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ADDENDA and CORRECTIONS

None

(ALL TIMES IN THIS BULLETIN ARE UTC)

ACCIDENT

Aircraft Type and Registration:	Eurocopter EC225 LP Super Puma, G-REDU
No & Type of Engines:	2 Turbomeca Makila 2A turboshaft engines
Year of Manufacture:	2008
Location:	Approximately 500 metres south of the ETAP platform in the North Sea Central Area
Date & Time (UTC):	18 February 2009 at 1835 hrs
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 2 Passengers - 16
Injuries:	Crew - None Passengers - 3 (Minor)
Nature of Damage:	Damaged beyond economic repair due to salt water immersion, impact and salvage damage
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	55 years
Commander's Flying Experience:	17,200 hours (of which 198 were on type) Last 90 days - 137 hours Last 28 days - 54 hours
Information Source:	Inspector's Investigation

Background

The helicopter was approaching its destination, the ETAP oil production platform located 132 nm east of Aberdeen, at night, when it was seen by observers on the platform to strike the surface of the sea. The helicopter remained afloat, all the occupants escaped into two liferafts and all were subsequently rescued. Although the accident was observed from the ETAP platform and a Search and Rescue (SAR) operation was initiated immediately, it was some time before the passengers and crew were located.

Following the arrival of the first SAR helicopter in the vicinity of the ETAP platform, 27 minutes elapsed before the occupied liferafts were identified approximately 400 m from the platform. The search was hampered by the darkness, fog and the weakness/absence of homing signals on the emergency frequencies 121.5 MHz and 243.0 MHz, although survival equipment designed to transmit on both these frequencies had been activated by the crew. The liferafts were finally located by a combination of aircraft weather radar, visual guidance from personnel on the ETAP platform and a weak signal on 121.5 MHz.

The initial details of this accident were described in AAIB Special Bulletin S3/2009.

Aircraft equipment

The helicopter was equipped with an externally mounted, automatically deployable Crash Position Indicator (CPI). It failed to release and, hence, did not transmit a signal. The reason for this remains under investigation.

Four hand portable locator beacons were also carried in the helicopter. There was one in each of the crew's life-jackets and one in each life-raft. The former are known as Personal Locator Beacons (PLB)s and the latter as Emergency Locator Transmitters (ELT) s. All four of these units were, however, of identical TechTest 500-12Y design and, like the CPI, approved equipment.

Once switched on, the units each transmit coded identification signals on 406.0 MHz, which interface with the international Cosmicheskaya Sistyema Poiska Avariynich Sudov / Search And Rescue Satellite (COSPAS/SARSAT) distress alerting system.

In addition to its 406 MHz function, each of the ELT/PLBs is capable of broadcasting continuous homing signals on 121.5 MHz and 243.0 MHz frequencies. The signal detection range is up to a nominal 40 nm for a search aircraft operating at 3,000 ft. For maximum effectiveness, particularly on the 121.5 MHz frequency, the antenna of each ELT/PLB must be pivoted to the vertical position and the telescopic upper section must be extended.

These ELT/PLBs also have the facility to receive signals on 121.5 MHz and 243.0 MHz. If an external signal on 121.5 MHz or 243.0 MHz is detected when one of these ELTs/PLBs is selected on, it will operate only in standby mode and not transmit on these frequencies. In the case of multiple ELTs/PLBs in the same vicinity, the first ELT/PLB to transmit becomes the 'master'. It will be the only 500-12Y unit transmitting, until it is switched off, its battery becomes depleted or it otherwise ceases to function. The other ELTs/PLBs of this type, in receipt of such signals, remain in standby mode and do not transmit on either of these frequencies whilst external signals are being received from the 'master' ELT/PLB.

This feature is designed to avoid the difficulty experienced in homing to two or more different ELT/PLBs, in close proximity, transmitting on the same frequency. In addition, the battery life of those ELT/PLBs in standby mode is conserved. Once the transmitting ELT/PLB ceases to function, another adjacent 500-12Y ELT/PLB, switched on and in standby mode, will become active and start transmitting on 121.5 MHz and 243.0 MHz. This feature is not active if the 500-12Y ELT/PLBs are greater than around 300 m apart.

The TechTest 500-12Y ELT/PLBs have a voice broadcast facility to assist communication during the final rescue phase. Operation of the 'Press-To-Transmit' button allows the voice of a survivor to be broadcast on 121.5 MHz and 243.0 MHz and to be heard by the crew of a rescue aircraft. This function overrides the suppression of the signal by another ELT/PLB.

Although operating instructions are annotated on the bodies of the beacons, no mention is made thereon of the requirement to correctly position and extend the antenna.

The 406 MHz signal, and hence the COSPAS/SARSAT alerting system, is not affected by the signal suppression feature.

Passenger equipment

Passengers on the helicopter had been provided with special wrist watches, which incorporated low power transmitters functioning on 121.5 MHz. These Wrist Watch Personal Locator Beacons (WWPLBs) are issued in an armed condition before passengers enter a helicopter and, thereafter, transmit a distress signal on that frequency whenever they come into contact with salt water. Amongst other functions, the WWPLBs are capable of operating automatic alarms in the control rooms of nearby oil and gas platforms and certain surface vessels, should a WWPLB wearer fall overboard whilst working offshore.

Tests and calculations were conducted by the ELT/PLB manufacturer, in the presence of representatives of the WWPLB manufacturer and the AAIB. These showed that one of these WWPLBs is capable of suppressing both the 121.5 MHz and 243.0 MHz signals from an operating ELT/PLB, of the TechTest 500-12Y design, when the WWPLB is positioned less than 48 metres from a TechTest 500-12Y unit. Thus, when survivors wearing transmitting WWPLBs are in close proximity to the ELT/PLBs of the type in question, such as in a liferaft, the former can cause the more powerful homing signals from the latter to be suppressed.

Although the signals from the WWPLBs are understood to be capable of receipt at up to 5 miles range in certain directions and under ideal conditions, the actual transmission range of their signal is usually reduced, especially when worn by liferaft occupants following extensive exposure to the elements. Under such circumstances, they are unlikely to be orientated and positioned optimally to maximise their broadcast signal.

It is known that a number of types of low power PLB devices, in the form of wrist watches, pendants and other items, capable of being worn on the body, are available worldwide.

Events following the evacuation

Once the occupants of the helicopter entered the life rafts, a total of at least three ELT/PLB units were activated by the crew. Three of the units correctly broadcast coded identification signals on 406 MHz and these were successfully received and logged by the COSPAS/SARSAT alerting system. No signal was identified from the second liferaft stowed unit. This unit was the only one of the four TechTest 500-12Y units not recovered.

Although at least three ELT/PLB units were switched on, no emergency signal on 121.5 MHz or 243.0 MHz was detected by SAR aircraft as they approached the location of the ETAP platform.

The flight crew of G-REDU reported that voice transmission was attempted using the microphone and press to transmit facility on one ELT/PLB whilst a rescue helicopter could be heard. No voice signals were reported as having been received by any rescue vessels or aircraft. Only after a 27 minute period of searching in the vicinity of the platform was a faint signal on 121.5 MHz detected.

It has also been established that the crew were not aware that the upper section of the antenna on the beacon type is telescopic. Consequently, although each antenna was reported to have been correctly pivoted to an angle close to the vertical, the telescopic sections were not extended.

Conclusions

It is most probable that the presence of the WWPLBs adjacent to the TechTest 500-12Y ELT/PLBs inhibited the operation of the latter's more powerful emergency signals on 121.5 MHz and 243.0 MHz. As a result, this search facility was much reduced.

The failure to extend the antenna on any of the ELT/PLBs reduced the broadcast strength and probably accounted for the non-receipt of voice signals. Had WWPLBs not been in use, the broadcast signal from the master ELT/PLB, though present, would have been reduced by the lack of extension of the antenna. This would also have handicapped the homing capability of the search aircraft.

The following Safety Recommendations are made:

Safety Recommendation 2009-064

It is recommended that the Civil Aviation Authority review the carriage and use in commercial air transport helicopters of any radio location devices which do not form part of the aircraft's certificated equipment.

Safety Recommendation 2009-065

It is recommended that the Civil Aviation Authority advise the European Aviation Safety Agency of the outcome of the review on the carriage and use in commercial air transport helicopters of any radio location devices which do not form part of the aircraft's certificated equipment.

Safety Recommendation 2009-066

It is recommended that European Aviation Safety Agency require manufacturers of Emergency Locator Transmitters (ELTs)/Personal Locator Beacons (PLBs) units to add details, where absent, of the correct use of the antenna to the instructions annotated on the body of such beacons.

Safety Recommendation 2009-067

It is recommended that the Civil Aviation Authority ensure that all aspects of Emergency Locator Transmitter (ELT)/Personal Locator Beacon (PLB) operation, particularly correct deployment of the antenna, are included and given appropriate emphasis in initial and recurrent commercial air transport flight crew training, as applicable.

Published June 2009

ACCIDENT

Aircraft Type and Registration:	Eurocopter AS332L2 Super Puma, G-REDL
No & Type of Engines:	2 Turbomeca Makila 1A2 turboshaft engines
Year of Manufacture:	2004
Date & Time (UTC):	1 April 2009 at 1255 hrs
Location:	In the sea approximately 11 miles north-east of Peterhead, Scotland
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 2 Passengers - 14
Injuries:	Crew - 2 (Fatal) Passengers - 14 (Fatal)
Nature of Damage:	Helicopter destroyed
Commander's Licence:	Airline Transport Pilot's Licence (H)
Commander's Age:	31 years
Commander's Flying Experience:	2,575 hours (of which 1,870 were on type) Last 90 days - 96 hours Last 28 days - 37 hours
Information Source:	AAIB Field Investigation

This Special Bulletin details the progress made towards identifying the initiating factor(s) and failure sequence of the epicyclic gearbox module, and follows the publication of two initial reports which contained four Safety Recommendations. This Special Bulletin contains two further Safety Recommendations.

History of the flight

The helicopter was operating a return scheduled passenger flight from Aberdeen to the Miller Oil Platform, situated in the North Sea approximately 145 nm north-east of Aberdeen. When it arrived from its previous flight to the Bruce Platform, approximately 190 nm north-east of Aberdeen, a 'rotors running' crew change was carried out. The helicopter was serviceable except for a deferred defect affecting a part of its ice detection system. The daily in-flight checks had already been completed satisfactorily by the off-going crew. The helicopter was refuelled, the passengers boarded, and it lifted off at 1040 hrs. The helicopter landed on the Miller platform, after an uneventful flight, at 1149 hrs, where it was refuelled again with the rotors-running. When the refuelling was complete, fourteen passengers boarded the helicopter for the return flight to Aberdeen. The weather conditions were benign with light south to south-easterly winds, good visibility with generally clear skies but with occasional broken cloud at 5,000 to 6,000 ft. Flying conditions were reported as smooth and the sea was calm.

The helicopter lifted from the Miller Platform at 1203 hrs and climbed to 2,000 ft, tracking inbound towards Aberdeen. Recorded information on the combined Cockpit Voice and Flight Data Recorder (CVFDR) shows that the crew were engaged in routine cockpit activities and there were no operational abnormalities. At 1254 hrs the co-pilot made a routine call on the company operating frequency stating that the helicopter was serviceable and the ETA was 1314 hrs. Twelve seconds later, one of the pilots made a brief MAYDAY call on the ATC frequency. This was followed by a similar call that included some position information, from the other pilot. The radar controller at Aberdeen acknowledged the MAYDAY call and tried unsuccessfully to contact the crew of G-REDL. He then asked the crew of another helicopter, outbound on a similar routing, to examine the sea in the area of the last radar position.

Recorded radar information showed the helicopter flying inbound towards Aberdeen at 2,000 ft, climbing momentarily to 2,200 ft and then turning right and descending rapidly. Surface visibility was good and an eye witness, working on a supply vessel approximately 2 nm from the accident site, heard the helicopter and saw it descend rapidly before it hit the surface of the sea. Immediately after impact he saw the four main rotor blades, still connected at their hub, strike the water. Around this time, he also heard two bangs close together. He immediately raised the alarm and the ship turned towards the accident site, which by now was marked by a rising column of grey then black smoke. The ship launched a fast rescue boat whilst making way towards the scene. The crew of this boat and the helicopter arrived promptly on the scene to discover an area of disturbed water, roughly 150 m in diameter containing debris from the helicopter. Other search and rescue vessels, aircraft and helicopters arrived on scene within 40 minutes. All persons on board G-REDL were fatally injured.

The Air Accidents Investigation Branch (AAIB) was notified of the accident within minutes and a team of inspectors, including engineers, pilots and flight recorder specialists deployed to Aberdeen that evening. 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 appointed an Accredited Representative to lead a team of investigators from the BEA, Eurocopter (the helicopter manufacturer) and Turbomeca (the engine manufacturer). The EASA and the UK Civil Aviation Authority also provided assistance to the AAIB team.

Wreckage recovery

The availability of radar data, and the fact that the accident was witnessed by an observer working on a supply vessel some 2 nm distant, indicated the location where the wreckage was likely to be found. On the afternoon of 1 April, floating debris was recovered by several vessels which had positioned to the area and, by the evening of 2 April, a survey vessel which had been operating in the area on behalf of the Marine and Coastguard Agency, was tasked to survey the seabed using its high definition sonar system. By the afternoon of 3 April, the ship had identified the location of three main items of wreckage. A 'saturation diving recovery vessel' was chartered, and this was on station late on the afternoon of 4 April. That evening, the combined CVFDR was located and recovered to the AAIB and, by early morning on 5 April, all the wreckage that could be identified on the seabed had been recovered on-board. This was transported to the AAIB facility on 6 April, for a detailed examination of the helicopter.

Helicopter Usage Monitoring System (HUMS) data and recorded information

HUMS

The helicopter was equipped with a HUMS, which comprises a system of sensors around the engines, airframe and drive train. This system is a mandatory fit for offshore helicopter operations in the United Kingdom. Recorded information included vibration levels together with gearbox chip detection from a series of magnetic plugs. The data accumulated during helicopter operations is transferred, usually on a daily basis, to the operator's ground-based computer system. The data is then subjected to mathematical processes that establish basic signatures and enable trends to be monitored for individual components. Some of these signatures are subject to threshold limitations which will alert the ground crew to a rising trend.

Recorded information

The CVFDR was successfully recovered from the sea bed and downloaded as a priority at the AAIB. Data has also been recovered from a number of on-board sources including the Digital Engine Control Units (DECUs), Smart Multimode Displays (SMDs), Digital Flight Data Acquisition Unit (DFDAU), HUMS card, and on-board Helicopter Operations Monitoring Programme (HOMP) card. This data is being used collectively to build a sequence of events that occurred during the accident.

Recorded flight data identified G-REDL flying on a heading of 234°M, at an indicated airspeed speed of 142 kt and at a radio altitude of 2,000 ft. At approximately 1251:19 hrs a chip[1] was detected by the epicyclic gearbox magnetic chip detector plug. Over the next minute and 43 seconds, three further chips were apparently detected. The design of the chip detection system is such that the flight crew would not have been aware of these detections, although as noted earlier, they were logged by the HUMS.

At approximately 1254:01 hrs, the first officer made a radio call to company operations indicating that the helicopter was 'serviceable' and was expected to arrive in Aberdeen at 1314 hrs. Seventeen seconds later, a main rotor gearbox (MRG) low oil pressure warning was recorded on the CVFDR, with an associated reduction in recorded MRG oil pressure. After this, a deviation from cruise flight can be seen with the crew responding with flight control inputs which appeared to have had only a limited effect.

The CVFDR continued recording data for 5 seconds after the MRG low oil pressure warning but ceased at around 1254:23 hrs. The reason for this is as yet unknown. HUMS and other recovered avionics data, radio transmissions and radar continued to be recorded after the CVFDR stopped. This data is currently being analysed to establish the remainder of the accident sequence.

In addition, spectral analysis work on the audio recordings is underway to identify frequencies associated with the gearbox operation. Historic HUMS data will also be analysed using advanced statistical and data mining techniques.

General

The Eurocopter AS332L2, is a twin-engine helicopter, designed for passenger transport and aerial work, etc. It is constructed primarily from aluminium alloy, with many panels being made from a lightweight honeycomb material sandwiched between two thin skin sections. G-REDL was constructed in 2004 and was configured

Footnote

[1] Chip - a small sliver or flake of metallic/magnetic material.

with seating for 14 persons in the cabin, and a flight crew of two.

Transmission

Two shafts, one from each of the two free turbine Turbomeca Makila 1A2 engines, drive the main and tail rotors through the MRG, where the high speed of these shafts (23,000 rpm) is reduced to the nominal main rotor speed (265 rpm).

The lower section of the MRG, referred to as the 'main module', reduces the shaft speed to around 2,400 rpm. The speed is further reduced to main rotor speed through a two-stage epicyclic gearbox. Each epicyclic stage is configured with eight planet gears, mounted on a planet gear carrier. Each gear contains a double row spherical roller bearing with a separate inner race; the rollers bear directly on the hardened inner spherical surface of the gear, which forms the outer race of the bearing. Integral with the first stage carrier is the sun gear for the second stage. The second stage carrier directly drives the main rotor mast, Figures 1 and 2.

The epicyclic module is located between the main module and the main rotor mast conical housing, Figure 3. The ring gear for both stages is integral with the circular housing. The MRG is fitted with three magnetic chip detector plugs. One is located in the sump area below the main module, one adjacent to the epicyclic gearbox module and one in the main rotor conical housing. These are designed to detect and retain any chips of magnetic material shed, for example, from the gears or their bearings. The sump magnetic plug provides a warning to the flight crew should a chip be detected, whilst the plug adjacent to the epicyclic stages provides evidence of chip detection to the HUMS system, when the aircraft is equipped with such a system, which was the case with G-REDL. The magnetic plug in the conical housing is not connected to any warning system and is only visually inspected.

|In previous variants of the AS332 there had been a number of main rotor gearbox removals as a result of distress within the epicyclic stages of the gearbox. In order to minimise these removals, the MRG of the AS332L2 was separated into 'modules' which allows the removal of the epicyclic reduction gearbox module without necessitating the removal of the complete MRG assembly. The magnetic chip detector was fitted in the epicyclic module and another in the conical housing to provide an indication of potential distress in these areas. The epicyclic module was separated from the main module by two concentric plates designed to channel the oil draining from the epicyclic module past a ring of magnets prior to it reaching the main module. This was to prevent metallic particles generated within the conical housing and epicyclic module from contaminating the main module.

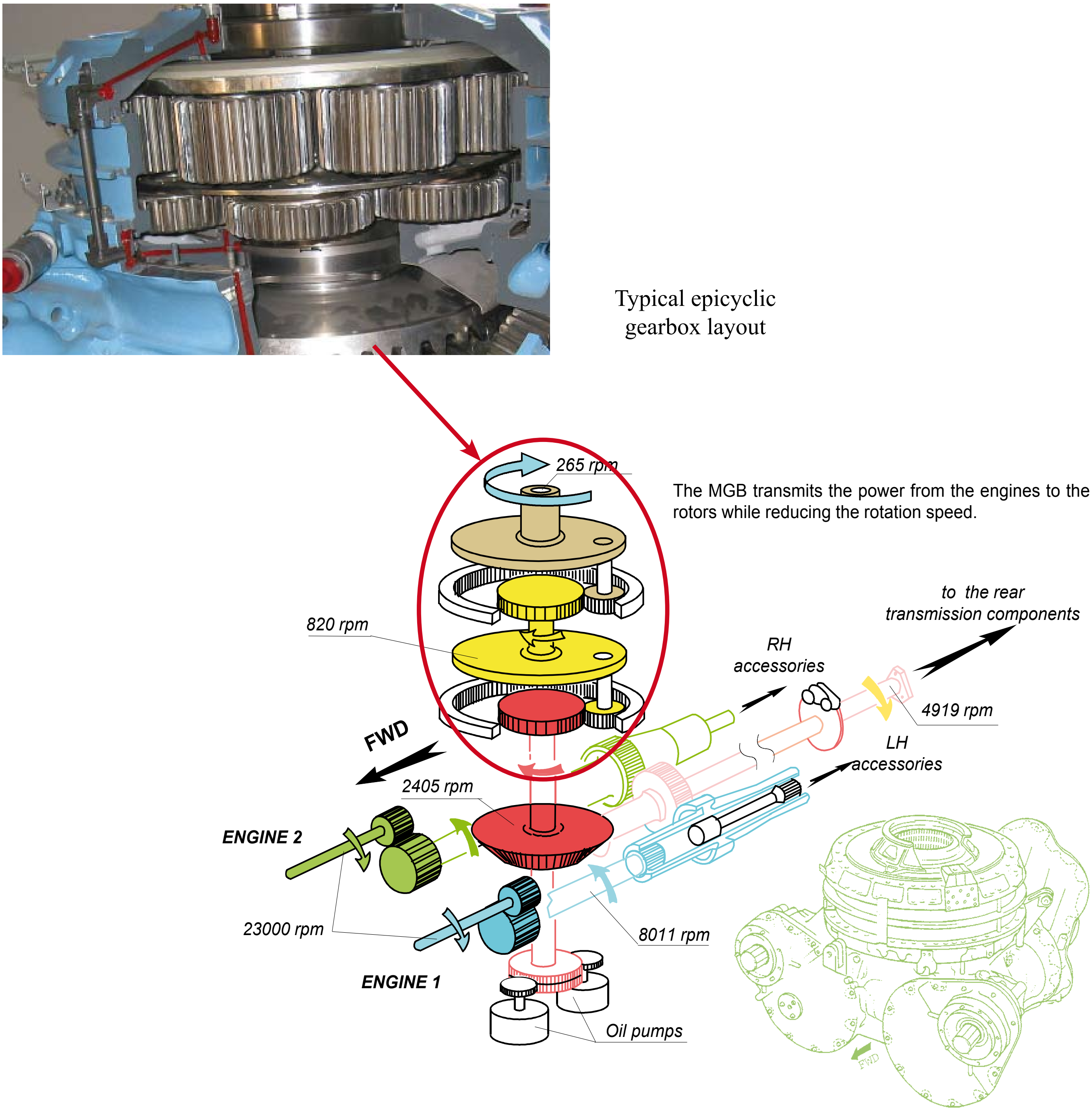
The investigation

The initial examination of the wreckage, in conjunction with radar, HUMS, CVFDR and witness data, determined that a failure within the epicyclic reduction gearbox module of the MRG resulted in the rupture of the gearbox case. This allowed the main rotor head, together with the upper section of the MRG, to separate from the helicopter.

Other areas of the gearbox, including the engines, the main module and the rotor head/mast have been examined, as follows.

