated events. Where multiple reports for the same unit are received, these units may operate normally for several weeks or months between indicated failures.

The operator has noted that a number of IOP units removed and sent to the vendor for repair after the faults were confirmed during maintenance troubleshooting, have been returned with the statement 'No Fault Found (NFF)' but subsequently continued to cause problems when reinstalled on an aircraft. As a result, the operator had adopted a process of tracking the serial numbers of suspect units. After the third occasion on which a particular unit is faulted on an aircraft but no faults are detected during workshop testing, it is designated as a 'rogue' unit and not permitted back into the operator's spares inventory. At the time of the incident, the operator had identified three rogue units in this way. From a review of the operator's records there was no indication that the incident unit, S/N 364, had been removed for vendor testing or repair prior to its removal on 8 October 2010.

The IOP manufacturer is aware of the issues reported by the operator and in 2010 established an NFF Task Force for 'repeater' units which repeatedly test NFF in the workshop but continue to cause problems when returned to service. The manufacturer has developed an action plan to detect faults which cannot be reproduced during Acceptance Test Procedures (ATP) in the workshop. These actions consist mainly of visual inspection of the electronic boards for signs of corrosion, dust, impact, missing varnish or solder and visual inspection and vibration testing of sensitive components such as connectors. Through this process, a number of weak components have been identified which can be considered common contributors to IOP failures. One such component is the secondary power supply module on the IOP CPU board, known as the ERACLE module.

Of 34 unscheduled IOP removals from the operator's Dash 8 fleet between March 2007 and August 2010, 10 units satisfactorily passed the ATP and were returned to the operator as NFF. Seven units (including three which had previously tested NFF) required replacement of components on the ERACLE secondary power supply module. In the 12-month period to the end of October 2010, there were 17 unscheduled IOP removals, including S/N 364.

Operator tracking of recurrent defects

The operator monitors repetitive defects for their entire fleet via a spreadsheet which is manually updated daily based on defects reported in the previous day's technical log sheets. It also uses an electronic technical log system, which generates an automated alert if a particular defect has occurred 3 times within a rolling 21-day period. This system generally operates with a time lag of a few days, due to delays associated with data entry, limiting the efficacy of the alerting function. Also, nuisance alerts are common. The operator therefore considers that the repetitive defect spreadsheet is the primary tool for monitoring and reporting repetitive defects within the organisation. Quarterly 'Reliability' meetings held by the company are attended by representatives of the Civil Aviation Authority (CAA), as part of their operator oversight function. The CAA consider that the processes in place for the monitoring of recurrent defects are adequate.

IOP Testing

The removed IOP was sent to the manufacturer's repair facility where extensive testing was performed in consultation with the AAIB and under the supervision of the French 'Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile' (BEA).

Analysis of the IOP Non Volatile Memory (NVM) memory content showed that the CDS recorded two internal IOP failures at 18:46 hrs on 11 September 2010, corresponding to the time of the incident, and again on 20 September 2010, corresponding to the subsequent IOP failures reported in the technical log. The unit was tested in accordance with the manufacturers ATP to determine the cause of these failures. This is a test programme used in production and maintenance to identify hardware failures and requires a series of functional tests to be performed on the unit on a test bench. The unit initially tested 'No Fault Found.' As it was not possible to reproduce the IOP failure on the test bench it was considered that an intermittent fault may exist so a further more robust and iterative test schedule was devised and performed on a dedicated systems test rig, to simulate the aircraft environment and flight conditions during the incident. The IOP was subject to long operating periods and varying temperatures on the test rig; an ATP test was also performed before and after each temperature endurance test. Following many iterations of these tests, an intermittent fault was identified. The unit subsequently failed Part 2 of the ATP which specifically tests the IOP power supply, and this pointed to a problem with the ERACLE secondary power supply module. The fault was also successfully repeated at ambient temperature. During further testing the fault became permanent, rather than intermittent and was traced to the -15 V DC output of the ERACLE module.

An X-ray examination of the ERACLE secondary power supply module revealed cracks in the solder of some of the surface-mounted components on one of the electronic boards, in particular the pins of the TR1 transformer. It was concluded that the cracked solder would have caused intermittent electrical contact in the -15 V DC power supply path and led to the intermittent fault on IOP S/N 364 experienced during the incident flight and repeated during subsequent testing.

Flight director control

The flight director (FD) and autopilot (AP) are functions of the AFCS. The FD function provides lateral and vertical guidance to fly the aircraft, displayed in the form of a vertical and horizontal bar on each pilot's PFD. The pilot can manually fly the displayed commands or engage the AP which couples the FD guidance to the aircraft control surfaces for automatic control of the aircraft. Pilots manage the flight director and autopilot engagement using a flight guidance control panel (FGCP) mounted in the centre of the glare shield above the main instrument panel, and via two buttons on each pilot's control wheel.

The status of the FD is displayed on the flight mode annunciator (FMA) at the top of each PFD. The FMA has three fields. Vertical guidance modes are indicated in the right hand field and lateral modes in the left hand field. The modes appear in white if armed and in green if active. A mode is considered to be engaged only when it is indicated on the FMA, not just when the associated pushbutton has been pressed. It is vital that pilots monitor the FMA in response to each selection on the FGCP or control wheel.

Altitude Select mode

In the ALTITUDE SELECT mode the FD provides commands to acquire and hold a selected altitude target. It has ARM and CAPTURE sub-modes. To operate the ALTITUDE SELECT mode, pilots must pre-select an altitude target using the ALT knob, press the ALT SEL pushbutton to arm the mode and manoeuvre the aircraft towards the pre-selected altitude target using a FD vertical mode.

When armed, the symbol 'ALT SEL' appears in white on the FMA. If the ALTITUDE SELECT mode is not armed, the aircraft will continue through the selected altitude in the active vertical mode unless either pilot intervenes to change the flight path.

Vertical modes

The aircraft can be manoeuvred vertically in several modes using the FD and AP. The pilots of G-JECF used the VERTICAL SPEED mode to descend the aircraft towards the selected altitude of 2,600 ft. This mode is activated by pressing the VS pushbutton on the FGCP and indicated by the symbol 'VS' in green in the right hand field of the FMA, when active. The desired vertical speed is selected using the pitch thumbwheel in the centre of the FGCP, and is indicated beside the 'VS' symbol in the same FMA field.

With the AP engaged, and in the absence of further pilot inputs or system failures, as the aircraft approaches the selected altitude, the FD will change automatically to the altitude capture mode and the symbol 'ALT*' (referred to by this operator as 'altitude live') will appear in green on the FMA. As the aircraft levels at the selected altitude, the FD will change automatically to the ALTITUDE HOLD mode and the symbol 'ALT' will appear in green on the FMA.

If, before the FD enters a capture mode, the altitude selection is changed to one above the current aircraft altitude, or if the altitude select mode is disengaged, the aircraft will continue to descend in the active vertical mode until the pilots intervene to change the flight path.

Vertical basic (pitch hold) mode

The PITCH HOLD mode is the default basic vertical guidance mode and is activated in the case of an ADC reversion; when any other active vertical mode is de-selected by the pilot; if the AP is engaged and no other vertical mode is active; or when a lateral mode is active and no other vertical mode is active. In this mode the FD provides commands to hold a target pitch attitude; the pitch target is initially set to the aircraft pitch attitude that exists when PITCH HOLD is activated.

Lateral modes

The aircraft can be manoeuvred laterally in several modes using the FD and AP. The pilots of G-JECF used the HEADING SELECT mode to acquire and hold a selected heading target, as they positioned the aircraft to acquire the ILS localiser and glideslope signal. This mode is activated by pressing the HDG SEL pushbutton on the FGCP and indicated by the symbol 'HDG SEL' in green in the left hand field of the FMA, when active. The desired heading is selected using either the left or right HDG knobs on the FGCP, depending upon which PFD is coupled to the FD.

Lateral basic modes

The default lateral basic mode is activated if the AP or a vertical FD mode is engaged when no other lateral mode is active. There are three sub-modes, which automatically transition when the appropriate flight conditions are met. In the ROLL HOLD sub-mode the FD commands to hold a target roll attitude, equivalent to the bank angle at the time of mode engagement, and is selected if the roll angle is greater than 6°. In WINGS LEVEL sub-mode the FD commands to hold a zero degree bank angle, and is selected if roll angle is less than greater than 6°. In the HDG HOLD sub-mode the FD commands to hold a target heading, equivalent to the heading at the time of mode engagement, and is selected if the roll angle is less than 3° for 10 seconds.

ILS Approach mode

The ILS APPROACH mode is a combined lateral and vertical mode in which the FD captures and tracks the ILS localiser (lateral) and glideslope (vertical) beams. When an appropriate ILS frequency is tuned and selected as the navigation source, the GLIDESLOPE sub-mode (and, simultaneously, the LOCALISER sub-mode) is armed by pressing the APPR pushbutton on the FGCP and indicated by the symbol 'GS' in white on the FMA.

As the aircraft approaches the ILS glidepath, the FD will change automatically to the GLIDESLOPE CAPTURE mode and the symbol 'GS*' (referred to by this operator as 'glideslope star') will appear in green on the FMA. Having intercepted the glideslope beam, the FD will change automatically to the GLIDESLOPE TRACK mode and the symbol 'GS' will appear in green on the FMA. If the vertical path of the aircraft remains below the ILS glideslope, the FD will not be able to capture the glideslope and the aircraft will continue to descend in the active vertical mode unless the pilots intervene to change the flight path.

For an ILS approach, the position of the aircraft relative to the localiser and glideslope beams is also presented on separate localiser and glideslope deviation scales on the PFD. Deviation from the glideslope and localiser course is expressed in terms of 'dots' (eg the aircraft may be described as being 1 dot left or right of localiser or 1 dot above or below glideslope). This display is commonly referred to as 'raw data.'

Flight director source selection

The HSI SEL pushbutton on the FGCP selects which PFD (1 or 2) is coupled to. Pressing the HSI SEL pushbutton switches from the left side system inputs displayed on the pilot's PFD, to the right side system inputs displayed on the co-pilot's PFD and vice versa. The HSI SEL is selected to the side of the handling pilot before the flight. The selected side is indicated by illuminating the corresponding arrow next to the HSI SEL button. The selected side is also indicated on the non-selected PFD by an HSI caption plus and arrow. If the dual FD mode is active, both the left and right side arrows adjacent to the HSI SEL pushbutton are illuminated and pressing HSI SEL has no effect. Pressing the HSI SEL pushbutton has the following effect on the AFCS: no effect on AP / yaw damper engagement; clears all the active and armed lateral and vertical FD modes, and removes the FD bars if the AP is not engaged; clears all the active and armed lateral and vertical FD modes if the AP is selected. The FD modes revert to basic modes and the FD bars remain.

Enhanced ground proximity warning system (EGPWS)

The EGPWS monitors the flight path of the aircraft and compares aircraft position, attitude, airspeed and glideslope inputs with internal terrain, obstacle and airport databases to determine if the present flight path would result in impact with terrain and, if so, will provide visual and aural indications to alert the pilots. The EGPWS provides the indications well ahead of the projected collision with terrain. In the event that a caution or warning alert is triggered, an automatic display of the terrain feature on the MFDs is activated.

When the conditions have been met to generate a Terrain Caution Alert, the "CAUTION TERRAIN, CAUTION TERRAIN" audio alert is triggered, the TERRAIN CAUTION light is illuminated and the background image on the terrain display on the MFD is enhanced to highlight the terrain caution threats. The audio alert is repeated after seven seconds if the aircraft is still within the terrain caution envelope.

When the conditions have been met to generate a Terrain Warning Alert , the "TERRAIN TERRAIN, PULL UP" audio alert is triggered, the TERRAIN WARNING light is illuminated and the background image on the terrain display is enhanced to highlight the terrain warning threats. The phrase "PULL UP" is then repeated continuously while within the terrain warning envelope.

Standard operating procedures (SOPs)

Part B4 of the operator's operating manual makes several references to the importance of monitoring the flight path of the aircraft. Section 2.4 includes the statement:

> *'PF's[3] main task is to fly the aircraft and monitor its flight path. PNF[4] must also monitor the aircraft flight path wherever possible whilst carrying out his other tasks.'*

Abnormal and Emergency Procedures

Division of responsibility

Chapter 2 of Section 3 of the Dash 8 Q400 Operating Manual prescribes the division of responsibility between the two pilots when dealing with abnormal and emergency procedures. It states that the pilot flying remains responsible for the safe navigation of the aircraft '*in three dimensions*'. It also identifies that the pilots may need to change role, should the failure result in the loss of instruments on the side of the pilot flying.

Footnote

3 Pilot flying.
4 Pilot not flying.

IOP failures

The operator publishes its own version of the manufacturer's QRH which it refers to as the Emergency Checklist (ECL). The ECL largely resembles the QRH but is not necessarily identical. Section 25B of the ECL refers to Engine Display advisories (Figure 2). Issue AL-17 of this page, dated April 2010 was valid at the time of the incident and contained no information on either single or dual IOP or IOM failures, other than to advise that the avionics caution light would illuminate when the aircraft was on the ground. The equivalent manufacturer's QRH also contained no information on these failures at that time.

The operator considered information regarding avionics failures annunciated on the engine display (ED) screen was not suitably comprehensive and raised the matter with the aircraft manufacturer, prior to this incident, in July 2009 at a meeting of the manufacturer's Flight Operations Steering Committee.

The manufacturer subsequently amended Chapter 6 of the QRH to include enhanced information about dual IOM and IOP failures, but did not include information regarding single IOP failures. This revision of the QRH was published in October 2010, and the relevant extract is shown in Figure 3.

Following the incident, the operator reported that early in 2011 they had, on the ground, replicated the effects of failing each IOP in turn and also both together by pulling the relevant IOP circuit breakers. They stated that the resulting individual IOP failures produced a significant loss of information on the on-side PFD. They stated that, significantly, an IOP 1 failure caused the disappearance of ALTITUDE SELECT mode together with all other lateral and vertical FD modes and the left side landing speed bugs. They reported that failure of IOP 2 did not cause a loss of ALTITUDE SELECT mode, but did result in the loss of the active and armed lateral and vertical FD modes. Additionally they reported that failure of both IOPs caused an even more significant loss of cockpit indications, this being greater than the sum of the individual IOP failures observed.

The IOP manufacturer subsequently reported to the investigation that the circuit breaker pulled by the operator is common to IOP 1, IOM 1 and Flight Guidance Module 1 (FGM 1) and advised that it was not possible to replicate the individual effects of an IOP 1 failure by this means. The IOP manufacturer further stated that this explained the loss of ALTITUDE SELECT mode observed by the operator during ground testing.

Believing that the extent of the observed loss of indications, both in the case of individual and dual IOP failure, was not fully reflected in the manufacturer's amended QRH caused the operator to register a technical query (CNAG-Q11-8126308) with the manufacturer on 22 March 2011.

This requested a review of the drills for failure of either IOP 1 or IOP 2 and for both IOP 1 and 2 and highlighted the fact that the loss of ALTITUDE SELECT mode with a failure of IOP 1 or both IOPs together was not mentioned in the relevant drills. In their response, dated 5 April 2011, the manufacturer stated that they were:

> *'investigating all mode failures relating to IOM/IOP and will amend the QRH accordingly.'*

The operator did not include in their ECL the changes relating to IOP failures published by the manufacturer

HOT DISPLAYS or FANS FAIL on ED

- Two or more displays are hot or two or more fans have failed
- Land at nearest suitable airport

ENGINE DISPLAY ADVISORIES

- For an ED message of DU BAD CONFIG – Refer to QRH Supplemental Procedures page 3.5-6.
- If any of the following advisory messages appear on the ED, maintenance action is required prior to next flight:

⇒ **Avionics Caution Illuminated:**

IFC Messages:
IOP1 / IOP2 / IOPS FAIL
IOM1 / IOM2 / IOMS FAIL
WTG1 / WTG2 / WTGS FAIL– Refer to QRH Page 6/7
WOW/IOP1 FAIL or WOW/IOP2 FAIL or WOW/IOPS FAIL
IOP BAD CONF

Display Messages:
FANS FAIL – Land at nearest suitable airport
HOT DISPLAYS – Land at nearest suitable airport
ED MON FAIL
PFD1 / PFD2 / PFDS MON FAIL
HOT PFD1/2
HOT MFD1/2
HOT ED

NOTE; Avionics Caution light illuminates on the ground only.

⇒ **Avionics Caution NOT Illuminated:**

IFC Messages:
GPWS I/F FAIL
RA1/RA2/RAS FAIL

Powerplant Messages:
POWERPLANT - Refer to QRH Supplemental Procedures page 3.5-9
FADEC1/DU or FADEC2/DU or FADECS/DU

Display Messages:
PFD1/2 LINK FAIL
MFD1/2 LINK FAIL

CHECK ED

Note: There is a discrepancy between displays of one or more display parameters which has been detected by an MFD.

- MFD 1 .... ENG

If CHECK ED remains lit:

- MFD 1 .... As required and monitor ED
- Report to maintenance

AL:17 400 Series **25B**

Figure 2

FlyBe ECL Section 25B (rev A/L 17)
Engine Display advisories

IOPS FAIL (ED)

(Both avionics data Input/Output Processors have failed)

Lost Services:

Stall Warning and Stick Pusher
Warning Tones and Audible Alerts
VHF Nav 1 and 2 Course Deviation and Bearing Pointers
DME 1 and 2 Distance
ADF 1 and 2 Bearing Pointers
FMS 1 and 2 Course Deviation, Distance, Track and Bearing Pointers
Radar Altitude Indication
Weather Radar Display
EGPWS Terrain Display and Audible Warnings
TCAS Traffic Display, TA/RA Advisories and Audible Advisories
ATC Mode S

– Establish and use alternate means to determine aircraft position in order to navigate and to ensure required clearance from terrain, obstructions, convective weather and other aircraft is maintained.

Note: *Avionics Caution light will illuminate after landing.*

IOP1 FAIL or IOP2 FAIL (ED)

(The indicated avionics data Input/Output Processor has failed)

– Maintenance action required prior to next flight.

Note: *Avionics Caution light will illuminate after landing.*

MFD1 LINK FAIL or MFD2 LINK FAIL (ED)

(The EIS is no longer able to monitor information displayed on the indicated MFD for errors)

– Maintenance action required prior to next flight.

