CONTENTS

SPECIAL BULLETINS

None

COMMERCIAL AIR TRANSPORT

FIXED WING

Lockheed L188C	G-FIZU	19-Mar-07	1
Piper PA-23-250 Aztec	G-BGTG	19-Jul-07	12
Rockwell Turbo Commander	N51WF	29-Jan-08	15

ROTORCRAFT

None

GENERAL AVIATION

FIXED WING

Cap 232	G-IIVI	03-Mar-08	16
Cessna 182G Skylane	G-ASSF	26-Dec-07	17
DH82A Tiger Moth	G-ANDE	14-Sep-07	18
Europa	G-HOFC	01-Jun-07	21
Piper PA-28-161 Cherokee Warrior II	G-BODC	17-Nov-07	35
Reims Cessna FRA150M Aerobat	G-BFGZ	10-Feb-08	37

ROTORCRAFT

Robinson R22 Beta	G-DODR	14-Dec-07	38

SPORT AVIATION / BALLOONS

Pegasus Quantum 15	G-BZJF	26-Aug-07	40

ADDENDA and CORRECTIONS

None

Summary of: **Aircraft Accident Report No: 5/2008** 49
Report on the accident to Boeing 737-300, OO-TND
at Nottingham East Midlands Airport on 15 June 2006

List of recent aircraft accident reports issued by the AAIB 54

(ALL TIMES IN THIS BULLETIN ARE UTC)

INCIDENT

Aircraft Type and Registration:	Lockheed L188C, G-FIZU
No & Type of Engines:	4 Allison 501-D13 turboprop engines
Year of Manufacture:	1960
Date & Time (UTC):	19 March 2007 at 2350 hrs
Location:	London Stansted Airport
Type of Flight:	Commercial
Persons on Board:	Crew - 2 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Failure of propeller synchrophase unit
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	38 years
Commander's Flying Experience:	3,625 hours (of which 1,075 were on type) Last 90 days - 60 hours Last 28 days - 15 hours
Information Source:	AAIB Field Investigation

Synopsis

Immediately after takeoff on a night flight from Stansted to Edinburgh, the flight crew experienced control difficulties and fluctuation of the rpm and power on all four engines. As the aircraft climbed towards 3,000 feet above mean sea level (QNH) the No 2 engine was observed to be running down. The crew shut the engine down, declared a PAN and prepared to return to Stansted. The remaining three engines continued to suffer from fluctuating parameters throughout the rest of the flight until, when on final approach with landing flap selected, both the No 1 and No 3 engines appeared to run down. The aircraft landed using only the No 4 engine. The investigation revealed that the incident was the result of a failure of the propeller synchrophaser.

History of the flight

The aircraft was due to complete a scheduled night flight from Stansted Airport to Edinburgh carrying freight. On board were the commander and co-pilot, as well as an engineer who travelled with the aircraft to carry out maintenance between flights, but who had no official in-flight role. The engineer occupied the jump seat between the two pilots on the flight deck.

The aircraft was loaded with freight and departed from Runway 05 on a Buzzard 2S departure at 2350 hrs with the co-pilot acting as handling pilot. The Takeoff Weight (TOW) was 97,388 lbs and under the prevailing conditions the Maximum allowable TOW (MTOW) was calculated as 103,956 lbs.

Just after rotation the crew became aware of the aircraft yawing, pitching and rolling erratically, combined with a loud fluctuating noise emanating from the propellers. The crew stated the engine rpm gauges were all fluctuating rapidly through a range of about 1,000 rpm with the needles rotating through almost 360º. This was combined with fluctuations on the engine horsepower gauges and various other gauges. The aircraft, however, remained controllable and continued to climb.

The engineer pointed out to the pilots that the No 2 and 4 engine temperatures were about 1,080ºC (max temperature for takeoff is 971ºC) and the commander reduced the power on these two engines so that the temperatures fell back within limits. Once through acceleration altitude the crew began to accelerate the aircraft and raised the flaps before carrying out the after takeoff checks. The aircraft was by then climbing through about 2,000 feet QNH.

Neither the pilots nor the engineer had experienced a similar situation before, and they tried to identify the nature of the problem. They noticed that the No 2 engine propeller rpm was about to run down below the normal operating range and so shut down the engine. The aircraft was climbing through about 3,000 feet when the commander declared a PAN to ATC, requesting vectors to return to Stansted for an ILS approach. The aircraft was levelled at about 4,500 feet QNH, flying at about 240 KIAS and with the propeller rpm continuing to fluctuate on the three remaining engines. The aircraft also continued to yaw, pitch and roll, so much so that the commander stated he had difficulty in reading the checklist. The commander tried to adjust the power levers to see if it would have an effect but the propeller rpm continued to fluctuate as before. The autopilot remained disengaged, as was normal during the climb, and the co-pilot was able to maintain the cleared altitude within about +/- 300 feet.

The crew then noticed that engine No 3 propeller rpm had stabilised and appeared to be pitch-locked (see 'Over speed protection', on page 4) at about 14,300 rpm (normal propeller rpm is 13,820). The crew decided to leave the engine running with the intention of shutting it down on final approach. The aircraft was by then positioned downwind for their requested return to Runway 05 and the pilots managed to slow the aircraft to 190 kt for the approach by reducing the power set on engines Nos 1 and 4. The co-pilot descended the aircraft to 2,300 feet QNH and turned onto finals at which point the commander took control. The aircraft had been flying in intermittent IMC but they were now visual with the runway and were able to continue for a visual approach. At 190 kt the flaps were set to 78% and the gear was lowered. At about 7 nm on finals the No 3 engine appeared to come out of its pitch-locked condition and to operate normally. The pilots completed the landing checks and selected 100% flap with the aircraft decelerating through about 170 kt towards their planned two-engine approach speed of 150 kt. As the aircraft descended through about 1,000 ft, however, both engines Nos 1 and 3 appeared to flame out.