Engines

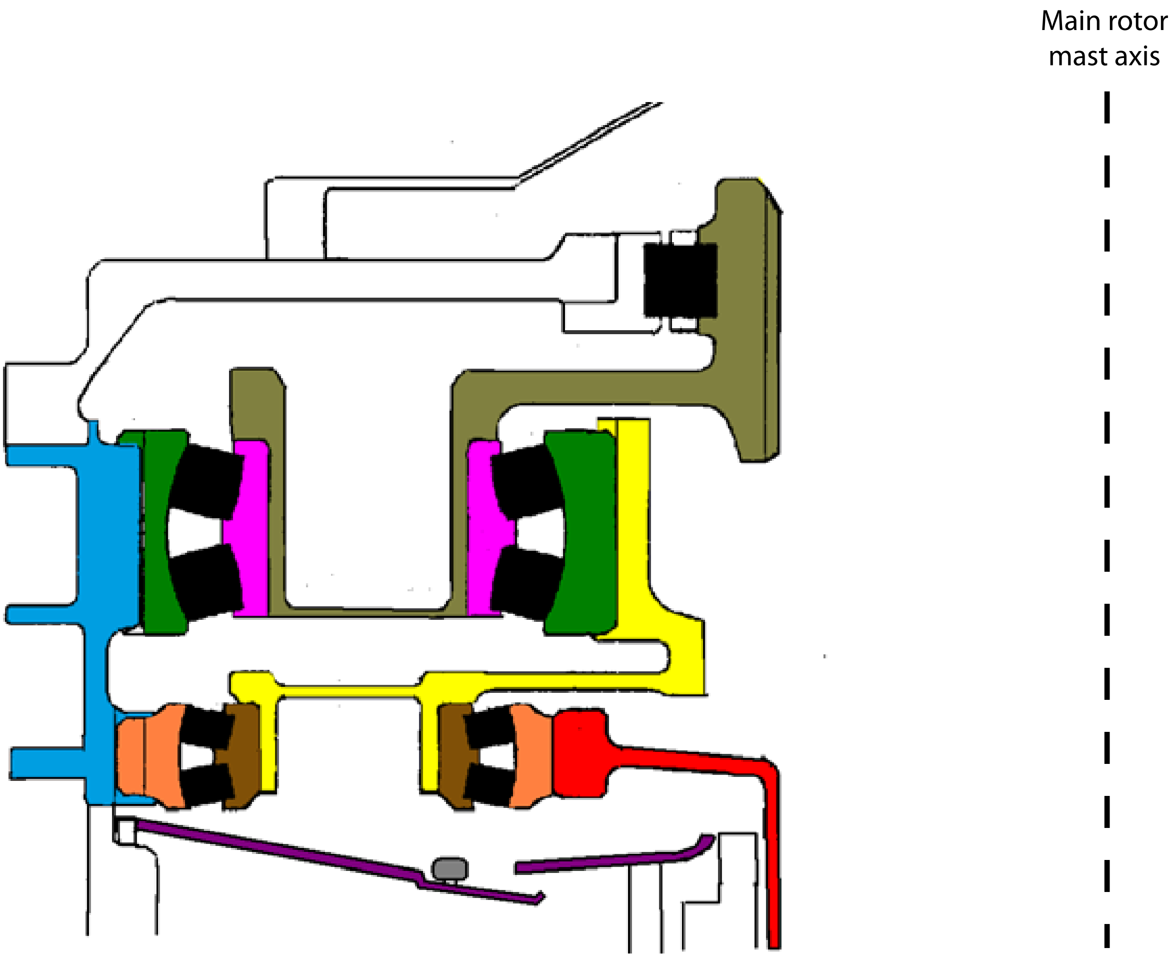
The engines were taken to the manufacturers overhaul facilities for detailed examination under supervision of the investigation team. Both engines had suffered external damage consistent with the accident, which



Courtesy of Eurocopter

Figure 1

Schematic of the Main Rotor Gearbox



- 1st stage planet gear
- 1st stage planet gear bearing inner race
- 1st stage planet gear carrier
- 1st stage sun gear
- 2nd stage planet gear
- 2nd stage planet gear bearing inner race
- 2nd stage planet gear carrier
- Ring gear
- Bearing roller
- Oil collector plates
- Magnets

Figure 2

Schematic cross-section of epicyclic module

included deformed casings, damaged engine mounts and accessory mounting flanges.

Internal damage to both engines indicated that they were rotating at the time of the casing deformations. Foreign object impact damage to the first stage compressor blades and airframe debris in the internal air paths of the engines confirmed rotation at the time of the impact with the sea.

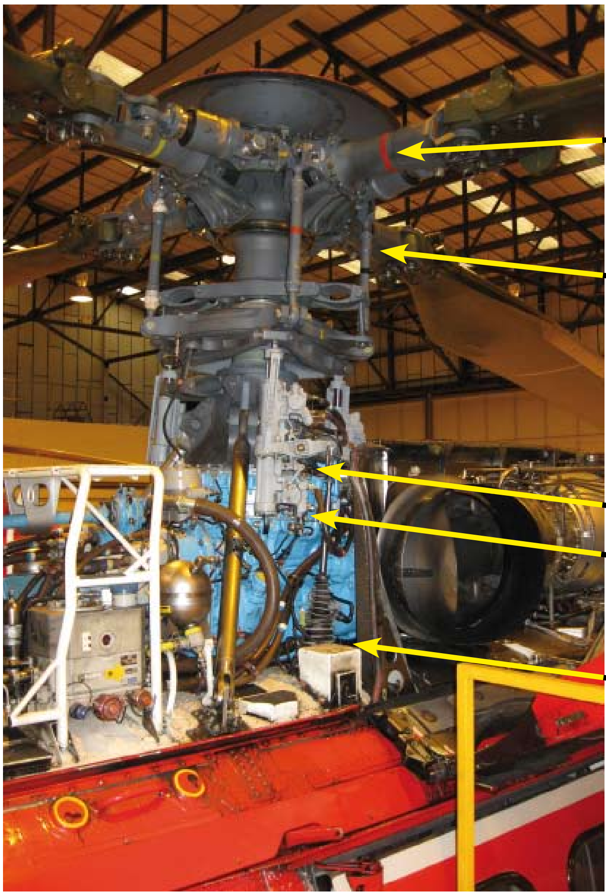


Figure 3

MRG installation

A rupture in the right (No 2) engine power turbine containment casing was of particular interest. Examination showed that this rupture originated at a large deformation and grew due to the rotating turbine blades contacting the casing. A number of turbine blades were 'cropped' to the level of this deformation. The deformation was consistent with being formed as the fuselage struck the sea.

Both engines DECUs were downloaded. Analysis showed that there were no recorded parameter exceedences. The One Engine Inoperative (OEI) mode indicated that it had not been activated and this was confirmed by the position of the overspeed relays.

Both engines were assessed to have been in good condition prior to the accident and no signs of pre-existing anomalies or over-temperature were found.

Main module

The gearbox had remained attached to the airframe by the flexible titanium mounting plate (the 'barbecue plate'), which is designed to react the gearbox torque. The mounting plate had sustained little damage in the accident (although some distortion had occurred during the removal and inspection process). This observation was pertinent in that it helped to exclude the possibility of a suspension (lift) strut failure as being a primary cause of the accident, since such an event would tend to transfer excessive loads, via the gearbox, into the mounting plate.

The first stage sun gear had remained engaged, via its splined connection, with the bevel gear in the main module and it was established that there was little measurable run-out. This suggested that little if any disruption had occurred upstream of the sun gear. However, the teeth had sustained heavy damage, which was more severe than that seen on the first stage planet gears. It was separately established that the sun gear had most probably contacted the first stage planet gear inner races following the break-up/release of the planet gears, whilst turning at speed. The sun gear was extracted easily, at which point some comparatively minor damage was observed on the splines.

A breach in the circumference of the bevel gear support plate at the approximate 5 o'clock position[2], matched the location of the vertical split in the epicyclic ring gear. Gear teeth marks were visible in the surface of the plate adjacent to the breach, together with significant abrasion around the entire circumference; this had resulted in smearing of several of the bevel gear support plate attachment bolt heads. In addition, most of the chip collector tray containing the magnets had been abraded away. All this damage is likely to have been caused by the first stage planet gears during the break-up sequence.

The bevel gear chamber was severely contaminated by the products of corrosion arising from seawater immersion. However, the bevel gear, its drive pinion and components such as the main and emergency oil pumps showed no evidence of running distress. The reduction gears at the engine input side of the gearbox, together with the accessory gearbox components, similarly showed no evidence of running distress. The only noteworthy feature was that the right hand torque meter shaft showed evidence of a permanent set in the over-torque direction. This may have resulted from the right engine continuing to apply torque during the series of temporary seizures that probably occurred during the break-up of the epicyclic gear stages.

During the examination, metallic particles and a number of planet gear bearing rollers were recovered from within the main module sump.

Rotor head/mast

The rotor head, mast and gearbox conical housing (complete with the lift bars) were stripped and inspected at the manufacturer's facility under AAIB supervision. Examination of the components showed that all of the damage was consistent with it being produced as a result of the failure of the epicyclic module. There was no evidence of a primary failure within any of the components examined.

Epicyclic module

As no pre-existing defects or failures have been identified in the above areas, the investigation continues to be centred on understanding the gearbox epicyclic module failure.

There is evidence of damage throughout the epicyclic module, consistent with it operating for a period whilst contaminated with sizeable debris. Several imprints of rollers from the first stage planet gear bearings are evident on second stage gears.

The ring gear (which had burst open), both sun gears, all eight of the planet gears in both stages, together with the planet gear carriers, were recovered, with the exception of approximately 33% of one planet gear from the second stage. This was the only gear in that stage to have failed.

Footnote

[2] The twelve o'clock position equates to the longitudinal axis of the helicopter looking forward.

Two gears in the first stage also suffered failures; one had suffered a single fracture, the other had broken into four sections. All first stage planet gears had separated from the carrier, releasing their rollers; only a proportion of which have been recovered. The inner raceways from all the planet gear bearings have been recovered, with none exhibiting 'classic' evidence of pre-accident failure or degradation. However, one raceway associated with a first stage planet gear exhibited damage over a limited area of its circumference.

It is considered that a section of the failed second stage planet gear became jammed between the ring gear and a planet gear, precipitating the ring gear failure, (Figure 4). There is evidence on all gear teeth of damage caused by debris being present, consistent with the gearbox running in an abnormal condition prior to the separation of the main rotor head. However, no evidence has indicated that the flight crew were aware of any problem with the MRG until shortly before the accident, when the loss of MRG oil pressure occurred, and a noise became evident on the CVR. This was likely to have been at the time the ring gear burst open.

The initiating cause of the epicyclic gearbox module failure remains to be established, and work continues at the AAIB in the UK and, under AAIB supervision, at the manufacturer's facility in France. This work includes detailed metallurgical examination of all the components from the epicyclic gearbox module from the accident helicopter and similar components from another MRG.

Three sections of the failed second stage planet gear were recovered, amounting to approximately 66% of the complete gear. Detailed examination of these sections has revealed several areas of particular interest. The most significant of these is a complex fracture surface on one of the gear sections consisting of five conjoined cracks, with the majority showing characteristics of propagation in fatigue. One of these conjoined cracks, believed to have been the first one to form, appears to have originated from a single origin in a region at or close to the outer race surface. The precise origin has not been determined due to the severe mechanical damage occasioned in this region during the break-up of the module. However, the nature of the fracture surface would suggest that the origin is aligned with a position on the wear track of the lower set of rollers where the highest surface loading is imparted by the rollers.

Extensive non-destructive examination and testing has been carried out with the assistance of Eurocopter, QuinetiQ, the National Physical Laboratory, the Open University materials laboratory and Mertis(X-Tech), a manufacturer of X-ray Tomography equipment. These have included surface laser mapping, 3D tomography, residual stress measurement, 3D laser microscopy, Scanning Electron Microscopy and conventional optical microscopy. Results have provided significant evidence regarding these fractures and allowed the development of a programme of destructive tests and examinations which are currently being undertaken. These tests are designed to identify, if possible, the initiation point of these fractures and the reason for their initiation.

Further work is planned to examine the remaining intact second stage gears, and a selection of 'time-expired' gears removed from service, with the intention of identifying any defects which may exist.

Detailed examination continues to be performed on the metallic chip removed from the G-REDL epicyclic module magnetic chip detector on 25 March 2009, 34 flying hours before the accident. It has been identified as planet gear material and the nature of this chip

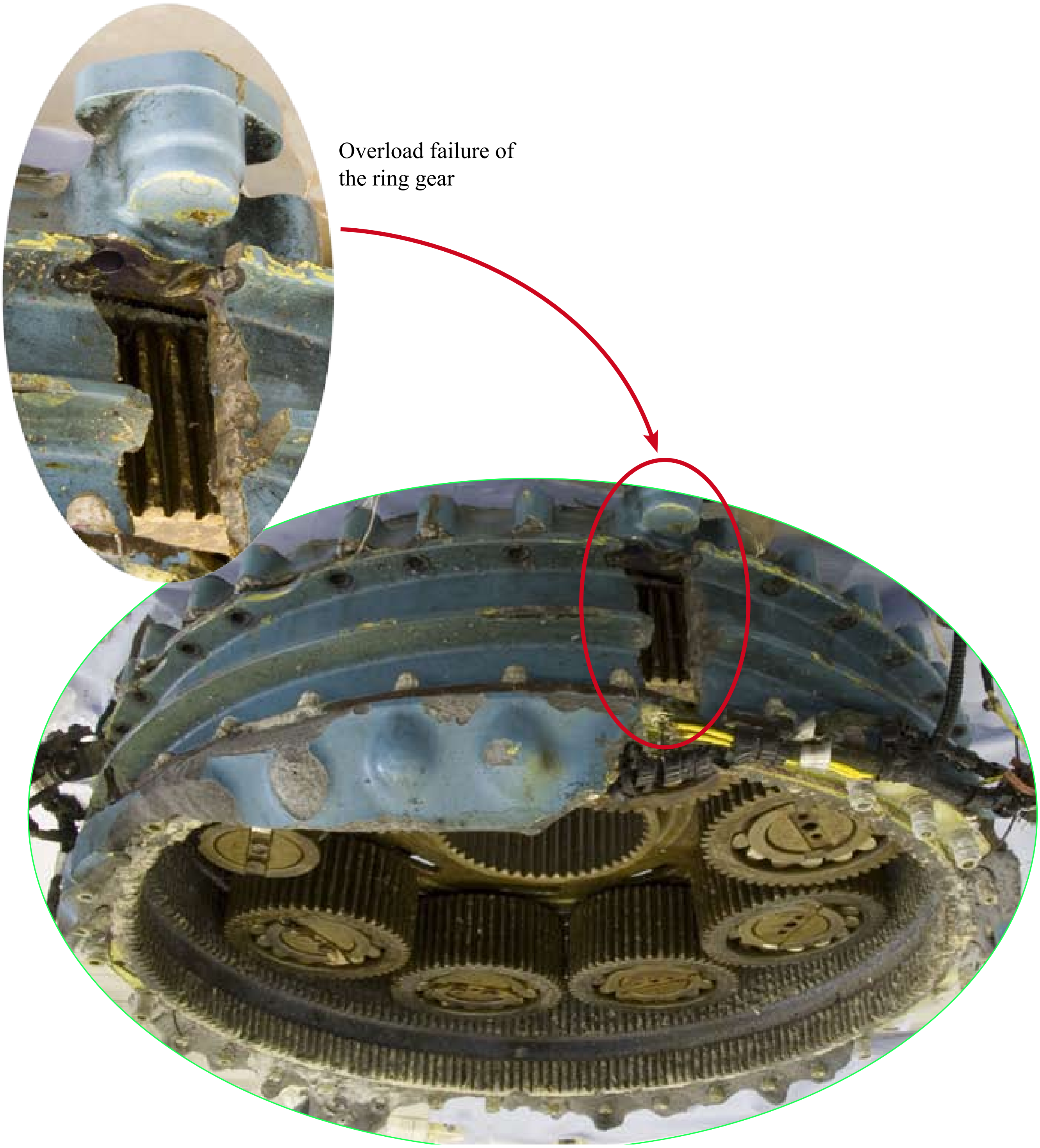


Figure 4

Failed ring gear details with second epicyclic stage reinstalled - viewed from below.

suggests that it may have been released by the process of spalling[3], or possibly by some other unidentified phenomena. On one side, the chip exhibited evidence of manufacturing marks characteristic of the surface of the 'outer race' of a second stage planet gear bearing. Comparison of these marks with an intact second stage planet gear established that it came from a location on the raceway in the wear track of one set of rollers, close to where the maximum surface loading from the rollers is to be expected. The absence of 'in-service' damage[4] on any of the other inner or outer races of the planet gear bearings strongly indicates that the chip came from the outer race of the broken second stage gear. However, due to mechanical damage on the available gear segments, and the absence of approximately 33% of the broken gear, it has not been possible, so far, to establish any link between the fracture surface containing the area of conjoined cracks, and the chip.

As reported in Initial Report No 2, Issued by the AAIB on 17 April 2009, on the morning of 25 March the HUMS system detected a chip on the epicyclic module magnetic plug whilst in flight. After the helicopter's return to Aberdeen, the plug was removed and visually examined, but no evidence of any chips was reportedly found. The helicopter was due for a 25 hour check that evening but, as it was already at its maintenance base, the operator decided to bring this forward. Part of this check, defined in the Aircraft Maintenance Manual, calls for the examination of the magnetic chip detector plugs and, when the epicyclic module plug was re-examined as part of the check, a particle was found.

The clarity of relevant information available to the operator and helicopter manufacturer, used to inform the decisions taken following this discovery, continues to be investigated; however, the outcome was that the MRG remained in service. It was concluded, at that time, that the particle was of a type that did not require further investigation of the epicyclic module. In addition, the operator drained the MRG oil system and, after filtering the oil and examining the filters, identified no other contamination. As a result of the discovery of this particle, a daily inspection of the epicyclic gearbox magnetic chip detector was initiated by the operator and the HUMS data was downloaded and analysed each time the helicopter returned to its base at Aberdeen for the following 25 flying hours. This concluded on the 31 March, the day before the accident and, as no further abnormalities were identified during this period, this served to reinforce the view that a correct diagnosis of the chip had been made. However, had a different diagnosis of the chip type been made on 25 March, it is possible that the operator would have removed the MRG for further investigation.

The assessment of particles, their quantity and significance is carried out in accordance with the AS332L2 Standard Practices Manual procedure, MTC.20.08.01.601. This assessment procedure was contained in a generic 11 page text only, block diagram, document covering most of the helicopters currently and previously produced by the manufacturer. This deals with the assessment of chips discovered on the magnetic chip detector plugs in the power transmission assembly.

As it appears that the process of assessing the relevance of a magnetic chip may, in this case, have led to an inappropriate diagnosis, consideration should be given to introducing appropriate methods of information exchange between an operator and the manufacturer

Footnote

[3] SPALLING: The flaking-off of material from the bearing raceways in areas of high loading. High cyclic loads generated by the movement of the rollers within the bearing can initiate cracking in the material immediately below the surface of the raceway. Progression of these cracks can then allow the liberation of 'flakes' from the raceway surface.

[4] Micro-pitting/spalling, for example.

to facilitate the accurate determination of a chip type. Therefore, the following Safety Recommendation is made:

Safety Recommendation 2009-074

It is recommended that the European Aviation Safety Agency, in conjunction with Eurocopter, review the instructions and procedures contained in the Standard Practices Procedure MTC 20.08.08.601 section of the EC225LP and AS332L2 helicopters Aircraft Maintenance Manual, to ensure that correct identification of the type of magnetic particles found within the oil system of the power transmission system is maximised.

In response to this safety recommendation, the manufacturer is issuing Safety Notice No 2075-S-63, introducing a revised, more comprehensive, version of the Standard Practices Procedure MTC 20.08.01.601. This revised document contains many colour illustrations of types of chip and debris likely to be encountered to aid operators in determining the significance a chip.

The Alert Service Bulletins and Emergency Airworthiness Directives issued following previous safety recommendations made during this investigation, have addressed the timely detection of debris/chips produced by the epicyclic gearbox module. This has been achieved by enhanced monitoring of the MRG chip detectors and the removal of the ring of magnets and the flanged edge from the oil collector plates fitted below the module. Whilst this improves the chances that the 'normal' precursors of a bearing failure will be detected, (ie, the release of metallic particles over a period of time), the evidence from the 34 hours of operation of G-REDL prior to the accident, and the general absence of evidence of distress on the bearing inner and outer races of all the planet gear bearings available for inspection, suggested that few, if any, further chips were generated during that period. At this stage of the investigation, it is not known if debris generation was associated with the observed cracks on the failed gear. However, as the ring of magnets was not examined after the discovery of the chip on 25 March, the possibility cannot be dismissed that further chips, which may have been generated from localised areas of the missing or damaged sections of the failed gear, became trapped by these magnets.

Examination of the failed components continues, in particular, in the region of the cracks on one section of the failed second stage planet gear. It is likely that one or more cracks were present prior to the module failure. However, as it is not presently known if the enhanced monitoring of in-service MRGs for chips will identify any potential cracks in the planet gears, and the initiating factor of the epicyclic module catastrophic failure remains to be established, the following Safety Recommendation is made:

Safety Recommendation 2009-075

It is recommended that the European Aviation Safety Agency, in conjunction with Eurocopter, urgently review the design, operational life and inspection processes of the planet gears used in the epicyclic module of the Main Rotor Gearbox installed in AS332L2 and EC225LP helicopters, with the intention of minimising the potential of any cracks progressing to failure during the service life of the gears.

In response to this recommendation, the EASA have stated that significant work has already been carried out with respect to re-assessing the planet gear design, safe operating life and methods of inspection. The manufacturer is also undertaking a comprehensive review of the planet gears.

Safety action to date

An initial report on the circumstances of this accident was published by the AAIB on 10 April 2009; this report contained three Safety Recommendations relating to additional inspections and enhanced monitoring of the main rotor gearbox. EASA responded immediately to these recommendations by issuing the Emergency Airworthiness Directive No 2009-0087-E, dated 11 April 2009.

In Initial Report No 2, published by the AAIB on 17 April 2009, Safety Recommendation 2009-051 was issued to EASA, which stated:

> *'It is recommended that Eurocopter, with the European Aviation Safety Agency (EASA), develop and implement an inspection of the internal components of the main rotor gearbox epicyclic module for all AS332L2 and EC225LP helicopters as a matter of urgency to ensure the continued airworthiness of the main rotor gearbox. This inspection is in addition to that specified in EASA Emergency Airworthiness Directive 2009-0087-E, and should be made mandatory with immediate effect by an additional EASA Emergency Airworthiness Directive.'*

The EASA responded by issuing Emergency Airworthiness Directives Nos:2009-0095-E, dated 17 April 2009, and 2009-0099-E, dated 23 April 2009, and stated the following reason.