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Figure 3

Bombardier QRH
(Oct 2010) - IOP failures

in October 2010, but stated that they would be amending this section of the ECL after further enquiries. The next revision of the ECL was planned for publication in October 2011. They did, however, publish a technical update to crews in July 2011 with information relating to IOP failures and stating their intention to update the ECL.

GPWS Procedures

Section 8.3 of the operator's General Manual provides information on GPWS procedures. This section includes the following statement, in bold type:

> *Note: Care must be taken when re-setting altitude alerting devices which form part of the aeroplane's Automatic Flight Control System (AFCS) in order to prevent any unplanned aeroplane excursion from its desired flight path.'*

It further states:

> *'GPWS/EGPWS Warnings* ***must never be ignored.***
>
> *An immediate and positive response must be made to all EGPWS alerts and warnings. Flight crews must beware of becoming slow to react to EGPWS alerts or warnings on the basis of previous suspect performance or over familiarity with a particular area or approach to an aerodrome.'*

The section also instructs:

> *'a full-energy EGPWS pull-up manoeuvre must always be flown if a hard warning is received, unless all the following criteria are met:*

- *Below 1,000ft AAL*
- *Clear visual conditions*
- *Runway in sight*
- *Established on the final approach track*
- *Established on the correct vertical profile as confirmed by an electronic glideslope or visual indicator (eg VASI/PAPI)*
- *Stabilised in the landing configuration with approach power set*
- *It is immediately obvious to the flight crew that the aircraft is in no danger in respect of its configuration, proximity to terrain or its current flight path.'*

In addition, section 27A of the ECL refers to GPWS events[5], and is shown in Figure 4.

Operator's accident and incident handling procedures

Part A, Section 12 of the operator's Operations Manual relates to the handling of accidents and incidents.

Section 11.2 gives guidance on the actions to be taken by a commander and the logistics department in the event of an accident. Section 11.3 gives guidance on air safety and mandatory occurrence reporting. Section 11.1.11 defines a serious incident and gives various examples, including '*Controlled flight into terrain (CFIT) only marginally avoided*'; however, neither section 11.2 or 11.3 refers directly to how serious incidents should be handled.

Section 11.3 requires the commander to send any incident report to the Flight Safety Department via the operator's internal electronic system. These reports are then distributed for investigation by Central Safety, a position manned by an administrator within the Flight Operations Department during normal office hours. The Operations Manual instructs that outside office hours the Logistics Duty Manager should communicate any issue of an '*urgent Flight Safety nature*' to the Flight Operations General Manager. The manual does not make clear how, in these circumstances, the Logistics Duty Manager would become aware of any such event.

Section 11.2.1 'Action by Commander and Logistics Department' includes a list of subsequent actions to be taken. This includes the instruction that:

'Following an accident or incident in which it is necessary to contact the Chief Inspector of Accidents, the crew are immediately grounded. No allocation of blame is attached to this automatic procedure which can only be lifted by the Chief Pilot, or in his absence the Fleet General Manager.'

Section 11.4 refers to the preservation, production and use of FDR and CVR recordings. The version in place at the time of the incident is reproduced below.

On 1 September 2010 the operator published Notice to Air Crew (NOTAC) 84/10, containing revised policy information on the preservation of CVR and FDR data. This was in response to information published by the CAA to all commercial operators as a result of AAIB Safety Recommendation 2010-012.

Footnote

[5] The GPWS go around attitude (GA Attitude) referred to in the checklist for this aircraft type, under the prevailing configuration, would have been nine degrees.

"WHOOP WHOOP, PULL UP"
OR
"TOO LOW TERRAIN" Note 1
OR
SEVERE WINDSHEAR - DESCENDING

Warning: Do not fly at stick shaker as a recovery technique

- Autopilot .... Disconnect
- Bank Angle.................................... Level Wings
- Condition levers .... MAXIMUM
- Power levers .... Detent

Pull up to achieve Max ROC (GA Attitude)

If continuing to descend or closing on terrain:

- Firewall Power
- Increase Pitch sufficiently toobtain positive separation from terrain (IAS not below V_2/V_{GA}

If stick shaker activates:

- Reduce pitch attitude sufficient to stop the shaker

When vertical flightpath is under control:

- Gear .... UP
- Speed .... V_2 Minimum
- Flaps .... As Reqd (Check V_{FRI})
- Altitude.......................... Check MSA & Altimeters
- ATC.. Inform

Note 1: *When prior warning of 'TERRAIN' is given on instrument approach plates due to the nature of the terrain, then pilots must positively Identify their position when warning occurs.*

OTHER GPWS WARNINGS

Aural Warning	Action
Glideslope	Stop descent, Regain glideslope
Too low gear / Flap	Check configuration
Minimums (CAT II)	Go around if not visual
Sink rate	Reduce ROD
Don't sink	Increase ROC and check power

GPWS Caution

GPWS

- Check GPWS CB (A1 on Left Avionics CB Panel)

27A 400 Series AL14

Figure 4

FlyBe ECL - GPWS Extracts

NOTAC 84/10

BACKGROUND

This NOTAC has been published in response to AAIB safety recommendation 2010-012. The recommendation concerns an incident where the investigation was hampered by unintentional overwriting of the cockpit voice recording, which erased information necessary to assist the investigation. The Cockpit Voice Recorder (CVR) is designed to record audio information when the electrical power is selected on the aircraft, and is designed to preserve either 30 minutes or 2 hours of audio information (depending on type). In the particular reported incident, because the system was not isolated to preserve the recording, the CVR continued to function during the subsequent maintenance activities following the event and therefore all the audio information relating to the event was lost. Evidence from other previous incidents identified that even where the Flight Crew had isolated electrical power to the CVR, subsequent maintenance or other activity may have reinstated the power supply resulting in the unintentional loss of the recording.

POLICY

Preservation of flight recorder information (CVR & FDR) is covered by the following

a) The Captain or in his absence the First Officer shall ensure, to the extent possible, in the event an aeroplane becomes involved in an accident or incident, the preservation of all related flight recorder records and, if necessary, the associated flight recorders, and their retention in safe custody pending their disposition.

b) In the absence of the Flight crew, the attending engineer needs to ensure that the above is followed.

c) Following an accident, the Pilots of an aeroplane on which a flight recorder is carried shall, to the extent possible, preserve the original recorded data pertaining to the accident, as retained by the recorder for a period of 60 days unless otherwise directed by the investigating authority. This is either the AAIB (Air Accidents Investigation Branch) or Flight Safety. When appropriate, the relevant circuit breakers should be pulled and collared/tagged and an entry made in the aircraft technical log to make clear to any airline personnel that an investigation is in progress. Furthermore, confirmation from the investigating authority/operator is required to be obtained before systems are reactivated and power restored. At stations where contract maintenance or ground handling is carried out by a third party, relevant departments should ensure that the contracted organisation is made aware of all the relevant procedures.

Chief Pilot

Reporting of the incident

After landing, the commander submitted an air safety report (ASR) via the operator's internal electronic network. The ASR was titled '*IOP 1 Failure Leading to Descent below Platform Altitude for the ILS and subsequent GPWS warnings*'. The FDR and CVR were not isolated, either by the pilots or engineering staff.

Two days later, on Monday 13 September 2010, Central Safety processed the ASR and allocated it to the Engineering Safety Department for action. It was also distributed to various other departments and managers for information, including the Chief Pilot, Flight Safety Department and relevant fleet managers. The Flight Safety Department had also been contacted on the same day by the commander who wished to discuss the event. It was as a result of this discussion that a decision was made not to remove the crew from flying duty. A copy of the flight data was also requested to be downloaded from the aircraft.

On Wednesday 15 September 2010 the Engineering Safety Department handed the matter over to the Flight Safety Department who, that afternoon, contacted the AAIB to report it as a serious incident.

On Friday 17 September 2010, having reviewed the flight data, it became apparent to the operator that the crew had not responded properly to the GPWS 'TERRAIN TERRAIN, PULL UP' warning. It was decided, as a result, to ground both pilots until they had undergone remedial training.

Flight Safety Department

At the time of the occurrence the operator's Flight Safety Department was led by a Flight Safety Manager supported by a Flight Safety Officer and a Flight Safety Co-ordinator. There was also a part-time administrative assistant. The department carried out safety functions, including the operator's flight data monitoring programme, covering 14 bases and 70 aircraft and over the 12 months preceding the incident had dealt with about 3,100 ASRs.

Previous occurrences

AAIB report EW/C2008/12/05 concerns two previous events involving the same operator and aircraft type in which aircraft descended below their cleared level during approach due to inappropriate mode selection of the flight director, and inadequate monitoring of the FMA annunciations.

Analysis

Effect of IOP I failure

The commander reported the loss of speed bugs and MDA indications on PFD 1 coincident with the IOP 1 fail advisory message on the ED. The System Safety Analysis for the EIS, and the FMECA contained therein describe a number of IOP failure scenarios which can result in the loss of these and other cockpit indications. Although the observed loss of indications was in keeping with the expected system response and can therefore be considered in accordance with the system design, this represented a significant distraction to the crew at a late stage in the approach.

The 'IOP FAIL' message on the ED is an advisory message and there is no requirement in the manufacturer's QRH checklist for any flight crew action to be taken in response to this indication. In an attempt to regain the lost indications on his PFD, however, the commander decided to switch the ADC source selector to ADC2, and then back again when this did not have the desired effect.

In response to concerns raised by the operator following this incident, the aircraft manufacturer agreed to investigate fully the cockpit effects associated with IOP failures. At the time of publication of this report, the results of the manufacturer's investigation had not been made available to the operator, and the QRH had not been updated. Therefore the following Safety Recommendation is made:

Safety Recommendation 2012-017

It is recommended that Bombardier Aerospace publish information in the Quick Reference Handbook section of the Dash 8 Q400 Aeroplane Operating Manual describing the effects of single Input Output Processor failures on the operation of the aircraft.

Effect of ADC Reversion

The aircraft was descending to a selected altitude of 2,600 ft at a selected vertical speed of -500 ft/min, with the APPROACH mode armed, when the IOP failure occurred. From the FDR data presented in Figure 1, the loss of the ALTITUDE SELECT armed, VERTICAL SPEED and HEADING SELECT modes are evident, coincident with the ADC reversion. While the commander was aware that the ADC reversion would cause the APPROACH mode to become disarmed, and duly reselected the latter, the effect, as per design, was the loss of *all* selected FD modes, which subsequently reverted to basic modes.

Although the FDR data shows that the default vertical and lateral modes PITCH HOLD and ROLL HOLD were activated, and these would have been annunciated on the FMA, but the crew did not report being aware of this. It is also evident that following the ADC reversion, that ALTITUDE SELECT and VERTICAL SPEED modes were not subsequently re-engaged, and the ALT SEL and VS indications on the FMA would have disappeared. HEADING SELECT mode was, however re-engaged, deactivating the ROLL HOLD mode but in the absence of any other vertical modes being selected, the aircraft continued to descend with the basic PITCH HOLD vertical mode engaged.

Loss of Altitude Select (ALT SEL) Armed mode and failure to select HSI button

The deactivation of the ALTITUDE SELECT mode, and the associated disappearance of the ALT SEL indication on the FMA, which went unnoticed by the flight crew, allowed the aircraft to descend below the cleared and selected altitude. After reviewing the recorded flight data from the incident, both the aircraft and IOP manufacturers advised that the loss of all the active FD modes, including ALTITUDE SELECT, was directly attributable to the ADC reversion, and not to the IOP failure. The FDR data shows that the loss of ALTITUDE SELECT, and other FD modes was coincident with the ADC reversion.

The commander elected not to press the HSI SEL button when control of the aircraft was handed over to the co-pilot. The HSI SEL button determines to which PFD the flight director is coupled, and pushing the button clears all active and armed lateral and vertical navigation modes, which must then be reselected. Had the HSI SEL button been pressed at this point and had the previously active FD modes been reselected, the excursion below the selected altitude might have been detected earlier, or possibly prevented.

The flight crew selected the HSI SEL button to the right side shortly after the GPWS 'CAUTION TERRAIN' alert annunciated.

Crew monitoring

While attempting to resolve an unfamiliar failure which had resulted in unexpected cockpit effects, both pilots became distracted from the primary roles of flying and monitoring the aircraft and did not notice that ALTITUDE SELECT and VERTICAL SPEED modes were no longer engaged. As a result the aircraft continued to descend below the selected altitude of 2,600 ft and below the

ILS glideslope. The selected altitude was changed from 2,600 ft to 2,500 ft approximately 60 seconds after the ADC reversion but the aircraft was already descending below that altitude. The aircraft captured the localiser beam as it was descending through 2,200 ft but, because the aircraft was already below the glideslope with a vertical speed sufficient to remain below it, it could not intercept the glideslope even with APPROACH mode armed. The aircraft continued to descend until proximity to rising terrain triggered a GPWS "CAUTION TERRAIN" alert as the aircraft passed through 1,759 ft (1,066 ft agl), by which time the aircraft was more than 700 ft below the previously selected platform altitude, and approximately ¾ of a dot below the ILS glideslope. The absence of any action to correct the aircraft's flight path prior to the GPWS "TERRAIN TERRAIN, PULL UP" warning suggests that the pilots were not aware of the extent of the deviation from the intended flight path. The aircraft reached a minimum height of 700 ft, 8 nm from the runway, before a recovery was achieved.

The fact that the aircraft did not maintain the intended flight path indicates that the pilots were not monitoring the flight path or the FMA, either during the expected level off at the original cleared altitude or when the revised altitude selection was made. Additionally, they were not cross-checking the FD guidance against other data, such as the basic indication of glideslope and localiser deviation displayed on the PFD. The operator's procedures refer to the importance of monitoring the flight path but this incident shows that the pilots' monitoring of the approach had degraded to the point that they were unaware of the extent of the flight path excursion. AAIB report EW/C2008/12/05 relating to two previous similar incidents involving the same operator, where aircraft descended below the glideslope, also identified an absence of appropriate monitoring of the flight path and the FMA as contributory factors. In all three events it took an intervention, either by ATC or the EGPWS (a system designed to detect an imminent risk of collision with terrain or obstacles) to alert the pilots to the flight path deviation and prompt a recovery.

In the case of G-JECF, the altitude excursion was not detected by ATC until after the GPWS warning had sounded; by this stage the aircraft was already climbing to re-capture the glideslope.

The aircraft's continued deceleration during the approach suggests the airspeed also was not being monitored. The minimum speed recorded prior to the GPWS go-around was only three knots above the minimum manoeuvring speed and below the target speed for this configuration specified in the operations manual. It is possible that in the absence of the GPWS 'pull up' warning the aircraft would have continued to decelerate.

GPWS recovery manoeuvre

The pilots' reaction to the GPWS alert and warning was not in accordance with the procedure laid down by the operator. This, they stated, was due to their familiarity with their surroundings and the fact they could see the runway; they did not perceive a risk to the aircraft. This view continued after the event when filing the ASR and in subsequent discussions with the safety department and fleet management.

The dangers of such a perception lie behind the instructions provided by the operator in handling GPWS events. When it became apparent, through studying the recorded flight data, that the crew had not reacted appropriately, the operator provided both pilots with additional training before returning them to flying duties.

Safety reporting and incident notification

The crew believed they had reported the event properly based on their perception of the seriousness of what had happened. Its significance was not understood by the operator until it examined the data from the quick access recorder, six days after the event. Although Central Safety had directed the original safety report to the engineering department, copies had also been sent to relevant parties in the Operations and Safety Departments. Also, the commander had contacted the Flight Safety department of his own volition two days after the event.

The commander had given his own assessment of the incident, but this had not identified the true nature of the problem nor the failure to comply with the appropriate GPWS procedures. Acceptance of his initial assessment delayed further investigation of the occurrence.

The AAIB considered that the Operations Manual did not present clearly the operator's procedures for handling serious incidents. This may have contributed to the delay in notifying the AAIB and in securing data for use in the subsequent investigation. Therefore, the following Safety Recommendation is made:

Safety Recommendation 2012-018

It is recommended that Flybe amend their Operations Manual to provide appropriate guidance for the handling of serious incidents and ensure timely notification to the Air Accidents Investigation Branch.

Troubleshooting and Defect Rectification

Although the troubleshooting carried out by the airline in response to the incident IOP failure and subsequent recurrent failures of the same unit was in accordance with the troubleshooting guidance provided by the manufacturer, these procedures were not successful in determining a fault with the unit. While the nature of the fault was subsequently confirmed as intermittent, the maintenance procedures are clearly not designed to detect such faults. Also, despite the operator receiving eight reports of an IOP failure on the same unit within a 48-day period, and a recurrent defect monitoring system being in place which logged all these events, the suspect IOP unit remained on the aircraft for a further 26 days after the incident. After the fourth report a transient fault was suspected but nevertheless the aircraft was cleared for release to service when the fault could not be confirmed; four subsequent reports of IOP failures were made. Each report appears to have been treated as an individual defect with no link made to the fact that the same unit was failing repeatedly.

The operator acknowledged that IOP failures had become a routine aspect of operations on their Dash 8 Q400 fleet. Prior to this incident the operator was mainly concerned with minimising operational delays associated with the required maintenance action and IOP reliability issues. However, on this occasion a loss of terrain separation followed what had been thought to be a benign avionics failure. The incident demonstrated that the associated loss of cockpit indications arising from an IOP failure can be distracting during the approach. Accordingly, the operator has raised concerns with the aircraft manufacturer regarding the adequacy of published operational guidance relating to such failures.

Post-incident testing

The IOP manufacturer performed extensive tests on the incident unit over several months before the IOP fault was successfully reproduced. This, together with the operator's experience of units being returned from the manufacturer after testing with no fault found, and the manufacturer's establishment of an NFF Task Force for repeater units, indicates that the Acceptance Test Procedures, and other existing means of testing, were not sufficient to identify intermittent faults. The NFF Task Force processes had successfully identified a number of intermittent failures to ERACLE power supply modules. In order to reduce the risk further of IOP units with intermittent faults being declared serviceable and subsequently fitted to aircraft, the following Safety Recommendation is made:

Safety Recommendation 2012-019

It is recommended that Thales Aerospace review the Input Output Processor test procedures to improve the detection of intermittent failures of the ERACLE power supply module in order to reduce the number of faulty units being returned to service.