The commander increased power on engine No 4 to its maximum limit with the propeller rpm still fluctuating. The aircraft began to descend below the correct approach path and crossed the threshold with three red lights showing on the PAPIs and the speed decaying rapidly below 130 kt. The aircraft touched down just short of the marked touchdown point and, after slowing on the runway, vacated via a high speed turn off onto a taxiway where it was brought to a halt. The pilots isolated services to engines Nos 1 and 3, as they were hot, by pulling the respective fire handles. The crew then completed the after-landing checks and spoke on the radio to the attending fire crew before shutting down engine No 4 normally.

Weather

The ATIS information 'Whiskey' valid at 2320 hrs reported the following weather conditions:

Wind	340º degrees at 11 kt
Visibility	5,000 metres
Cloud	FEW at 100 feet and SCT at 600 feet
Temperature/Dew point	1º/+0º
QNH	1005

Organisational information

The operator was originally part of a larger aviation company but had become a separately owned and operated company in 2005. At the time of the incident it operated five BAe ATPs and seven Lockheed Electras, solely employed in freight operations.

The Electra fleet had begun operations in 1993 and the number of aircraft had been gradually increased so that by the time the present operator became independent, all seven of its Electra aircraft, including G-FIZU, were already in operation.

Propeller operation

Six of the seven Electra aircraft were fitted with Aeroproduct propellers. The seventh, G-FIZU, was fitted with Hamilton Standard propellers.

Both types of propeller are controlled by a hydro-mechanical governing system which maintains engine speed at approximately 13,820 rpm. Further control is provided by electronic means to damp inputs from the hydraulic governor and to provide speed and phase synchronisation of three 'slave' engines to a 'master' engine within a governed range of 13,820 +/- 140 rpm. These systems are described in detail below.

Aeroproduct propellers

This type of propeller is controlled by a propeller solenoid and a rotary actuator. In addition each propeller control system makes use of a synchrophaser. The solenoid acts as a fine tuner for the hydro-mechanical propeller governor to smooth small variations in engine power. The rotary actuator works in conjunction with the synchrophaser to synchronise all four engine propeller speeds and to ensure the propellers rotate in phase to achieve minimum interference between adjacent blades. The synchrophaser is switched off for takeoff and landing. It is normally switched on as part of the 'after takeoff' checks at about 3,000 feet and is switched off again as part of the approach checks, again at about 3,000 feet.

Propeller speeds are synchronised to either the No 2 or 3 engine, the pilot being able to select which is to be used as the 'master' by a rotary selector on the central pedestal. Each propeller rpm is governed when the synchrophaser is switched on and the propeller rpm is within the governed range of 13,820 +/- 140 rpm. The maximum control range for rpm synchronising is approximately +/- 2% of nominal on-speed condition. Phase synchronisation is turned on in cruise only.

Should the propeller electronic system fail, the propeller rpm will be governed by hydraulic control only and synchronisation with the other propellers will not be possible; therefore the system must be isolated. This is achieved by turning the rotary selector to the OFF position and pulling the four propeller solenoid circuit breakers situated in the flight deck overhead panel.

Hamilton Standard propellers

This type of propeller has a hydro-mechanical governing system which maintains the propeller speed at the desired in-flight rpm of 13,820 rpm when in reasonably smooth air and with smooth power lever movement. Each propeller has a synchronisation servo and a speed bias motor which fulfills the same function as the propeller solenoid and rotary actuator on the Aeroproducts propeller. Synchronisation and phasing of all four propellers is controlled by a single synchrophaser which is turned on after takeoff and off before landing.

Unlike the propeller solenoids on the Aeroproducts design, there are no circuit breakers for the individual synchronisation solenoids and bias motors. Instead there are individual toggle switches on the overhead panel situated adjacent to the synchronisation master switch. These can be switched off in the event of propeller rpm fluctuations. The powerplant has three governing modes:

(1) Mechanical governing

This uses a mechanical 'fly ball' governor to ensure that a constant rpm is maintained throughout the propeller pitch range. As with any mechanical governing system there is some lag within the system which can produce overshoots and undershoots of the selected power during throttle movement.

(2) Normal governing

In order to minimise these power fluctuations, normal governing makes use of a speed bias servo motor fitted to each mechanical governor, a synchronisation servo on each propeller and the 'synchrophaser' unit. The speed bias motor, a small reversible alternating current motor, provides a supplemental force on the mechanical governor and therefore, as its name implies, can bias the nominal control speed of the propeller governor. Mechanical stops prevent the speed bias mechanism from driving the mechanical governor to more than 14,650 rpm (plus 6% of nominal rpm) or less than 13,270 rpm (minus 4% of nominal rpm). With the synchronisation servos switched to NORMAL the synchrophaser receives signals from 'rate' potentiometers fitted to each throttle lever which allows it to anticipate the commanded power change. The synchrophaser then provides a signal to the speed bias servo motor, which acts on the mechanical governor. This feature minimises the mechanical lag in the governor thus improving response times and minimising power over and under shoots during speed and power changes. This governing mode remains in operation, without crew input, as long as the synchrophaser unit is powered by electrical bus 'A'. The synchrophaser can be isolated by pulling the respective circuit breaker on the bus 'A' panel.

(3) Synchrophasing

The third governing mode is Synchrophasing, which is designed to synchronise all four propellers. In order to synchronise the propellers the synchronisation master switch is set to 'ON' and either the No 2 or No 3 propeller is selected as the 'master'. The synchrophaser unit then compares the signal from the 'master' propeller synchronisation servo with the remaining 'slave' propeller synchronisation servos and generates signals to the 'slave' propellers' speed bias motors to synchronise their respective propellers. When used in the 'synchrophasing' mode the travel of the speed bias motors is restricted to allow a +/- 2% change to the governed speed.