> *Emergency Airworthiness Directives 2009-0087-E and 2009-0095-E were issued following the accident of the AS 332 L2 helicopter registered G-REDL that occurred on April 1, 2009, off the coast of Scotland near Aberdeen. Early investigations showed that a failure within the epicyclic reduction gear module of the Main Gear Box (MGB) resulted in the rupture of the MGB case, which allowed the main rotor head to separate from the helicopter. In the light of this information, enhancement of the means for detection of MGB contamination was deemed of the utmost importance. As an initial precautionary measure AD 2009-0087-E dated 11 April 2009 was published with that aim. Additionally, AD 2009-0095-E dated 17 April 2009 was issued to require a one-time inspection for absence of particles in the MGB epicyclic reduction gear module on the entire fleet. While the investigation is still in progress with the aim of determining as soon as possible the sequence of the failure(s) and initiating cause(s), this new AD, which retains the main requirements of the superseded ADs 2009-0087-E and2009-0095-E, requires modifying the chip collector inside the MGB – located between the epicyclic module and the main module – to enhance the early detection capability of the magnetic plugs of the gearbox sump and the epicyclic module. To that aim, this AD requires removing the magnetic elements installed on the chip collector, and the flanged edged from the chip collector (MOD 07.52522). After accomplishment of the modification, this AD specifies also how to further monitor the MGB epicyclic reduction gear module magnetic plug.'*

SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A319-111 Airbus, G-EZDM
No & Type of Engines:	2 CFM56-5B5/3 turbofan engines
Year of Manufacture:	2008
Date & Time (UTC):	15 December 2008 at 2123 hrs
Location:	Shortly after takeoff from Charles de Gaulle Airport, Paris
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 130
Injuries:	Crew - None Passengers - None
Nature of Damage:	Severed hydraulic line
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	52 years
Commander's Flying Experience:	7,471 hours (of which 1,128 were on type) Last 90 days - 243 hours Last 28 days - 69 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent enquiries by the AAIB

Synopsis

Upon selecting landing gear UP, the crew received a message on the Electronic Centralised Aircraft Monitor (ECAM) that the main landing gear doors were not closed. Passing 1,500 ft agl, further messages relating to Green hydraulic system 'fluid low contents' and Yellow system 'fluid reservoir overheat' were also generated. This resulted in the aircraft operating for a short time on a single hydraulic system. Yellow system pressure was recovered and the aircraft made an uneventful precautionary landing.

History of flight

After takeoff the Pilot Not Flying selected the landing gear UP but received an ECAM message L/G DOORS NOT CLOSED. ATC were advised of the problem and that the speed would be kept low: the ECAM procedure for this failure was performed but to no avail. Upon reaching 1,500 ft agl, a HYDG RSVR LO LVL (Green system hydraulic reservoir low level) caption was displayed on the ECAM and a Green system low pressure caption illuminated. Whilst the crew performed the drill for this failure, a HYDY RSVR OVHT (Yellow system hydraulic reservoir overheat) caption was also displayed. The ECAM actions for this required switching off the Yellow system engine-driven pump (EDP) and the power transfer unit

(PTU, see below), putting the aircraft into single system hydraulic power operation.

A MAYDAY call was made with a request for radar vectors for landing. A short time after completion of the ECAM actions, the Yellow system overheat caption disappeared and the EDP was reselected, restoring hydraulic pressure in that system.

After briefing the senior cabin crew member, and advising the passengers to prepare for a precautionary landing, the commander took control. Because Paris CDG airport was operating low-visibility procedures at the time due to low cloud, a Category IIIA instrument landing was performed (the highest allowable with two hydraulic systems operating). The landing was uneventful but the commander asked for, and received, a fire service escort to the gate, where the passengers disembarked normally.

Engineering investigation

Upon examination, the flexible hose for the left main landing gear (MLG) 'door close' actuator was found damaged and leaking. After replacement of this, and the 'door open' hose, which was also found worn, the hydraulic systems were inspected, replenished as necessary and found serviceable. Leakage from these hoses had been experienced a number of times before, so the operator has imposed a 6,000 flight cycle life on the hoses until the aircraft manufacturer devises an engineering solution to the problem.

Analysis of the sequence of events showed that they could be rationalised in terms of the system and warnings philosophy. After liftoff, as the landing gear was selected UP, the 'door close' hose ruptured, depleting the Green hydraulic system contents. As the pressure in the Green system dropped sufficiently to provide a differential with the Yellow system of 500 psid, the power transfer unit (PTU) between the two systems automatically switched on. The PTU uses hydraulic power from one system to power the other in case of a loss of pressure. However, if the loss of pressure is caused by a lack of fluid, the PTU will overheat about two minutes after starting but the cautions for this condition, as well as the original Green system 'reservoir low fluid level', are inhibited by design below 1,500 ft agl in order to avoid pilot distraction.

The above sequence of events was thus invisible to the crew until they passed 1,500 ft, when the Green system contents caption was displayed followed shortly by the Yellow system overheat. Part of the drill for the latter involved switching off the PTU and reselecting the EDP when the overheat condition cleared.

At least one similar case of such a dual-system hydraulic power loss is known to the manufacturer, who reported on the scenario described above in their 'Safety First' magazine, Edition 4 in June 2007. Discussion is included concerning the pros and cons of various options to prevent the loss of a single system developing into a double failure. The manufacturer decided that the most satisfactory solution was to inhibit automatic operation of the PTU below 1,500 ft and Service Bulletin 29-1115 was issued to introduce two modifications which need to be embodied before accomplishing SB 29-1126, which activates the inhibition logic. New aircraft have the first SB embodied but the activating logic remains optional. The manufacturer encourages operators to retrofit the modifications.

ACCIDENT

Aircraft Type and Registration:	BAe 146-200, G-ZAPO
No & Type of Engines:	4 Lycoming ALF502R-5 turbofan engines
Year of Manufacture:	1990
Date & Time (UTC):	25 February 2009 at 2057 hrs
Location:	Stand A1, London Stansted Airport
Type of Flight:	Commercial Air Transport (Cargo)
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Dent in aircraft radome, damage to tug windscreen
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	45 years
Commander's Flying Experience:	4,600 hours (of which 1,600 were on type) Last 90 days - 70 hours Last 28 days - 22 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot, CVR recording and company investigation reports

Synopsis

During pushback from the stand, a loud bang was heard on the flightdeck of the aircraft. The pushback continued, but the towbar became disconnected from the tug due to a failed shear pin. The tug then stopped, but the aircraft could not be halted in time to prevent it colliding with the stationary tug. The nose of the aircraft penetrated the windscreen of the tug, but no injuries occurred.

History of the flight

The aircraft had been attached to the tug using a conventional towbar arrangement and was ready for pushback from Stand 1L on the Alpha Apron at London Stansted Airport. The aircraft was due to depart on a routine cargo flight, with the aircraft commander as the handling pilot. The pushback commenced with the intent of following a standard procedure involving the tug pushing the aircraft backwards and to the left, then pulling it forwards and to the right (as viewed by the commander), until the aircraft was lined up on the taxiway centreline. Just after the point where the aircraft had stopped moving backwards and the tug was starting to pull it forwards, a loud bang was heard on the flightdeck. The commander asked the headset operator if he had identified the source of the noise. The headset operator replied that he had not. The commander then requested that the headset operator ask the tug driver what had happened. The headset operator was then seen to converse with the tug driver, but no response was provided to the commander's request. Meanwhile the tug continued to pull the aircraft forward, and the crew diverted their attention to completing the 'after start' checklist. As the crew focused on this task, they heard an urgent call for "brakes on" by the headset operator. The commander responded by applying the aircraft brakes, but the aircraft could not be stopped in time to prevent a collision with the now stationary tug in front of it, resulting in the nose of the aircraft penetrating the tug's windscreen. No injuries occurred as a result of the collision. The headset operator reported that he had requested brakes be applied by the aircraft crew as soon as he observed the failure of the towbar.

Post-accident findings

The towbar connecting the tug to the aircraft had detached at the tug end. Failure of a shear pin resulted in the main body of the towbar (attached to the aircraft) separating from the 'eye' fitting, which remained attached to the tug. The aircraft commander reported that he inspected the failed shear pin immediately after the accident and that it was heavily corroded and had partially sheared prior to the final failure. However, a subsequent investigation by the ground handling company did not determine the cause of failure of the pin. The aircraft operator reported that the ground handling company could not provide the pin when requested, preventing any further failure analysis taking place. An internal report by the operator also suggested that there was evidence the pushback had been 'erratic' but the ground handling company reported that they considered the pushback was fully compliant with their procedures.

The ground handling company advised that, due to the relative sizes of the aircraft and towbar, there is only a small clearance between the aircraft nose and the tug windscreen during pushback. In the event of a problem, this gives little reaction time before contact occurs. The company also suggested that the limited nature of the damage, to both the aircraft and the tug, indicated a very low speed impact.

Conclusion

Both the aircraft operator and the ground handling company carried out separate internal investigations into the accident. The operator's investigation concluded that the ground handling company's pushback procedures were adequate for the task. It did, however, raise concerns about the condition and standard of maintenance of the ground equipment and recommended an audit be carried out. The ground handling company has confirmed that the equipment is subject to scheduled six-monthly maintenance and routine operational checks. It has also put in place a three-monthly check of the towbar shear pins as a result of the accident. With regard to the operator's own procedures, a change has been made to delay the 'after start' checks until all pushback movements have been completed and ground equipment removed. This change will allow the crew's attention to be focused on the safe completion of the pushback phase of the departure.

INCIDENT

Aircraft Type and Registration:	BD700 Global Express, N618WF
No & Type of Engines:	2 BR700-710A-20 turbofan engines
Year of Manufacture:	1999
Date & Time (UTC):	12 January 2009 at 1352 hrs
Location:	Runway 26 Luton Airport
Type of Flight:	Commercial Air Transport (Non-Revenue)
Persons on Board:	Crew - 3 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Left wing: tip (underwing), front edge slat, trailing edge flap, flap track fairings
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	5,600 hours (of which 900 were on type) Last 90 days - 120 hours Last 28 days - 55 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

The aircraft was on final approach to Runway 26 at Luton Airport with the autopilot engaged. At about 210 ft above the touchdown zone, the aircraft suffered a disturbance probably due to a gust of wind. The autopilot was disengaged below a radio altitude of 10 ft but there was insufficient time for the pilot to prevent the left wingtip hitting the runway, marginally before the left landing gear. It is possible that the unusually high rate of decrease of radar altitude, a feature of the approach to this runway, contributed to the late disconnection of the autopilot.

History of the flight

The aircraft was on final approach to Runway 26 at Luton Airport and the crew had been instructed to maintain 160 kt to four nautical miles on the approach. The pilot reported that the wind was "53 kt, just from the left". At four nautical miles from touchdown, full flap was selected and the speed was reduced to 121 kt which corresponded to V_{REF} plus five knots. The pilot stated the approach was stable and that ATC reported the surface wind from 210º/15 kt.

The pilot reported that "below about 150 ft, but probably a lot lower, the left wing dropped, the nose pitched up and the plane suddenly lost height". N618WF landed and the pilot was unaware of any further incident. After parking, the marshaller brought to the pilot's attention the fact that the left wing had been damaged.

The pilot believed the incident was caused by a strong gust of wind or some windshear just before landing.

Aircraft damage

Damage was limited to the left wing. A small section of the trailing edge of the flap delaminated. There was scrape damage to the underside of one flap track fairing and to the tip of another. The outboard end of the leading edge slat was damaged immediately inboard of the navigation light. There was scuff damage to the composite material underneath the wing tip.

Flight data recorder (FDR) information

The aircraft manufacturer provided the AAIB with data from the FDR. The data showed that the approach was flown by the autopilot, which was disengaged between 10 ft and 2 ft radar altitude. The auto-throttle was disengaged between 4 ft and 0 ft radio altitude.

During the last 80 seconds of flight, the flight management system (FMS) commanded a speed of 121 kt and the IAS deviated from this value by ± 6 kt. In the five seconds before touchdown the IAS dropped from 124 to 114 kt. During the approach, the pitch attitude varied by 2° either side of a mean value of approximately 4° nose up. In the three seconds before touchdown, the nose attitude increased to 8° nose up.

During the approach, the bank angle varied by up to 10° either side of wings level. Twenty seconds before touchdown, at about 210 ft above the touchdown zone, there was a wing drop from wings level to 10° left wing low followed by a reversal over five seconds to 8° of right bank. The bank angle reduced slightly over the next four seconds but returned to 8° six seconds before touchdown. In the following six seconds, the bank angle changed from 8° right wing low back to 9° left wing low. Approximately half a second before the left landing gear touched the runway, the bank angle reversed direction abruptly, probably due to the wingtip coming into contact with the surface. The left landing gear weight on wheels switch activated between 4 ft and 2 ft radar altitude.

Wind velocity

The crosswind component of the wind velocity was forecast to be 13 kt, temporarily 16 kt gusting to 26 kt.

Airplane Flight Manual

The airplane flight manual states that the minimum altitude for the autopilot to be used *'for a precision approach (Category I or II ILS) is 50 ft AGL'*. The Global Express is not equipped with an autoland capability.

UK Air Information Publication (AIP) entry for Luton Airport

The UK AIP entry for Luton Airport states that

> *'due to the sloping terrain in the approach area of ILS Cat II operations, the rate of radio altimeter height reduction prior to the threshold will be approximately double the normal rate.'*

Analysis

It appeared that while descending through approximately 210 ft above the touchdown point, the aircraft suffered a disturbance which caused it to roll first left, then right and then left again. It is probable that the disturbance was caused by a gust in the wind. During the second roll to the left, the IAS decreased and the nose pitched up, possibly due to the autopilot trying to maintain the ILS glideslope at the lower speed. This left the aircraft in a nose up, left wing down attitude when the left wingtip hit the runway marginally before the left landing gear.

Following the initial disturbance, the autopilot was unable to regain a normal aircraft attitude before it was disconnected. After disconnection at between 10 ft and 2 ft radar altitude, N618WF was at such a low level that the pilot had insufficient time prior to landing to prevent the wingtip impacting the runway. The unusually high rate of decrease of the radar altitude may have contributed to the pilot disconnecting the autopilot below its minimum disconnection height.

SERIOUS INCIDENT

Aircraft Type and Registration:	Gulfstream G5, CS-DKE
No & Type of Engines:	2 Rolls Royce BR710 turbofan engines
Year of Manufacture:	2007
Date & Time (UTC):	21 November 2008 at 0740 hrs
Location:	'D' Ramp, Farnborough Airport, Hampshire
Type of Flight:	Public Transport
Persons on Board:	Crew - 3 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Scuffing to winglet on CS-DKE. Top of winglet broken off on parked aircraft
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	44 years
Commander's Flying Experience:	5,500 hours (of which 994 hrs were on type) Last 90 days - 75 hours Last 28 days - 26 hours
Information Source:	AAIB Field Investigation

Synopsis

As CS-DKE taxied from its parking position on the Delta ramp at Farnborough Airport, its left winglet severed the right winglet of a parked, unoccupied Global Express aircraft, C-GGLO. The Delta ramp was not painted with parking stand markings. Although the flight crew had identified that wingtip clearance was a concern, the pilot taxiing CS-DKE did not detect the collision. The investigation identified similarities with collisions involving the wingtips of larger aircraft. The operator of CS-DKE has introduced a procedure to prevent reoccurrence, and the airport operator has taken safety action.

History of the flight

C-GGLO had arrived at Farnborough some days before the event and was parked on the Delta ramp according to the airport's normal procedures (the Delta ramp is a long ramp area, formerly a taxiway, now used for aircraft parking and as a taxiway). CS-DKE then arrived and was parked adjacent to C-GGLO. Both aircraft were parked at approximately 45° to the edge of the ramp area, facing north-east, such that if CS-DKE were to move straight forwards from its position, the left winglet of CS-DKE would pass close to the right winglet of C-GGLO.

CS-DKE was scheduled to fly to West Palm Beach, Florida. The flight crew consisted of a captain under training in the left seat and a training captain in the right seat, who was the commander. During pre-flight preparations, it was decided that the captain under training was to be pilot flying (PF) for the sector; the training captain was to be pilot monitoring (PM).

The PM carried out the exterior inspection, noting as he did so that C-GGLO was parked close to the path which CS-DKE would take as it taxied from its position. The PF also carried out an exterior inspection of the aircraft and estimated the clearance between the aircraft winglets to be about three metres if he taxied forward without turning.

The PF stated in his pre-flight briefing that he intended to manoeuvre slightly to the right as he began to taxi, to ensure that there was no danger of a collision.

At about 0730 hrs, the PF began to taxi the aircraft forward. The sun had risen and the PF later stated that there was sufficient daylight to see the wingtip clearly. He made a "slight" turn to the right[1] as he moved off the parking position. He stated that he was conscious of the need to monitor the wingtip clearance and that he was also paying attention to positioning his aircraft accurately onto the taxiway ahead, which was not marked with a centreline. After taxiing forward a short distance, he brought the aircraft to a halt again, aware that the winglet of his aircraft was "quite close" to the winglet of C-GGLO. However, he perceived that sufficient clearance existed and continued taxiing.

CS-DKE took off normally. A short time later, airport staff noticed the severed upper section of the winglet of C-GGLO on the ground, and recognised that there may have been a collision when CS-DKE left the ramp (no other aircraft had moved in that area). The operator of CS-DKE was contacted and a satellite telephone call made to CS-DKE, which was over the western Atlantic. The flight crew were informed that their aircraft may have been involved in a wingtip collision on the ramp at Farnborough. The flight crew and cabin attendant inspected the wingtip in flight but did not observe any damage.

After landing at West Palm Beach, a visual inspection by an engineer showed slight scuff marks on the winglet of CS-DKE, consistent with a collision. There was no structural damage, and the marks were polished out. C-GGLO was subsequently fitted with a new winglet.

Flight crew

The captain under training had a total of 7,500 hours flying experience, of which 150 hrs were on the G5. He was widely experienced in business jet operations and had been a commander on other aircraft types. The operator of CS-DKE required captains transitioning onto the G5 fleet to spend a short period, typically about six months, as co-pilots on the type before releasing them as captains on the fleet. The captain under training of CS-DKE had successfully completed this period, and was undergoing line training as a captain on the accident flight. The training captain in command of CS-DKE was experienced in his role.

View of the wingtip from the flight deck

The AAIB investigator inspected an aircraft identical to CS-DKE and found that the winglet and the outer part of the left wing could be seen clearly from a seated position in the left flight deck seat. This required either the use of a small mirror fitted to the window structure for the purpose or positioning one's head against the side window. The wingtip was not visible from the other flight deck seat.

Footnote

1 FDR data showed that the aircraft turned from a heading of approximately 045° onto a heading of slightly more than 050° soon after beginning to taxi.

The captain under training reported that he preferred to look directly at the wingtip, rather than using the mirror.

Aircraft parking at Farnborough

Farnborough has operated as a civil airport, specialising in executive aviation, for several years with routinely used parking procedures. Aircraft arriving at Farnborough were parked under the guidance of a marshaller, such that they might depart without needing to be towed or marshalled from their position. Because of the wide variety of aircraft sizes using the airport, no parking stands were marked out, although the edges of parking areas were clearly identified by painted lines.

The airport management considered that although marking parking stands out might reduce the likelihood of a wingtip collision, the consequent reduction in parking capacity would require aircraft to be routinely re-positioned by tug and this activity would incur additional risk. The airport operator provided marshalling staff to departing aircraft either on request, or if the marshallers themselves considered their attendance desirable.

Analysis

Although the flight crew of CS-DKE were aware that wingtip clearance was a concern, they judged that the aircraft could depart safely under its own power without a marshaller. The PF's decision to make a gentle right turn as he taxied forward may have been significant as it is possible that CS-DKE was not parked precisely parallel to C-GGLO, but may already have been pointing slightly towards it[2]. The lack of ground markings at 45° to the centreline makes accurate positioning of aircraft difficult although no such marking is specified in the relevant international standards.

The PF was monitoring the progress of his aircraft's wingtip as he taxied forward and yet did not see the collision or recognise it was imminent. Other investigations into ground collisions have identified that pilots of large swept-wing aircraft have difficulty perceiving the path a wingtip will take on account of its remoteness and the geometry of the flight deck and wingtip. This geometry had not previously been identified in smaller aircraft accidents but it is possible that this was a factor in this event.

Safety action

Following the event, the operator of CS-DKE issued an instruction to flight crews that all aircraft departing from Farnborough were to be marshalled out of their parking positions.

The airport operator introduced additional procedures after the event, requiring aircraft departing the Delta apron to be marshalled from their parking positions. However, the airport operator has since withdrawn that procedure and replaced it with information in the UK Integrated Aeronautical Information Package (IAIP) and broadcast on the ATIS, advising flight crew that marshalling is available.

Footnote

2 The precise parked position of CS-DKE from CCTV could not be ascertained.

SERIOUS INCIDENT

Aircraft Type and Registration:	Piper PA-31-350 Navajo Chieftain, G-VIPP
No & Type of Engines:	2 Lycoming TIO-540-J2BD piston engines
Year of Manufacture:	1979
Date & Time (UTC):	30 May 2008 at 0915 hrs
Location:	After departure from Boscombe Down, Wiltshire
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 2 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Fire damage to a circuit breaker and to electrical wiring near the overhead panel
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	29 years
Commander's Flying Experience:	980 hours (of which 280 were on type) Last 90 days - 270 hours Last 28 days - 60 hours
Information Source:	Aircraft Accident Report Form and subsequent AAIB investigation

Synopsis

During the climb after departure, the crew observed smoke in the cockpit and flames emanating from the overhead panel. All non-essential electrics were turned off and the aircraft returned to the departure airfield safely. There were no injuries. One of the air recirculation fans was found to have suffered a mechanical failure and there was evidence that its circuit breaker had failed to trip. The excessive current drawn by the fan had caused the wiring to overheat, producing the smoke and flames.

History of the flight

The aircraft departed from Boscombe Down and was passing through FL70 when a burning smell was noticed by the crew. Flames then appeared from the overhead panel and smoke emanated from the circuit breaker for the air recirculation fans. The commander attempted to pull the circuit breaker, but found that it was stuck in the closed position. He turned off all non-essential electrics, but kept the radio, transponder and navigation equipment on to avoid entering Danger Areas, and proceeded to return to Boscombe Down. He maintained frequent radio communication with Boscombe ATC and requested fire service attendance.

The co-pilot tackled the fire with a BCF fire extinguisher, but the fire continued to smoulder throughout the descent. The aircraft landed with a fire crew in attendance. Although the three occupants reported no ill effects or injuries, they were taken to a local medical centre as a precaution.

Aircraft information

The aircraft is fitted with two air recirculation 'blower' fans, located in the lower fuselage, just forward of the wing main spar. The fans draw cabin air from floor level and distribute it to vents situated throughout the cabin. There is a HIGH/LOW switch in the overhead panel, and a single 10 Amp (A) circuit breaker in the switch and circuit breaker panel, located to the left of the left pilot's seat.

The fans are checked for 'condition and operation' every 200 hours. They are classified as 'on-condition' and therefore have no overhaul life. Circuit breakers must be checked for 'compliment and rating' every 200 hours, but they are not required to be functionally checked.

Service Bulletin (SB 704) 'Cabin Fan Fuse Installation', applicable to certain PA-31-350 models, was introduced in 1982 due to problems with the windings in fan motors shorting and circuit breakers failing to trip. SB 704 required the installation of in-line fuses in the fan motor power circuit, of a lower rating than the circuit breaker. However, SB 704 was not applicable to this aircraft.

Engineering investigation

The 10A circuit breaker was found to have significant heat damage and although it would operate mechanically, it remained in the open circuit electrical state. There was also significant heat damage to the wiring and connectors in the cockpit roof area, near the overhead panel.