Conclusion

This serious incident was the culmination of a sequence of events. The initiating factor was an avionics failure which led to a loss of cockpit indications during a critical phase of flight. Existing operational procedures did not provide clear guidance for flight crews to deal with this failure. This situation was exacerbated in this case by a departure from standard operating procedures, resulting in the loss of previously selected flight director modes. A breakdown in the monitoring of the approach profile led to a descent below the glide path and the triggering of a GPWS warning.

This incident, once again, highlights the importance of monitoring the flight profile, especially when dealing with unfamiliar situations, and the need to react appropriately to GPWS warnings, particularly when the cause is not immediately apparent.

SERIOUS INCIDENT

Aircraft Type and Registration:	DHC-8-402 Dash 8, G-JEDV
No & Type of Engines:	2 Pratt & Whitney Canada PW150A turboprop engines
Year of Manufacture:	2004
Date & Time (UTC):	29 November 2011 at 2110 hrs
Location:	Overhead the Thames Estuary
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 50
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	42 years
Commander's Flying Experience:	12,113 hours (of which 1,098 were on type) Last 90 days - 168 hours Last 28 days - 52 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

At FL240, the aircraft began to depressurise, at first slowly but then rapidly. The CABIN PRESS warning activated and the pilots commenced an emergency descent. When level, the pilots carried out a manual depressurisation, following which they landed at their destination. The cause of the depressurisation was not determined.

History of the flight

The aircraft was in the cruise at FL240 over the Thames Estuary when a member of the cabin crew reported that the forward left door was making a loud whistling noise despite appearing to be closed correctly. Information displayed in the flight deck indicated that the door was closed. Shortly afterwards, the pilots noticed that the cabin altitude was increasing at almost 500 ft/min and, following clearance from ATC, they began a descent towards FL140.

During the descent, the noise from the door increased, the cabin altitude increased rapidly and a red CABIN PRESS warning activated, indicating a loss of cabin pressure. The commander initiated an emergency descent while the co-pilot transmitted a MAYDAY call and both donned their oxygen masks. ATC cleared the aircraft to descend to FL100 and vectored the aircraft for an approach to land at Gatwick Airport.

The pilots reviewed the situation and established that there was no damage to the aircraft and no injuries to the passengers. They decided that a slow descent to their destination, Southampton Airport, would be preferable to a quicker descent into Gatwick Airport because it would give them time to complete checklist items and brief for the approach. It would also be more comfortable for the passengers. At FL80, the pilots carried out a manual depressurisation and flew an uneventful approach to Southampton Airport, maintaining a low rate of descent.

Operator's assessment of the cause

The operator stated that G-JEDV had suffered several recent pressurisation events. Although no cause for these events was positively identified, following this occurrence the door seal, cabin pressure controller and pressurisation control panel were replaced. At the time of writing, the aircraft had suffered no further pressurisation problems.

ACCIDENT

Aircraft Type and Registration:	Alpi Aviation Pioneer 300, G-VIXX
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2010
Date & Time (UTC):	25 November 2011 at 1145 hrs
Location:	Gloucestershire Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Substantial
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	78 years
Commander's Flying Experience:	6,000 hours (of which 3 were on type) Last 90 days - 15 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft was positioned on the apron with the parking brake set and after completing the pre-flight checks, the pilot started the engine. When the engine fired, it immediately accelerated to a high power setting. The aircraft surged forward across a taxiway and verge before striking a large shipping container, causing substantial damage to the aircraft. The pilot suffered minor injuries but was able to leave the aircraft unaided.

Discussion

The aircraft was fitted with a Rotax 912 ULS engine which is a common choice for this class of aircraft. The throttle butterfly valves on each of the two carburettors are spring biased to the fully open, FULL POWER, position as the throttle cable used to control them is typically of a 'pull only' design. The throttle control fitted to this aircraft was a plunger type with a separate friction nut to allow pilot adjustment of throttle friction during flight. If the friction nut was loosened sufficiently the throttle butterfly would move to the FULL POWER position under the action of the bias spring and therefore this type of throttle control may not be best suited to this type of engine. Some other aircraft designs that are fitted with this type of engine utilise a throttle control system that prevents rapid uncommanded throttle movement by incorporating, for example, a balance spring or a fixed friction device.

The pilot reported that in the future he intends to face the aircraft towards a clear area and confirm the throttle is in the idle position immediately prior to starting the engine.

Safety Action

The LAA are reviewing the design requirements for throttle control mechanisms on aircraft, for which they are responsible, that are fitted with this type of engine.

ACCIDENT

Aircraft Type and Registration:	DH82A Tiger Moth, G-AOIL
No & Type of Engines:	1 De Havilland Gipsy Major I piston engine
Year of Manufacture:	1940
Date & Time (UTC):	15 May 2011 at 1408 hrs
Location:	Near Witchampton, Dorset
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Serious) Passengers - 1 (Fatal)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	44 years
Commander's Flying Experience:	210 hours (of which 41 were on type) Last 90 days - 3 hours Last 28 days - 2 hours
Information Source:	AAIB Field Investigation

Synopsis

The pilot and a passenger were on a local pleasure flight. The aircraft was seen by observers on the ground to pull up into a loop and during the manoeuvre it entered a spin from which it did not recover. The pilot was not formally trained in aerobatics and had limited experience of spin recovery. The manoeuvre started at 1,500 feet agl and there was insufficient height for the pilot to recover from the subsequent spin. The passenger was seriously injured and died later the same day in hospital. The pilot, who was also seriously injured, survived.

History of the flight

The pilot arranged to take two friends up separately for flights from Compton Abbas Airfield. He arrived at the airfield about an hour before he was due to meet them in order to prepare the aircraft. When he arrived he found that the aircraft had already been flown on a number of flights earlier in the day. No problems had been reported with the aircraft; it had been refuelled, to just below the full tank level, and parked on the apron area.

The pilot met up with his two friends and between them it was arranged that the lighter of the two should go on the first flight. This was because the aircraft was full of fuel and the pilot did not want the weight limit for the aircraft to be exceeded.

First flight

The pilot discussed plans for the first flight with his passenger, which included the possibility of the pilot flying a couple of loops.

The passenger was seated in the front cockpit. The pilot ensured that he was strapped in correctly and gave him a safety briefing. The engine was started after a couple of swings of the propeller, after which the pilot removed the chocks and strapped himself in to the rear seat. He carried out a check of the interphone which was satisfactory.

The aircraft took off at 1302 hrs, climbed to around 2,000 ft amsl, and headed towards Blandford Forum to look at a house the passenger was proposing to buy. The aircraft descended to about 900 ft agl as it passed close by the house and then climbed and flew further to the south, close to an area where a mutual friend of theirs lived. The pilot carried out a clearing turn and a loop at 1,200 ft agl. (Figure 1 depicts a plot of the track with altitude and height profile of the flight.) The aircraft then flew back towards Compton Abbas. One further loop was carried out en-route at 1,600 feet agl. The aircraft landed back at Compton Abbas at 1330 hrs.

Accident flight

When the aircraft returned the passengers changed over. The second passenger was wearing an 'Irvin' type flying jacket. He was considerably larger than the first passenger and the pilot spent some time helping him to adjust and secure his harness. The passenger took with him a camera which he wore around his neck on a strap. During the taxi out before takeoff he took several photographs, holding the camera up in front of him and pointing it backwards. There were no photographs taken with the camera during the flight.

The aircraft took off at 1356 hrs and after leaving the circuit flew in a generally southerly direction at an altitude of between 1,600 ft and 2,200 ft. At 1404 hrs, when the aircraft was 3 nm north-west of Tarrant Rushton Visual Reference Point (VRP), the pilot turned onto a south-easterly track and contacted Bournemouth Radar. He requested permission to transit into the Bournemouth Control Zone to Broadstone and to make two circuits there at 2,000 ft. The Bournemouth radar controller instructed the pilot to remain clear of controlled airspace and advised that it was very busy. The controller said he would call him back if it was possible to accept him, but subsequently, after determining that the aircraft was not fitted with a transponder, the controller advised that the aircraft could not be accepted.

The pilot continued on a south-easterly track for approximately two minutes, then turned to the left through 180º and flew in a north-westerly direction. Observers on the ground described seeing the aircraft climb up and reach the top of a loop, before they saw it enter a spin. The spin continued through a number of turns until the aircraft struck the ground.

The accident manoeuvre was performed in the same location that the pilot had completed a loop on the previous flight, near to the house of a friend. This friend was out walking his dog and saw the accident. He ran over to the site, a distance of about 500 m, and gave first aid assistance to the two people on board. Both were seriously injured and trapped in the wreckage but he was able to keep them breathing until an air ambulance arrived. They were treated at the scene before being flown to local hospitals. The passenger died later that evening as a result of his injuries.

Meterological information

The weather situation was dominated by high pressure lying to the southwest of the UK, maintaining a north-westerly flow over the accident area. The visibility was good to excellent with no weather reported in the area. The conditions for the flight were good with broken cloud at around 3,000 feet. The surface wind at Compton Abbas, at the time of the accident, was reported as from the north-west at 15 kt to 20 kt and the surface temperature was 16°C.

The Bournemouth Airport METAR recorded at 1420 hrs was:

> *'surface wind from 300° at 10 kt, visibility 10 km or greater, few cloud at 3,700 ft, temperature 16°C , dewpoint 5°C and pressure 1027 hPa.'*

An analysis of recorded meteorological data was carried out by the Met Office to obtain an estimate of the wind and temperature profile in the area of the accident, the results were:

1000FT: 310/15-20KT +09°C and
2000FT: 310/20-25KT +06°C

Pilot information

The pilot had attended a military Flying Grading evaluation course at Middle Wallop in 1992, while serving in the armed forces. He completed 13 hours dual flying in a Chipmunk but did not progress onto the flying training course. The syllabus for the Flying Grading included some experience of aerobatic manoeuvres.

In December 2008 the pilot started flying training with the intention of obtaining a PPL and then progressing onto a CPL. He completed his PPL in April 2009 and continued flying in order to accumulate sufficient hours to start the CPL training. During his PPL training, before his first solo flight had taken place, his instructor spent a one hour session with him in a Cessna 172 demonstrating and teaching spin and spin recovery techniques. A total of four spins were carried out.

In May 2009 the pilot purchased a share in G-AOIL. He was checked out by another member of the owners' group, who was a qualified flight instructor, and received a total of 9 hours of dual conversion training and an hour of observed solo flight. During the check-out the instructor reported that he had demonstrated some aerobatic manoeuvres. When the pilot had completed the check-out he was advised that further training, including in aerobatics, would be available at any time if he wished. The owners' group had a verbal agreement that no solo aerobatics were to be undertaken until a pilot had been cleared to do so.

The pilot carried a GPSMAP 695 during the flights fitted to a kneeboard strapped to his left leg.

Pilot's recollections

The pilot was seriously injured in the impact and suffered some memory loss, with an incomplete recollection of events around the time of the accident. He was however able to provide some information to the investigation in the months following the accident.

He reported that he would occasionally perform loops in G-AOIL but he did not consider that a loop constituted an aerobatic manoeuvre. He said that he would normally carry them out starting at an altitude of 2,500 ft. He also stated that he was familiar with HASELL[1] checks, including the requirement to

Footnote

[1] Height, Airframe, Security, Engine, Location, Lookout.

recover by 3,000 ft agl, and would always carry out the checks before executing a loop.

When the pilot was asked what the spin recovery technique should be, he commented that he had only previously spun in a Cessna 172 and stated that you should centralise the rudder, to stop the spin, and then apply back pressure gently, due to the high speed.

The pilot remembered clearly the radio telephony exchange with Bournemouth Radar and thought that immediately afterwards he had turned to the north to avoid entering the control zone. He did not recall entering a loop but reported later that he had encountered a problem with a restriction of the left rudder pedal during the left turn to the north. He recalled the aircraft being in a spin to the left and stated that although he had pushed hard on the right rudder pedal, it would not move and he could not recover from the spin.

Aircraft information

The Tiger Moth is a two-seat bi-plane fitted with dual controls. There are two cockpits, and the aircraft is usually flown from the rear cockpit. G-AOIL was built in 1940 and at the time of the accident it had accumulated 3,380 hours since an extensive overhaul in 1999, and the engine had accumulated 117 hours having been zero-lifed in 2009. On 15 April 2011 both the airframe and the engine had undergone a 50 hr / 6 month inspection and servicing.

The primary flying controls consist of a rudder, elevators and ailerons on the lower mainplanes only. This Tiger Moth had anti-spin strakes and autoslots fitted, although these are not mandatory. The autoslots are on the upper mainplanes which, when unlocked, deploy automatically at high angles of attack, for example during landing. Autoslots must be locked for aerobatics.

Key information for the support and continued airworthiness for Tiger Moths, such as modifications and inspections, is published by De Havilland Support in a series of Technical News Sheets (TNS). Whilst there are modifications that date from 1933, the TNS system has been actively updated in recent years.

'Z' type harnesses were fitted to the aircraft. These were commonly fitted at the time of this aircraft's restoration, and each occupant's harness consisted of two lap and two shoulder straps. The shoulder straps were fixed to the aircraft by a cable running across the fuselage, and the lap straps were attached to the fuselage structure. TNS 37 issue 2, issued in 2000, is a CAA mandatory TNS which specifies the fitting of higher strength transverse cables for the attachment of shoulder straps.

The original 'Sutton-type' harness was designed to '*keep the wearer firmly in his seat*' when subject to certain loads and the specification dated from circa 1940. The harness was not part of an integrated crashworthy aircraft design in which energy absorption and survivable space were considered to the extent that they are for more modern aircraft.

The fuel tank is installed above the front cockpit and has a capacity of 19 gallons.

Weight and balance

The contents of the baggage stowage were weighed and an estimate was made for the fuel state. The aircraft was the subject of a weight and balance report in 1999 and, using the weights of the occupants, it was estimated that the aircraft's weight, at the time of the accident, was 815 kg with a centre of gravity position of 15.2 inches.

The Airworthiness Certificate loading limitations for G-AOIL specifies that the maximum total weight is 828 kg and that when aerobatic manoeuvres are performed the aircraft shall not operate at a total weight in excess of 802 kg. It also specifies that the centre of gravity position for aerobatics shall be within the range of 7.0 inches to 15.3 inches aft of datum.

Spinning tests carried out originally by the manufacturer showed that centre of gravity position did not have a significant effect on the spin characteristics.

Spinning characteristics

This Tiger Moth aircraft was cleared for a number of aerobatic manoeuvres, including loops and spins, when operated within the required weight and centre of gravity range and when fitted with anti-spin strakes.

Spin characteristics vary between different aircraft types. For the Tiger Moth, each aircraft will be rigged slightly differently and this will affect the individual spin characteristics. In 1941, as a result of concern about a number of aircraft being lost in spinning accidents, the Royal Aircraft Establishment undertook a study of Tiger Moth spin characteristics. The study resulted in a recommendation that anti-spin strakes be fitted.

Engineering investigation

Examination of the wreckage at the accident site

The aircraft wreckage was in a grass field and was largely intact. The field was bounded by a thick 3 m high hedge, and 3 m from the hedge and inside the field was a 1 m high single-wire electric fence. The tail of the aircraft was resting on the wire with the nose of the fuselage pointing in a direction perpendicularly away from the wire towards the centre of the field. Importantly, there were no signs of the aircraft having touched the 3 m hedge, despite the close proximity.

There was significant damage to the leading edge of both lower mainplanes. The furthest piece of wreckage from the fuselage was a piece of propeller 11 m from the nose of the fuselage. The nose of the aircraft had struck the ground causing significant damage to the engine and the forward fuselage. The fuel tank was damaged and leaking, but still contained approximately 15 litres of fuel.

There was damage to both the lower forward portion of the engine cowling and the spinner that matched two significant indentations in the ground near the wreckage of the fuselage. The rear fuselage, which was intact, was aligned at approximately 25° to the ground marks made by the spinner and cowling which gave strong evidence that there was rotation about a vertical axis with the aircraft rotating to the right when the aircraft struck the ground. This direction of rotation was further corroborated by ground marks made by the tail skid dragging to the left (ie in the direction of aircraft nose to the right).

It was concluded that the aircraft had struck the ground at low speed, approximately 30° to 40° nose-down, with the right wing low and with the aircraft rotating to the right; consistent with the aircraft spinning to the right.

Three large pieces from one blade of the wooden propeller had broken off. There were chordwise marks on these pieces and a slash mark in the ground (50 cm long x 3 cm deep) in close proximity to an indentation in the ground that was probably made by the spinner. It was concluded that the engine had been turning, probably under low power, when the aircraft struck the ground.

A preliminary check on the continuity and integrity of the controls to the ailerons, rudder, elevator and autoslots was made at the wreckage site; nothing significant was found.

The attachment cables for both the front and rear occupants' shoulder straps had failed in overload so shoulder restraint had been compromised for both occupants.

Assessment of possible control restriction

A Tiger Moth aircraft, fitted with similar harnesses and seats, was used to assess the possibility that there might have been a restriction on the controls. Whilst the fuselage is constructed from tubular sections, the Tiger Moth has a comprehensive set of foot plates, plywood cover plates and a leather shroud around the base of each control stick minimising the risk of a control restriction to the sticks or rudder pedals from a loose article or a foot.

The passenger's camera was badly damaged in the accident. A camera of similar dimensions was obtained and its neck strap adjusted to be similar to that carried by the passenger. An assessment of the control movement was made with an occupant in the front seat wearing a similar flying jacket and of similar height and build to the accident passenger. This assessment included a full and free check on the control sticks. It was concluded that the clasp for the four-point harness had some potential to restrict full back stick for the elevator. It was considered unlikely that the camera could have restricted the full movement for the elevator.

Detailed examination of the wreckage

Engine

The engine was removed from the wreckage and inspected. Apart from the damage caused by the impact, nothing abnormal was found and the engine appeared to have been serviceable prior to the impact.

Aircraft structure

The fabric covering material was removed from much of the aircraft and the structure was inspected. The airframe appeared to have been in a serviceable condition prior to the accident, and there was no evidence of an in-flight malfunction or failure.