Overspeed protection

The propeller assembly contains a mechanical pitch lock mechanism which operates independently from the other engine control mechanisms. When the propeller rpm exceeds approximately 14,285 rpm, the lock engages and prevents further decrease in propeller blade pitch angle. It will however continue to allow the blade pitch angle to increase if the normal governing control is restored.

In the event that a propeller exceeds 14,500 rpm, the mechanical fuel control significantly reduces the fuel supply to the engine. This process, known as 'fuel topping', produces a large drop in fuel flow to the engine with an associated drop in rpm and torque. Once engine speed falls below 14,500 rpm normal fuel flow is restored. However, lag within the system means that the rpm and torque fluctuations produced by fuel topping are both rapid and severe.

Checklists

The operator had published abnormal procedures relating to propeller governor malfunctions on the Aeroproducts equipped aircraft, but not for the type of synchrophaser fitted to the Hamilton Standard equipped G-FIZU. On their initial investigation of the event, the operator realised that such a procedure existed but that it had been omitted from the published procedures. It is thought likely that the omission occurred when the manuals had been previously amended, probably at the time the operator had become separate from its parent company.

Engineering investigation

The AAIB was informed of the incident approximately three days after it had occurred and the operator had, after troubleshooting the defect, returned the aircraft to service. The troubleshooting had identified the synchrophaser as the probable cause of the event; the unit had been replaced and extensive engine runs were carried out which confirmed that the defect had been rectified. The AAIB then carried out further examination of the synchrophaser unit.

The synchrophaser unit fitted to G-FIZU was an analogue unit, designed in the 1960s, which consisted of six circuit boards held within a protective case. The circuit boards consisted of two transistor amplifier boards, a double synchrophaser board, a saw-tooth synchrophaser board, a speed derivative board and a power supply board. Examination of these circuit boards showed that several components within the power supply board had overheated, with one area showing localised burning of the board (see Figure 1). X-ray examination confirmed that several of the resistors had suffered a breakdown of their internal construction and that a resistor connector had melted and 'shorted' across several other connections within the board (see Figure 2). A review of the maintenance records for the component confirmed that the unit had recently been removed from G-FIZU due to the No 4 engine failing to follow the master engine. The unit had been inspected and the defect rectified prior to being returned to the operator in January 2007. The overhaul agency confirmed that the unit passed the post-rectification tests with no abnormalities and that no work was carried out on the power supply circuit board. Discussions with the National Transportation Safety Board of the USA and the engine and airframe manufacturers revealed that this type of unit had also been fitted to the Lockheed P3 Orion and early variants of the Lockheed C130 and L100 (the civil variant of the C130) but had been replaced in the 1980s by a solid state unit. It was confirmed that G-FIZU was the only remaining L188 Electra fitted with this type of synchrophaser unit. Due to the age and low number of these units remaining in operation, only one approved test facility existed worldwide and the damage to the circuits prevented testing of the unit to identify how the failures within the circuit board would have affected the functioning of the unit. The scale of the engine rpm gauges is such that relatively small variations in rpm would produce large movements of the gauge needle, as observed by the crew.