Both fan units were removed, whereupon the right fan was found to have seized. Further inspection revealed that the impeller had detached from the central boss. This was apparently due to a material failure in the fan back plate. The insulation on two of the three wires in the power feed cable had suffered significant heat damage. It was concluded that the fan failure had caused the circuit to become overloaded and, since the circuit breaker had not opened, a small fire had ensued. The circuit breaker was found in the open circuit state; this was probably due to the effects of the heat.

Internal inspection of the circuit breaker revealed significant heat damage. There were some signs of slight corrosion but, given the heat damage, it was not possible to make any firm conclusions about the serviceability of the circuit breaker at the time of the incident.

The circuit breaker and heat damaged wires were taken to a specialist electrical laboratory. Tests were carried out on lengths of wire in an attempt to generate similar heat damage to the insulation material and thus infer the electrical loading in the circuit during the incident. The currents tested ranged from 20A to 50A. The most noteworthy test was on the undamaged third wire from the fan motor which was tested for 30 minutes at 40A. Whilst there was some discolouration of the insulation material, there was no significant deformation. The temperature of the wire reached 80°C after three minutes and remained constant thereafter. Although it was not possible to simulate accurately the physical environment of the various wires that were damaged (for example the proximity of other cables or the volume of air around the cable), the test results suggested that the fan motor circuit was probably subjected to a current of at least 40A, well in excess of the 10A circuit breaker rating. At 400% of the maximum rated load, a 10A circuit breaker should typically trip in under 5 seconds.

Civil Aircraft Airworthiness Information and Procedures – CAP 562

CAP 562 gives general information on a variety of matters concerned with the manufacture, overhaul, repair, maintenance and operation of civil aircraft. Leaflet 11-22 Appendix 24-4 is entitled 'Thermal Circuit Breakers', and in Section 5 'Maintenance Considerations' it states:

> *'It has become apparent that the progressive development of the Maintenance Review Board determining scheduled maintenance has led to a significant erosion of maintenance checks on circuit breakers. Users are reminded that there is a continuing duty to monitor the performance of equipment and that items such as circuit breakers which are largely passive in nature should be assessed for dormant faults.*
>
> *As a minimum and where Maintenance Schedules do not require a high level of checking, all CBs which are not regularly exercised by mechanical switching should be checked for correct mechanical operation by performing two manual switching cycles at periods of not more than two years. The necessary action should be taken to revise Maintenance Schedules as appropriate.'*

Operator's safety actions

As a result of this incident the operator has:

1. Embodied SB 704: 'Cabin Fan Fuse Installation'
2. Amended the maintenance programme to include a check for 'any abnormal noise' during the recirculating fan functional check
3. Amended the maintenance programme to include a circuit breaker functional check every 600 flying hours or 12 calendar months

Some time after the incident the operator discovered that a landing gear circuit breaker on the same panel on the incident aircraft was open circuit, despite appearing to work mechanically. When the circuit breaker was opened significant internal corrosion was found that showed some similarities to the heat damaged circuit breaker from this incident. The proximity of the circuit breaker panel to the DV window might be a contributory factor to the corrosion and the operator is considering a program of circuit breaker replacement.

Other circuit breaker failures

Interrogation of the CAA Mandatory Occurrence Report (MOR) database for circuit breaker failures resulting in smoke in the cockpit revealed only three occurrences since January 2002. One of these was attributed to a 'faulty circuit breaker', but no further information was available. There have been several incidents worldwide of arcing faults which failed to trip a circuit breaker due to the current remaining within the rated circuit breaker load; this has led to research into alternative circuit protection devices. However, there is good evidence that this incident was caused by a failure of the circuit breaker to trip when exposed for a significant period of time to levels of current well in excess of the rated value.

Discussion

The crew's actions of concentrating on flying the aircraft, isolating all non-essential electrics, fighting the fire and making a prompt decision to return to Boscombe Down ensured that a more serious, potentially catastrophic situation was avoided. The aircraft landed safely and there were no injuries to the crew or passenger.

The operator's decision to include a functional check of the recirculation fan circuit breaker and to check for abnormal fan noise should help to identify fan problems prior to failure and thus prevent similar incidents in the future.

SERIOUS INCIDENT

Aircraft Type and Registration:	Saab-Scania SF340B, G-LGNE
No & Type of Engines:	2 General Electric CO CT7-9B turboprop engines
Year of Manufacture:	1989
Date & Time (UTC):	17 January 2009 at 0830 hrs
Location:	Runway 24 at Benbecula Airport, W Isles, Scotland
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 3 Passengers - 10
Injuries:	Crew - None Passengers - None
Nature of Damage:	Abrasion of aluminium skin and mounting bracket
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	37 years
Commander's Flying Experience:	5,924 hours (of which 1,155 were on type) Last 90 days - 114 hours Last 28 days - 20 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft touched down on Runway 24 at Benbecula Airport and, despite the control column being moved forward, the aircraft nose could not be lowered. The underside of the rear fuselage contacted the runway surface and as the groundspeed reduced to approximately 40 kt, the aircraft nose pitched down, the nosewheel lowered onto the runway and nosewheel steering became available.

The loading of the aircraft had not been in accordance with the planned load sheet and the aircraft's CG position was outside the aft limit for landing.

History of the flight

The crew reported for duty at 0620 hrs for a 0720 hrs departure from Glasgow to Benbecula. Having completed the flight planning and requested fuel from the handling agent, they arrived at the aircraft some 45 minutes before departure. Seat rows 8 to 11 inclusive, on the right side of the aircraft, were not available for passengers as seat converters for the carriage of newspapers had been fitted. Having boarded the passengers, their bags and the freight, the cabin attendant informed the commander of the actual seating of the passengers by zone. He then checked this against the seating plan shown at the bottom of the load sheet and found it to be correct.

Push-back was at 0718 hrs and the aircraft departed at 0727 hrs with the co-pilot as the pilot flying (PF). He stated the rotation from the runway appeared normal and shortly after takeoff engaged the Auto Pilot (AP). The aircraft climbed to a cruising level of FL145. Having briefed for a VOR/DME approach to Runway 24, the aircraft descended to 1,500 ft. The weather at Benbecula was given as surface wind 260°/15 kt, visibility 20 km with scattered cloud at 1,500 ft. The crew saw the airport at approximately 12 nm on the base leg, and continued with a visual approach. At about 5 nm, the AP was disconnected and with flaps set to 20º the aircraft touched down normally on the runway.

The co-pilot attempted to lower the aircraft nose but even with the control column moved forward, it remained high and the rear fuselage came into contact with the runway. The commander attempted to lower the aircraft nose using a combination of propeller reverse thrust and wheel brakes, using main wheel differential braking to maintain aircraft directional control as nosewheel steering was not available. At about 40 kt the nosewheel lowered onto the runway and the aircraft was brought to a stop. The aircraft was then taxied onto the parking area and shut down.

The attachment bracket on the underside of the rear fuselage onto which a length of tubing known as a 'pogo stick' is secured when the aircraft is parked, was worn away. The 'pogo stick', when attached, hangs down in order to prevent the aircraft tipping back onto its tail when loading passengers and freight. As this was not available, the freight was offloaded first, followed by the passengers, in order to keep the nosewheel in positive contact with the ground. At no time during the flight was there any indication that the aircraft CG was outside the permitted limits for landing and takeoff.

Damage to the rear fuselage is shown in Figure 1.

Weight and Balance

The aircraft had a maximum permitted takeoff mass of 13,155 kg; the mass and CG envelope for takeoff and landing is shown at Figure 2. The aircraft landing mass was 11,947 kg and the CG index with the passengers, baggage and freight as loaded on the incident flight was calculated as 67.5. Had the aircraft been loaded as per the final load plan, the landing mass would have remained the same, but the index would have been 47. With the aircraft as loaded, the CG position was significantly outside the aft limit for takeoff, landing and flight.

Figure 1

Damage to the underside of the aircraft tail

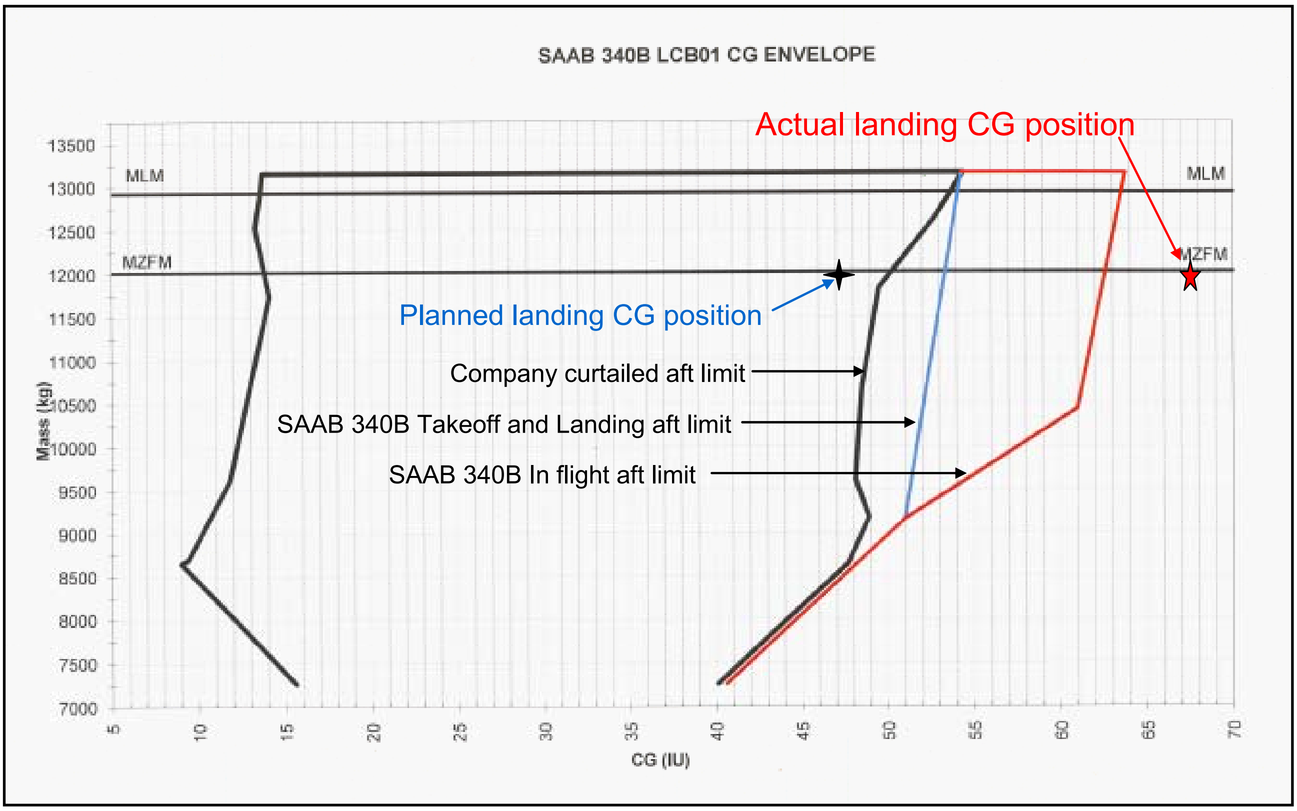


Figure 2

SAAB 340B CG position limits for takeoff, landing and flight

Aircraft loading procedures

On Friday, Saturday and Sunday each week, a large volume of newspapers are transported from Glasgow to Benbecula. Seat converters are fitted to contain bundles of newspapers which are then restrained in the normal passenger seat belts.

Two separate computer based systems are used to check-in the passengers and calculate the weight and CG index of the aircraft. Passenger check-in uses a software programme called SHARES which simply allocates seats which are available. Mass and CG planning is carried out using a software package called D-PLAN. The SHARES system is located at Glasgow airport and the D-PLAN computations are carried out at Central Load Control (CLC) based at Manchester. The D-PLAN system divides the aircraft seating into six zones from the front of the aircraft to the rear designated OA, OB, OC, OD, OE and OF. Each zone comprises two seat rows, each of which has a single seat on the left and a double seat on the right, with the exception of zone OF, which is one row of four seats. A curtailed CG envelope is used based on passenger loading within the six bay layout[1]. In order to simplify checking passenger distribution after boarding, the operator reduced the number of zones to two. Zone A included five rows of seats. Zone B included seats in row seven rearwards. With only two zones, there is an increased possibility that weight distribution, using

Footnote

[1] In order to use the full AFM CG envelop, the actual masses of the passengers and cargo must be used and their individual moments calculated. The bay method is simpler, but requires the envelope to be reduced to ensure the AFM CG envelope is not exceeded. The use of six bays allows a much wider envelope to be used than the manual load sheet, which uses two bays.

standard passenger weights, may be less accurate and therefore the CG envelope is reduced as a safeguard when using this method.

In order to prevent seats fitted with the seat converters being allocated to passengers, the seats are 'blocked' from use on the SHARES system. The 'blocked' seats were notified to the check-in SHARES system on the day before the incident in order to facilitate passengers checking in using the internet. A total of 17 seats had been blocked on the SHARES system. This comprised all the seats in the first three rows and the double seats on the right side of the aircraft in rows 8 to 11 inclusive, where the seat converters had been fitted. The first three rows should not have been blocked and no reason for this was identified.

The dispatch department at Glasgow pass CLC the details of the aircraft registration and number of crew. The anticipated number of passengers with their bags and the freight from the cargo handling agent is also passed. Based on these details, CLC send the first edition of the load plan to the dispatcher; all load plans are controlled using an edition number for any changes. The first edition is referred to as EDNO1.

When all the passengers are checked in and the freight has been loaded in the seat converters and baggage bays, the dispatcher sends a Flight Closure Breakdown (FCB) message to CLC which contains the final number of passengers, together with their seat allocation and baggage weights. This, along with the fuel load determined by the commander, is used by the CLC Load Controller to produce the loadsheet. CLC check that the closure details match those planned and send the loadsheet to dispatch.

A release message is sent from CLC confirming the load details, including any significant details that may not have been shown on the load plans, for example, any seat changes. This release message relating to the incident flight was passed from CLC to the gate using landline telephone, although the procedure is for hard copy to be sent by fax or telex.

Where seat changes are made, the dispatcher will call the passengers forward at the gate and re-allocate them a seat in accordance with the load sheet. The SHARES seating plan attached to the bottom of the load sheet is then amended by the dispatcher to show the revised passenger seating.

The dispatcher passes the load sheet to the aircraft commander, who establishes how many passengers are seated in Zones A and B and confirms with the cabin crew that the numbers match where passengers are actually seated. If this is correct, then he signs the load sheet and the aircraft is permitted to depart.

Incident loading activity

The load controller reported for duty at 0500 hrs and occupied a work station dedicated to the aircraft operator. This is necessary as the aircraft operator's load control system is different and separate from the other systems used by CLC.

The cargo weights for the flight were sent by fax from the freight handling agent to CLC where they were received at 0623 hrs. The EDNO1 was prepared and sent to dispatch at Glasgow at 0630 hrs, showing 10 passengers, baggage compartment one (CPT 1) containing 450 kg of newspapers, and 200 kg newspapers and 124 kg of baggage in compartment two (CPT 2)[2].

Footnote

[2] The baggage compartments are located at the rear of the cabin with CPT 1 being forward of CPT 2.

At 0632 hrs, the aircraft fuel load was received at CLC, which showed 1,500 kg of fuel onboard the aircraft and an estimated trip fuel of 331 kg. The correct flight number and aircraft registration were confirmed.

The EDNO2 was prepared and sent to Glasgow despatch at 0634 hrs, showing 10 passengers, CPT 1 with 450 kg newspapers, CPT 2 with 124 kg baggage and 210 kg of newspapers. There were three SI entries showing 150 kg of newspapers in seats 9 C/D, 10 C/D and 11 C/D. The load controller calculated that a change of passenger seating was required in order to obtain the maximum payload whilst retaining the aircraft within trim. This was passed by the load controller to the departure gate at Glasgow by telephone as a verbal instruction.

A flight closure message was sent from Glasgow to CLC and was received at 0647 hrs showing two passengers seated in bay B, four in C, one in D, two in E and one in F, with 124 kg of baggage. No change had been made to the seating plan.

The final load sheet was produced by CLC and sent to Glasgow at 0649 hrs. This showed that the passengers should be moved forward, with six in bay A and four in bay B. In order to remain in trim, 24 kg of newspapers had to be offloaded from CPT 2. However, no flight release message was sent from CLC to Glasgow, as required. The dispatcher was therefore, not aware of the need to move the passengers. They therefore boarded the aircraft and occupied the seats allocated at check in. He did not amend the seating plan at the bottom of the load sheet as there were no changes, as far as he was aware. The commander divided the seating plan into two zones at row seven and the cabin attendant confirmed that there were five passengers in zone A and five in zone B, in accordance with the seating plan. The commander then signed the load sheet.

Analysis

A procedure for calculating the safe loading of the aircraft had been established, and the load sheet for the incident flight contained the information for the correct passenger seating using the six zone method. However, in order to simplify the seating check for the crew, the operator had reduced the number of cabin zones from six to two. The addition of a seating plan at the bottom of the load sheet allows the crew to identify how many passengers should be seated in each zone and, providing the flight closure message containing any seating changes reaches the dispatcher, means the aircraft is safe to operate.

However, the flight closure message regarding the passenger seating changes on the incident flight was not received by the dispatcher and, therefore, the seating plan at the bottom of the load sheet was incorrect. The crew, using the two zone method, confirmed the passengers were apparently seated in accordance with the seating plan but this load distribution placed the aircraft CG index significantly beyond the aft limit for takeoff and landing, and slightly beyond the aft limit for flight. The situation was not recognised during takeoff or during flight, but only landing, when the nose could not be lowered and the underside of the rear fuselage contacted the runway surface. The application of reverse propeller thrust, or aerodynamic drag from discing propellers on landing, given the relatively high thrust line above the aircraft wheels, may have acted to increase the tail down moment.

Safety action

Both the operator and the handling agent carried out internal investigations. As a result, they agreed to instigate changes to their procedures. The two most significant changes are:

The seating plan is currently still required to construct a manual load sheet, which is split into Zones A and B. However, for automated D-Plan loads sheets, the check to ensure that passengers are seated in the correct zones will be based on the six zones listed on the load sheet. A 'Passenger Headcount Confirmation Form' has been produced which is completed to show where the passengers are seated on the aircraft. The zones reflect those used in the D-PLAN programme and can be sub-totalled and checked against the zones shown on the load sheet. This procedure will ensure that the aircraft is correctly loaded. A copy is shown at Figure 3.

A flight release message will be sent by Fax or Telex clearly stating the reference number of the final load sheet. The Dispatcher can then ensure that the correct load sheet is passed to the aircraft commander and the loading of the aircraft accords with the load sheet.

SAAB 340 PASSENGER HEADCOUNT CONFIRMATION FORM

DATE:			FLIGHT #:		
FROM:		TO:		ACFT REG:	

Circle each occupied seat and enter Cabin/Bay split sub-totals and Total Pax

Cabin	Seat				Bay
Fwd OA	2A		2C	2D	OA Sub tot:
	3A		3C	3D	
	4A		4C	4D	OB Sub tot:
	5A		5C	5D	
Sub tot:	6A		6C	6D	OC Sub tot:
Aft OB	7A		7C	7D	
	8A		8C	8D	OD Sub tot:
	9A		9C	9D	
	10A		10C	10D	OE Sub tot:
	11A		11C	11D	
Sub tot:	12A	12B	12C	12D	OF Sub tot:

Total Pax:

LOGANAIR SCOTLAND'S AIRLINE

LCB01 Config (Blue loadsheet) NA/B/C/D/E/F/G Form No: 9010 Iss 1

Figure 3

Conclusions

The misloading of the aircraft occurred due to a failure in communication during the aircraft loading procedure. The flight closure message was not received by the dispatcher and the change of passenger seating was not passed to the crew. This led to an aft CG index significantly outside the permitted takeoff, landing and in-flight limits, and the underside of the tail contacting the runway surface on landing.

ACCIDENT

Aircraft Type and Registration:	Agusta A109 A2, N745HA
No & Type of Engines:	2 Allison 250-C20R turboshaft engines
Year of Manufacture:	1988
Date & Time (UTC):	13 January 2009 at 1630 hrs
Location:	Fairoaks Airport, Chobham, Surrey
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - None
Nature of Damage:	Nose landing gear damaged
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	38 years
Commander's Flying Experience:	3,220 hours (of which 1,384 were on type) Last 90 days - 134 hours Last 28 days - 10 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The student was performing an autorotation with both engine Speed Select Levers (SSLs) retarded from the flight idle position. They should have been returned to the flight idle position for the recovery to the hover but were reinstated too late in the descent and a run on landing was performed, damaging the nose landing gear. The instructor was distracted from advancing the SSLs whilst carrying out instruction for the student.

History of the flight

The training flight was conducted as part of a type rating course. The instructor had briefed the student for a simulated double engine failure exercise which involved an autorotation to a powered recovery, using Runway 24 as the aiming point. The instructor would retard both engine Speed Select Levers (SSLs) for the autorotation ensuring that they were reinstated to the flight idle position by 500 ft agl. The aircraft was to be flared at approximately 120 ft and the aircraft brought to a hover at a height of six feet above the runway. Autorotation to a touchdown is not permitted in this aircraft.

The aircraft was positioned onto the final approach for Runway 24, level at 1,200 ft aal with an IAS of 100 kt. The instructor initiated the autorotation with the verbal instruction, "double engine failure, GO", and retarded both SSLs from the flight idle position. The aircraft was established in autorotation at approximately 75 kt, manoeuvring towards Runway 24. It became apparent that the student was not going to achieve the required aiming point and the instructor advised the student of corrective action to rectify the situation. Late in the exercise he realised that he had not reinstated the SSLs and advanced them to the flight idle position. He took control and performed a running landing on the grass area alongside the runway. This was an area which he normally used for engine off landings in other helicopters. The touchdown seemed to be normal, with a landing run on of some three to four metres and no excessive vertical or sideways forces.

The aircraft was hover-taxied back to the parking area for a 'precautionary check' and landed with no apparent signs of damage. After shutting the aircraft down, the pilot noticed that the retractable nose landing gear did not appear to be fully extended. Close inspection revealed that the extension strut had collapsed and that the nose leg was resting against the underside of the fuselage.

The pilot considered that the damage had occurred during the short run on landing on the softer ground.

Analysis

Although the exercise had been properly briefed, the instructor became distracted from reinstating the SSLs by 500 ft agl while assisting the student. He concluded that it would have been better to reinstate the SSLs to the flight idle position before carrying out instruction or to abandon the exercise and repeat it, having debriefed the student on the previous attempt.

ACCIDENT

Aircraft Type and Registration:	Aero AT-3 R100, G-SACX
No & Type of Engines:	1 Rotax 912-S2 piston engine
Year of Manufacture:	2007
Date & Time (UTC):	30 April 2009 at 1715 hrs
Location:	Sherburn in Elmet Airfield, North Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Propeller blades, nose gear, pitot head, left wingtip and left aileron damaged
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	62 years
Commander's Flying Experience:	179 hours (of which 7 were on type) Last 90 days - 11 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot had successfully completed 10 to 11 circuits during which he had carried out a combination of touch-and-go's and full stop landings on Runway 11. The wind was from 150º at 8 to 10 kt. On this approach he rounded out too high and allowed the airspeed to decay to around 40 to 45 kt, causing the aircraft to touch down heavily on the runway. It then bounced back into the air and touched down on the nosewheel before pitching nose up. The pilot increased power in an attempt to regain control, but did not apply right rudder to counter the yaw effect, resulting in the aircraft yawing to the left and departing the paved surface. He brought it to a halt on the grass adjacent to the runway. The tips of the propeller blades and the nosewheel assembly were damaged. Damage to the left wingtip, left aileron and pitot tube indicated that the left wing had struck the ground during the accident.