The fitting of the higher strength attachment cables for the shoulder straps to G-AOIL was documented in the log book and dated August 2002. The attachment cables were inspected and, apart from the overload failure to the front and the rear cables, they appeared to have been in good condition prior to the accident and they both had valid part numbers.

Flying controls

A detailed check on the continuity and integrity of the controls to the ailerons, rudder, elevator and autoslots was made from each point of control input to each control surface, including checks for any restrictions; nothing significant was found. The autoslots appeared to have been stowed and locked at the time of the accident.

The cockpit area was badly disrupted as a result of the aircraft striking the ground. This included significant damage to the rudder controls and control sticks, with a multitude of scratches and witness marks on the structure, some of which would have occurred in normal usage. Witness marks from any restriction would have been difficult to detect, even without the significant damage from the ground impact. Thus it was not possible to determine if there was any damage or witness mark that might have arisen from a control restriction in the cockpit.

Pathological information

The aircraft was in a nose-down attitude when it struck the ground and the front cockpit was subjected to greater impact forces than the rear. An expert in aviation pathology carried out a post-mortem examination on the passenger. It was found that he had died of multiple injuries sustained in the accident as a result of the impact forces. Although the shoulder strap attachment wire of his harness failed and he had sustained a head injury, it was considered that this probably did not affect the outcome.

Recorded information

The RTF transmissions between the pilot and Bournemouth ATC were recorded.

Radar data from the radar head at Bournemouth Airport was recorded for the accident flight. All the radar returns were primary so no height information was available. The quality of positional information of these the returns was also low because they had to be extracted from screen shots of the recorded data as would have been displayed to the radar controller.[2]

A Garmin GPSMAP 695 was recovered from the accident site and subsequently downloaded at the AAIB. It contained the track logs for a number of flights of which the last two were for the day of the accident. The second of these was the accident flight. Each flight log contained time, position and altitude, as well as the track angle and average groundspeed between each point. The GPS was set up to record points using a Garmin proprietary algorithm based on the distance and/or track angle change from the previous point. The time between points was therefore variable, ranging from between 1 and 16 seconds for the first flight and between 2 and 13 seconds for the accident flight.

First flight

The first recorded flight was a local flight from Compton Abbas with a duration of 31 minutes. (Figure 1 depicts the ground track and altitude trace). Indicated on the altitude trace are significant points in the flight in terms of minimum altitude, descent rates and manoeuvres, as well as the height of the ground below the aircraft. Of note was the minimum altitude of 850 ft agl close to the town of Blandford Forum, some tight level turns, and a loop at about 1,200 ft agl followed by a descending turn to the right at 2,330 ft/min, from 1,000 ft agl down to a height of 410 ft agl, near Witchampton. This loop was performed on a north-westerly heading, into the prevailing wind, and was started within 20 m of the position of the subsequent accident site. Further on, near Chettle House, there was a second loop at about 1,600 ft agl, followed by an immediate right descending turn of 300 ft at 2,350 ft/min. The maximum recorded altitude during the flight was 2,150 ft amsl.

Accident flight

Figure 2 shows the ground track and altitude trace for the accident flight. The track again heads south south-westerly with the aircraft climbing to, and levelling off at, 2,000 ft amsl for two minutes. It then climbs to 2,170 ft amsl (the maximum recorded altitude for the flight), before descending and climbing a little as it turned onto a southerly track, followed by a left turn towards Bournemouth Airport. The aircraft then descended to 1,610 ft amsl, during which time the pilot was in contact with Bournemouth Radar. Over the next 100 seconds the aircraft made a series of short

Footnote

[2] Bournemouth Radar is only recorded by the Air Traffic Service (ATS) Unit at Bournemouth Airport, and is not part of the UK's national coverage that is recorded by the National Air Traffic Service (NATS). The latest version of CAP 670 SUR 10 , effective January 2012, requires all ATS units to provide recorded radar data in a useable format.

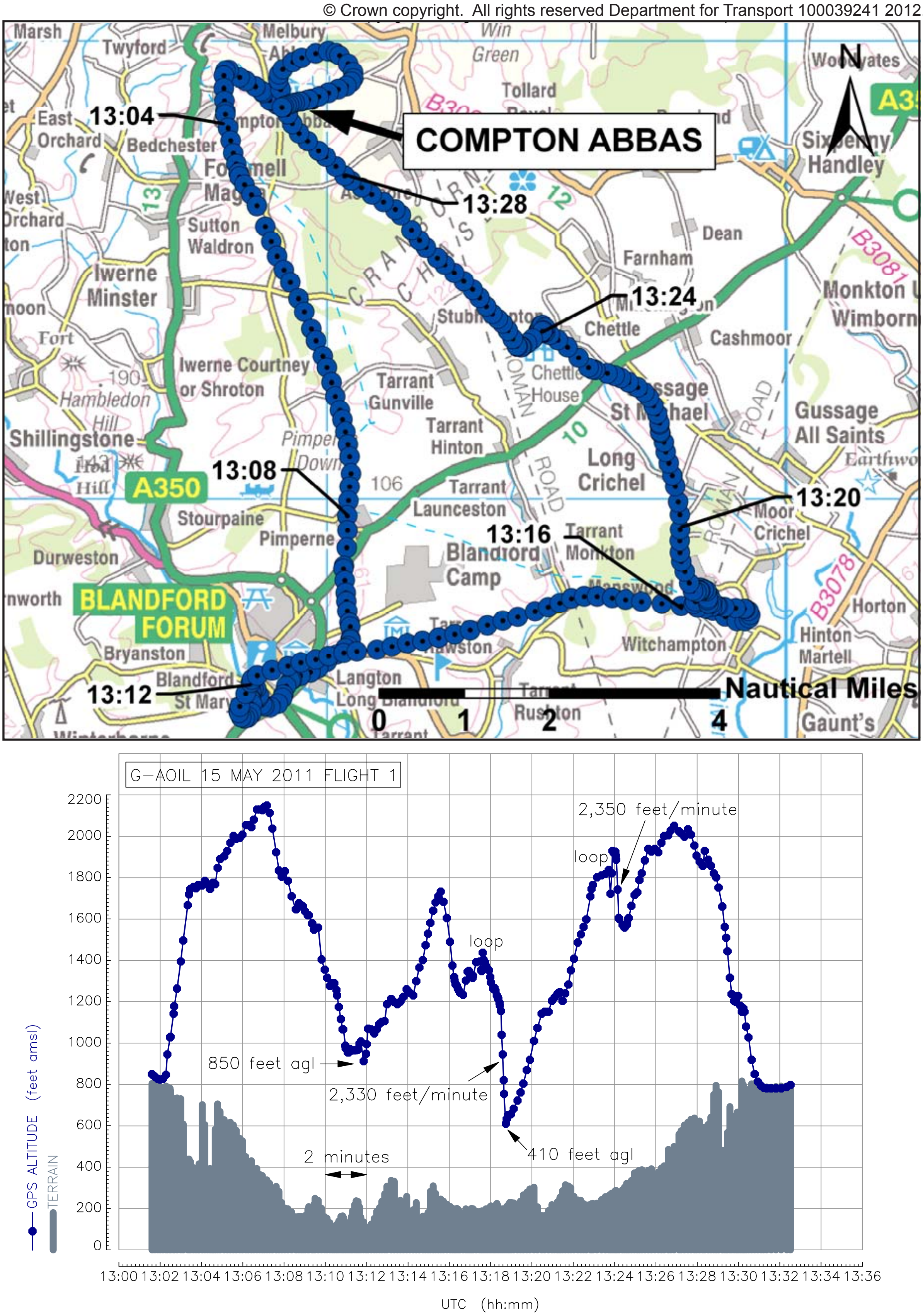

Figure 1

GPS track and altitude data for first flight of G-AOIL on 15 May 2011

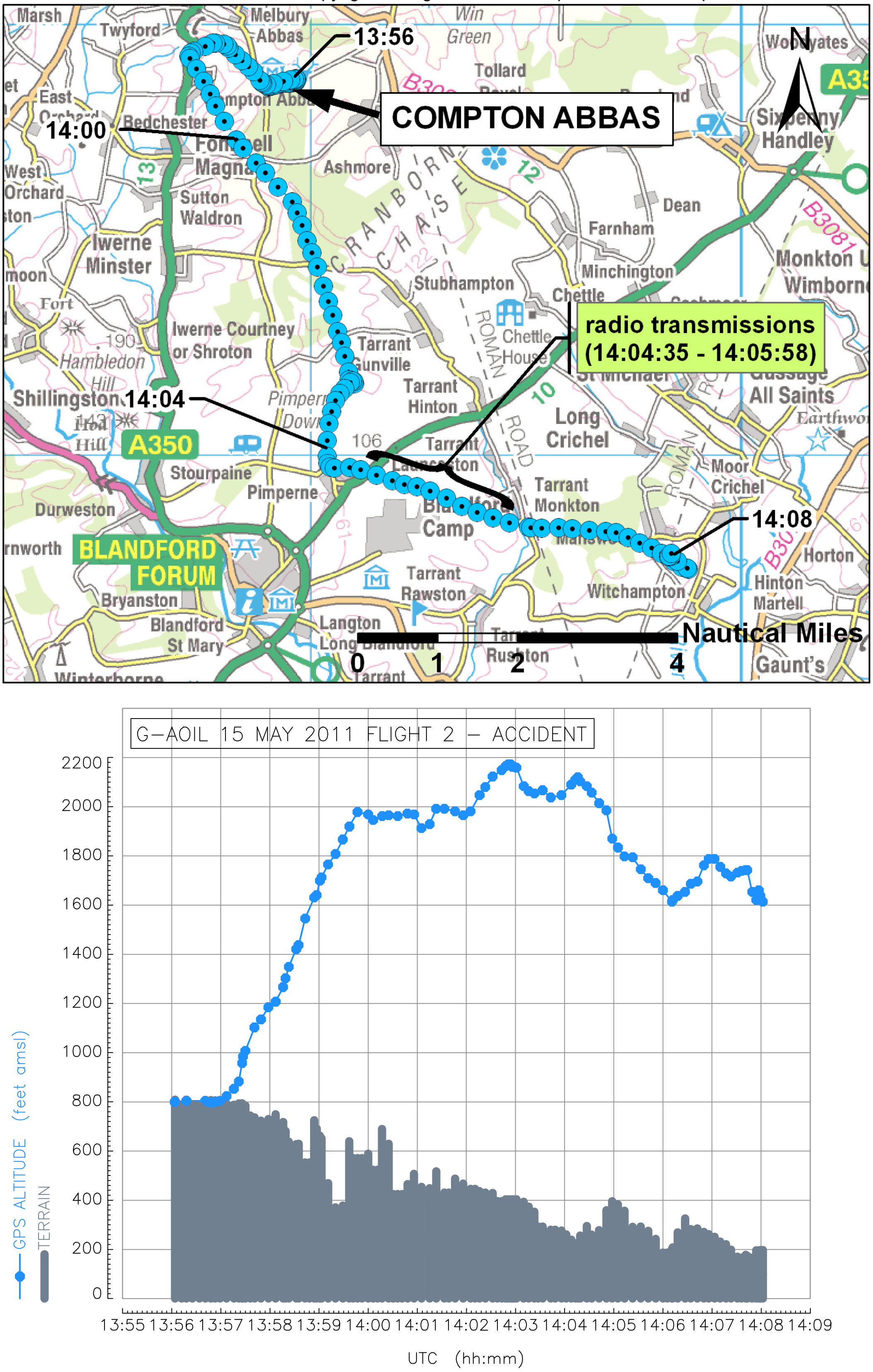

Figure 2

GPS track and altitude data for accident flight of G-AOIL on 15 May 2011 climbs and descents before turning left through 180º in the vicinity of Witchampton. This portion of the flight is illustrated in Figure 3 and shows the aircraft, after the turn, descending 120 ft over a distance of about 0.25 nm. The forward movement then stops and the aircraft climbs 40 ft to a point left of track 3 seconds later before descending 45 ft in the opposite direction to a point about 1,400 ft agl over 5 seconds. This was the last recorded point on the GPS. The absence of any further recording was probably due to the recording algorithm calculating that the horizontal position of the aircraft relative to the ground (ie ignoring height) had not changed sufficiently; lack of satellite reception is unlikely but could not be ruled out.

Other information

Witnesses

The passenger for the first flight was able to give a good description of his flight. He said that the pilot had carried out several loops, steep turns and steep turning descents. When asked what height the loops were performed at he thought it was around 1,200 ft[3].

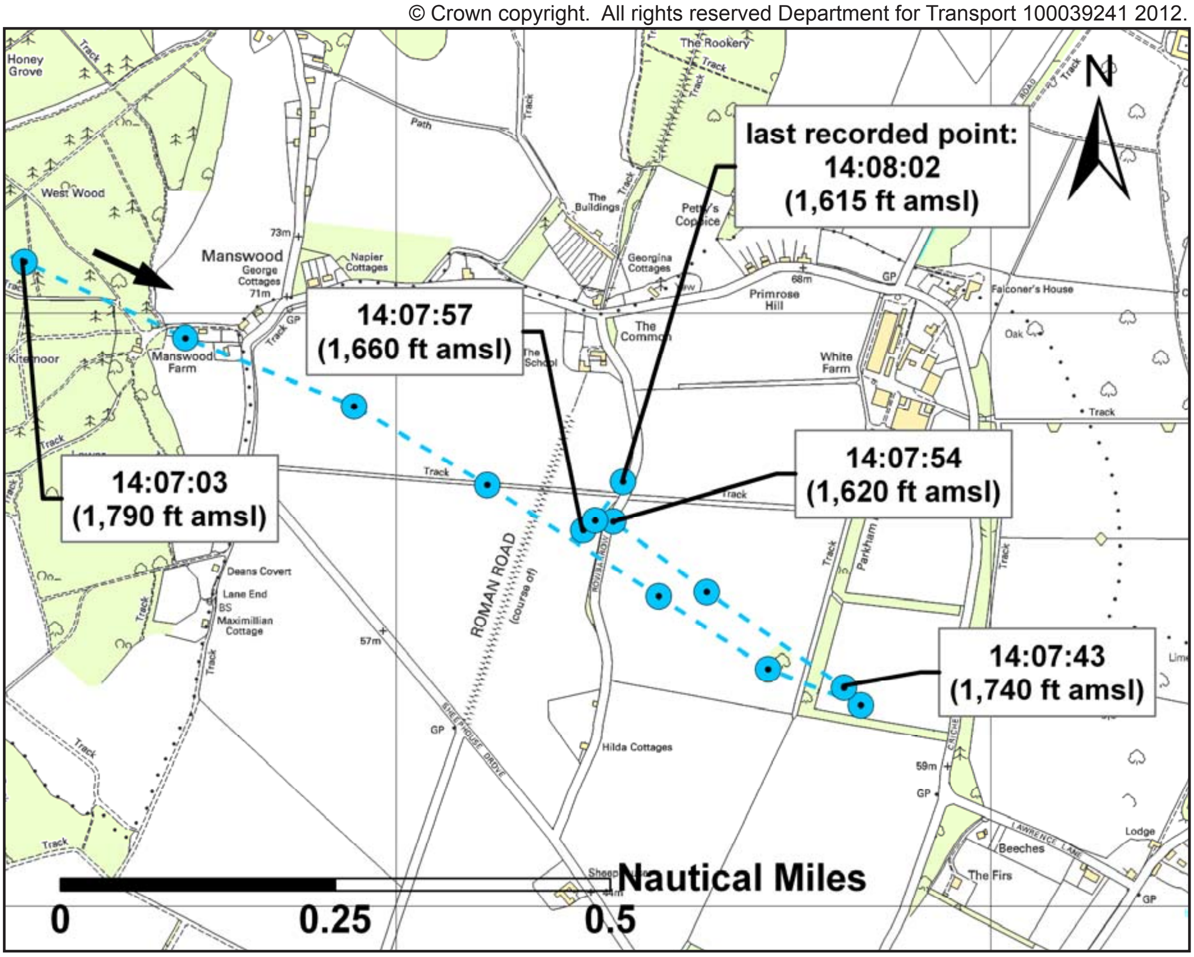

Figure 3

GPS track for the last one minute of the accident flight

Footnote

[3] After the accident the front cockpit altimeter was found to have been set at aerodrome QFE, the airfield elevation was 811 ft amsl.

There were a number of witnesses to the activity of the aircraft in the period just before the accident, the closest of whom was some 350 m distant.

Two witnesses, one of whom was a retired professional pilot, saw the aircraft at some distance away carry out a steep turn and then shortly afterwards commence a loop. They did not see the conclusion of the manoeuvre but one was sufficiently concerned by the low level of the manoeuvre to express this to the other.

One witness was in his garden and saw the aircraft doing aerobatics before watching it spiral down. The engine went quiet and he expected to see the aircraft "swoop up again", but it disappeared from view behind some trees and he heard the sound of the crash.

Another witness, also in his garden and closest to the accident site, watched the aircraft reach the top of a loop. He then saw it start to spin and described the spin as flattish at first and then steeper. His estimate was 30 to 40º nose-down initially and later, up to 80º. The noise of the engine stopped and he could hear the aircraft making a "whishing" sound. He realised it was too low to recover. When he heard the impact he ran to telephone the emergency services.

Several other witnesses saw the aircraft in a spin. One witness, who was the friend of the pilot and the passenger, ran to assist at the scene. The witnesses were consistent in saying that the engine noise ceased during the spin.

Aerobatics

There are several publications produced by the UK Civil Aviation Authority (CAA) which provide information and guidance for general aviation pilots about aerobatics and spinning.

The (CAA) Publication *'Safety Sense Leaflet 19 General Aviation Aerobatics'* includes the following statement:

> *'Aerobatics, whether in a glider or a powered aircraft, provide an opportunity for pilots to learn and participate in a new facet of sporting aviation. It is, however, vital to keep safety in mind, since a reckless or careless attitude can result in serious injury or death. Almost every year accidents occur where the height available proves insufficient to recover from an intentional or, more usually, a badly executed aerobatic manoeuvre.'*

The leaflet goes on to detail the HASELL[4] check:

> *'The standard HASELL check needs to be carried out with particular vigilance:*
>
> - *Height – depends on experience of pilot, but novices should commence at no less than 5000 ft above ground level and all manoeuvres should be completed by 3000 ft agl.*
> - *Airframe – flaps up, brakes off, (in some aircraft brake application restricts rudder movement), wheels up, etc to suit your particular aircraft.*
> - *Security – all harnesses fastened, canopy/ doors secure and no loose articles.*
> - *Engine – all engine instruments reading normally, mixture rich, carb heat check, adequate fuel selected and electric fuel pump on if applicable.*

Footnote

[4] A standard mnemonic introduced during PPL training to prompt a series of safety checks prior to carrying out many types of manoeuvres, such as stalls, spins, spiral dives or aerobatics.