Both the engine and airframe manufacturer confirmed

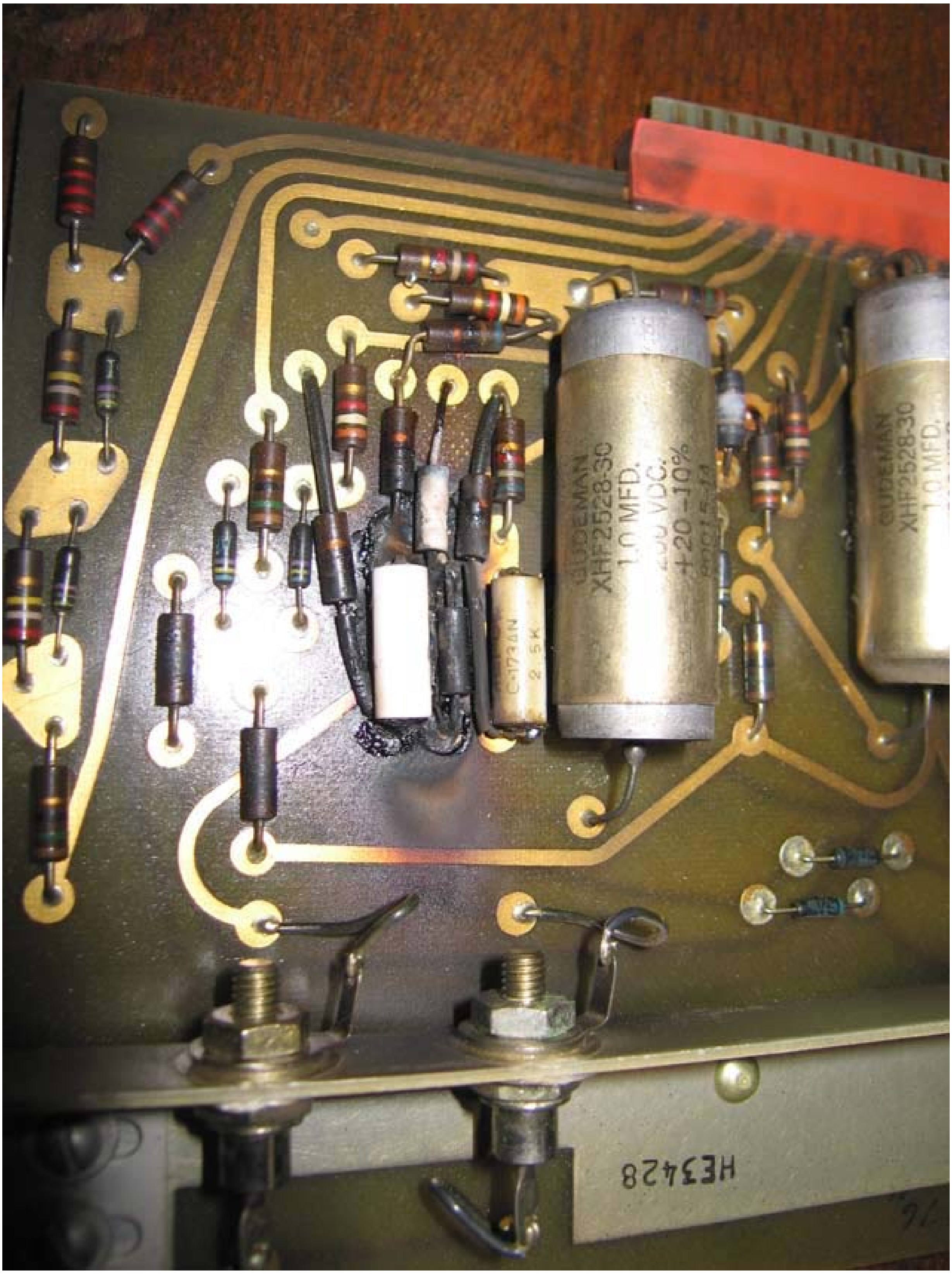

Figure 1

that in the event of an identified failure within the synchrophaser unit, the system could be electrically isolated by pulling the circuit breaker on the 'BUS A' panel and the engines would then revert to basic mechanical engine governing.

Flight recorders and radar

The aircraft was fitted with a 25-hour Universal Flight Data Recorder (UFDR) and a 30-minute Cockpit Voice Recorder (CVR). Although the AAIB was not informed of the incident until three days afterwards, during which time the aircraft had gone back into service, the UFDR was removed from the aircraft and taken to the AAIB for downloading. Data was recovered for the incident flight. CVR audio recordings, however, would have been overwritten with later recordings, so the CVR was not removed.

Only a limited number of parameters was recorded and a time history of these parameters during the incident flight is shown at Figure 3. The only parameter relating to the engines is torque, measured between the power section of the engine and the reduction gearbox, the values of which are also displayed to the crew via digital indicators but converted to horsepower (HP). The horsepower is calibrated to indicate the power output of the engine

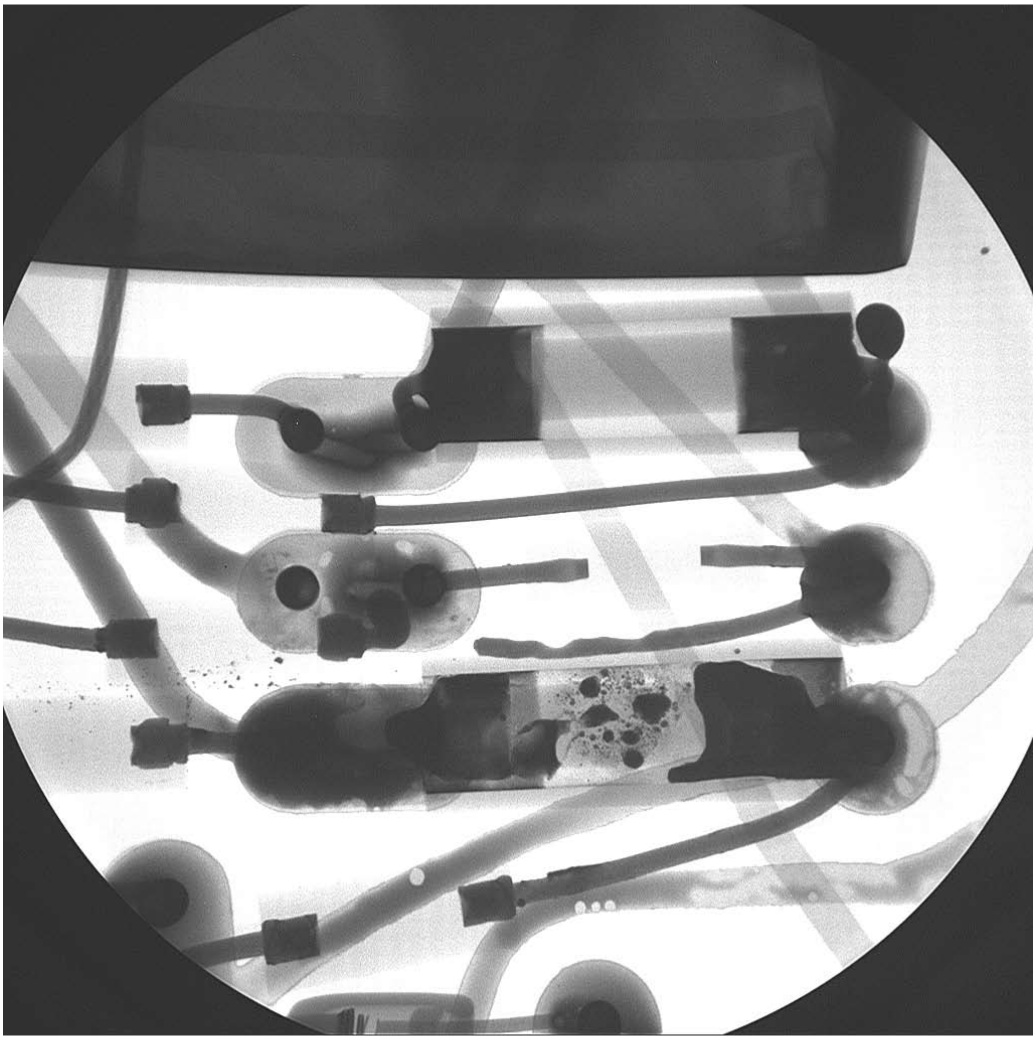

Figure 2

at the constant on-speed condition of 13,820 rpm[1]. This horsepower is also illustrated on Figure 3 with the equivalent horsepower at 13,820 rpm scale shown alongside the torque. Each of the engine torques appears to have a certain amount of noise (±30 lb ft or ±80 HP @ 13,820 rpm) which is also evident on all previous flights recorded on the UFDR.