The pilot considered that he might have lost concentration after having spent approximately one and a half hours flying in the circuit.

ACCIDENT

Aircraft Type and Registration:	Aero AT-3 R100, G-SACY
No & Type of Engines:	1 Rotax 912S piston engine
Year of Manufacture:	2007
Date & Time (UTC):	14 May 2009 at 1101 hrs
Location:	Sherburn in Elmet Airfield, North Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Significant damage to fuselage and fin
Commander's Licence:	Private Pilot's Licence
Commander's Age:	39 years
Commander's Flying Experience:	167 hours (of which 10 were on type) Last 90 days - 3 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot, who was flying a series of circuits, inadvertently selected the choke instead of the carburettor heat during the downwind leg of the fifth circuit. As he reduced power and turned onto final approach, the engine stopped and he made a forced landing in a nearby field. The aircraft nosed-over during the landing roll and the pilot, who was uninjured, had to be released from the aircraft by the Airfield Fire and Rescue Service. The most likely reasons for the engine stoppage were considered to be an over-rich mixture due to the inadvertent selection of the choke or carburettor icing due to the carburettor heat not being selected.

The choke and carburettor heat controls are situated close together on the centre panel extension (Figure 1). The choke control has a cylindrical yellow knob and the carburettor heat has a square blue knob. Both controls have a similar action: pulling the knob selects the system ON and turning the knob to the right locks it in the ON position.

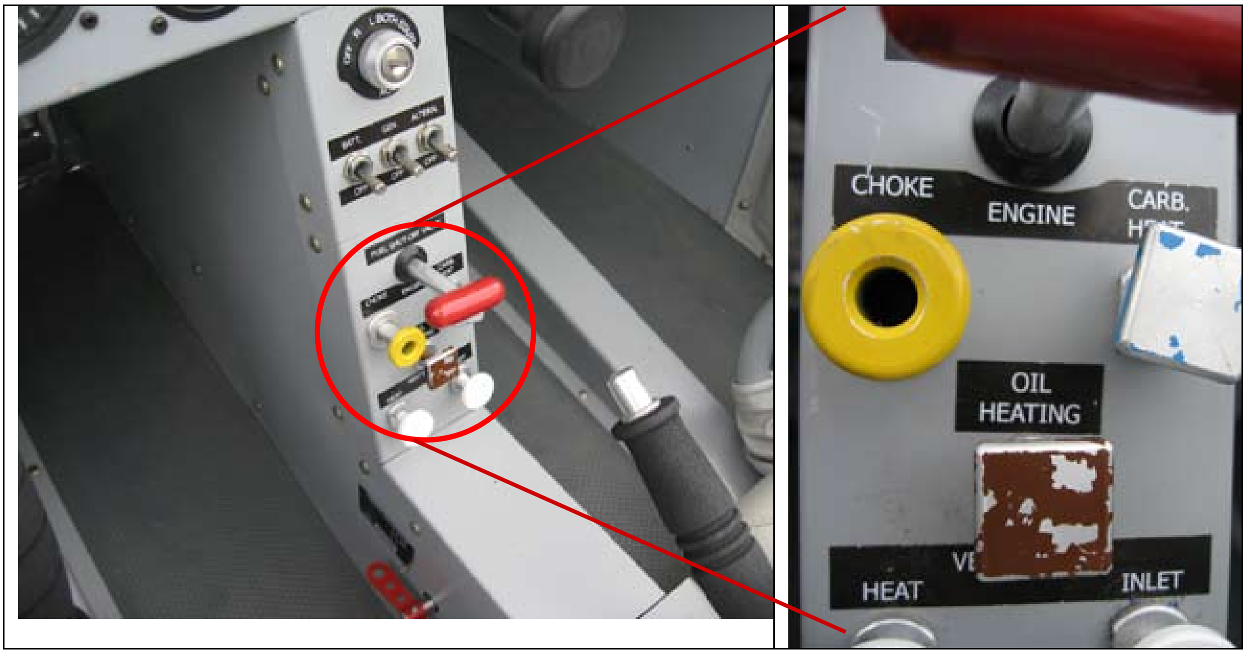


Figure 1

Ancillary engine controls (similar aircraft)

ACCIDENT

Aircraft Type and Registration:	Beech 76 Duchess, G-TWNN
No & Type of Engines:	2 Lycoming O-360-A1G6D piston engines
Year of Manufacture:	1980
Date & Time (UTC):	2 April 2009 at 1001 hrs
Location:	Runway 08, Bournemouth Airport
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Wing tip, flap, flap support, foot step
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	34 years
Commander's Flying Experience:	2,654 hours (of which 1,035 were on type) Last 90 days - 68 hours Last 28 days - 42 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Internal corrosion of the right main landing gear oleo shock strut had limited its free movement, such that landing gear was able to retract, but not extend. The aircraft landed with the right gear in the retracted position.

History of the flight

When the landing gear was lowered during a stalling exercise, only two green 'down and locked' lights illuminated. The light for the right main landing gear did not illuminate, although the 'push to test' feature confirmed that the bulb was serviceable. The emergency gear extension system was then used, but the indication did not change; similarly, there was no change in the indication when the aircraft was manoeuvred vigorously in an attempt to release the right gear.

The commander briefed his student to fly an ILS approach down to 500 ft, at which point he would take control and fly past the control tower to allow ATC personnel to conduct a visual inspection of the landing gear position. He would then fly a visual circuit and land.

Having informed ATC of the nature of the problem and of his intentions, the commander flew the aircraft past the tower, where ATC confirmed that the right main landing gear was not extended. The aircraft was asked to delay landing in order to allow other aircraft to land first. During this time the crew reviewed the checklist for a wheels-up landing and subsequently followed that procedure. Following clearance to land from ATC, the aircraft flew a normal approach but, during the flare, both engines were shut down and the propellers feathered. After touchdown on the left main wheel, the pilot held the right wing up for as long as possible; the wing tip eventually contacted the ground and the aircraft swung to the right before coming to rest at the side of the runway. The occupants were uninjured and exited the aircraft without difficulty.

Subsequent investigation of the aircraft

The landing gear on this type of aircraft is operated by a hydraulic system powered by an electric motor. Figure 1 is an illustration of the trailing link main landing gear where vertical movement of the wheel is controlled by an oleo strut/shock absorber. Disassembly of this strut revealed internal corrosion that had inhibited movement of its internal piston. This had had the effect of preventing the strut from fully extending, such that following the previous takeoff, it was probably no more than around three quarters of its maximum length. This in turn would have caused the wheel to trail aft of its normal weight-off-wheels position and it was found that, in this position, the wheel fouled the edge of the wheel-well. Although this had not prevented gear retraction, it had 'hung up' during the subsequent attempts at gear extension.

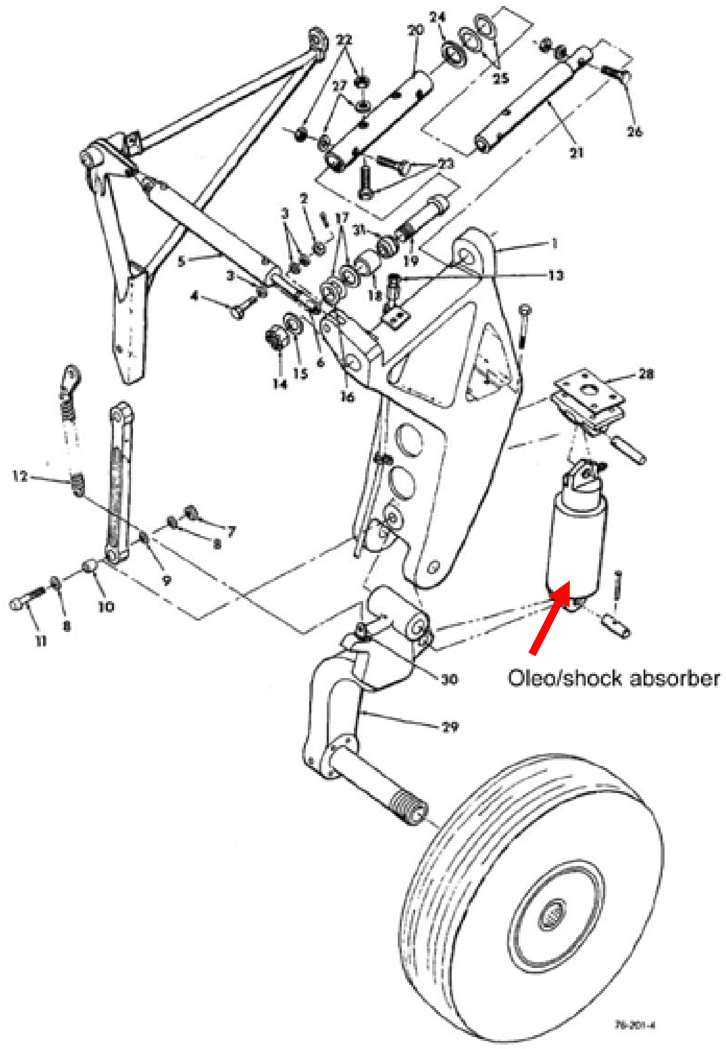


Figure 1

Beech Duchess main landing gear

The oleo is maintained 'on condition', meaning it is not subjected to periodic internal inspections. Following this event, the maintenance organisation commented that they were unaware of any previous occurrences of this type of problem. The company has subsequently instigated a maintenance action at the 150 hour inspection, whereby the range of travel of the oleo struts is checked whilst the aircraft is jacked up.

ACCIDENT

Aircraft Type and Registration:	Cessna U206G Stationair, G-LEMO
No & Type of Engines:	1 Continental Motors Corp IO-520-F piston engine
Year of Manufacture:	1979
Date & Time (UTC):	23 May 2009 at 1500 hrs
Location:	East Winch Airfield, Norfolk
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 3
Injuries:	Crew - None Passengers - None
Nature of Damage:	Nose landing gear collapse and damage to engine cowling
Commander's Licence:	Private Pilot's Licence
Commander's Age:	46 years
Commander's Flying Experience:	189 hours (of which 127 were on type) Last 90 days - 8 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Following an uneventful local flight the aircraft bounced on landing on Runway 09 at East Winch airfield, after which it 'porpoised', leading to the nose landing gear collapsing. The propeller then struck the grass runway surface before the aircraft came to a halt. The pilot and passengers were unhurt and exited the aircraft normally.

The pilot's assessment of the reason for the accident was that he flared too high during the approach, leading to the bounce which he failed to control.

ACCIDENT

Aircraft Type and Registration:	Cessna 172, OO-MDQ
No & Type of Engines:	1 Lycoming O-320-E2D piston engine
Year of Manufacture:	1973
Date & Time (UTC):	14 June 2009 at 1700 hrs
Location:	Chatteris Airfield, Cambridgeshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Propeller bent, nosewheel broken
Commander's Licence:	Private Pilot's Licence
Commander's Age:	31 years
Commander's Flying Experience:	59 hours (of which 14 were on type) Last 90 days - 15 hours Last 28 days - 15 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Whilst landing on Runway 19, the aircraft drifted to the left and its left wheel entered some rough grass to the side of the runway. The pilot applied opposite rudder and brake but the aircraft departed the runway and struck a deep drainage hole, damaging the nose gear and propeller. The weather conditions were good and the reported wind was 170º/5 kt.

ACCIDENT

Aircraft Type and Registration:	Denney Kitfox Mk 3, G-BWYI
No & Type of Engines:	1 ROTAX 912 piston engine
Year of Manufacture:	1997
Date & Time (UTC):	4 August 2007 at 1400 hrs
Location:	Rollington Farm private strip, near Corfe, Dorset
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to airframe, propeller, landing gear
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	71 years
Commander's Flying Experience:	274 hours (of which 140 were on type) Last 90 days - 3 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

As power was applied for takeoff, the aircraft veered to the left. Despite the application of right rudder, the aircraft drifted left until the left wheel ran into the long grass by the side of the airstrip. The aircraft swung further left, tipped forward and came to rest inverted.

History of the flight

This accident took place on 4 August 2007 and was reported to the AAIB on 18 March 2009. The pilot planned to take off from a grass airstrip approximately 400 m long and 18 m wide, orientated south west, with long grass on each side. The flight was the second flight the pilot had undertaken in G-BWYI and its Rotax 912 was a more powerful engine than he was used to. He reported that the weather was "good with a light to moderate south west wind, good visibility and 'few' cumulus cloud at approximately 3,000 ft".

The pilot applied power for the takeoff and stated "the aircraft soon drifted to the left. I applied right rudder, however this was not effective and soon the left wheel started to run through the long grass." The aircraft turned further left and tipped forward, coming to rest inverted. Both occupants were able to exit the aircraft unaided and were unhurt.

AAIB notification

The pilot notified his insurance company of the accident and was told the AAIB would be informed. The fact that this did not happen became apparent when, subsequently, the Light Aircraft Association (LAA) received an application for a Permit to Fly for the repaired aircraft.

Analysis

As with many aircraft engines, the Rotax 912 rotates the propeller clockwise when viewed from the pilot's seat. Such engines at high power produce a yawing moment to the left which must be resisted through the application of right rudder. In this case the engine was more powerful than the pilot was used to and, although rudder was applied in the correct sense, the aircraft continued to veer left. The airstrip was only 18 m wide and so there was little time for further corrective action. Once the left wheel ran into the grass, the extra friction increased the swing to the left and made the aircraft less controllable.

AAIB comment

This type of accident is fairly frequent and characterised by the lack of time available to pilots for corrective action. The swing is caused by the high power of the engine and the yawing tendency would be removed by closing the throttle. Although many pilots consider their actions should the engine fail during takeoff, it seems that fewer pilots consider their actions in the case of loss of control.

Although the AAIB is often informed about a given accident by a number of sources, the responsibility for notification lies with the aircraft commander.

ACCIDENT

Aircraft Type and Registration:	Extra EA 300/L, G-IIEX
No & Type of Engines:	1 Lycoming AEIO-540-L1B5 piston engine
Year of Manufacture:	1995
Date & Time (UTC):	26 May 2008 at 1351 hrs
Location:	Hastingleigh, near Ashford, Kent
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Minor) Passengers - 1 (Serious)
Nature of Damage:	Extensive - aircraft damaged beyond economic repair
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	41 years
Commander's Flying Experience:	1,716 hours (of which 204 hours were on type) Last 90 days - 119 hours Last 28 days - 47 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was en-route from a flying display at Southend Airport, to its home base at Shoreham. Due to inclement weather, with a low cloudbase and poor visibility, the pilot planned to fly around the Kent coast, but having encountered better weather than expected when airborne, he set off across the county. Unfortunately the visibility deteriorated and the cloudbase lowered so he decided to abandon his route and re-trace his path. Instead of reversing his course, however, he turned through approximately 270°, and found he was flying up a valley. He elected to carry out a precautionary landing into a field, but lost control of the aircraft on final approach. The aircraft struck the ground at low speed while rolling and banked to the right. Although the airframe remained relatively intact and no ground fire occurred, both occupants were injured, one seriously. Three Safety Recommendations are made.

Background information

The pilot was to carry out a flying display at the annual Southend Airshow, and positioned his aircraft to Southend the day before the accident. He was a regular display pilot and aerobatic instructor, and a part owner of the accident aircraft. The aircraft was fitted with basic instrumentation and a GPS receiver, but not an artificial horizon (AH) or direction indicator (DI)[1]. The GPS, that

Footnote

[1] It is usual for aerobatic aircraft of this type not to have an AH and DI permanently fitted, as they are likely to sustain damage when the aircraft is manoeuvred aggressively.

appeared to be slow to refresh its position, was not his, and was set to the 'north up' mode and not his preferred 'track up' mode, Additionally, he explained, that for aerobatic flying, the circuit breaker for the stall warning system was routinely 'pulled', to avoid repetitive warnings during manoeuvres, which would otherwise be a nuisance and a distraction.

Before flying the display, he examined weather information on the internet. This suggested that, although the weather at Southend was poor, with a cloudbase of around 600 ft, it was expected to clear from the south as the day progressed. He took off and carried out a 'flat' display then landed to refuel the aircraft to full tanks in preparation for his flight to Shoreham.

The pilot stated that he had booked the aircraft until the following morning and could have left it at Southend for another night. However, he felt some pressure to get himself and his passenger home, and he was also concerned about rain getting into the cockpit if the aircraft was parked outside at Southend. He believed that this pressure and concern influenced his decision to make the flight to Shoreham.

History of the flight

The pilot decided to fly a substantially longer route[2] around the Kent coast, to avoid the high ground of the North Downs as the cloudbase was fairly low. He ascertained that the weather at Shoreham had improved from early low cloud and rain, and he considered it appropriate to fly. He secured his passenger in the front cockpit seat, and then took his normal place in the rear seat.

The pilot took off from Southend, in a visibility 5 km as given by the ATIS, and flew across the Thames Estuary, west along the north shore of the Isle of Grain, and then south. Just before he reached Gillingham, he turned east towards the Isle of Sheppey to a position north of Faversham at 600 ft amsl and contacted Manston Approach, requesting a Radar Advisory Service. The controller informed him that no radar service was available and passed the Manston QNH, which was acknowledged. The pilot then requested the latest Manston weather and was told that according to the most recent observation at 1320 hrs, the wind was 070/23 kt, visibility was 4,500 m in mist, and the cloud was five to seven octas at 600 ft aal.

The pilot saw that the cloudbase to the south of his position seemed higher and conditions looked brighter. He gained the impression that the forecast improvement in the weather had been correct and decided to alter his track to route overland across low-lying ground east of Ashford. He transmitted his intention to Manston Approach and then flew south for five or six miles, at about 1,200 ft amsl. He monitored his progress using the GPS receiver and identifying familiar landmarks on a map. As he continued the cloudbase ahead lowered so he decided to execute a 180° turn, as he was entering cloud, and retrace his route back to the better weather on the north coast of Kent.. He transmiited to Manston Approach that he was "REALLY STRUGGLING" to maintain VMC, and requested a radar position fix. The controller replied that he would arrange for the radar to be manned. The pilot then reported that he intended to make a precautionary landing.

Having made the turn, he did not recognise any of the features as those he had just overflown, and found that he was in a valley with cloud on the hill tops. There appeared no way out of the valley so he transmitted

Footnote

[2] Analysis of the two possible routes showed that the coastal route was approximately 125 nm, compared to the straight-line route from Southend to Shoreham that was approximately 56 nm.

to Manston that he was in difficulties. He told his passenger that he intended to carry out a precautionary landing, selected a large field, and overflew it to ascertain it was suitable for a landing. He recalled flying at 800 ft or 900 ft amsl, with patches of cloud below the aircraft. He remembered deciding to land downwind, but on the upslope in the field, rather than into wind and on the downslope. He recalled manoeuvring for an approach but had no recollection of the landing itself. His next recollection was that of assisting his passenger after the accident.

A passer-by called the emergency services, who responded promptly. A Search and Rescue helicopter flying nearby was directed to the accident site and transferred the injured passenger to hospital.

Meteorological conditions

The Met Office aftercast showed low pressure centred west of the Channel Islands, with:

> *'a slow moving, complex arrangement of fronts over southern England.'*

The aftercast summarised conditions relevant to the accident:

> *'Cloudy, with mist patches across Kent, but also patches of rain/drizzle. It is likely that there would be isolated patches of hill fog in the general area' and stated that 'Due to the patchy nature of the precipitation and mist, only a range of likely visibility can be given. That range would be 1,300 metres to 10 KM underneath cloud, but possibly less than 200 metres if the aircraft was in cloud or in hill fog.'*

Reports from the area indicated that cloud cover over Kent was generally between five and eight octas, base 600 ft to 1,000 ft amsl. The Met Office report commented that:

> *'It is feasible, if not likely, that in isolation over the peaks the cloudbase would be slightly lower than the reports available, and so isolated patches of cloud base 500ft AMSL and covering the highest hills should be considered possible.'*

The report stated that the wind at the accident site was 060/15 kt at the surface, 070/22 kt at 1,000 ft, and 080/27 kt at 2,000 ft.

Meteorological forecasts

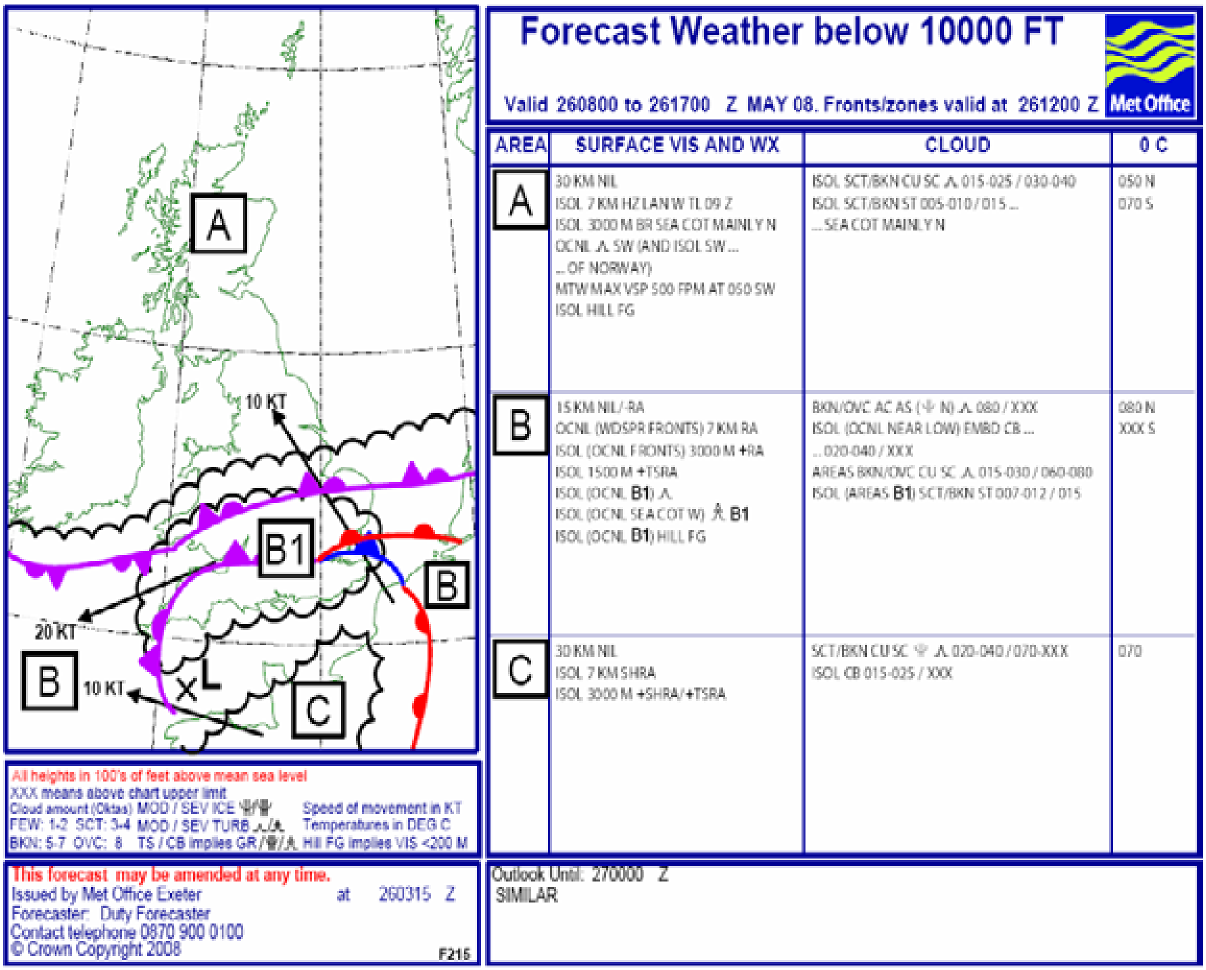
No record of precisely which forecasts and reports the pilot consulted before flight was available. However, a selection of relevant forecasts and reports are reproduced in Figure 1.