- *Location – clear of congested areas and outside or below any controlled airspace (unless appropriate permission from the controlling ATC unit has been given). An area offering good forced landing options in the event of engine problems is wise. Note a good landmark to assist orientation. However, avoid likely navigation "choke points", and remember gliders use the rising air under cumulus clouds.*
- *Look-out – clearing turns in both directions and check above and particularly below for aircraft which might enter your operating space.'*

The CAA Publication '*Handling Sense Leaflet 3, Safety in Spin Training*' advises the following Standard Spin Recovery technique:

'Throttle: Closed

Aileron: Neutral

Rudder: Check the direction of yaw and use FULL anti-yaw rudder. A pause is often recommended between moving the rudder and elevator, and this is important to ensure rudder effectiveness.

Elevator: Move the control column centrally forward. As the aeroplane starts to recover the attitude will steepen and the rate of rotation will increase; keep moving the column towards full deflection until the spin stops.

Centralise: Centralise all controls as soon as the spin stops or the aeroplane will flick in the opposite direction!

Climb: Roll towards the nearest horizon and pitch into a climb attitude applying power carefully.'

Analysis

Evidence suggests that the aircraft was serviceable before the flight and no pre-existing defect which contributed to the accident was found in the investigation.

The physical evidence at the wreckage site, for example the difference in the alignment of the ground marks to the fuselage, and the tail skid drag mark, made it possible to conclude that the aircraft was in a spin to the right when it struck the ground.

The pilot stated that he had a rudder control restriction. The inspection of the wreckage, and in particular the flying controls, revealed nothing conclusive to suggest that there was a control restriction. However, given the level of damage sustained by the aircraft, the possibility of a control restriction could not be eliminated.

The pilot completed a loop on the first flight in the same location as the subsequent accident, from a similar heading and at approximately the same height. The GPS and eyewitness evidence indicates that the pilot had commenced a vertical manoeuvre consistent with the start of a loop, prior to the spin. There could be a number of reasons why the loop was not completed successfully. One possibility is that the pilot was unable to pull the stick fully back during the manoeuvre due to interference between the passenger's harness and the front cockpit control stick.

The pilot did not recollect attempting a loop during the accident flight. His recollection was that following the exchange with the Bournemouth radar controller he had immediately turned left, away from the Control Zone, and had experienced a rudder control restriction during the turn. However, the GPS data shows that the aircraft did not turn to the left until approximately two minutes after his last radio transmission.

The pilot had not undertaken aerobatic training and had limited experience of spinning and spin recovery. He had been shown spins in a Cessna 172 aircraft at an early stage of his PPL training. However, its spin characteristics are unusual in that it will normally recover from a spin if the pro-spin controls are released and no further action is taken. When asked what the recovery actions from a spin should be, the pilot reported that opposite rudder would be required to stop the spin and then when rotation had stopped back stick would be required to recover from the dive. He omitted the crucial inputs of closing the throttle, neutralising the ailerons, and applying forward stick to unstall the wings. Thus, as he did not have sufficient knowledge or training on the Tiger Moth's correct spin recovery technique, it is probable that he would not have been able to recover from an unintentional spin, especially given the limited height available.

When an aircraft enters an unintentional spin it can sometimes be difficult for a pilot to determine the spin direction correctly. In this case the pilot believed he had entered a spin to the left, whereas the evidence shows the aircraft was spinning to the right.

The pilot had carried out loops earlier in the day at significantly less than the recommended height from which recovery could be effected should something happen during the manoeuvre. The standard HASELL check, published in CAA Publication '*Safety Sense Leaflet 19 General Aviation Aerobatics*', recommends that all manoeuvres should be completed by 3,000 ft agl. The pilot did not provide a reason why he chose to commence the loops at a height lower than that recommended.

The AAIB has investigated several accidents where pilots have carried out aerobatics with either insufficient training and/or at lower than recommended heights. It is not well understood why a pilot might disregard the recommended safe margins for carrying out aerobatics, although there are a number of possible reasons. Some of these may be: overconfidence, airspace ceiling restrictions in the area in which they are flying, the length of time it takes to climb up to a safe altitude or a wish to be seen from the ground.

The reason for the loss of control during the loop could not be determined but regardless of the reason, the manoeuvre was carried out at too low a height for the pilot to be able to recover from the subsequent spin.

ACCIDENT

Aircraft Type and Registration:	Maule MX-7-180B Star Rocket, G-URUS
No & Type of Engines:	1 Lycoming O-360-C1F piston engine
Year of Manufacture:	1998
Date & Time (UTC):	11 November 2011 at 1200 hrs
Location:	Treborough Airfield, Somerset
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Engine cowling, propeller and empennage damaged, engine shock-loaded
Commander's Licence:	Private Pilot's Licence
Commander's Age:	52 years
Commander's Flying Experience:	324 hours (of which 100 were on type) Last 90 days - 20 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot, who was experienced in operating from grass strip airfields, was visiting Treborough Airfield for the first time. After overflying the airfield and assessing the surface wind as 200º at 10 kt, he flew a right-hand circuit to position the aircraft to land on Runway 25, which has a grass surface approximately 800 m in length and a slight upslope. During the landing the aircraft experienced a strong gust of wind from the left and the aircraft ground looped, coming to rest inverted. Despite sustaining mild concussion and a hand injury in the accident, the pilot was able to vacate the aircraft quickly, amid a strong smell of fuel. He considered that the primary contributory factor in the accident was the gusting crosswind caused by the undulating terrain surrounding the airstrip.

ACCIDENT

Aircraft Type and Registration:	Pioneer 200, G-CEVJ
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2007 (Serial no PFA 334-14710)
Date & Time (UTC):	25 March 2012 at 1625 hrs
Location:	Godney Moor Airfield, Somerset
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Damaged forward and underside of fuselage, landing gear, propeller, cockpit cover and flaps
Commander's Licence:	Private Pilot's Licence
Commander's Age:	67 years
Commander's Flying Experience:	218 hours (of which 71 were on type) Last 90 days - 3 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and photographs and witness accounts supplied by the police

Synopsis

The aircraft struck power lines whilst landing at a small airstrip. The pilot was aware of the hazard but did not recall seeing the power lines before the aircraft struck them. Recent changes in the physical environment around the airstrip since the pilot last flew from there may have contributed to an unusual visual effect which caused him to fly lower on approach than he intended.

History of the flight

The pilot made an uneventful flight to Compton Abbas earlier in the day and had departed there at 1600 hrs for the return flight to Godney Moor. The grass airstrip at Godney Moor is orientated 01/19 and approximately 600 m in length. The approach in the 01 direction passes over two sets of power lines, both orientated east-west: high voltage transmission lines pass 1,400 m south of the airstrip, and smaller lines supported by wooden poles pass about 100 m south.

The pilot was in contact with ATC at Bristol Airport and advised them that he was preparing to land. The wind at the airstrip was easterly at about 8 kt but gusty, presenting a crosswind approach and landing. The strip was relatively narrow and bounded on both sides by agricultural electric fencing, so the pilot was conscious of the need for accurate lateral positioning.

The aircraft struck the smaller power lines on approach and crashed a short distance further on, between the power lines and the airstrip. The pilot, who was wearing a full harness, was seriously injured, although he had vacated the aircraft by the time a local resident arrived to assist. The emergency services attended and the pilot was airlifted to hospital. Photographs of the scene showed the aircraft in an upright but nose-low attitude with the nose leg having detached. The aircraft's flaps were lowered, consistent with the intended landing.

The pilot did not recall specific details of the accident. He was well aware of the position of both sets of power lines and of the hazard they posed, but on this occasion he did not remember seeing them. He reported that the airstrip had until recently been surrounded by overgrown hedges and trees to about 30 ft in height, particularly to each side, but these had been cut down in the three weeks since he had last flown from the airstrip. He considered that he might therefore have been subject to an unusual visual effect which caused him to approach the strip lower than he intended. The added distraction presented by the demands of the crosswind may have also contributed to the accident.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-161 Cherokee Warrior II, G-BOER
No & Type of Engines:	1 Lycoming O-320-D3G piston engine
Year of Manufacture:	1981
Date & Time (UTC):	16 February 2012 at 1755 hrs
Location:	Coventry Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 2
Injuries:	Crew - None Passengers - None
Nature of Damage:	Dent in wing leading edge, light damage to wing and aileron of parked aircraft
Commander's Licence:	Private Pilot's Licence
Commander's Age:	67 years
Commander's Flying Experience:	218 hours (of which 82 were on type) Last 90 days - 12 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot was taking part in a night flyout event and was taxiing the aircraft prior to takeoff when the accident occurred. It was moving along on a taxiway, past parked aircraft on grass to the left and two parked aircraft on a small hangar apron to the right. One of these, a PA-28, had recently been moved out of the hangar to take part in the flyout, but no-one had yet boarded it.

One of the aircraft parked on the left was further forward than the others, so the pilot steered to the right side of the taxiway to ensure sufficient clearance. In doing so, his aircraft's right wing collided with the left wing of the parked PA-28. It was parked facing the same direction as the taxiing aircraft, with its left wingtip reportedly protruding about 2 ft over the taxiway. The pilot reported that he had been concentrating on avoiding the aircraft to the left and neither he nor his two passengers had seen the wing of the PA-28 before the collision.

BULLETIN CORRECTION

The second aircraft involved was incorrectly identified as being a PA-24 instead of a PA-28. Additionally, the commander held a Private Pilot's Licence as well as the National Private Pilot's Licence stated. The online version of this report was corrected on 14 June 2012.

ACCIDENT

Aircraft Type and Registration:	Reims Cessna F152, G-BIUM
No & Type of Engines:	1 Lycoming O-235-L2C piston engine
Year of Manufacture:	1980
Date & Time (UTC):	21 March 2012 at 1550 hrs
Location:	Netherthorpe Airfield, South Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nosewheel collapsed, engine shock-loaded, propeller, spinner, left wing, cockpit screen and empennage damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	63 years
Commander's Flying Experience:	346 hours (of which 284 were on type) Last 90 days - 1 hour Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

Having flown one touch-and-go landing on grass Runway 24, the pilot positioned the aircraft for a second landing. He recalled that the approach had appeared normal, but as he flared the aircraft to land it suddenly lost height and touched down heavily on the runway. The aircraft then bounced twice before tipping forward until it came to rest inverted. The pilot was uninjured and vacated the aircraft unaided through the right window.

The pilot stated that he had inspected the aircraft several days after the accident and noted that the cockpit flap selector switch and the flaps, which are electrically powered, were in the fully up position. The pilot considered that when configuring the aircraft to land he had inadvertently selected the flaps up.

ACCIDENT

Aircraft Type and Registration:	Rockwell Commander 112TC, N4599W
No & Type of Engines:	1 Lycoming TO-360-C1A6D piston engine
Year of Manufacture:	1976
Date & Time (UTC):	10 March 2012 at 1125 hrs
Location:	Fenland Airfield, Lincolnshire
Type of Flight:	Private (Training)
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Left undercarriage and right mainwheel detached, both wings and tail damaged, fuel tank disrupted
Commander's Licence:	Private Pilot's Licence
Commander's Age:	39 years
Commander's Flying Experience:	589 hours (of which 175 were on type) Last 90 days - 4 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The accident occurred during a short field landing of a differences training and familiarisation flight. The instructor flew the approach and landing on Runway 18 as the student was not confident with crosswind conditions. From the windsock, the wind was estimated to be 250/260 at 10 kt. After the flare, the aircraft floated longer than expected and full power was applied on touchdown as there was insufficient stopping distance remaining. The pilot applied back pressure early in order to clear an obstacle and the aircraft touched down in the next field. The pilot then saw a dyke and trees and elected to get airborne once more. The left undercarriage hit a tree, resulting in the aircraft coming down backwards, causing significant damage to the airframe and leaking fuel into the field. The crew were uninjured and exited the aircraft unaided.

The pilot attributed the accident to flying the approach too fast with no headwind component and that the late go-around decision was due to the bright sunshine directly ahead reducing his visual cues.

ACCIDENT

Aircraft Type and Registration:	1) Vans RV-6A, G-RVGC 2) DA 40D Diamond Star, G-CEZR
No & Type of Engines:	1) 1 Lycoming 0-320-D3G (Modified) piston engine 2) 1 Thielert TAE 125-02-99 piston engine
Year of Manufacture:	1) 2004 2) 2008
Date & Time (UTC):	4 July 2011 at 1528 hrs
Location:	Shoreham Airport, West Sussex
Type of Flight:	1) Post-modification test flight 2) Training
Persons on Board:	1) Crew - 1 Passengers - None 2) Crew - 2 Passengers - None
Injuries:	1) Crew - 1 (Fatal) Passengers - N/A 2) Crew - None Passengers - N/A
Nature of Damage:	1) Destroyed 2) Propeller and gearbox detached, damage to left wing
Commander's Licence:	1) Private Pilot's Licence 2) Airline Transport Pilot's Licence
Commander's Age:	1) 62 years 2) 60 years
Commander's Flying Experience:	1) about 20,600 hours (of which n/k were on type) Last 90 days - n/k hours Last 28 days - n/k hours 2) 3,450 hours (of which 32 were on type) Last 90 days - 35 hours Last 28 days - 13 hours
Information Source:	AAIB Field Investigation

Synopsis

Two aircraft collided, in good weather, in the visual circuit. G-CEZR was rejoining the circuit on the crosswind leg and G-RVGC was on the downwind leg. G-RVGC was rendered uncontrollable by the collision and the pilot was fatally injured when the aircraft struck the ground. G-CEZR, though damaged, was able to land without further damage or injury.

Background G-RVGC

G-RVGC (GC) was on its third flight following an extended period in maintenance, undergoing major modification. The pilot, who was a friend of the owner, had been asked to carry out the test flying required for approval of the modifications, prior to the aircraft undergoing a check flight for renewal of its Permit to Fly. The pilot arrived at the maintenance organisation's hangar at about 0830 hrs and spent between 60 and 90 minutes inspecting the aircraft and familiarising himself with its new avionics fit, which included an Electronic Flight Information System (EFIS) display. Two flights of 19 and 23 minutes, respectively, were then completed with no major defects reported. A minor oil weep was rectified between these flights and the manifold pressure gauge was found to be unserviceable. This was traced to a faulty sensor and the pilot accepted the aircraft without this gauge functioning.

Background G-CEZR

G-CEZR (ZR) was operated by a Shoreham based flying school. One of the flying school's instructors was in the process of upgrading his instructor qualifications and the objective of the flight was for him to practise teaching instrument flying to another instructor.

To facilitate the training, the aircraft commander sat in the left seat, acting as a student. The trainee instructor sat in the right seat, practising his instructional technique. No instrument flying screens or 'foggles' (goggles modified to simulate instrument flying conditions) were in use. At the time of the accident the lesson was complete and the aircraft was making a visual return to Shoreham. The pilot in the right seat was pilot flying (PF) and making the radio calls.

History of the flights

GC departed from Shoreham on its third flight at 1433 hrs and the majority of the flight was recorded by radar (see Figure 1). The pilot called Shoreham ATC for rejoin from the Washington intersection Visual Reporting Point (VRP) at 1519:10 hrs. He was offered a direct arrival, to right base, for Runway 20 but he requested a crosswind join for circuits, saying that he needed to "DO SOME HOURS ON THIS".

ZR departed Shoreham at 1430 hrs and operated, initially, in the instrument pattern overhead the airfield, before departing to the west to conduct general handling exercises. ZR's flight was also recorded on radar (see Figure 1). At 1522:20 hrs the PF reported at the Littlehampton VRP and requested a crosswind join for Runway 20.

Shoreham ATC was operating a single radio frequency with one ATCO operating as both the Approach Controller and Tower Controller.

At 1522:30 hrs the Shoreham ATCO told ZR to report north abeam Worthing Pier (see Figure 2) and "LOOK OUT FOR AN R V SIX JOINING LIKEWISE". GC had already crossed the upwind end of Runway 20 and, immediately after ZR acknowledged the ATCO's instruction, GC reported "G-GC WE'VE JUST JOINED ER CROSSWIND JUST ABOUT TO TURN DOWNWIND". The ATCO acknowledged this call and asked GC to report downwind, which the pilot did at 1523 hrs. He was then told that he was number two to a helicopter on long final and to report on final approach.

At 1524:30 hrs GC reported on final approach for a touch-and-go, with the helicopter in sight, and was told to continue the approach before, at 1524:50 hrs, being cleared for the touch-and-go. Another aircraft, G-TLET (G-ET), a Piper PA-28, was then cleared "AFTER THE R V SIX ON FINAL LINE UP TWO ZERO". At 1525:10 hrs ZR reported north abeam Worthing Pier and was instructed to report crosswind. The ATCO advised the crew that there were "TWO IN THE CIRCUIT".[1]

At 1526 hrs G-ET was cleared to take off, with a left turn out. The radio frequency was then occupied for

Footnote

[1] G-RVGC (GC) was on final approach and G-WARZ (G-RZ), a Piper PA-28, was on the downwind leg.