Figure 3 also includes a plot of the aircraft's ground track based on recordings from Stansted radar. It was noted from the radar recordings that the aircraft's Mode S transponder was transmitting the unique ICAO 24-bit Aircraft Address (24-bit AA) incorrectly (460850 instead of 400850). The provision of Air Traffic services in a Secondary Surveillance Radar Mode S environment relies on this aircraft-unique 24-bit AA for selective interrogation of individual aircraft. The 24-bit AA is also an essential element of the Airborne Collision and Avoidance System, ACAS II. The UK Civil Aviation Authority (CAA) is responsible for the management and assignment of 24-bit AAs in the UK and, during the certification of a Mode S installation, it is ensured that Instructions for Continued Airworthiness (ICA) include a requirement for a periodic check of the correct setting of the 24-bit address. This is included within JAA Technical Guidance Leaflet 13 (Paragraph 12.2/3).

Of note from Figure 3 are the following points: **[A]** five seconds after the engines reached takeoff power, just as the aircraft started accelerating, the torque on engine No 2 fell, dropping to 60% of the takeoff level over 30 seconds, while the other engines' torques increased slightly. The torque on engine No 2 then recovered but appeared erratic for two minutes **[B]**, before the engine was shut down **[C]**. This was immediately followed by a sharp drop in engine No 1 torque, before this recovered more gradually back to its original value. 30 seconds later **[D]**, the torque on engine No 3 reduced as the aircraft levelled off, and then reduced again to about 70% of the torque values of engines Nos 1 and 4. It then continued to reduce while the torque of engines Nos 1 and 4 remained nominally constant. G-FIZU, now downwind, then descended to 4,310feet above aerodrome level (aal) as the engine No 1 and No 4 torques reduced **[E]**, while the engine No 3 torque continued to reduce. Just over halfway along the downwind leg, the torques of engines Nos 1 and 4 reduced further as the aircraft started its descent (at about 1,200 ft/min). However just as the aircraft began to turn on to base **[F]**, the engine No 1 torque fell rapidly to zero where it remained for over 30 seconds, during which time the descent rate increased to about 2,200 ft/min. Halfway around the base leg, the torques on engines Nos 1 and 3 started to increase **[G],** with a split of about 350 lb.ft (900 HP) in favour of engine No 3, while the engine No 4 torque eventually levelled off at 190 lb.ft.

On the descent into Stansted **[H]**, at 1,130 ft aal and 180 kt airspeed, the torque on engine No 3 suddenly dropped from just over 1,000 lb.ft (2,700 HP) to about 380 lb.ft (1,000 HP) where it remained for just under 30 seconds, at which point the engine No 1 torque fell rapidly to the same level. G-FIZU was now at 510 ft aal with 160 kt airspeed. Both engine No 1 and No 3 torques continued to fall towards zero as the engine No 4 torque rose rapidly **[I],** to over 950 lb. ft (2,500 HP) for the final stage of the approach to land. The landing and subsequent ground roll were uneventful.

Footnote

[1] Horsepower @ 13,820 rpm = torque x 13,820 / 5252 = 2.63 x torque [where torque is measured in lb.ft].