Terminal Area Forecasts (TAFs)

Manston

EGMH 260737Z 260716 04020KT 6000 -RA BKN010 TEMPO 0710 05022G33KT 2000 +RA RADZ BKN004 BECMG 1013 9999 NSW SCT015

EGMH 260906Z 261018 04020KT 6000 -RA BKN010 TEMPO 1019 05022G33KT 2000 RADZ BR BKN004 PROB30 TEMPO 1218 9999 NSW SCT012



AREA	SURFACE VIS AND WX	CLOUD	0 C
A	30 KM NIL ISOL 7 KM HZ LAN W TL 09 Z ISOL 3000 M BR SEA COT MAINLY N OCNL SW (AND ISOL SW ... ... OF NORWAY) MTW MAX VSP 500 FPM AT 050 SW ISOL HILL FG	ISOL SCT/BKN CU SC 015-025 / 030-040 ISOL SCT/BKN ST 005-010 / 015 ... ... SEA COT MAINLY N	050 N 070 S
B	15 KM NIL/ -RA OCNL (WDSPR FRONTS) 7 KM RA ISOL (OCNL FRONTS) 3000 M +RA ISOL 1500 M +TSRA ISOL (OCNL B1) ISOL (OCNL SEA COT W) B1 ISOL (OCNL B1) HILL FG	BKN/OVC AC AS (N) 080 / XXX ISOL (OCNL NEAR LOW) EMBD CB ... ... 020-040 / XXX AREAS BKN/OVC CU SC 015-030 / 060-080 ISOL (AREAS B1) SCT/BKN ST 007-012 / 015	080 N XXX S
C	30 KM NIL ISOL 7 KM SHRA ISOL 3000 M +SHRA/+TSRA	SCT/BKN CU SC 020-040 / 070-XXX ISOL CB 015-025 / XXX	070

Figure 1

UK Forecast Weather, Form F215

Lydd

(The TAF for the period beginning at 1000 hrs was the earliest produced.)

EGMD 260906Z 261019 07030G40KT 8000 -RA BKN008 TEMPO 1013 3000 RA BR BKN004 BECMG 1114 9999 NSW BKN020 TEMPO 1519 8000 SHRA BKN014=

EGMD 261200Z 261319 07025KT 8000 -RA BKN008 TEMPO 1315 3000 BR BKN004 BECMG 1316 9999 NSW BKN020 TEMPO 1519 8000 SHRA BKN014=

Shoreham

(The TAF for the period beginning at 1000 hrs was the earliest produced.)

EGKA 260906Z 261019 04025G35KT 7000 -RA BKN012 PROB30 TEMPO 1014 3000 RA BR BKN008 BECMG 1114 06015KT 9999 NSW BKN020 TEMPO 1519 8000 SHRA BKN014=

Meterological Actual Reports (METARS)

Southend

EGMC 261320Z 06014G25KT 4500 BR SCT006 BKN008 12/11 Q1010=

Manston

EGMH 261350Z 07021KT 4500 BR BKN006 13/12 Q1009=
EGMH 261320Z 06023KT 4500 BR BKN006 14/13 Q1009=

Recorded information

No radar data was available for the accident flight; however, the pilot was using a Garmin GPS Pilot III that recorded position and time, but no height information. Processing of this data allowed the average ground speed between recorded points to be calculated, ie, based on the horizontal straight-line distance between successive points. The accident track is illustrated in Figure 2.

The first recorded point from the accident track was at 13:15:56, as the aircraft departed from Southend Airport. At 13:48:27, about six nm east of Ashford, the aircraft turned through 270°, to the left, before heading towards Ashford. The last recorded point was at 13:49:59, just prior to ground impact.

Figure 3 illustrates the last minute of the aircraft's track, together with the position of the initial ground-impact mark and main wreckage. The last two points recorded on the GPS unit were three seconds apart, suggesting an average ground speed of 69 kt between these points, and the last GPS point, initial ground-impact mark and main wreckage lie on a line with a track of 208°.

Figure 3 also shows the direction and strength of the wind taken from the Met Office aftercast, which illustrates a large tailwind component of the wind along the track from the last GPS point to the wreckage. The effect of such a tailwind with a groundspeed of 69 kt results in an airspeed of 56 kt.

Recordings of RTF communications between the pilot and ATC were also obtained.

Air display operations

In the UK, flying displays take place regularly throughout the year at a variety of locations both on and off airports. Aircraft participating in displays may be:

- Military
- Private - operated by enthusiasts who absorb the costs of their flying
- Commercial - operated by organisations or individuals aiming to make a profit, or seeking to recoup some of their costs

The pilot operated the aircraft on the flying display 'circuit' and was paid fees for his displays. He explained that, although the fees did not form the foundation of a profitable business, they were an important contribution to the costs of operating and displaying the aircraft. He enjoyed his display flying activities and said that he would not be able to fly so often without the income.

Many aircraft participating in displays are either historic or aerobatic. In either case, they are often not equipped, or flown by pilots qualified, to operate under IFR. Displays may be flown some distance from the operator or aircraft's base so lengthy transit flights are often associated with display flying. It was reported

Figure 2

Garmin GPS Pilot III final logged track for G-IIEX

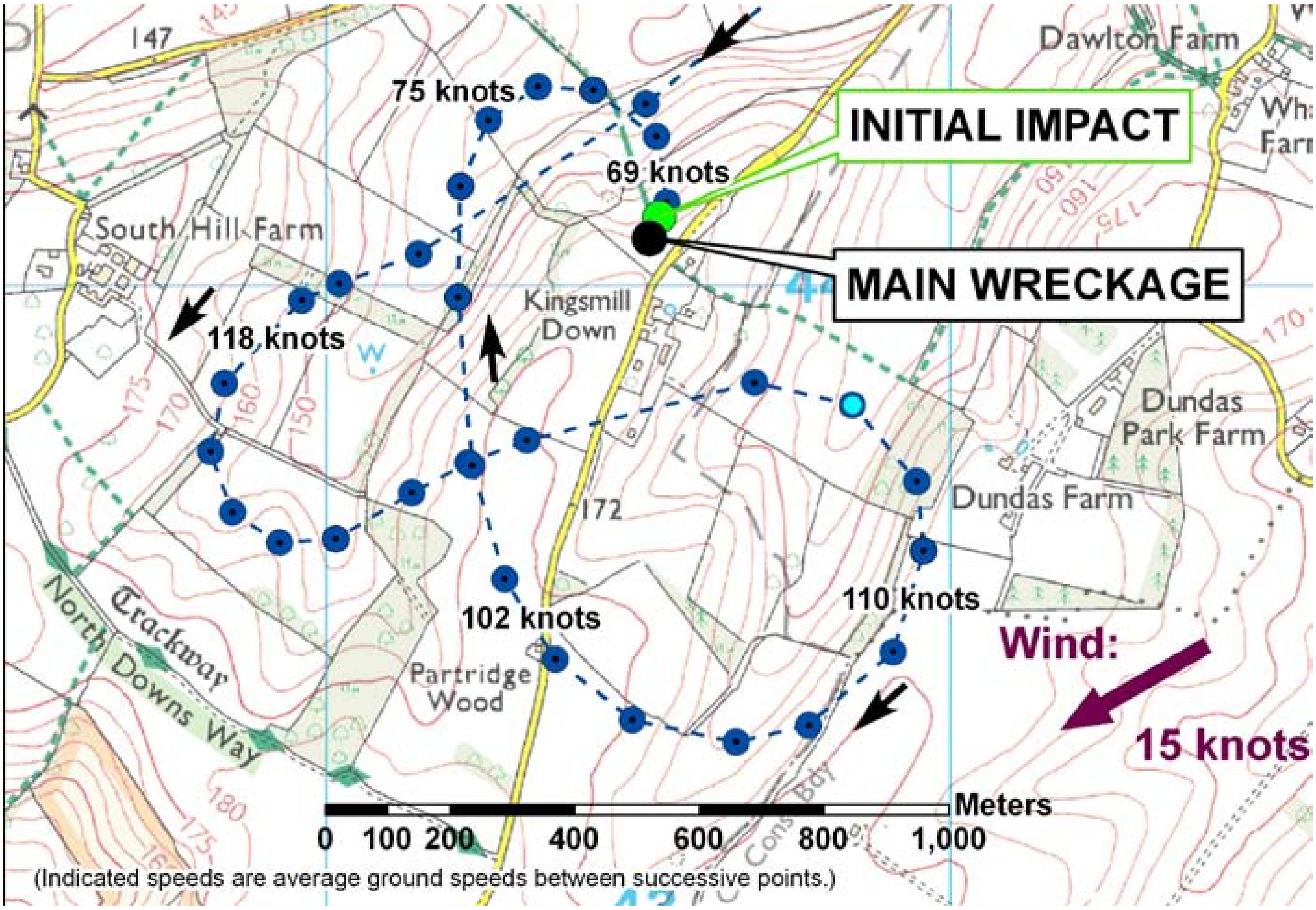


Figure 3

G-IIEX precautionary landing track

by various display pilots that, because display flying involves operations at low level, they perceived a habit amongst their peers to continue with transit flights under VFR in unsuitable conditions, and in particular, in poor visibility and low cloudbases.

Aircraft description

The Extra 300/L is a single-engine low-winged monoplane, designed to be fully aerobatic, Figure 4. It is qualified for manoeuvre load factors of ±10g. The aircraft is powered by a 300 shp piston engine driving a four-bladed constant-speed wooden propeller. The fuselage is constructed of a tubular steel frame covered with aluminium and fabric fairings; the wings are of carbon-fibre reinforced plastic (CRP). The ailerons are almost full span and there are no flaps. The aircraft is of tailwheel configuration with fixed landing gear. The wing section creates a 'conventional' turbulent flow. At maximum all-up weight, at 1g, the aircraft stalls at 55 kt.

The aircraft has two cockpits, in tandem, covered with a one-piece canopy. Each seat is constructed of a single-piece CRP moulding covered with a few millimetres of soft plastic foam overlaid with a thin leather lining. In the case of G-IIEX, both occupants were wearing parachutes; these provided a degree of occupant/seat padding but, with the parachutes

Figure 4

Configuration of G-IIEX

compressed under the occupant's weight, this would not be regarded as substantial. The rear cockpit seat is upright; the front cockpit seat is reclined by approximately 20°. In both cockpits, the underside of the seat pan is separated from the structure and various systems by several inches. A seven-point Sutton harness (aerobatic-type, with broad-straps) is fitted at each seat position. The fuselage framework intrudes into the cockpits in the form of a diagonal horizontal steel bracing tube in the upper part of each cockpit forward corner, angled inwards from aft to forward and spanning between the cockpit coaming and the instrument panel area, Figures 5 and 6. These tubes are sheathed in thin leather.

The front cockpit has aircraft flight and system controls and basic flight instruments, ie, an airspeed indicator, an altimeter and an inverted slipball. The rear cockpit has similar controls, system indicators and standard flight instruments, including a turn and slip gauge. A gyroscopic AI and DI can be fitted in the centre of the rear cockpit instrument panel, but neither was installed on G-IIEX. A GPS moving-map unit, powered from the aircraft electrical system, was fitted to the top of G-IIEX's rear cockpit instrument panel.

The initial model in the aircraft series, the Extra 300, was certificated by the German LBA in 1990, and by the FAA in the US in 1993. The Extra 300/L was certificated by the FAA in 1995.

G-IIEX was first registered in the UK in 2005. At the time of the accident the aircraft had accumulated around 920 flight hours from new and the engine around 135 hours.

Figure 5

G-IIEX front copckpit

Figure 6

G-IIEX rear cockpit

Accident site

The aircraft crashed 50 m from a country lane in a field of long grass in rolling hills, 5.2 nm east-north-east of the town of Ashford, Kent, at an elevation of 525 ft amsl. At the point of impact, the ground sloped 4° up and 9° down to the right relative to the flight path. The field boundary, in the direction of aircraft travel, was some 75m beyond the initial impact point, in the form of a low wire fence. Beyond the fence was a second field, virtually level, though with a slight upslope from east to west. It had a smooth flat surface covered with short grass that was unobstructed for its first 825 m, over a width of around 100 m.

Surface marks and the examination of the wreckage showed that G-IIEX had initially made ground contact with its right wingtip, with the aircraft banked an estimated 30° to the right, and whilst rolling to the right, causing the outboard one third of the right wing to detach. The right main landing gear struck the ground 4 m further on, almost immediately followed by the propeller blades, the left main landing gear, the undersurface of the forward fuselage and the left wing. The aircraft then slid and bounced across the field, coming to rest 34 m from the initial ground contact point.

The evidence indicated that, at the time of ground impact, the aircraft had been tracking approximately 214ºM, with a descent path in the order of 10º-15º to the horizontal; groundspeed was estimated at 60-70 kt. The fact that the wooden propeller blades had shattered, and their associated ground marks, showed that the engine had been turning at substantial speed at impact.

Aircraft examination

The aircraft had remained generally intact, although the canopy transparency had shattered. The canopy frame, together with the outer part of the right wing and the main landing gear, had detached, the engine mounts had fractured and the propeller blades were fragmented. The engine was not displaced substantially relative to the fuselage and the GPS unit had broken free from its mounts. The fuselage framework sustained some damage to its lower portion, but was not appreciably deformed, and there was no significant incursion of the fuselage structure into the cockpits. Both the fuel system and the electrical system escaped significant damage. There was no fire.

Detailed examination of the aircraft revealed no sign of pre-impact failure of the structure, powerplant or control systems. Two 2A circuit breakers in the rear cockpit for the turn and slip indicator and for the stall warning system, were found tripped, ie, their respective systems were isolated from the electrical power supply. Eleven other circuit breakers, mounted close by on the panel, were found with the expected settings and it appeared likely that the settings of all the breakers corresponded to their pre-impact settings.

The harnesses in both cockpits remained attached to the aircraft and with all buckles intact. In the rear cockpit, the seat pan had partially fractured near its right side, reducing the vertical stiffness of the pan. The seat attachments remained intact. The pilot's helmet exhibited a number of areas of substantial impact damage and the visor had fractured in two. Red smears on the front left of the helmet corresponded with the colouring of the canopy release handle, which had broken off. Cuts in the leather sheath on the diagonal bracing tube at the left forward corner of the cockpit were consistent with the effects of a strike by the helmet and visor. Impact markings on the left rear of the helmet indicated that it had forcibly contacted a vertical steel tubular A-framework located just behind the normal head position.

The front seat and its attachments were undamaged. Although no evidence was found that the passenger had struck any part of the structure or equipment in the front cockpit, there were numerous hard points adjacent to both sides of the seat in the form of the exposed fuselage framework and various controls. It also appeared possible that, even with the occupant restrained by the harness, violent longitudinal, vertical and/or lateral aircraft deceleration could cause head contact with the diagonal bracing tubes at the forward corners of the cockpit, and/or with the cockpit coaming.

Survivability issues

Advice was obtained from a biomedical specialist from the Royal Air Force (RAF) Centre for Aviation Medicine (CAM) at RAF Henlow, who examined the aircraft after its removal from the site and who provided a report on occupant crash injury aspects.

The pilot in the rear cockpit was wearing a HISL Alpha helmet; the passenger in the front cockpit was not wearing a helmet.

G-IIEX's pilot sustained a fractured left wrist and a cut to the forehead. The specialist concluded that the pilot had initially flailed forwards and to the left, causing the helmet strike on the canopy release handle and the left bracing tube. He then flailed backwards, causing the helmet strike on the A-frame. The specialist noted that the helmet was designed to conform to British Standard BS6658 (with reservations), which is similar to that worn by UK military fast-jet aircrew and affords the same protection standard. He judged that, while the impacts may have caused the pilot to lose consciousness, the helmet had prevented significant head injury. He noted that the seat pan fracture had acted to attenuate the vertical loads on the pilot.

The passenger was described as much smaller in stature and lighter than the pilot. She suffered fractures to her ribs, the left shoulder blade, skull and a vertebra. The CAM specialist observed that she had escaped head contact with the front left side of the cockpit possibly because, being smaller, it was outside her head's forward flail envelope. He assessed that her chest and shoulder injuries probably resulted from impact with the left side of the cockpit. Rearward flailing probably caused her head to strike the hard, rigid, plastic rear coaming of the cockpit, resulting in skull fracture. Impact with the detached GPS unit may have contributed to this fracture. The specialist judged it likely that the skull fracture would have been less serious, or even prevented, had the passenger been wearing a helmet.

The CAM specialist concluded that the passenger's spinal injury had resulted from the transfer of impact loads into her back from the seat. The rigid mounting of the seat, and the absence of appreciable padding between the seat and the occupant, would have provided little load attenuation. He also noted that, consequent on her relatively light build, attenuation had not been provided by fracturing of the seat.

The CAM report concluded that:

> *'if similar injuries are to be prevented in similar circumstances in future accidents, it should be recommended that protective helmets should be worn by both the front and rear seat occupants*

> *and consideration be given to fitting energy attenuating foam cushions to the front and rear cockpit seats.'*

Additional information

Published research shows that substantial attenuation of shock loads transmitted to a seat occupant's spine can be achieved by use of an energy-absorbing foam cushion. The information included reports of testing carried out in 1986 by the RAF Institute of Aviation Medicine and, in 1995, by the Defence Research Agency, Farnborough, in relation to seating in gliders. The results suggested that flexible domestic foam cushions generally provide little attenuation of spinal loads and, in some cases, may increase them. However, a one to two inch thick cushion of highly damped seating foam, which remains rigid under normal loading but crushes under impact shock loading, has been shown to reduce substantially the spinal loads induced by vertical deceleration in a crash situation. Trials of such foam showed that it did not appear to suffer significant deterioration in performance due to normal service use.

Published information also suggests that occupant head injury in potentially survivable aircraft crash situations is common, caused by the occupant striking parts of the aircraft, and is likely to have a major influence on survivability. This type of injury can be substantially reduced by use of inflatable occupant restraint systems. Such systems, designed particularly to protect the head and torso, have been available for aircraft for some years. A system used in civil aircraft is generally similar to the air bags typically used for road vehicles, but with the bag stowed in the lap-strap portion of the seat belt and deploying forwards in a crash situation. When deployed, the bag helps to pre-tension the restraint, which aligns the spine better to withstand vertical loads. The units have been certificated and employed in both public transport and General Aviation (GA) aircraft, at crew and/or passenger seat positions, both from new and as retrofit equipment. A leading manufacturer of the system has reported that deliveries for GA aircraft began in mid-2005 and that, by mid-2008, around 13,000 units were in service in GA aircraft. The manufacturer claimed that, in 2008, over 80% of new single-engine GA aircraft had front seats equipped with the airbag. No inadvertent deployments have been reportedly experienced to date.

Effect of 'wet wings'

The pilot commented that the aircraft's stall characteristics, in terms of stall speeds under specific loading and the characteristics of the onset of the stall, may have been influenced by the fact that the aircraft flew through rain and drizzle, and that the wings were wet. Information relating to this phenomenon is available. One relevant research paper was identified, *'Potential Influences of Heavy rain on General Aviation Airplane Performance,'* produced by NASA's Langley research Centre in 1986[3], and contained some relevant information. The report stated that aerofoils subjected to rain may behave differently depending on whether they have laminar flow or turbulent flow. The paper identified that the performance of laminar flow aerofoils is degraded when they are subjected to rain, and went on to say:

> *'Airfoils which are normally operated with a turbulent boundary layer have also been tested in simulated rain spray. However, these tests were conducted with small scale models and the*

Footnote

[3] AIAA-86-2606 *'Potential Influences of Heavy rain on General Aviation Airplane Performance'* by RE Dunham Jr.

scaling laws are not known for extrapolating the results to full scale. The results so far tend to indicate that heavy rain causes a performance loss for these airfoils.'

In response to this subject, the manufacturer has stated:

'…….it is known that an airfoil will have performance decrements when it is exposed to heavy rain environment or icing conditions.

Considerable loss in performance is expected only for the laminar airfoil sections. For a conventional turbulent airfoil in a high lift configuration, the rain influence occurred mostly at the higher angles of attack (reduced lift and increased drag). The performance penalty for a turbulent airfoil is normally the consequence of premature separation.

Anyhow, with regard to the EA 300/L we did not find any abnormal behavior or handling characteristics while flying in rain.'

Analysis

Operational aspects

Display flying

Weather in the UK is a recurring factor in aircraft accidents, often involving pilots 'pressing on' in inclement or worsening weather. The variable nature of the British weather, even in summertime, and the regular need for transit flying by 'VFR only' aircraft and/or pilots involved in display flying, has, therefore, the potential to bring together a combination of factors which may increase the risk of such accidents occurring. The fact that some display aircraft are operated in a commercial or quasi-commercial manner may introduce the additional factor that pilots may feel 'obliged' to position the aircraft in accordance with a timetable in order not to miss any planned display. The pilot stated that he had booked the aircraft until the following morning, and could have left it at Southend for another night. However, he felt some personal pressures to get himself and his passenger home, and he was also concerned about rain getting into the aircraft's cockpit if it was parked outside at Southend. He believed that this pressure and concern influenced his decision to fly.

The pilot considered that the routine 'pulling' of the stall warning circuit breaker prevented repetitive warnings during display flying, and that this avoided the possibility of a pilot becoming conditioned to accepting the warning as normal.

Safety action

The CAA has taken 'Pressing on' as a theme for safety discussion throughout 2009, and will publish an editorial in *'Display Flying News'* on this topic, as well as promoting awareness of the potential problem during safety evenings attended by general aviation pilots. They have asked the pilot to give a presentation at a display pilots' seminar, explaining some of the factors which contributed to the accident.

Forecasting

It is clear that the weather conditions in the south-east of England on the day of the accident were changeable and inclement. The Met Office Form F215, showed an occluding frontal system lying along the Thames Estuary, and described the associated weather in detail. It showed fronts valid at 1200 hrs and gave an indication that they would pass over the Southend area at about 1200 hrs.