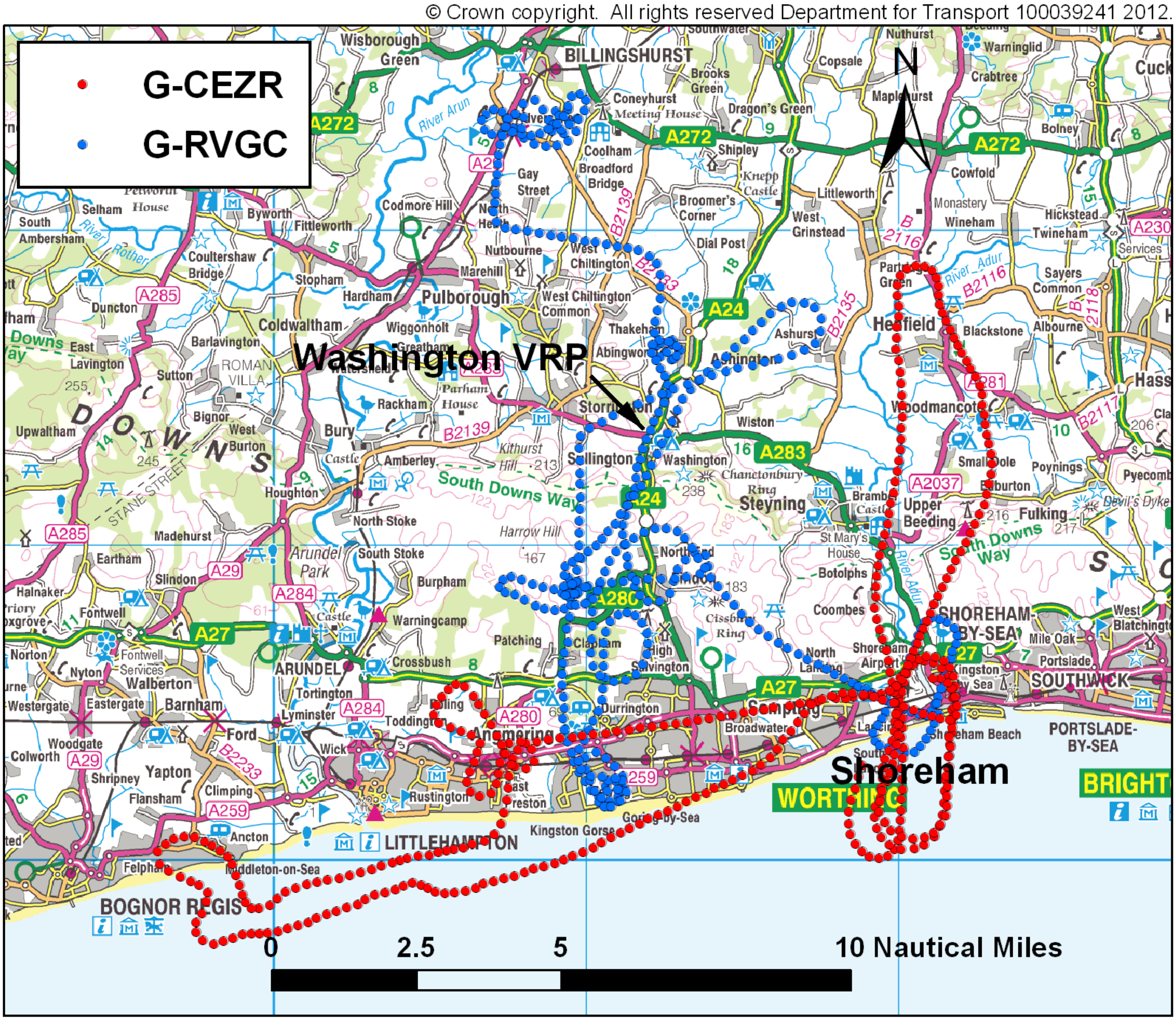

Figure 1

Radar tracks of G-CEZR and G-RVGC from 1444 hrs to the collision at 1527:18 hrs

50 seconds by two other aircraft (G-HD and G-OS) asking for, and one receiving, joining instructions. At 1526:50 hrs ZR reported crosswind. This was acknowledged by the ATCO who instructed ZR to report turning downwind. The ATCO did not see ZR as it approached the airfield. Based on the first circuit flown by GC, the ATCO believed that it would be ahead of ZR and was expecting it to be near the downwind position when ZR crossed over the upwind end of Runway 20.

ZR was still on the crosswind leg when there was a "huge bang" and the aircraft rolled to the left by a substantial amount. To confirm who was handling the aircraft, the PF called "I have control" and recovered the aircraft to a glide attitude, turning left downwind. He assessed the damage and realised that the propeller was missing and that there was a hole in the leading edge of the left wing. Although he needed to use considerable right rudder to maintain control, the PF was able to land ZR on non-active Runway 25, with no further damage.

While the PF flew the glide circuit, the instructor saw GC make a wide descending left-hand spiral into open ground near the airfield. Neither pilot had seen GC before the collision.

The ATCO had continued to issue joining instructions to the previous request, before, at 1527:25 hrs, G-RZ reported on final approach for a touch-and-go. As the ATCO cleared this aircraft for its touch-and-go, a radio transmission was heard saying "MAYDAY MAYDAY". The transmission was partially garbled by other simultaneous transmissions and the callsign was unintelligible. The ATCO replied "STATION TRANSMITTING MAYDAY SAY AGAIN". "MAYDAY MAYDAY" was repeated. However, again the transmission was garbled, with the station identity and message being blocked. At 1527:40 hrs the ATCO again requested "STATION TRANSMITTING MAYDAY SAY AGAIN". Another aircraft then reported that "HE'S GONE IN BEHIND THE AIRFIELD BEHIND".

Eyewitnesses, including an off-duty police officer, ran to the scene of the accident. A large fire had developed and its intensity prevented them from approaching GC. The Airport Fire and Rescue Service and West Sussex Fire Service also attended the site and the fire was extinguished about 10 minutes after the accident had happened. The pilot's body was found in the aircraft wreckage. He had been fatally injured.

Figure 2 shows the radar tracks, starting at 1524:55 hrs, with ZR approaching Worthing pier and GC on final approach, as it was cleared for a touch-and-go, before it briefly descended below radar coverage. The figure also includes all relevant radio transmissions.

G-CEZR

The pilots of ZR had been alerted to other circuit traffic by the ATCO's radio call of "TWO IN THE CIRCUIT" when they had just passed Worthing Pier. When interviewed on the evening of the accident the PF could recall that, as they approached the airfield, there was an aircraft on base leg, an aircraft which had just touched down and a third aircraft was calling for rejoin. The instructor could not recall any radio messages that led him to believe there were any aircraft that would be in their proximity.

When interviewed later, with the aid of the radio recordings, the crew of ZR were able to place the other aircraft in their approximate circuit positions. The PF recalled that, as they approached the airfield, he had seen an aircraft on the runway and, based on his expectations of its flightpath, believed that there would be no confliction. The PF commented that, throughout the flight, he was maintaining his normal lookout, which he described as a sine wave pattern above and below the horizon with a series of short stops to allow his eyes to focus. On the crosswind leg he saw no traffic to his right.

At the second interview the instructor could place one aircraft on the runway and another about to line up but considered there should have been no conflict with them. The instructor stated that he would not rely on ATC for traffic alerting and that circuit traffic could come from "all over the place". When they were approaching the downwind leg he was looking to the right for traffic coming up from the runway, though he was not expecting anything that might be in close proximity to them.

Witnesses

Various witnesses on the ground saw the collision and aftermath. Before the collision, there was no evidence of any avoiding action by either aircraft. Following the collision, GC appeared to the ground witnesses to have lost its fin and rudder and to have sustained damage to

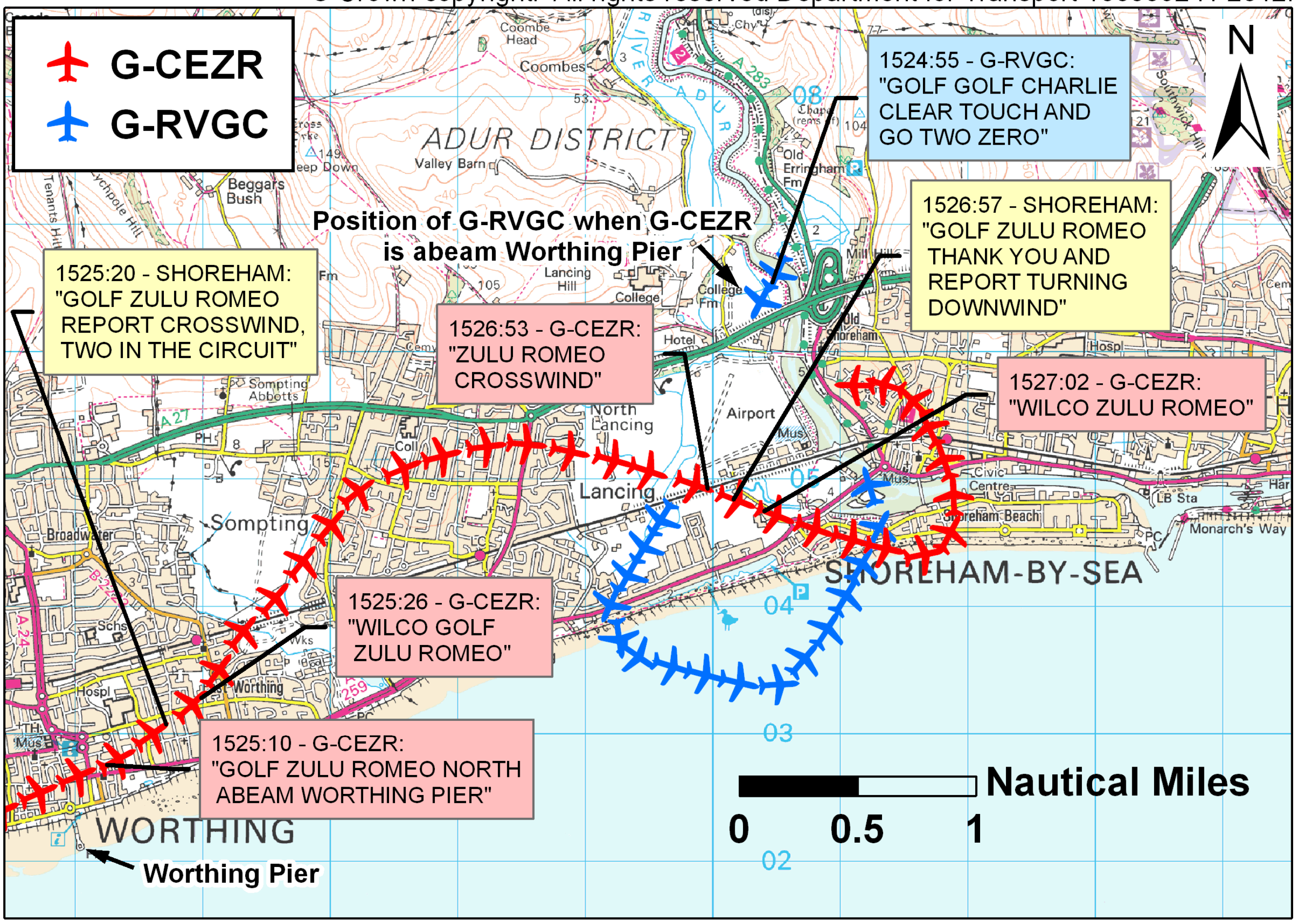

Figure 2

Radar tracks of G-CEZR and G-RVGC from 1524:55 hrs, with relevant radio calls

one or both horizontal stabilisers and elevators. It was described as, initially, descending towards the River Adur before changing course slightly to crash into an open area at the Adur recreation ground.

Recorded Data

Both aircraft were equipped with a GPS unit. ZR's GPS unit did not include the memory card necessary for recording flight logs and the unit recovered from the wreckage of GC had been destroyed by the post-impact fire, rendering any recorded data irrecoverable. Both aircraft were, however, fitted with Mode S transponders, enabling the radar head at Pease Pottage, about 15 nm to the north of Shoreham, to record their position and altitude every six seconds. The transponder fitted to GC had a basic setup which only broadcast altitudes with 100 ft resolution (ie ±50 ft), together with groundspeed and track angle. The transponder fitted to ZR gave altitudes with 25 ft resolution (ie ±12.5 ft), as well as groundspeed, airspeed, roll attitude, track and heading.

Figure 3 shows a close up of the radar tracks at Shoreham and details the relative positions of the aircraft leading up to the collision.

The figure shows that as ZR was about 1 nm from the airfield, on a track to pass over the upwind end of

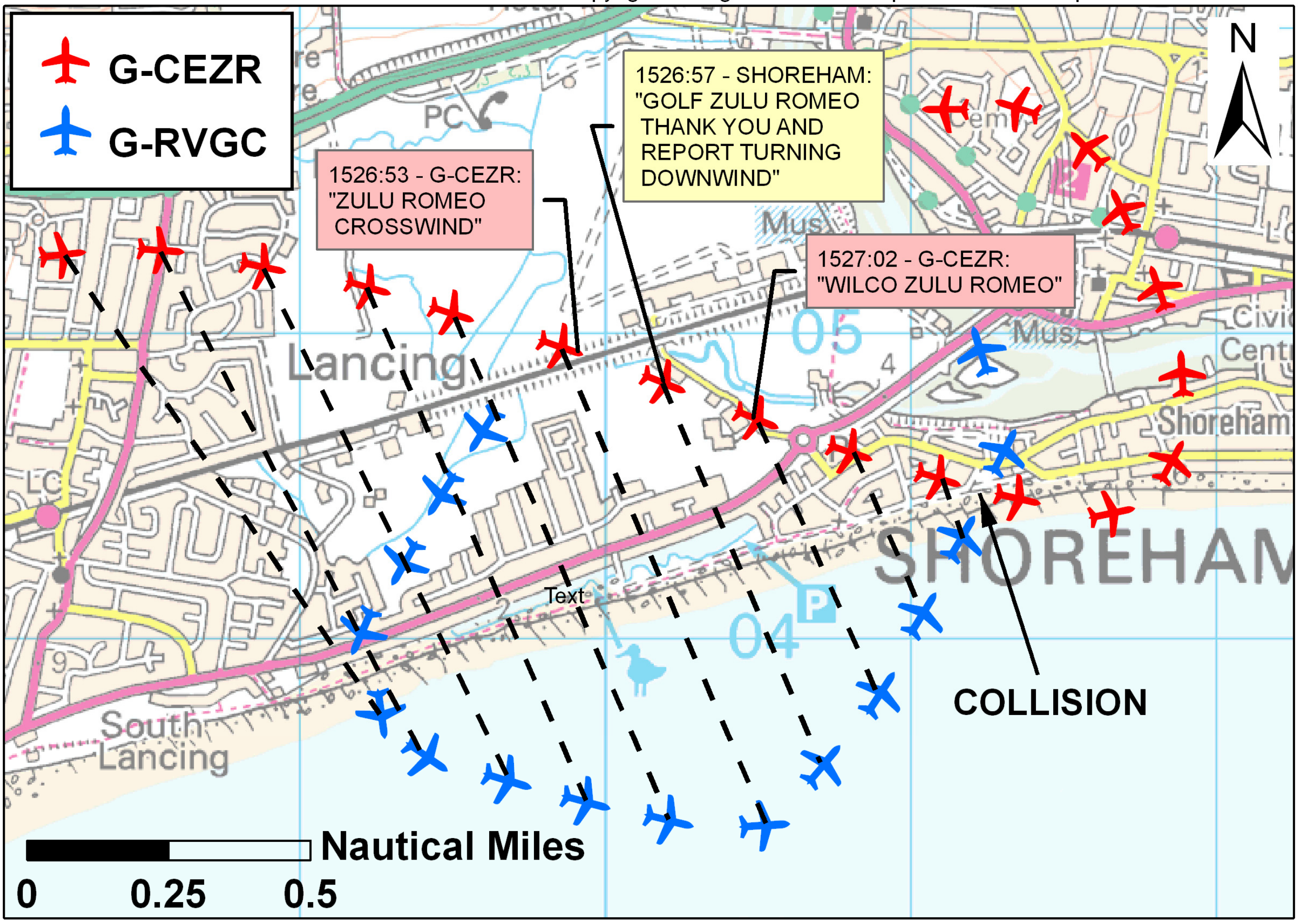

Figure 3

Close up of radar tracks with G-CEZR joining, and G-RVGC, in the circuit, through to the collision

Runway 20, GC was turning onto the crosswind leg of the circuit. ZR was descending through 1,225 ft (±12.5 ft) aal and GC was climbing through 800 ft (±50 ft) aal, with a groundspeed of about 90 kt. As ZR crossed over the upwind end of Runway 20 it levelled off at 1,075 ft (±12.5 ft) aal, where it remained until the collision. GC climbed through 1,100 ft (±50 ft) aal as it turned onto the downwind leg, levelling off briefly at 1,200 ft (±50 ft) aal before descending. At 1527:16 hrs, about 3 seconds before the collision, ZR was at 1,075 ft (±12.5 ft) aal and GC was at 1100 ft (±50 ft) aal; the groundspeed for each aircraft was about 96 kt and 94 kt respectively. Figure 3 also shows that, from the perspective of the ZR cockpit, GC was on an approximately constant bearing from the time it turned onto the crosswind leg until the collision.

Pilot information

G-RVGC

The pilot had worked as an airline pilot on UK registered large commercial passenger jet aircraft. He owned an RV-6, equipped with EFIS, and had considerable light aircraft flying experience. Although his latest logbook was destroyed in the accident, a logbook, starting in August 2002 and ending in July 2010, showed that he ceased airline flying during 2003, with a total of

20,120 hrs. He continued to fly light aircraft and in May 2010 had accrued a total of 20,540 hrs. This was a rate of some 60 flying hours per year and there was anecdotal evidence that he had continued flying at a similar rate in the period between the end of the complete logbook and the accident. The pilot's JAR Private Pilot's Licence (Aeroplanes) was issued in December 2009, on the expiry of his Airline Transport Pilot's Licence. He held a Single Engine Piston (SEP) rating.

G-CEZR

Commander

The commander had held a flying instructor rating for over 30 years. At the time of the accident he was qualified to instruct on single and multi-engine aircraft, as well as to train instructors to teach instrument and multi-engine flying.

Trainee instructor

The trainee instructor held a Commercial Pilot's Licence with a flying instructor's rating. He had qualified as a flying instructor in 2008, had 1,200 hrs and was in the process of upgrading his instructor's rating to allow him to teach instrument flying.

Meteorology

The weather observation at Shoreham Airport at 1541 hrs reported a surface wind from 160° at 4 kt, greater than 10 km visibility and no low cloud. The sun was to the south-west at an angle of about 55° above the horizon. Other pilots were able to provide additional weather information for the time of the accident; they reported no cloud and estimated the visibility at over 30 nm.