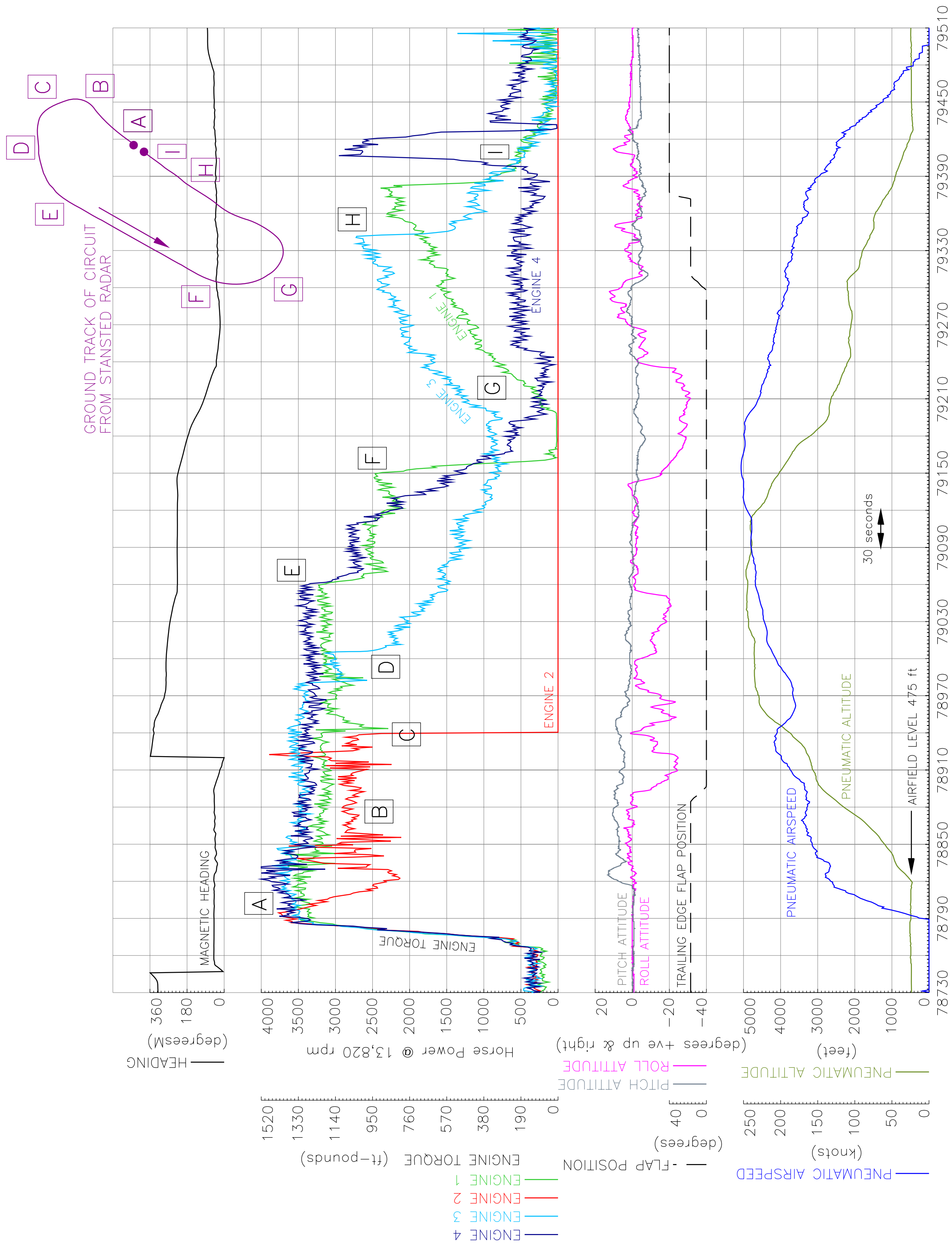

Figure 3

FDR Parameters

Analysis

The limited range of parameters on the flight data recording hampered efforts to understand fully the behaviour of the powerplants during this incident. In order to determine the possible causes of the severe fluctuations experienced by the flight crew, the data was examined by both the NTSB and the engine manufacturer in conjunction with the AAIB. This confirmed that the behaviour of the powerplants appeared to be consistent with a failure of the synchrophasing unit. The fluctuating parameters experienced by the flight crew appear to have been the result of spurious commands being sent to the speed bias motors, producing fluctuations in fuel flow and hence all other engine parameters. The physical limitations within the speed bias motor would have allowed the engine to reach a maximum of 14,650 rpm. It is therefore considered probable that during the power fluctuations the No 2 engine exceeded its governor fuel topping limit of 14,500 rpm. This resulted in a rapid loss of engine rpm and torque giving the flight crew the impression that the engine had begun to run down. After shutting the No 2 engine down, the remaining engines continued to fluctuate until both the No 1 and 3 engines became 'fuel topped' and lost rpm and torque. The flight data recording confirmed that although they both appeared to lose power, they did not run down completely.

The data shows the No 2 engine torque began to decrease five seconds after it had reached takeoff power during the takeoff roll. The crew, however, reported that it was not until they had become airborne that any problem became apparent. It seems unlikely that the crew, including the engineer, who was on the jump seat, would have missed such an event. Equally, there is nothing to suggest that the data is incorrect and it has not been possible to reconcile this inconsistency.

Once presented with the problem, there was little to guide the crew in identifying the synchrophasing unit as being the cause. In particular, the unit, as was routine, had been turned off for takeoff and thus it would have seemed unlikely to them that this could have been causing the problem. The existing checklists had no procedures for multiple propeller malfunctions and the commander had trouble reading the checklists due to the movement of the aircraft and the fact that it was dark. This was compounded by the pressing nature of the problem and their relatively low altitude.

Conclusions

The cause of the incident was a failure within the power supply circuit board in the propeller synchrophaser unit. This caused significant power and rpm fluctuations on all four engines giving the flight crew difficulty in handling the aircraft. The No 2 engine exceeded its maximum governed speed which resulted in the fuel flow to the engine being cut back by its governor; this led the crew to believe that the engine had begun to run down and they shut that engine down. The remaining engines continued to fluctuate and, on final approach, the No 1 and 3 engines also appeared to run down, probably due to fuel being cut back after overspeeding.

Safety action

The operator, in consultation with the UK CAA, has amended its procedures to include the checklist items specific for multiple propeller malfunctions on G-FIZU that had been erroneously omitted. They have also informed crews of the incident and of the revised procedures now in force so that they will be able to identify any reoccurrence in the future and take effective remedial action.

A review carried out by the airframe manufacturer confirmed that the number of aircraft remaining in operation with the analogue synchrophaser fitted is extremely low, in the region of 10 aircraft of all types. All operators who may have aircraft with this unit fitted have been informed of this event and requested to ensure that their checklists include the correct actions to take in the event of multiple engine and propeller fluctuations. In view of the actions taken above and the very small number of aircraft which may be exposed to this type of propeller synchrophaser failure, no further safety action is considered necessary.

ACCIDENT

Aircraft Type and Registration:	Piper PA-23-250 Aztec, G-BGTG
No & Type of Engines:	2 Lycoming IO-540-C4B5 piston engines
Year of Manufacture:	1979
Date & Time (UTC):	19 July 2007 at 1615 hrs
Location:	Guernsey Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Scratch on the lower side of the right wing tip and aileron, damage to the right landing gear door, damage to footstep
Commander's Licence:	Private Pilot's Licence
Commander's Age:	58 years
Commander's Flying Experience:	1,171 hours (of which 12 were on type) Last 90 days - 16 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot, plus AAIB examination of a failed door actuating cylinder

Synopsis

Failure of the right gear hydraulic actuator when the landing gear was selected down led to the loss of the hydraulic fluid in the system. The emergency lowering system was used, which deployed the left and nose landing gears, but the right gear remained retracted. A successful emergency landing was subsequently carried out.

Examination of the actuator revealed the presence of pre-existing stress corrosion and critical cracking, in the actuator body. It was concluded that the failure was associated with the maritime environment in which the aircraft had operated, possibly exacerbated by very thin anodic coating.

History of the flight

During an ILS approach to Guernsey Airport in VMC, with 1/4 flap selected, the landing gear was selected to DOWN but failed to extend. The gear selector was re-cycled to no effect and, after a fly-past of the tower who confirmed that the gear was still retracted, the pilot departed the circuit area and carried out the emergency checklist. This included use of the manually operated pump in an effort to extend the gear, but this had no discernible effect. After consulting with the aircraft's maintenance base by radio, the emergency CO_2 blow-down system was operated. This resulted in the nose and left main gears extending but the right main gear did not. A further fly-past of the tower provided visual confirmation that it was still retracted.