The weather at Southend at the time G-IIEX departed was poor; a strong and gusty surface wind, a visibility of around 5 km - 4,500 m, scattered cloud at 600 ft aal and broken cloud at 800 ft aal, are challenging conditions for VFR flight. The forecasts for aerodromes along the pilot's planned route painted a complex picture. The 0700 hrs to 1600 hrs forecast for Manston predicted that by 1300 hrs, rain and drizzle would have ceased, the visibility would be 10 km or more and cloud would be scattered at 1,500 ft aal The later, 1000 hrs to 1900 hrs forecast, however, indicated very different weather, predicting that at 1300 hrs the visibility would be 6 km in slight rain and, temporarily, 2,000 m in rain, drizzle and mist, the cloudbase would be broken at 1,000 ft aal and temporarily broken at 400 ft aal. There was a 30% probability that temporarily, after 1200 hrs, the visibility would be 10 km or more, rain and drizzle would cease and the cloud would be scattered at 1,200 ft aal. The worst of these conditions would almost certainly preclude legitimate VFR flight, although the conditions predicted with 30% probability would be acceptable. It was not possible to determine which forecasts the pilot examined.

The 1000 hrs to 1900 hrs forecast for Lydd (the first available) indicated that by 1400 hrs, the visibility would be 10 km or more, rain would have ceased, and the cloudbase would be broken at 2,000 ft AAL. These conditions would again be appropriate for VFR flight. The later 1300 hrs to 1900 hrs forecast predicted that conditions would be markedly worse.

Thus, it seems very possible that the pilot did not obtain forecasts later than the 0700 hrs to 1600 hrs set and was, therefore, not aware of the worse conditions predicted in the later forecasts. This influenced his plan to fly across the Thames Estuary and around the Kent coast, which he could have done at low level without concern for terrain, and in compliance with the regulations relating to low flying. Had he seen the later forecasts, he may have realised that the previously forecast improvement in weather was not now expected.

The planned flight

The pilot described his plan to fly across the Thames Estuary and then around the coast of Kent. His GPS recorded track was across the Estuary, west along the north shore of the Isle of Grain and then east towards the Isle of Sheppey. His original plan was to remain clear of terrain by following the coast and this plan was followed initially.

Progress of the flight

Having reached Faversham, the pilot changed his mind and decided to route to the south across the county, albeit aiming to overfly the low-lying land east of Ashford. Although this meant initially overflying the North Downs, his impression was that he was flying into the widespread improvement in weather, forecast earlier in the day. However, it transpired that he was entering a less widespread area of benign weather, with poorer surrounding conditions. He was probably influenced in making this decision by his familiarity with the area across which he flew.

Having realised that the weather was now not suitable to continue the flight to the south, the pilot decided to turn back towards the better weather. However, instead of turning through 180°, he turned through 270° and found himself flying up a valley with weather closing in above and around him. The imprecision of this turn was probably a consequence, in part, of the poor weather conditions in which it was executed, and partly because of a lack of basic flight instrumentation and the 'slow updating' of the GPS receiver.

Examination of the field chosen for the landing, adjacent to that in which the aircraft crashed, showed it to be suitable. However, the pilot assessed the combination of slope in the field and the wind and decided on a downwind, upslope landing, and it was as he made his curving final approach that he lost control of the aircraft.

Loss of control

Evidence from the GPS receiver showed that the aircraft was manoeuvred over the chosen landing site until, on the curving final approach to land, control was lost. The downwind aspect of the approach, together with evidence gathered during the on-site examination of the aircraft, lead to the conclusion that the aircraft stalled on the approach with insufficient height in which to recover.

When approaching to land, an aircraft's speed must be carefully controlled, particularly when manoeuvring in the turn on to final approach. In assessing speed at low level, pilots use a number of cues: primarily the airspeed indicator, but also the power setting and attitude, the feel of the controls and the impression of speed, sensed in the peripheral vision, by the rate at which the ground texture passes by. This last cue has been identified as being particularly powerful and difficult to ignore, and is known to have been a factor in the context of downwind landing accidents. It is possible that this impression of increasing ground speed as the aircraft turned downwind influenced the pilot inadvertently to allow the airspeed to reduce until the aircraft stalled, at which point there was insufficient height in which to recover control. In addition, the curving approach itself was probably a contributory factor, as the stall speed would have risen in proportion to the increased load factor (g) in the turn.

Had the stall warning device been operable, it might have warned the pilot of the impending stall in sufficient time for him to take action. However, the pilot stated that the device was routinely disabled to avoid nuisance activation, and it is probable that the circuit breaker had not been re-instated before the accident flight.

A further contributory factor may have been the fact that the wings were wet from the rain. Although research showed that models of turbulent-flow wings did exhibit a *'performance loss'*, the lack of appropriate scaling laws prevented the extrapolation of this finding to full-scale wings. Nonetheless, it is probable that 'turbulent flow' wet wings do exhibit different characteristics close to the aerodynamic stall and generally become less efficient, than dry wings, with a measure of increased drag for a given lift and a higher stall speed. However, this effect could not be quantified in the context of this accident.

Engineering analysis

Analysis of the ground marks and wreckage showed that the aircraft had struck the ground while in a moderate rate descent, at relatively low groundspeed, in an appreciable bank to the right, and whilst rolling right. No signs of pre-impact anomalies with the aircraft were found, except that circuit breakers had probably been set to de-activate the stall warning system and the turn and slip indicator.

Although G-IIEX came to rest relatively intact and no ground fire occurred, both occupants were injured, the passenger seriously. The accident site features indicated that initial ground contact would have been followed by a rapid yaw to the right and an appreciable nose down pitch, with substantial vertical and horizontal decelerations imposed during the main ground impact. The nose down pitch probably generated somewhat higher vertical deceleration loads in the front cockpit than in the rear as the nose struck the ground.

The deceleration loads on the pilot in the rear cockpit, with his significantly higher body mass than the passenger, partially fractured the seat pan, thereby rendering the seat more flexible. This would have attenuated the vertical loading he experienced. The visor on the pilot's helmet probably fractured due to impact with the canopy release handle and/or the bracing tube at the left forward corner of the cockpit, and may have then caused the cut on his forehead. It was probable, given the significant impact damage to the pilot's helmet, that the helmet saved him from receiving a substantial head injury.

The passenger in the front cockpit suffered serious injury. The aerobatic-type harness fitted would, if tight, be expected to provide good occupant restraint. Analysis of her injuries showed that the damage to her back resulted from high deceleration loads applied by the seat. Additional ground impact loads, generated by the nose down pitch, had probably been a factor, in combination with her comparatively light body mass and the relatively high stiffness both of the seat and of the fuselage structure of the aircraft, which is qualified for high manoeuvre load factors. Also, whereas virtually all of the longitudinal deceleration loads on the occupant of an upright seat would be reacted by the harness, the appreciable angular recline of G-IIEX's front seat meant that longitudinal deceleration would generate a significant axial load component into the passenger's back from the seat pan. The minimal seat padding present would have provided relatively little attenuation of these loads.

Additionally, it appeared that in a crash situation, the harness, although robust, would not necessarily prevent passenger contact with hard points in the cockpit, particularly torso and/or head contact. In this regard, the absence of significant padding on the bracing tubes intruding into the forward corners of the cockpit appeared to represent a particular potential danger. The pilot's helmet had prevented serious head injury from this cause; the passenger had probably escaped head contact with the tubes only by virtue of her relatively small stature.

Safety Recommendations

It was considered anomalous that substantial occupant injury should result from a ground impact of moderate severity, when the fuselage remained intact, with virtually no compromise of the cockpit volumes, and where substantial harnesses were being worn and which remained fastened and attached. While there was no post-crash fire, displacement of the engine after its mounts failed created the potential for fuel release and ignition sources. The occupants' injuries may have rendered both unconscious and, in any event, were likely to have hindered or prevented their evacuation without assistance.

It appeared that the severity of the passenger's injuries and the potential severe impact injuries to the pilot's head, had he not been wearing a helmet, could have been substantially reduced by more effective padding in a number of areas. Calculations show that increasing the displacement over which an impact acts by a relatively small amount, results in a major reduction of the peak deceleration loads experienced. Energy-absorbing plastic foams, that remain rigid under normal loading but progressively crush when subjected to crash impact loads, have been available for some years. The addition of a cushion of such foam between the occupant and the seat pan, and of padding material to areas of the cockpit that might be contacted by the occupants in a survivable crash, would be likely to reduce occupant injury substantially. It appears that sufficient space is available in the Extra 300/L for the installation of such measures, and it is likely that the cost, weight and maintenance penalties would be relatively small.

The following Safety Recommendation is therefore made:

Safety Recommendation 2009-013

It is recommended that aircraft manufacturer, Extra-Flugzeugbau GmbH, develop modifications for the Extra 300/L, and other models of similar configuration, to substantially improve the cockpit environments by the addition, for example, of energy absorption provisions for seats and relevant areas of the cockpit, with the aim of reducing the likelihood and severity of occupant injury during an accident.

It was also considered anomalous that this and other aircraft should have been certificated without a requirement for better provisions for protecting the occupants from injury in a crash. Passive means of impact load attenuation using energy-absorbing foams and other padding have been available for some time. Active systems, such as air bags, have been fitted as basic equipment to most road vehicles for many years, apparently with considerable success in improving crash survivability, without major added cost and without excessive inadvertent deployment problems. Air bags have also been available for aircraft fitment for some time. With substantial numbers in service, they have not reportedly suffered inadvertent deployments. While such systems are now widely fitted to new GA aircraft, this is not standard. The following Safety Recommendations are therefore made:

Safety Recommendation 2009-014

It is recommended that the European Aviation Safety Agency revise their certification requirements applicable to light aircraft crash survivability, with the aim of reducing occupant injury in otherwise survivable accidents. Detailed consideration should be given, for example, to requiring energy absorption provisions for seats, improved padding of aircraft components that might be impacted by an occupant and the fitment of air bag systems for both crew and passengers.

Safety Recommendation 2009-015

It is recommended that the European Aviation Safety Agency consider requiring the modification of light aircraft types for which they have airworthiness responsibility, where the extant restraint systems are unlikely to prevent contact of the occupants with hard parts of the aircraft, with the aim of reducing the likelihood and severity of occupant injury in an otherwise survivable accident. Detailed consideration should be given, for example, to requiring energy absorption provisions for seats, improved padding of aircraft components that might be impacted by an occupant, and the fitment of air bag systems for both crew and passengers.

ACCIDENT

Aircraft Type and Registration:	Gulfstream AA-5A Cheetah, G-RATE
No & Type of Engines:	1 Lycoming O-320-E2G piston engine
Year of Manufacture:	1978
Date & Time (UTC):	17 May 2009 at 1345 hrs
Location:	Disused airfield at Oakley, Oxfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to right wing and propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	30 years
Commander's Flying Experience:	140 hours (of which 40 were on type) Last 90 days - 19 hours Last 28 days - 8 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During a cross-country flight, the engine started to run roughly and would not produce full power. The pilot elected to land at a disused airfield but, after a normal touchdown, saw a fence across the runway which she was unable to avoid. The weather conditions were conducive to carburettor icing and the pilot assessed this as the most likely cause of the power reduction and rough running.

History of the flight

During a cross-country flight from Cranfield to Enstone, the pilot diverted 15° left of track to avoid a band of weather (rain) en-route, with the intention of regaining her original route by turning right through 30° after 10 minutes to intercept the original track. As she initiated this turn, the engine started to run roughly. After completing the emergency checklist, full power had not been restored and with the engine continuing to run roughly she elected to land on one of the disused runways at Oakley Airfield, which was below the aircraft at that stage.

During the landing roll, after a successful touchdown on the into-wind runway, the pilot noticed a line of steel-cable fencing, supported by posts, across the runway. She was able to turn the aircraft left, off the hard surface and onto the grass, using wheel brakes but was unable to prevent it subsequently striking the fence at a shallow angle, resulting in a puncture of the right wing fuel tank.

The pilot reported that the forecast and actual temperatures/dewpoints as +9ºC/+2ºC and +10°C/+2°C respectively, and assessed the cause of the power reduction and rough running as carburettor icing. Standard icing charts show that these conditions straddle the boundary between predicted 'serious icing at glide power' and 'serious icing at cruise power'.

ACCIDENT

Aircraft Type and Registration:	Helio H-295 Super Courier, G-BGIX
No & Type of Engines:	1 Lycoming GO-480-G1A6 piston engine
Year of Manufacture:	1974
Date & Time (UTC):	12 May 2009 at 1100 hrs
Location:	North Weald Airfield, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Left wing tip, left main landing gear wheel, left stabilator
Commander's Licence:	Private Pilot's Licence
Commander's Age:	75 years
Commander's Flying Experience:	515 hours (of which 245 were on type) Last 90 days - 2 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft landed on Runway 02 at North Weald aerodrome with a strong, gusting wind from the right. Shortly after touchdown, the right wing lifted and the left wing tip contacted the runway surface. It is probable that a sudden gust exceeded the crosswind limit for the aircraft.

History of the flight

The aircraft was being flown from Fanners Farm, a private airstrip some 5 nm north of Chelmsford, to North Weald aerodrome for its Certificate of Airworthiness (C of A) renewal inspection. Weather for the flight was fine, with visibility greater than 10 km and no cloud. However, there was a strong, gusting north to north-easterly wind which was forecast to be 020°/20 kt on arrival at North Weald.

The Helio H-295 Super Courier is a high wing, single engine, tailwheel aircraft, with seating for up to six occupants, which was produced for the United States Air Force. It was specifically designed as a robust Short Take Off and Landing (STOL) aircraft, capable of using unprepared strips. The aircraft is fitted with electrically powered wing flaps which may be selected to any angle up to 40°. The leading edge slats are in four sections, two on each wing, and extend across the full width of the wing. Each slat section is independent of the others and deploys automatically, depending on the airflow over the wing. They normally extend at approximately 50 to 60 mph. The maximum crosswind component for landing is 10 kt.

After departure from Fanners Farm, the aircraft climbed to 1,000 ft for the 20 minute transit to North Weald. Flying conditions were turbulent and the aircraft joined the left hand circuit for Runway 02 at North Weald. The flaps were lowered incrementally in the circuit, with the fully down position being selected on the final approach. The pilot normally only used 30° of flap for landing but, due to the strong, gusting wind, he elected to use 40°. The airspeed was reduced to some 60 to 65 mph on the approach, with the pilot describing the turbulence as severe and the worst he had encountered. ATC reported the surface wind as 060°/17-28 kt, which the pilot acknowledged, and, as the approach progressed, he found that he had to point the aircraft more into wind to maintain the final approach track.

Just before the aircraft touched down, the pilot attempted to reduce the drift and the aircraft landed on the left main wheel. Almost immediately he sensed that the aircraft had been caught by a gust of wind from the right. Despite applying full into-wind aileron to counteract the roll to the left, the right wing lifted and the left wing tip contacted the metalled surface of the runway. The pilot estimated that the surface wind at the point that the right wing lifted may have been more in the region of 070°/25 kt, due to a gust.

The aircraft slowed down, settling onto all three landing gear and was taxied to the maintenance organisation. Inspection of the damage revealed that the left main landing gear wheel rim was cracked and the tips of the left wing and left stabilator had abrasions.

Analysis

The pilot considered that the aircraft had encountered a strong gust at touchdown which probably exceeded the aircraft's crosswind limit. He explained that the light wing loading needed to give the aircraft its STOL performance meant that a crosswind gust of the magnitude experienced, at low air speed, resulted in the ailerons being unable to prevent the right wing lifting.

ACCIDENT

Aircraft Type and Registration:	Piper PA-25-235 Pawnee, G-BFPR
No & Type of Engines:	1 Lycoming O-540-G1A5 piston engine
Year of Manufacture:	1978
Date & Time (UTC):	31 January 2009 at 1215 hrs
Location:	Bicester Airfield, Bicester, Oxfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to landing gear
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	63 years
Commander's Flying Experience:	1,106 hours (of which 225 were on type) Last 90 days - 12 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The pilot reported that, during the approach to the grass Runway 13, he experienced an unusual increase in his rate of descent which resulted in a heavier than normal landing. During the ground roll he noticed that the right wing was lower than the left. This was caused by a bungee failure of the right main landing gear leg. The wind at the time of the accident was from 110° at 15 kt.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-181 Cherokee Archer II, G-TSGJ
No & Type of Engines:	1 Lycoming O-360-A4M piston engine
Year of Manufacture:	1980
Date & Time (UTC):	21 March 2009 at 1420 hrs
Location:	Bourne Park, near Andover, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 3
Injuries:	Crew - None Passengers - None
Nature of Damage:	Propeller strike, engine shock-loaded and nosewheel damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	68 years
Commander's Flying Experience:	360 hours (of which 260 were on type) Last 90 days - 4 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

While landing on Runway 29 at Bourne Park, near Andover, the aircraft appears to have clipped a fence and landed in the undershoot, which was deeply rutted. The aircraft bounced and was substantially damaged on the subsequent landing.

Additional information

Bourne Park Airfield has a 750 metre grass strip orientated 11/29 which slopes down to the west. There are white marker boards attached to a one metre high wire fence that crosses the undershoot of both runways, approximately 85 metre from the threshold. There is no radio facility.

Pooley's flight guide states that '*PPR [prior permission required] by telephone is essential.'* This is issued by the fixed wing maintenance facility.

History of the flight

The pilot stated that he was flying to Bourne Park, near Andover, Hampshire, so that one of his three passengers could collect a helicopter from a maintenance facility based there. Before departure the pilot telephoned the helicopter maintenance facility, as required by the Pooley's flight guide, but did not receive a briefing on the runway. He believes, in hindsight, this was because they thought he was visiting in a helicopter. The flight to Bourne Park was uneventful.

The pilot stated that when overhead Bourne Park, the windsock indicated a wind of approximately 330º/4-6 kt. A long approach to Runway 29 was established with a track slightly to the right of the centreline to compensate for the crosswind. His plan was to touch down as slowly and as early as possible, given that the aircraft was relatively heavy, with four occupants, and the grass strip had a negative gradient. Although his normal approach speed was 75 kt, he flew this final approach at 65 kt, 15 kt above the stall speed. He noted that there were no runway identifying numbers which would have provided a touchdown aiming point. Having crossed the fence, the pilot flared the aircraft, during which the stall warner sounded. After the aircraft touched down the nosewheel "slammed down." The aircraft veered 30 degrees to the left and continued for approximately 100 m, before the propeller struck the ground as the aircraft came to a halt, partially off the grass strip. All the occupants vacated the aircraft uninjured. The aircraft sustained damage to its nosewheel, engine frame, engine firewall, propeller and the engine was shock-loaded.

Accident site

Photographs of the accident site showed a recent witness mark on the fence in the undershoot that corresponded with a witness mark on the underside of the aircraft fuselage. The right main wheel and the nosewheel touched down in the deeply rutted undershoot of Runway 29, approximately 75 metres from the threshold and 9 metres inside the fence. The aircraft then appears to have bounced about 100 metres. On the subsequent landing the nosewheel bent back wards, probably as a result of the initial landing and the rough ground, causing the propeller to strike the ground.

Discussion

The pilot considered that the accident was caused by his misjudgement of the runway touchdown point. He believed this occurred because the undershoot was indistinguishable from the grass strip as the grass had not been mown over the winter months.

Safety action

As a result of this accident the maintenance organisations have nominated a limited number of personnel who can give landing permission over the telephone. They also have a written brief that will be read to all pilots requesting permission to land there.

ACCIDENT

Aircraft Type and Registration:	Brantly B2B, G-BPIJ
No & Type of Engines:	1 Lycoming IVO-360-A1A piston engine
Year of Manufacture:	1967
Date & Time (UTC):	21 May 2009 at 10:46 hrs
Location:	Hardwick Airfield, Barondale Lane, Hardwick, near Norwich
Type of Flight:	Aerial Work
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Beyond repair
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	68 years
Commander's Flying Experience:	9,444 hours (of which 93 were on type) Last 90 days - 9 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the commander, and follow up telephone inquiries and correspondence

Synopsis

Whilst the pilot under instruction was turning downwind in the hover, tail rotor effectiveness was lost and the helicopter developed a high yaw rate. Although the instructor intervened, he was unable to stop the rate of yaw completely before the helicopter touched down. The left skid collapsed and the helicopter rolled on to its left side.

History of the flight

The accident occurred during a training flight for the revalidation of the pilot's type rating.

The pilot under instruction was established in a low hover at approximately 6 ft skid height, and with the relative wind about 20º off the nose to the left, when the instructor asked him to execute a right turn to point downwind. Whilst carrying out this manoeuvre, the aircraft rapidly and unexpectedly started to yaw right at an increasing rate, and to climb. The handling pilot is uncertain whether he actively raised the collective but, after having yawed through about 180° to 270° in a matter of seconds, and climbed to a height of about 20 ft with the throttle by that stage fully open and full left pedal applied, the instructor took control.

The instructor immediately lowered the collective in an attempt to recover the rotor speed, which had drooped, while maintaining full left pedal. By the time these actions started to take effect, the aircraft had climbed to a maximum height of 30 ft to 40 ft and drifted some 30m to 40m downwind from its initial hover position. It continued yawing right, albeit at reducing rate, as the height was reduced, until a gentle touchdown was affected under power, still with a residual yaw rate to the right, having turned through 3½ to 4½ turns in all. After touching down, the aircraft continued yawing to the right through about 60°. The left skid collapsed, causing the aircraft to roll left and the main rotor blades to strike the ground. The helicopter came to rest on its left side. Neither occupant was injured and both were able to vacate the aircraft through the right door, having first turned off all services.

The wrecked aircraft was subsequently inspected by the instructor for any signs of a disconnection or malfunction of the tail rotor pitch control linkages, or of the tail rotor drive mechanism. No such indications were found.

The instructor expressed the view that, had he been actively 'following through' on the controls, as he would have been had the student been an ab-initio pilot, as opposed to a qualified pilot undergoing refresher training, then he probably would have been able to intervene in time to have prevented the loss of control. As it was, the aircraft was already yawing and climbing uncontrollably before he was able to intervene.

Discussion

The tail rotor authority under the prevailing conditions of high main rotor torque in the hover was likely to have been marginal when associated with an increase in the collective pitch and reduction of rotor both main and tail rotor speed. If tail rotor authority is lost, the resulting uncontrolled yaw reportedly sets in very rapidly, and is inherently difficult to contain. This is particularly so if insufficient height is available to permit an immediate lowering of the collective to reduce the main rotor torque reaction, without risk of the aircraft contacting the ground prematurely with an unacceptably high rate of yaw.

ACCIDENT

Aircraft Type and Registration:	Pegasus XL-Q, G-MWNC
No & Type of Engines:	1 Rotax 462 HP piston engine
Year of Manufacture:	1990
Date & Time (UTC):	21 March 2009 at 1100 hrs
Location:	Hingham, Norfolk
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 2 (Minor) Passengers - N/A
Nature of Damage:	Front wheel shattered, extensive damage to the airframe
Commander's Licence:	Private Pilot's Licence
Commander's Age:	39 years
Commander's Flying Experience:	3,100 hours (of which 250 were on type) Last 90 days - 4 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and additional AAIB inquiries

Synopsis

Shortly after landing, the nosewheel failed, causing the microlight to tuck under and roll on to its left wing. No pre-existing fault was determined in the wheel.