Medical information

G-RVGC

A specialist aviation pathologist conducted a post-mortem examination and reported that the pilot had died of head and chest injuries, the cause of which was consistent with the aircraft striking the surface of the ground. There was no evidence to suggest that the pilot was alive during the subsequent fire. The pathologist also reported that there was no evidence of drugs or alcohol having been consumed or natural disease which could have had any bearing on the accident. The pilot held a valid JAA Class 2 medical certificate.

G-CEZR

Neither pilot reported any medical condition, or level of fatigue, likely to have affected the operation. Following the accident, both were breathalysed by the police and the results were negative. Both pilots held valid JAA Class 1 medical certificates.

Aircraft information

G-RVGC

The RV-6A is a two-seat, side-by-side, low-wing monoplane with tricycle landing gear. Constructed from a kit and primarily of aluminium, GC was predominantly coloured white with a dark blue lower fuselage. It was equipped with avionics featuring Advanced Flight Systems Inc EFIS displays. The displays can be integrated with traffic alerting systems; however, GC was not equipped with a compatible system. GC was operating under an LAA Permit Flight Release Certificate to allow the aircraft to be test-flown following installation of an autopilot, new avionics and a propeller overhaul. The permit was valid between 17 June and 17 July 2011. The permit-to-test named the accident pilot as the approved pilot for this test flying.

G-CEZR

The DA-40D is a four-seat, low-wing monoplane with tricycle landing gear. It is primarily constructed of composite materials and, therefore, is mainly coloured white. ZR was equipped with Garmin G1000 avionics. A traffic alerting system, which detects Mode S transponder signals, was available as an option but was not fitted.

Examination of both aircraft

G-RVGC

The wreckage of GC was examined on-site on the afternoon of the accident. Much of the aircraft had been consumed by an intense ground fire and lay in the Adur Recreation Ground, some 100 metres south of the airfield boundary. A series of ground marks and a trail of wreckage showed that the aircraft had struck the ground, some 70 metres east of the main wreckage, in a left-wing-low and 45° nose-down attitude, at high speed. Two propeller slash marks were found in the ground and this evidence, together with the degree of disruption to the wooden propeller blades, indicated that the propeller was turning under moderate to high power.

After the heaviest impact mark, caused by the engine, the aircraft appeared to have performed a 'cartwheel' before coming to rest with the rear fuselage and tailplane resting on top of the inverted right wing, with the engine only partially attached. It was immediately evident that the vertical fin and rudder were not present at the site and closer examination showed that the tip of the left tailplane and elevator (including its mass balance) were also missing. An impact had also separated the left elevator into two halves, although both sections had remained loosely attached until after ground impact.

G-CEZR

The aircraft had been towed to the Police Air Support Unit's secure hangar before the AAIB examination. It was immediately apparent that the propeller was missing, as a result of fracturing in the reduction gearbox which connected it to the engine. There was a 90 cm section of the left wing composite leading edge missing, at about mid-span, (Figure 4) and a piece of the fin structure from GC was lodged in the left aileron control horn. There was other minor damage to the aileron and flap on the left wing, and the nosewheel. Apart from these, there appeared to be no further damage to ZR.

Debris field

Pieces of both aircraft were located some distance from the main wreckage, the furthest debris lying about 1.25 km southeast, on Shoreham Beach. This comprised ZR's wooden propeller attached to a section of the reduction gear casing, minus the majority of the two shattered blades. Some composite parts of the leading edge of ZR's left wing were also recovered. In addition, in this debris field were the fin and rudder from GC, its left tailplane and elevator tip and its inboard elevator hinge.

ATC

The ATCO, who had been qualified at Shoreham for over 12 years, commenced duty at 0830 hrs and followed a rotating work cycle of two hours on operational duty followed by a one hour break. The ATCO had been on operational duty for 58 minutes prior to the accident, acting in support of the other off-going operational ATCO. At 1521 hrs, the ATCO took over the operational position, providing a combined Aerodrome (ADC) and Approach Procedural (APP) service, without the aid of surveillance equipment. At interview, the ATCO indicated being "comfortable" with the workload.

Figure 4

Leading edge damage to G-CEZR

Shoreham ATC operated an abbreviated flight progress strip system, using acrylic flight progress 'chips' for all local and visiting aircraft. Flight progress strips were used, as required, to provide more specific flight information for local flights of a more complex nature.

The construction of the Visual Control Room (VCR), and the level of its roofline, limits the ATCO's view of traffic joining overhead. The ADC position affords a good view of aircraft joining crosswind for Runway 20 at a circuit height of 1,100ft.

ATC procedures

An Aerodrome Traffic Zone (ATZ) has the characteristics of the airspace in which it is located. The Shoreham ATZ is located within an area of Class G uncontrolled airspace. Therefore, ATC are not required to provide separation between VFR traffic.

The *Manual of Air Traffic Services* Part 1 (MATS 1), Section 2 defines the responsibilities of the Aerodrome ATCO as:

> *'2.1 Aerodrome Control is responsible for issuing information and instructions to aircraft under its control to achieve a safe, orderly and expeditious flow of air traffic and to assist pilots in preventing collisions between: a) aircraft flying in, and in the vicinity of, the ATZ;'*

Responsibility for collision avoidance, therefore, rests with the pilot(s) in command.

Rules of the air

Civil Aviation Publication (CAP) 393, *Air Navigation: The Order and the Regulations, Section 2, The Rules of the Air Regulations 2007* states in *Section 4, General Flight Rules*:

'Avoiding aerial collisions

8 (1) Notwithstanding that a flight is being made with air traffic control clearance it shall remain the duty of the commander of an aircraft to take all possible measures to ensure that his aircraft does not collide with any other aircraft.

(5) Subject to sub-paragraph (7), an aircraft which has the right-of-way under this rule shall maintain its course and speed.

Converging

9 (3) Subject to paragraphs (1) and (2), when two aircraft are converging in the air at approximately the same altitude, the aircraft which has the other on its right shall give way.'

Standard civil aerodrome circuit pattern

The standard circuit at UK civil aerodromes is set out in Figure 5 below.

The CAA publishes a *Guide to Visual Flight Rules in the UK* which states:

'...however, because of the diverse nature of aircraft types, performance and the application of local requirements it is not possible to define an actual common pattern for use at all aerodromes.'

The crosswind join into the circuit

The crosswind join is a shortened adaptation of the standard overhead join. It requires an aircraft joining the circuit to cross the upwind end of the runway at 90°, at circuit height, giving way to aircraft already in

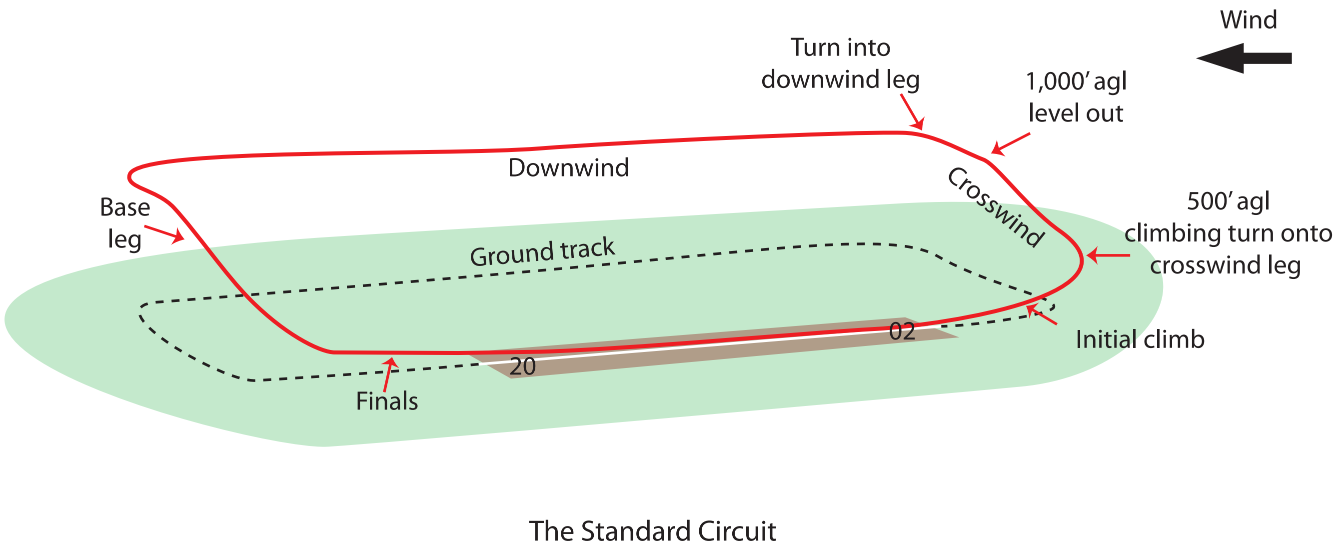

Figure 5

The standard circuit, adapted with permission from *The Private Pilot's Licence Course* by J M Pratt[1]

Footnote

[1] The Private Pilot's Licence Course, Jeremy M Pratt, published by Airplan Flight Equipment, 2001.

the pattern. Aircraft requested to 'report crosswind' do so at that point, as they pass from the 'dead side' into the 'live' circuit, and they are then deemed to have joined the circuit. The aircraft then continues on its track until intercepting the downwind leg and turns into the normal circuit pattern at the 'downwind' position, abeam the upwind end of the runway.

The CAA's General Aviation Safety Sense Leaflet 6e, *Aerodrome Sense,* provides advice to pilots for aircraft arrivals at aerodromes. It includes the following guidance:

> *'Keep a good lookout, using others' radio calls to help identify all traffic joining or already in the pattern. Give way to aircraft already in the pattern.'*

Shoreham Airport

The *UK Aeronautical Information Publication* (AIP) provides published information for Shoreham Aerodrome. Regarding *Use of Runways,* the following is included:

> *'b. Runway 02/20 will always be preferred subject to operational limitations. Aircraft departing Runway 20 should avoid overflying as much of the built up areas to the south as is practical*
>
> *c. Circuit heights are 1100 ft aal for all runways…*
>
> *f. Aircraft joining direct to the crosswind leg should arrange their flight to track over the upwind end of the runway-in-use, ie in the same position as if approaching it from the 'deadside'. Unless otherwise instructed, this should be at circuit height.'*

Under *Noise Abatement Procedures,* the AIP states:

> *'Noise abatement techniques should be practiced at all times, the area to the east and west being particularly sensitive.'*

The Shoreham Airport circuit patterns for the various runways are published on their website and in certain flight guides. The indicated ground tracks are representative and for guidance. The website states that:

> *'Departure Runway 20 - aircraft must make a 10 degree turn to the right at the railway line for noise abatement until reaching the coast then a further left or right turn as required.'*

Circuit positioning

GC's first downwind leg was 0.7 nm from the runway centreline and on its second circuit, at the time of collision, the aircraft was 0.8 nm from the centreline. Based on interview, the PF of ZR intended to fly downwind between 1.3 and 1.7 nm from the centreline.

The time for an aircraft travelling at 90 knots from the crosswind joining position to the downwind leg, flown by GC, would have been about 32 seconds. From the time of ZR's radio call to the collision was 28 seconds.

See-and-avoid

In '*The Australian Transport Safety Bureau report on the Limitations of the See-and-Avoid Principle*[2]' it states that:

Footnote

2 Limitations of the See-and-Avoid Principle; ATSB Research Report, April 1991, http://www.atsb.gov.au/publications/1991/limit_see_avoid.aspx

'Numerous limitations, including those of the human visual system, the demands of cockpit tasks, and various physical and environmental conditions combine to make see-and-avoid an uncertain method of traffic separation.

...In determining visibility, the colour of an aircraft is less important than the contrast of the aircraft with its background. Contrast is the difference between the brightness of a target and the brightness of its background and is one of the major determinants of detectability (Andrews 1977, Duntley 1964). The paint scheme which will maximise the contrast of the aircraft with its background depends of course, upon the luminance of the background. A dark aircraft will be seen best against a light background, such as bright sky, while a light coloured aircraft will be most conspicuous against a dull background such as a forest.

...Lack of relative motion on collision course

The human visual system is particularly attuned to detecting movement but is less effective at detecting stationary objects. Unfortunately, because of the geometry of collision flightpaths, an aircraft on a collision course will usually appear to be a stationary object in the pilot's visual field.

If two aircraft are converging on a point of impact on straight flightpaths at constant speeds, then the bearings of each aircraft from the other will remain constant up to the point of collision.

From each pilot's point of view, the converging aircraft will grow in size while remaining fixed at a particular point in his or her windscreen.'

Traffic alerting systems

Studies in 1991[3] showed that alerted see-and-avoid is eight times more effective than unalerted. There is no requirement for traffic alerting systems to be fitted to light aircraft. Both GC and ZR were operating Mode S transponders and both were equipped with EFIS displays that could have been fitted with a traffic alerting system. Stand-alone alerting systems were also available.

Previous AAIB safety recommendations

Following the mid-air collision between G-BOLZ and G-EYES, in the circuit at Coventry Airport in 2008[4], the AAIB made Safety Recommendation 2010-003, which related to Section 2 of MATS, Part 1. It stated:

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. **Safety Recommendation 2010-003**

The CAA accepted this recommendation. In July 2011, they updated the AAIB with their progress, stating that they had:

'Completed a detailed and comprehensive Air Traffic Standards Division (ATSD) safety review,

Completed a documentary review,

Were undertaking a UK incident data review,'

Footnote

3 Unalerted Air to Air Visual Acquisition, J W Andrews, November 1991, Massachusetts Institute of Technology.

4 AAIB Aircraft Accident Report 8/2010.

Following the mid-air collision between G-BYXR and G-CKHT in 2009[5], the AAIB made Safety Recommendation 2010-041. It recommended that:

> …the Civil Aviation Authority, in light of changing technology and regulation, review their responses to AAIB Safety Recommendations 2005-006 and 2005-008 relating to the electronic conspicuity of gliders and light aircraft. **Safety Recommendation 2010-041**

The CAA accepted this recommendation and in March 2011 updated the AAIB with their progress. The CAA highlighted the complexities of the situation and the difficulties of finding a certificated but low cost and low power solution, such that it could reasonably be mandated to the large number of light aircraft and gliders on the UK register. The CAA concluded that no short term solution was available but, through the Future Airspace Strategy (FAS) and the Airspace & Safety Initiative (ASI), they would establish a cooperative workstream to address electronic conspicuity.

Other ongoing safety action

CAA visibility study

In September 2011, partly in response to the 2009 fatal collision involving G-BYXR and G-CKHT[6], the UK CAA announced that it was to fund research into improving the visual conspicuity of light aircraft and gliders. The CAA commented that:

> *'…being constructed of white composite materials many of these aircraft can be very difficult to spot when airborne.'*

Footnote

[5] AAIB Aircraft Accident Report 5/2010.
[6] AAIB Aircraft Accident Report 5/2010.

Analysis

Engineering

The tips of the detached left tailplane and left elevator from GC and the mid-span bisection of its left elevator showed that both had been caused by contact with the propeller of ZR. Both halves of the elevator had remained attached to the aircraft, the outboard half by the outer hinge and the inboard half by the torque tube. Upon impact with the ground, the outboard half had detached whilst the inboard half had remained with the main wreckage.

The recovered vertical fin and rudder of GC showed evidence of a distinct, horizontal crease caused by an object approximately halfway up the fin. This was on the left side and it was possible to match the imprint in the metal fin with the missing segment of the leading edge of ZR's left wing. It became clear that the two aircraft had been travelling at right angles to each other at impact and it was possible to determine the following sequence of contact, established using relative speeds derived from the radar records of both aircraft and an assumed propeller speed for ZR.

The first contact was between one propeller blade of ZR (rotating clockwise when viewed from behind) and the tailplane and elevator of GC, removing the tips of the left tailplane and elevator and destroying the wooden propeller blade of ZR (see Figure 6a).

As relative movement of both aircraft continued, a second propeller blade from ZR was in contact with the elevator further inboard, separating it into two halves (see Figure 6b). The severe out-of-balance forces rapidly fractured ZR's reduction gear casing and the propeller detached.

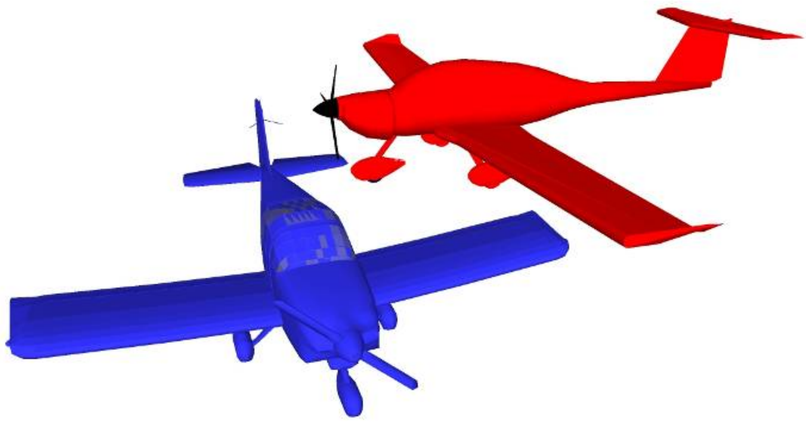

Figure 6a

Modelling of collision sequence (G-CEZR in red and G-RVGC in blue)

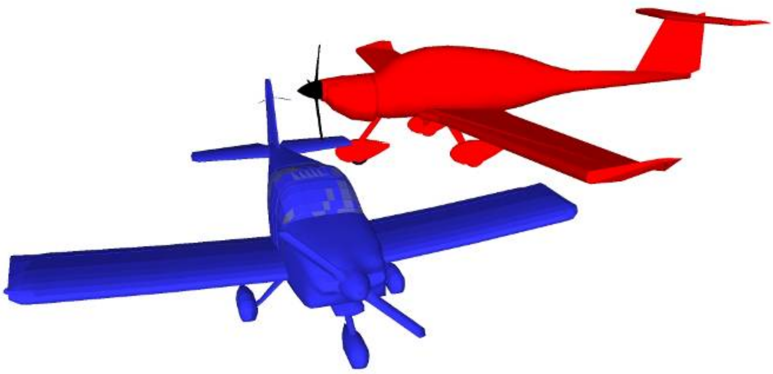

Figure 6b

Modelling of collision sequence

Figure 6c

Modelling of collision sequence

The third point of contact was between the fin/rudder of GC and the left wing leading edge of ZR; this contact detached the fin/rudder of GC (see Figure 6c).