After briefing the passenger, a landing was executed on the left main wheel, with the right wing being held off as long as possible. The engines were stopped using the magneto switches and, as the right wing settled into contact with the runway, the left wheel brake was applied and the aircraft brought to rest on the runway. After making the aircraft safe, both occupants evacuated without incident via the main door.

Aircraft examination

Examination of the aircraft after the accident revealed that the barrel of the right main landing gear door actuator had failed in such a manner as to allow the end-cap of the cylinder to detach. This caused a total loss of hydraulic fluid and consequent failure of the retraction actuating system. The AAIB examined the failed actuator and it was apparent that the end-cap had separated because of a 'breakout' of material around holes in the barrel of the cylinder. These holes provided location for a pair of roll pins that passed tangentially through the barrel and the cylinder end plug, on opposing sides of the cylinder housing, fixing the former to the latter (Figure 1).

In addition to the fractures associated with the breakout a series of longitudinal cracks of varying length and width were also apparent at other locations around each of the roll-pin holes in the barrel. This occurred both at the end which had failed and also around similar roll-pin holes in the opposite end of the barrel, which had not failed (Figure 2). It was evident that the breakout which had allowed the end plug to detach, resulted from exploitation of these pre-existing cracks, which gave the appearance of having been caused by stress-corrosion or a related mechanism.

The failed unit was subjected to detailed metallurgical examination, which included scanning electron microscopy. It was established that the cracks were indeed intergranular, probably caused by corrosion, which was widely apparent. Corrosion products had fully penetrated the grain boundaries, consistent with exposure to a marine environment. Cracks appeared to have been initiated by intergranular fissures in the surface of the barrel during manufacture, prior to the component being anodised, resulting in penetration of these fissures by anodic products (oxides). Additionally, the anodic coating of the barrel was unusually thin, being no more than 3 microns. This appeared to be not thick enough to prevent exploitation of these fissues subsequently by corrosion in service. The final overload fractures were ductile, suggesting that the material itself was not particularly embrittled, but Energy Dispersive X-Ray (EDX) analysis suggested the material was a copper/aluminium alloy, a type that generally offers poor resistance to corrosion.

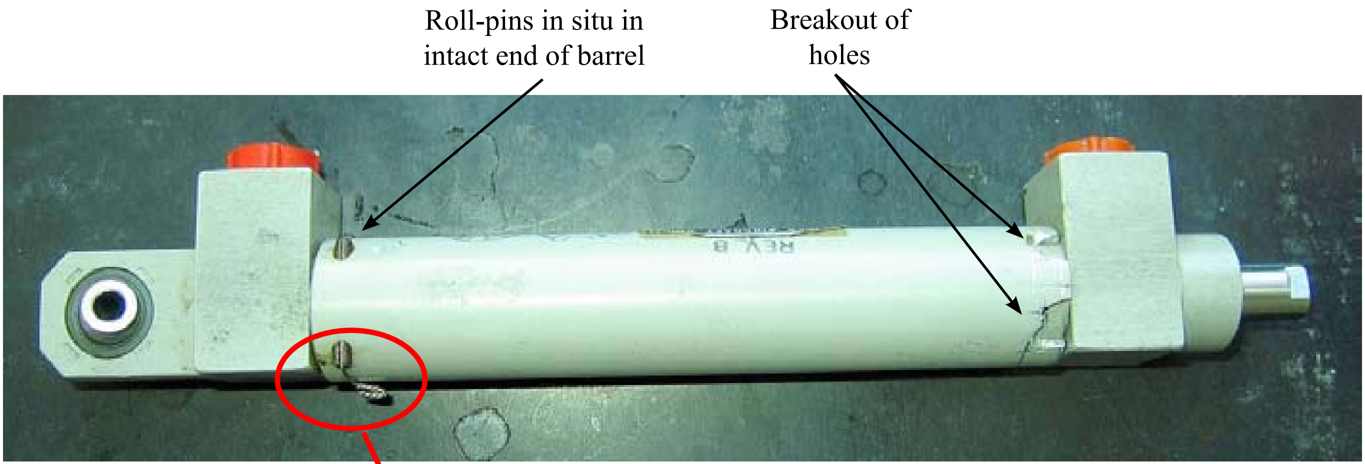

Figure 1 (above)

Failed actuator, showing broken-out roll-pin holes (end plug re-inserted in barrel)