History of the flight

The purpose of the flight was to provide a student with dual circuit practice. Although the aircraft was based at a small grass airfield at Great Ellingham in Norfolk, it would have meant operating with a slight crosswind, so the instructor decided to conduct the exercise at Hingham, which is another grass airfield approximately four miles to the northwest. Here the wind was more aligned with the runway.

The aircraft joined the circuit and flew a normal approach but it 'ballooned' slightly just before landing, to the extent that the instructor had to intervene. The subsequent touchdown was described as "….not perfect but certainly not hard". The second circuit proceeded uneventfully up to the point of touchdown. This occurred at an airspeed some 5 kt faster than intended, but was reportedly otherwise smooth. The aircraft decelerated normally for approximately 10 m when there was a shudder and the nose dropped suddenly. The aircraft quickly tucked and then rolled onto its left wing, which suffered substantial damage. The student released his harness and then assisted the instructor to release his. Both occupants sustained minor injuries.

The investigation

It was subsequently found that the nosewheel had disintegrated. The wheel comprised two nylon mouldings that were bolted together. An examination of the runway resulted in a number of nylon wheel fragments being found that were scattered either side of the nosewheel track, extending for several metres after touchdown. The track then became more defined, possibly as a result of the wheel locking up and skidding, followed by an area of larger wheel fragments. Further on, the skid mark became a deep gouge, which then ceased close to additional marks where the wing, propeller and trike unit struck the ground.

The pilot was of the opinion that the wheel had failed as a result of a manufacturing fault. The wheel fragments were returned to the aircraft manufacturer, who reported that they could see no evidence of such a fault. This particular example had only recently been fitted to the aircraft and, in fact, failed on its third landing. They commented that the same wheel design had been around for more than 25 years and was used on at least two other older types of microlight aircraft but they were not aware of a general problem of wheel failures. They additionally noted that their current production aircraft are fitted with aluminium alloy wheels.

The British Microlight Aircraft Association (BMAA) were similarly unaware of any widespread problem but, following the accident to G-MWNC, alerted their inspectors to the possibility of wheel failures and to the advisability of checking for cracks. The feedback so far has not revealed any defective wheels.

Both the BMAA and the manufacturer noted that this aircraft type is equipped with a nosewheel only braking system, which consists of a 'mud-scraper bar'. Application of foot pedal pressure causes a steel bar to contact the tyre, thus acting as a brake. This imposes a load on the wheel, with the possibility of this becoming excessive when the brake is applied in combination with a heavy landing or pitch-down of the trike unit. In this accident, the aircraft was conducting a 'touch and go'; hence the brake was not applied. In view of the fact the wheel was new (although the date of manufacture is not known), the possibility of a manufacturing defect cannot be excluded.

ACCIDENT

Aircraft Type and Registration:	Rans S6-ES Coyote II, G-BYOT
No & Type of Engines:	1 Jabiru 2.2 piston engine
Year of Manufacture:	2000
Date & Time (UTC):	18 July 2008 at 1920 hrs
Location:	Swaffham Priory Farm, Cambridgeshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to nose landing gear and propeller
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	55 years
Commander's Flying Experience:	85 hours (of which 14 were on type) Last 90 days - 14 hours Last 28 days - 13 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Whilst on a flight from Sutton Meadows airfield, Cambridgeshire, the pilot found himself in worsening weather conditions with reducing visibility. He became disorientated and lost, so he carried out a successful precautionary landing in a field. Having established his position, he planned a return flight and took off, but became lost again. The pilot then made a second successful precautionary landing, before re-calculating his position and planning a further route, this time to Newmarket Heath airfield, Cambridgeshire. After taking off again, the pilot found himself in worsening weather conditions and with limited fuel. A third precautionary landing was made into a field, but on landing the nose gear collapsed. The pilot had only previously conducted day VFR flights and did not have any navigation aids or a functioning radio in the aircraft, so he was reliant on visual navigation, map, compass and stop watch.

History of the flight

The pilot had recently completed about six hours of familiarisation training in the Rans S6. He had already completed some circuit work and his intention was to conduct a local flight in the vicinity of the Sutton Meadows airfield, Cambridgeshire. Prior to the flight he had checked the weather conditions by referring to the BBC weather forecast and calling RAF Wattisham, which declared a wind from the south west at 11kt, a visibility of 30 km and mostly cloudy. The pilot's observation at Sutton Meadows was a wind from 240° at 10 kt, 15 km visibility with overcast cloud having a cloud base of

2,000 ft and a QNH of 1010 mb and falling. There had been some recent rain but this had cleared. The pilot took off at about 1700 hrs without incident and climbed to 2,000 ft above the airfield before heading south.

On approaching Willingham, Cambridgeshire, the pilot observed a reducing cloud base. He turned the aircraft at Willingham, but during this manoeuvre it started to rain heavily and the visibility reduced. The pilot rolled out on his intended heading, but due to the reduced visibility he became disorientated but was able to continue flying on his planned heading. After continuing in straight and level flight for an hour and 20 minutes he found that he was now unsure of his position. The aircraft was not equipped with any navigation aids and the radio was unserviceable, so the pilot was reliant on visual navigation and use of a map, compass and stop watch. Having decided that he was now totally lost, the pilot located a suitable field and carried out a successful precautionary landing.

The pilot calculated his position and found that he was in a field just north of Swaffham, Norfolk. He decided that he was now able to continue the flight and planned to return to Sutton Meadows. He took off from the field and, after about 40 minutes of flight, he became lost again, so he conducted another successful precautionary landing in a field. He re-calculated his position as now being in a field at Eriswell to the west of Thetford, Norfolk. His next plan was to continue with the flight and then to land at Newmarket Heath airfield, Suffolk, after which he would continue the flight back to Sutton Meadows.

The pilot took off from this second field but he flew straight into worsening weather conditions. He then realised he only had about 6 litres of fuel left so he started to select fields for a third precautionary landing. The majority of the selected fields contained crops, which only became visible during the final approach. On two occasions, due to the crops, the pilot aborted the approach and selected another field. Eventually the pilot selected a field containing a flax seed crop and this time landed. On landing the nose landing gear collapsed, causing the propeller to strike the ground before the aircraft finally came to rest. There was no fire and the uninjured pilot exited the aircraft normally.

An aftercast was obtained from the Met Office for the day of the accident. At 1800 hrs the UK was within a broad warm sector with areas of rain and drizzle affecting East Anglia. Between 1730 hrs and 2030 hrs the area flown through by G-BYOT was affected by a region of moderate precipitation moving to the east. This region of precipitation caused a reduction in visibility to between 1,900 m and 2,400 m. The cloud, during the rain showers that occurred in this period, was reported as being scattered or broken with a cloud base as low as 600 ft amsl, but in general the cloud was reported as being broken and varying between 1,600 ft amsl and 5,000 ft amsl.

The pilot, in a full and frank statement, admitted that he should not have flown out of the circuit that day, due to the prevailing weather conditions. He also commented that the majority of his decisions that day were errors of judgement. During his training the pilot had never conducted any instrument flying, with all his flying being conducted in day VFR conditions.

ACCIDENT

Aircraft Type and Registration:	Savannah Jabiru(1), G-CBBM
No & Type of Engines:	1 Jabiru Aircraft Pty 2200 piston engine
Year of Manufacture:	2002
Date & Time (UTC):	3 May 2009 at 12:24 hrs
Location:	Southend Airport, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to nose landing gear and propeller
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	80 years
Commander's Flying Experience:	2,180 hours (of which 125 were on type) Last 90 days - 6.5 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Shortly after landing on Runway 24, the aircraft was affected by a gust of wind from the right which caused it to yaw to starboard. The pilot applied full left rudder to correct the unexpected yaw, but the aircraft then yawed to the left and the pilot was unable to stop the aircraft leaving the runway on the left, downwind side. At an estimated 5 to 10 mph, the aircraft hit an irregularity in the grass and came to an abrupt halt, damaging the nose landing gear and propeller. The airport's emergency services attended: the pilot and passenger were each wearing a lap strap and diagonal harness, and were uninjured.

The wind was reported by ATC as being from 300º(M) at 11 kt but gusty. The pilot considered that the aircraft had been affected by a gust of wind, of up to 25 kt, after landing.

ACCIDENT

Aircraft Type and Registration:	Skyranger J2.2(1), G-CCUD
No & Type of Engines:	1 Jabiru Aircraft Pty 2200A piston engine
Year of Manufacture:	2004
Date & Time (UTC):	10 May 2009 at 1215 hrs
Location:	Newtownards Airfield, Northern Ireland
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Severe damage to the nose and right wing
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	67 years
Commander's Flying Experience:	79 hours (of which 9 were on type) Last 90 days - 8 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Just prior to touching down on the second attempt at landing, the pilot lost control of the aircraft. He reported that it swung violently to the left, and, despite attempting to establish it in a climb for a go-around, it carried on turning left. The nose and right wing struck the ground and sustained significant damage.

History of the flight

The aircraft had earlier taken off from Runway 22 at Newtownards Airfield and flown in the local area for approximately 90 minutes before returning. Whilst obtaining the circuit joining information over the radio, the pilot was informed that Runway 04 was now in use. After joining the circuit overhead, he made an approach and flared the aircraft immediately before touching down. At this point the aircraft was on the runway centreline with the wheels close to the ground. However, while still holding off, the aircraft suddenly swung left and adopted a climbing attitude. The pilot immediately applied power, eased the control column back a little and climbed to circuit height in a go-around manoeuvre. The wind was reported as 'variable 5 to 8 kt and gusting'.

The next approach was essentially a repeat of the first. Once again, immediately prior to touching down, the aircraft swung suddenly and violently to the left. Again the pilot applied full power and attempted to establish the aircraft in a climb. Although the aircraft climbed to a height of around 30 ft, it continued to turn to the left. The nose then dropped until it contacted the ground to the left of the runway; and the aircraft flipped round, the right wing striking the ground in the process and sustaining significant damage. The aircraft came to rest upright, the pilot having suffered minor injuries.

Pilot's assessment of the cause of the accident

The pilot commented that he was uncertain as to the cause of the accident. However, he speculated that whilst the aircraft was in the flare, marginally above the stall speed, a crosswind gust from the right in combination with the subsequent power application and raising of the nose, precipitated a stall of the left wing, which then dropped. He additionally commented that when he was practising stalls in the aircraft, the left wing always dropped.

Subsequent examination of the aircraft revealed a broken aileron cable where it passed through the roof of the cockpit. However, the nature of the failure suggested that it was due to an overload imparted to the cable when the right wing struck the ground.

ACCIDENT

Aircraft Type and Registration:	Thruster TST MK1, G-MVBT
No & Type of Engines:	1 BMW R100 piston engine
Year of Manufacture:	1988
Date & Time (UTC):	8 October 2008 at 1308 hrs
Location:	Close to Chirk Airstrip, near Wrexham, Clwyd
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	52 years
Commander's Flying Experience:	170 hours (of which 170 were on type) Last 90 days - 0 hours Last 28 days - 0 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The single-engined aircraft suffered a power loss at 200 ft agl shortly after takeoff. The pilot attempted to return to the airstrip but the aircraft struck a mound short of the strip. The pilot sustained a fractured spine. It was not possible to determine the cause of the power loss with any degree of certainty, but a fuel system problem seemed the most likely cause.

History of the flight

The pilot had refuelled the aircraft and completed his pre-flight and power checks, including a full rpm check and checking both ignition circuits. He took off from Chirk airstrip on a runway heading of approximately 160°. He reported that the wind was light and easterly, and the visibility was around 30 km. At approximately 200 ft agl the engine started to lose power and the pilot immediately commenced a 180° turn back towards the airfield. He noticed that the reading on the fuel pressure gauge had dropped to a "very low level". The engine stopped as he completed the turn and he then became aware that he would not make the airstrip. As the aircraft was now heading towards the A483 road, he elected to turn it away from the carriageway and the aircraft struck a mound of earth short of the road.

The pilot, who was wearing a full harness, switched off the fuel and the electrics before evacuating the aircraft. He sustained a fractured spine from which he was expected to make a good recovery. The aircraft was damaged beyond economic repair.

Engineering investigation

The aircraft's fuel system includes a pre-filter, two automotive electronic fuel pumps installed in parallel, a glass filter and a regulator. All these components were removed and sent to the AAIB for inspection but nothing significant was found. Both fuel pumps and the regulator were functionally tested and operated satisfactorily. It was not possible to recover the engine or other parts of the fuel system for inspection.

The normal procedure was to operate the main pump throughout the flight and the other 'boost' pump for takeoff and landing. On a previous flight a 'surging' problem on the engine was cured by switching on the booster pump, albeit at a significant altitude.

Procedure for Engine Failure After Takeoff (EFATO)

Pilots are taught that height is rapidly lost in turns following an engine failure and that if the failure occurs below 500 ft agl, it is unlikely that the airfield will be reached on turning back. The guidance is to select a field, preferably within about 30° of the wind, and not to attempt to turn back unless there are no other options (for example being over water or near buildings). Deploying the flaps, issuing a MAYDAY call, and completing the appropriate checks should be made where appropriate and if time permits.

Comments

Given the low fuel pressure reading during the flight, a fuel system problem, possibly due to blockage or fuel contamination, would appear to be the most likely cause of the power loss. However, it was not possible to state this with any degree of confidence.

The pilot's decision to turn back to the airstrip was influenced by the fact that the engine initially had not lost all power. He noted that had the engine failed more abruptly, he would have been forced to choose a field ahead for a forced landing, rather than contemplating turning back.

ACCIDENT

Aircraft Type and Registration:	Thruster T600N, G-MZGZ	
No & Type of Engines:	1 Rotax 503-DCDI-2V piston engine	
Year of Manufacture:	1997	
Date & Time (UTC):	20 April 2009 at 1800 hrs	
Location:	Throckmorton Airfield, Worcestershire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Aircraft destroyed	
Commander's Licence:	National Private Pilot's Licence	
Commander's Age:	69 years	
Commander's Flying Experience:	200 hours (of which 50 were on type) Last 90 days - 10 hours Last 28 days - 4 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB	

Synopsis

Soon after takeoff the pilot stalled the aircraft. As the remaining amount of runway was insufficient to complete a safe landing, he turned the aircraft left to land onto a paved track. After landing the aircraft subsequently collided with a tree.

History of the flight

The pilot reported that he was planning on making a local flight from Throckmorton Airfield, Worcestershire, to gain some more experience on the Thruster, as he had not flown the aircraft recently. It was a clear day with a variable wind at 2 kt. During the takeoff the pilot's vision was impaired by the sun which made it difficult to read the ASI. Soon after becoming airborne the aircraft stalled. The pilot attempted to control the aircraft by pushing forward on the control column. However, realising the remaining amount of runway was insufficient to complete a safe landing he turned left to land on a curved paved track that diverged off the runway. Just before the aircraft landed the pilot switched off the magnetos. Shortly after landing the aircraft collided with a tree and an animal observation hide. The pilot vacated the aircraft uninjured but the aircraft was destroyed in the collision. A passing truck driver, who witnessed the accident, helped the pilot pull the wreckage clear of the trees.

The pilot acknowledged that the accident was as a result of a mistake on his part and that the sun also impaired his vision making it difficult to read the ASI and thus control the speed.

ACCIDENT

Aircraft Type and Registration:	X-Air 582, G-BZUP
No & Type of Engines:	1 Rotax 582/48-2V piston engine
Year of Manufacture:	2000
Date & Time (UTC):	4 December 2008 at 1410 hrs
Location:	Londonderry Park, on approach to Newtownards Airfield, Co. Down, Northern Ireland
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to right main wheel, nosewheel and propeller
Commander's Licence:	Private Pilot's Licence (Microlight) with Instructor rating
Commander's Age:	60 years
Commander's Flying Experience:	3,008 hours (of which 104 were on type) Last 90 days - 117 hours Last 28 days - 43 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

During final approach to the airfield the engine stopped suddenly. The instructor carried out a forced landing in a field, during which the right main landing gear and nose gear collapsed. The engine stoppage was the result of fuel exhaustion which was possibly caused by an abnormally high fuel flow, due to contamination within the fuel jamming a carburettor needle valve open.

History of the flight

The X-Air 582 is a high-wing microlight aircraft with a two-stroke Rotax 582 engine mounted forward of the leading edge of the wing (see Figure 1). A student pilot, who was the owner of the aircraft, was undertaking flying instruction with an instructor. Prior to the first flight of the day the instructor conducted the pre-flight checks with the student observing. He also oversaw the student refuelling the aircraft to just over the 35 litre level. The instructor reported that the first flight of the day lasted 39 minutes and was uneventful. After landing, the fuel level was marginally over the 25 litre level, so the fuel consumption had been about 15 litres/hr. Prior to the second flight of the day the instructor confirmed that the fuel level was still at the 25 litre level. The planned flight duration was one

Figure 1
X'Air 582 micro-light aircraft

hour so he was expecting to return with about 10 litres remaining.

The flight in the local area was uneventful and the aircraft returned to the airfield to join overhead about 45 minutes after departure. The instructor flew the aircraft and 'descended deadside' to join Runway 22 while briefing the student on his actions, pointing out circuit traffic and carrying out the pre-landing checks. He observed the fuel level at the 10 litre mark. During final approach, at a height of about 300 ft, the engine stopped suddenly. The instructor realised that he could not glide to the runway so he carried out a sideslipping turn to the left to land crosswind in a field immediately below, and to the left of, the final approach path. On landing the right mainwheel sunk into waterlogged ground and its axle sheared, resulting in the aircraft pitching forward, shearing the nosewheel fork and damaging the propeller. The aircraft remained upright and came to rest in a very short distance. The instructor and student were able to exit the aircraft normally and there was no fire.

Pilot's examination of the aircraft

Prior to lifting the aircraft on to a trailer, the pilot attempted to siphon the remaining fuel into a container but only found a "couple of cupfuls" in the tanks. The following day he examined the aircraft in more detail with an inspector from the British Microlight Aircraft Association (BMAA). They discovered that the front air filter was very oily and, on removal of the front carburettor bowl (the engine was fitted with dual carburettors), they discovered small black particles in the bottom of the bowl and a small area of aluminium corrosion. The rear carburettor bowl contained a smaller amount of the same material. The BMAA inspector had encountered a similar situation previously, in which particles in the carburettor had restricted closure of the needle valve, resulting in a fuel overflow condition. The fuel would overfill the carburettor and exit via the vent pipes. They examined the remaining fuel system and found no evidence of split lines or fuel leakages. A small amount of similar contamination was found in the bottom of the fuel tanks.

Pilot's assessment of the cause

The pilot concluded that the engine failure was caused by fuel exhaustion due to an abnormally high fuel usage during all or part of the last flight. He also believed that he may have made a mistake when he observed 10 litres of fuel remaining while joining overhead. The aircraft is fitted with two fuel tanks, one behind each seat, connected at their base by a fuel hose. To check the fuel level the instructor, seated in the right seat, had to look over his left shoulder to read the level indicated on the left tank located behind the student's seat. The instructor reported that he checked the fuel level while in a left bank and, if the turn had not been coordinated, the fuel could have sloshed from the right tank to the left tank and provided an erroneously high reading. The instructor was also very busy at the time, briefing the student while carrying out the pre-landing checks, and thought that he might also have been subject to 'expectation bias', as he was expecting there to be about 10 litres of fuel remaining.

Discussion

It is possible that some of the black particles in the carburettor bowls became lodged in the needle valve and jammed it open at some point during the final flight. This would have resulted in excess fuel venting overboard. The BMAA inspector was aware of this having occurred previously and considered that, although the vent lines were above the windshield, the propeller's slipstream and aircraft's forward speed would have been sufficient to blow the escaping fuel over the wing, allowing it to disappear undetected in flight. The oily front air filter was also consistent with an engine running excessively rich, which can cause oil blow-back. The source or composition of the black particles found in the carburettor bowls was not established. However, since similar particles were found in the fuel tanks it is likely that the contamination was introduced during refuelling.

ACCIDENT

Aircraft Type and Registration:	Zenair CH 701UL, G-CDGR
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2005
Date & Time (UTC):	11 March 2009 at 1750 hrs
Location:	Main Hall Farm strip, Conington, Cambridgeshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to right wing leading edge slat, propeller blades, engine firewall and engine mounts
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	53 years
Commander's Flying Experience:	12,200 hours (of which 6 were on type) Last 90 days - 67 hours Last 28 days - 37 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

After a normal touchdown the aircraft veered to the left and departed the grass runway surface. The aircraft entered a corn field and the high rate of turn, to the left, caused the aircraft to tip to the right and the right wing to hit the ground.

History of the flight

The Zenair CH 701UL is a three-axis, high-wing microlight aircraft with a tricycle landing gear configuration. The pilot had completed a local flight and was returning to land on Runway 27, a grass strip about 700 m long. The wind was from 240º at 6 kt. He carried out a normal approach at 55 mph with the flaps down and made a normal touchdown on the main wheels first, followed by the nosewheel. The aircraft then started to veer increasingly to the left. The pilot applied pedal pressure with his right foot but this had no effect and the rate of turn to the left increased, causing the aircraft to leave the grass runway surface and enter an adjacent corn field. The left main wheel lifted into the air due to the high rate of turn and the right wing leading edge hit the ground. Then the propeller struck the ground and the engine stopped immediately.

Pilot's assessment of the cause

The pilot reported that he was uncertain of the cause of the accident but offered two possible causes. He thought that the nosewheel fork might have bent on landing due to an earlier heavy landing on the nosewheel. Alternatively, he thought it was possible that he might have inadvertently applied left pedal after touchdown, instead of right pedal, to correct for the left turn. The aircraft was equipped with rudder pedals for the left pilot's seat and pedals for the right co-pilot's seat. The pilot's right pedal is mounted very close to the co-pilot's left pedal without a central divider between them. The pilot, seated in the left seat, considered it possible that when he attempted to apply his right foot to his right pedal he inadvertently applied pressure to the co-pilot's left pedal, thereby increasing the turn to the left.

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2008

3/2008 British Aerospace Jetstream 3202, G-BUVC at Wick Aerodrome, Caithness, Scotland on 3 October 2006.

Published February 2008.

4/2008 Airbus A320-214, G-BXKD at Runway 09, Bristol Airport on 15 November 2006.

Published February 2008.

5/2008 Boeing 737-300, OO-TND at Nottingham East Midlands Airport on 15 June 2006.

Published April 2008.

6/2008 Hawker Siddeley HS 748 Series 2A, G-BVOV at Guernsey Airport, Channel Islands on 8 March 2006.

Published August 2008.

7/2008 Aerospatiale SA365N, G-BLUN near the North Morecambe gas platform, Morecambe Bay on 27 December 2006.

Published October 2008.

2009

1/2009 Boeing 737-81Q, G-XLAC, Avions de Transport Regional ATR-72-202, G-BWDA, and Embraer EMB-145EU, G-EMBO at Runway 27, Bristol International Airport on 29 December 2006 and on 3 January 2007.

Published January 2009.

2/2009 Boeing 777-222, N786UA at London Heathrow Airport on 26 February 2007.

Published April 2009.

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

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