There was no further contact between the two aircraft, but GC would have been left with no yaw control and severely impaired (or possibly jammed) longitudinal control. The leading edge damage to ZR would have caused some drag increase on the left side but clearly the pilot was able to overcome this and perform a successful forced landing without power.

Operations

General

From eyewitness accounts and recorded data, both aircraft approached each other in broadly straight and level flight prior to the collision. Neither of the crew of ZR saw GC before the collision and the flight path of GC suggests that its pilot did not see ZR. The rules of the air require pilots to undertake certain actions, in order to avoid collisions. However, this is only possible if the pilots involved are aware of the position of the other aircraft.

Each aircraft was following the correct circuit pattern and was at the correct height at the time of the collision. Also, ZR's crew made their crosswind radio transmission in the correct position, as they crossed the upwind end of Runway 20 at an angle of 90° and joined the 'live' circuit.

GC's downwind leg was closer to the runway centreline than the crew of ZR were intending to fly on their downwind leg. However, beyond following the circuit pattern, there was no requirement for either aircraft to follow a specific ground track or overfly particular turning points in the circuit, apart from the noise abatement procedure while taking off from Runway 20. The radar data indicated that GC complied with this procedure.

The advice to pilots joining a circuit on the crosswind leg and the rules regarding converging aircraft indicate that ZR should have given way to GC. However, this depended on ZR's crew being aware of and seeing GC. Also, each aircraft commander had a duty to take all possible measures to ensure that his aircraft did not collide with any other aircraft. Again, this relied on each commander seeing the other aircraft.

Situational awareness

The ATCO's traffic information to ZR of "TWO IN THE CIRCUIT" alerted the pilots to look for other aircraft and, approaching the airfield, the PF believed they were aware of the approximate locations of the aircraft referred to. At the time, GC was landing for a touch-and-go, G-RZ was further back in the circuit, late downwind or on base leg, and G-ET was at the holding point, about to line up and depart before G-RZ landed. The ATCO's radio call and phraseology was correct. However, it is possible that G-ET's departure introduced a risk of misidentification, depending on whether the aircraft was on its takeoff roll or airborne when it was last seen. G-ET was cleared to take off 50 secs before ZR reported crosswind and 1 min 25 secs before G-RZ called on final approach for a touch-and-go.

Based on GC's first circuit, the ATCO believed that GC would be ahead of ZR on the downwind leg of the circuit and did not see a requirement to impose sequencing. Conversely, the PF of ZR, who had seen an aircraft on the runway, which he believed to be circuit traffic, considered that they would be ahead of it on the downwind leg. It is not certain that the aircraft, ZR's crew saw, was GC. If it was G-ET, that could have led the crew to dismiss it as a risk and may, therefore, have influenced their lookout for other circuit traffic.

It is not known what awareness the pilot of GC had of other aircraft in the circuit, and ZR in particular.

Sun position

The sun's position and angle, to the south-west and about 55° above the horizon, meant that it was unlikely to have affected the pilots' lookout. However, it may have affected the ATCO's who would have been looking generally towards the sun when looking for aircraft joining crosswind. The CAA acknowledges that composite aircraft can be difficult to see and, while the ATCO does not specifically recall the sun being a particular issue, the combination of factors may explain why ZR was not seen before it joined the circuit. The remainder of the approach to the collision occurred behind and at a high angle to the ATCO, making visual sighting unlikely.

Visual search

Visual search is not 100% effective and even in ideal conditions there is no guarantee that a conflicting aircraft will be sighted in sufficient time to avoid a collision. Studies show that a visual search is more likely to be effective when the searcher knows there is a target to find and approximately where to look for that target.

The ATCO had provided traffic information to ZR and this was sufficient to alert the pilots to the need to look for and acquire other traffic. They believed that they had sighted the circuit traffic and considered that it was not a collision risk. This information and ZR's crosswind joining call could also have alerted the pilot of GC to joining traffic.

Regardless of whether the crew of ZR had misidentified the departing aircraft or whether they had identified GC correctly, approaching the downwind leg they had a low expectation of encountering traffic. Therefore, their visual search was likely to be, at best, as effective as unalerted see-and-avoid.

It is not possible to know if the pilot of GC heard the crosswind call from ZR, or if he recognised the conflict posed by ZR and was actively looking for it.

Contrast

In order to acquire the other traffic visually, the pilot of GC would have had to see a white aircraft against a bright horizon. Likewise, the crew of ZR would have been required to detect a blue and white target against the background of the sea on a bright, sunny day. It is considered that neither of these targets would have contrasted strongly against their background.

Constant bearings

During the 24 seconds leading up to the collision, from the perspective of the crew in ZR, GC was on an approximately constant bearing. The ATSB report makes it clear that, due to the apparent lack of movement of the target, a constant bearing will reduce the probability of visual sighting.

Traffic alerting systems

In previous UK general aviation mid-air collisions a common AAIB finding is that the aircraft involved were not on a common ATC frequency or were not electronically conspicuous. As such, no form of alerting was practicable. However, in this collision both aircraft were transmitting Mode S data and both were equipped with EFIS systems capable of displaying traffic information. Neither aircraft was fitted with this optional equipment nor were they required to be. Had this equipment been fitted it could have been effective although it would not have detected aircraft not equipped with transponders.

Conclusions

Collision avoidance within an aerodrome circuit in Class G airspace is achieved by pilots visually acquiring conflicting traffic, aided by instructions or information from ATC and transmissions from other aircraft, and altering their aircraft's flightpath, as necessary.

Pilots' mental models of aircraft positions assist in deciding where to search visually. Visual detection is subject to numerous limitations and its success is not assured. In addition, there is a lower probability of seeing traffic if it is not where it is expected to be. Both aircraft commanders had a duty to take all possible measures to avoid a collision, in accordance with the Rules of the Air Regulations which specify who has right of way. However, the crew in ZR were not aware that an aircraft, which was on an approximately constant bearing, was approaching them from the right on the downwind leg, nor did they see it. Whether the pilot of GC was aware of ZR joining the circuit on the crosswind leg, or saw it is not known. There was no indication that he took any avoiding action, implying that he probably did not see ZR in time to avert the collision.

The CAA has recently conducted a review of light aircraft electronic conspicuity, is reviewing the MATS Part 1 requirements for ATCOs and is conducting a study aimed at improving composite aircraft visibility.

ACCIDENT

Aircraft Type and Registration:	Robinson R44 Raven, G-SRPH	
No & Type of Engines:	1 Lycoming O-540-F1B5 piston engine	
Year of Manufacture:	2007 (Serial no 1849)	
Date & Time (UTC):	11 February 2012 at 1415 hrs	
Location:	Crossmaglen, Northern Ireland	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Damage to tail boom, main and tail rotor blades, doors, panels and a Portakabin	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	63 years	
Commander's Flying Experience:	113 hours (of which 113 were on type) Last 90 days - None Last 28 days - None	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The pilot was attempting a takeoff from a confined site with various small buildings in the immediate vicinity. The surface wind was assessed as westerly at 8 kt and there was no significant weather. The pilot reported that, as the helicopter lifted off, it yawed to the left. He applied opposite pedal to counter the yaw but over-corrected. He then applied more collective in an attempt to escape from the situation but the helicopter yawed through about 180° and reached a height of about 25 to 30 ft, before descending. Before the helicopter hit the ground, the pilot pulled the cyclic control aft, to slow down. The tail struck the ground and the main rotor blades struck a nearby Portakabin, causing it severe damage. The helicopter came to rest upright on its skids. The pilot, who had not flown in the preceding 90 days, attributed the accident to over-controlling on pedals and collective.

ACCIDENT

Aircraft Type and Registration:	Cameron N-77 hot air balloon, G-BEEI
No & Type of Engines:	None
Year of Manufacture:	1978 (Serial no 249)
Date & Time (UTC):	25 March 2012 at 1707 hrs
Location:	Bozeat, Northamptonshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 2
Injuries:	Crew - 1 (Minor) Passengers - 1 (Minor)
Nature of Damage:	Minor burns to basket and holes in balloon envelope
Commander's Licence:	Private Pilot's Licence (Balloons)
Commander's Age:	18 years
Commander's Flying Experience:	26 hours (of which 20 were on type) Last 90 days - 2 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by AAIB

Synopsis

The balloon sank unexpectedly during an approach to land and struck high voltage transmission lines, coming to rest with the basket suspended about 15 m above ground level. The three people on board, two of whom sustained very minor injuries, were rescued by the emergency services once the power lines were confirmed safe.

History of the flight

The balloon took off in good weather conditions and an east-north-easterly wind of about 5 to 8 kt. On board were the pilot and two passengers. The flight progressed uneventfully at about 500 ft agl, in the company of five other balloons. About 15 minutes before the accident, the pilot flew an approach to low level at an alternative landing site before climbing again, experiencing no adverse conditions. Groundspeed was steady at about 5 kt.

The pilot identified a landing site in playing fields on the eastern side of the town of Bozeat, about 7.5 nm downwind of the takeoff location. Although the field itself was otherwise ideal, 132 kV transmission lines ran adjacent to it, from approximately north-west to south-east, passing about 250 m to the east of the field. This meant that the balloon would need to pass over them on its approach to land.

A few minutes before the accident, the pilot of another balloon, which was flying about 1 km ahead, called the pilot of G-BEEI to warn him that he had experienced windshear at a height of about 160 ft agl, while landing in the same area.

The pilot of G-BEEI continued the approach, flying towards the power lines and descending to fly level about 20 m above them. Suddenly he became aware that the balloon was descending steeply toward the power lines, so he put both burners on. He quickly realised that the balloon would not avoid the wires, so he turned off both pilot lights and took action to rapidly deflate the balloon, to minimise the risk of the more vulnerable basket and burner/fuel lines contacting the power lines.

The balloon struck the power lines above burner and basket height and then slid along them until it came to rest against a support pylon, with the basket suspended about 15 m above ground level. The pilot and one passenger sustained very minor singeing injuries and a small fire in the basket quickly extinguished itself. The pilot disconnected hoses from the fuel tanks, while witnesses alerted the emergency services, who quickly arrived on scene.

Circuit protections operated correctly to remove electrical power instantaneously when the balloon came into contact with the transmission lines. Before emergency services could be permitted to commence rescue operations, strict safety protocols and procedures had to be followed to ensure that circuits were correctly isolated and earthed. As the accident site was on the border of two electricity distribution network operators, this process was made more difficult and entailed the attendance of engineers at three separate locations. Consequently, rescue operations did not commence until about 2130 hrs.

The pilot, who gained his licence about six months earlier, reported that he had encountered a level of windshear on the approach which was greater than he had experienced before. Other pilots in the group that day also reported experiencing low level windshear, both in the landing area and en route.

The pilot later considered that he had not made an allowance for the possibility of unusual atmospheric effects in response to the other pilot's warning. Faced with a similar situation in future, he said he would aim to modify his approach accordingly or seek a more appropriate landing site.

ACCIDENT

Aircraft Type and Registration:	Gemini Flash IIA, G-MVSN
No & Type of Engines:	1 Rotax 503 piston engine
Year of Manufacture:	1989
Date & Time (UTC):	17 March 2012 at 1310 hrs
Location:	Eshott Airfield, Northumberland
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Student pilot
Commander's Age:	44 years
Commander's Flying Experience:	51 hours (of which 7 were on type) Last 90 days - None Last 28 days - None
Information Source:	Aircraft Accident Report Form submitted by the pilot and CCTV footage

Synopsis

The microlight's engine ran to full power on start-up. The student pilot was unable to stop the aircraft accelerating and abandoned it, sustaining injury. The microlight became airborne for a short while before crashing.

Description of the event

The student pilot, who part-owned the microlight, was preparing it for an instructional flight. The weather was fine and calm. The pilot had moved the microlight from its hangar to a suitable area and, while waiting for his instructor who was airborne at the time, carried out the pre-flight checks and prepared to start the engine. His normal practice was to start the engine prior to flight to let it warm up, and he had done this about 30 minutes earlier, running it successfully for about 10 minutes.

After priming the engine again, the student pilot sat in the microlight to start it. Part of the pre-start checks was to ensure the hand operated throttle was closed and the foot operated throttle was clear. However, on pulling the start cord, the engine started and immediately ran up to full power. The brakes were applied but did not prevent the aircraft moving forward. The pilot manipulated the throttle control but without obvious effect.

As the pilot was not intending to fly straight away, he was not strapped in or wearing a protective helmet.

With the aircraft accelerating towards a hangar, he chose to abandon it rather than risk injury if it struck the hangar. He threw himself out of the left side, sustaining a broken leg and torn ligaments when the aircraft's left wheel ran over his right knee.

The aircraft missed the hangar but continued and became airborne. Footage from a CCTV camera showed the microlight climbing steeply before stalling and entering a dive. It then performed a low-level looping manoeuvre, striking the ground at relatively high speed before the manoeuvre was completed. The aircraft was destroyed in the accident and a wire fence was also damaged. A small fire broke out, causing localised damage to an area of grass and small trees.

ACCIDENT

Aircraft Type and Registration:	Lindstrand LBL 330A hot air balloon, G-LRGE
No & Type of Engines:	None
Year of Manufacture:	2003 (Serial no 929)
Date & Time (UTC):	22 September 2011 at 1630 hrs
Location:	Micheldever, Hampshire
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 1 Passengers - 14
Injuries:	Crew - 1 (Serious) Passengers - None
Nature of Damage:	Damage to pilot's thumb requiring surgery
Commander's Licence:	Commercial Pilot's Licence (Balloons)
Commander's Age:	56 years
Commander's Flying Experience:	2,700 hours (of which 2,000 were on type) Last 90 days - 37 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The pilot's gloved thumb became caught in the quick release mechanism at takeoff, causing serious injury. He was able to land the balloon in a field without further incident.

Description of the event

The pilot gave a routine safety briefing to his 14 passengers and initiated balloon launch shortly afterwards. The launch site was a small clearing, sheltered by trees on all sides. After he had operated the quick release mechanism, the pilot's gloved right thumb became trapped by the portion of tether rope fixed to the balloon basket. This was running out through a 4 inch diameter ring, fixed to the second part of the tether rope arrangement which itself was securely attached to the support vehicle.

The pilot's thumb was pulled towards the ring, and jammed the passage of the rope through it, causing him to be dragged partially out of the basket as the balloon rose. Eventually, the upper joint of his thumb snapped back due to the increasing force on it and was released. The nature of the launch site meant it was not possible to land back there. Instead, the pilot landed the balloon in a field about a mile away. He was taken to hospital and detained for relocation and surgery on his damaged thumb.

After inflation, but prior to launch, the balloon basket had shifted to a position whereby the quick release mechanism and the ring were in close proximity, a situation which was not unusual. The pilot did not know why his thumb became caught but considered the proximity of the quick release line and the ring may have been contributory.

Safety message

The pilot was a very experienced balloonist, who was concerned that the accident arose through no obvious departure from normal procedures or through any obviously unsafe act. The quick release system in use was a common arrangement and, like other arrangements, typically required some tension to be present in the tether ropes to operate cleanly. Consequently, a pilot could find himself manipulating the release arrangement (by pulling on one of the ropes, for example) in order to temporarily create the required tension.

With the basket moving under light and variable winds, the pilot in this case believed he may have attempted to create the required tension by holding onto part of the securing rope, and that he may have developed this undesirable practice over a period of time without realising the potential danger. He felt this technique may have contributed to the outcome.

The pilot further observed that there was the real danger of being dragged completely out of the basket, although in this case this was averted by his safety harness and the fact that his thumb suddenly released. He believed it was not unusual for some pilots to be in the habit of securing their safety harness only after launch, which in the light of this accident could be seen as having the potential to subject the balloon and its occupants to grave risk.

ACCIDENT

Aircraft Type and Registration:	Rotorsport UK MTOsport, G-CGGL
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2009
Date & Time (UTC):	31 March 2012 at 1125 hrs
Location:	Kirkbride Airfield, Cumbria
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to airframe, engine, rotors and propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	1,900 hours (of which 1,500 were on type) Last 90 days - 60 hours Last 28 days - 26 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The gyroplane suffered a partial loss of engine power during takeoff. The instructor landed the aircraft on the remaining runway but was unable to bring it to a stop before it ran off the end.

History of the flight

The instructor pilot was flying a takeoff as part of an instructional exercise when the accident occurred. The weather was fine, with a surface wind from 050° at about 5-7 kt and an air temperature of 14°C; Runway 05 was in use. The pilot reported that the gyroplane waited on the ground longer than normal after engine start and before commencing takeoff, such that the engine temperature was higher than usual, while still within the normal operating range.

All pre-flight and engine checks had been carried out and the takeoff appeared normal until shortly after the gyroplane had left the ground, when there was a sudden reduction in engine power. The pilot was able to land the gyroplane on the remaining runway but could not bring it to a stop before it ran off the end and into the perimeter fence. Both the pilot and his student were wearing full safety harnesses and protective helmets. Although the pod sustained moderate damage, neither occupant was injured.

When the engine was examined, the spark plugs for cylinder 4 were found to be 'wet' with fuel, indicating that they had not been firing. The engine was subsequently run successfully. During discussion between the pilot and engineering personnel, the increased engine operating temperature, the relatively warm day and the use of winter grade MOGAS were considered to have been conducive to vapour lock in the fuel lines, although this would not have accounted for the 'wet' spark plugs in cylinder 4.

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British West Indies
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2 nm NNE of Biggin Hill Airport
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St Kitts, West Indies
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Super Puma, G-PUMI
at Aberdeen Airport, Scotland
on 13 October 2006.

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8/2010 Cessna 402C, G-EYES and
Rand KR-2, G-BOLZ
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2011

1/2011 Eurocopter EC225 LP Super Puma,
G-REDU
near the Eastern Trough Area Project
Central Production Facility Platform in
the North Sea
on 18 February 2009.

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Super Puma, G-REDL
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