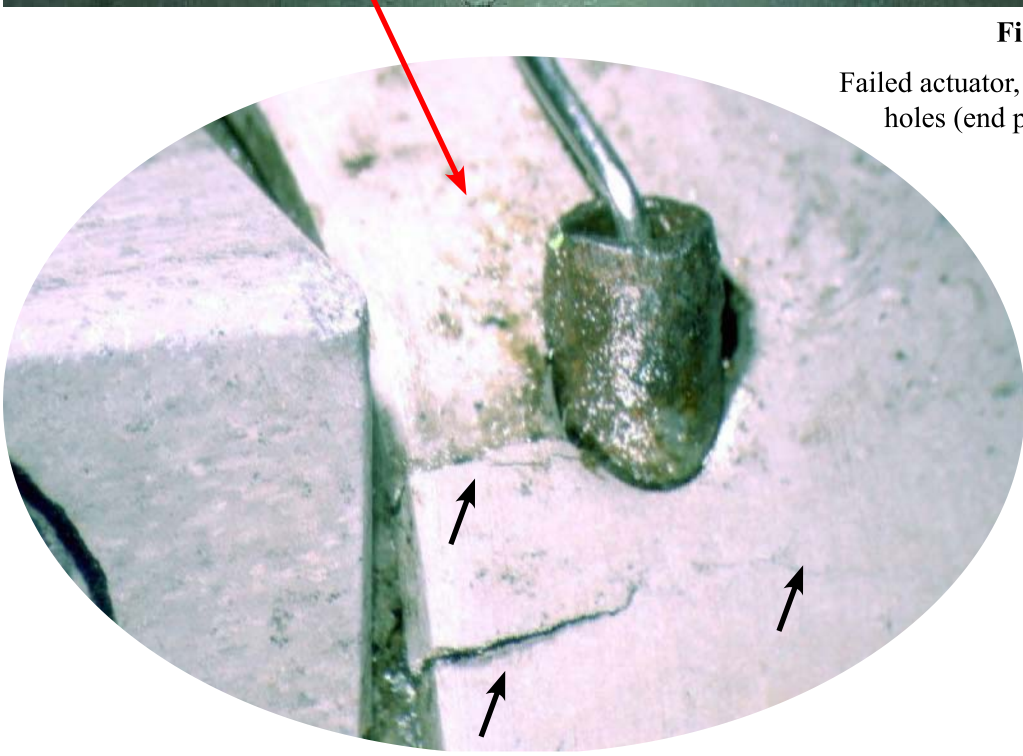

Figure 2

Typical cracks at hole in *intact* end of barrel

ACCIDENT

Aircraft Type and Registration:	Rockwell Turbo Commander, N51WF
No & Type of Engines:	2 Garrett 330 turboprop engines
Year of Manufacture:	1975
Date & Time (UTC):	29 January 2008 at 1204 hrs
Location:	Fairoaks Airfield, Surrey
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Severe distortion to rear fuselage structure and abrasion through underside of fuselage
Commander's Licence:	Private Pilot's Licence
Commander's Age:	75 years
Commander's Flying Experience:	1,744 hours (of which 696 were on type) Last 90 days - 10 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent AAIB enquiries

Synopsis

Landing in benign conditions, the pilot flared "too high" and the aircraft landed heavily, its tail contacting the ground.

History of the flight

The pilot reported that he positioned the aircraft on a left base for landing on Runway 24. The weather conditions were benign; visibility was good and the wind was calm. The approach proceeded normally, and the aircraft was configured for landing. However, the pilot stated that he flared "a little too high" and possibly at a slightly lower speed than normal. The landing was heavy and the tail of the aircraft contacted the ground, causing the fuselage to wrinkle and buckle around its circumference, just aft of the point at which the underside contacted the runway. The pilot stated that he believed he should have applied more power to arrest the sink rate.

ACCIDENT

Aircraft Type and Registration:	Cap 232, G-IIVI
No & Type of Engines:	1 Lycoming AEIO-540-L1B5 piston engine
Year of Manufacture:	1999
Date & Time (UTC):	3 March 2008 at 1200 hrs
Location:	Wickenby Airfield, Lincolnshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Engine shock-loaded, propeller destroyed and wheel spats and paintwork damaged
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	34 years
Commander's Flying Experience:	7,155 hours (of which 120 were on type) Last 90 days - 65 hours Last 28 days - 21 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

After making a successful crosswind landing, the aircraft was caught by a gust of wind from behind, causing the tail to lift and the propeller to strike the ground.

History of the flight

On arrival at Wickenby, at the end of a VFR flight from Sherburn, the wind was 270º at 15-20 kt, which was crosswind for both of Wickenby's runways, orientated 03/21 and 34/16 respectively.

After assessing the situation, the pilot decided to land on Runway 21, as it was slightly longer than the others and had an uphill slope. After carrying out a normal crosswind landing, the aircraft was brought to rest on the runway centreline just beyond the intersection with 34/16. However, when the pilot subsequently turned to taxi clear, the aircraft was caught by a gust of wind from behind which lifted the tail, causing the propeller to strike the runway and stop the engine. After turning off the electrical and fuel systems, he vacated the aircraft via the canopy, helped by airfield staff and others who had come to his assistance.

The pilot stated that he had done nothing different from previous occasions when flying tailwheel configured aircraft of various types, including in similar wind conditions, over a period of some fifteen years. He attributed the accident to an unexpected gust of wind.

ACCIDENT

Aircraft Type and Registration:	Cessna 182G Skylane, G-ASSF
No & Type of Engines:	1 Continental Motors Corp O-470-R piston engine
Year of Manufacture:	1964
Date & Time (UTC):	26 December 2007 at 1100 hrs
Location:	Eddsfield Airfield, East Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 3
Injuries:	Crew - None Passengers - None
Nature of Damage:	Engine shock-loaded, wings and rear fuselage damaged
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	67 years
Commander's Flying Experience:	129 hours (of which 50 were on type) Last 90 days - 6 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During the takeoff in a crosswind, the aircraft became light, yawed to the left and dropped its left wing. The aircraft then contacted the ground and came to rest inverted.

History of the flight

The aircraft lined up for takeoff on Runway 27 with a wind from 191° varying between 6 kt and 9 kt. With 'flaps 20' set the pilot began the takeoff. He applied 'up elevator' and left aileron. At 55 kt the aircraft became light on its wheels, yawed to the left and dropped its left wing. The aircraft then contacted the soft ground and came to rest inverted.

The pilot and passengers were uninjured and exited the aircraft via the left door. There was no fire.

The aircraft had been correctly loaded and was within its weight and centre of gravity limits. The pilot attributed the accident to a gusty crosswind and his lack of experience of operating in such conditions.

ACCIDENT

Aircraft Type and Registration:	DH82A Tiger Moth, G-ANDE
No & Type of Engines:	1 De Havilland Gipsy Major 1C piston engine
Year of Manufacture:	1943
Date & Time (UTC):	14 September 2007 at 1710 hrs
Location:	Homefield Farm Private Airstrip, 5 nm East of Redhill
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - 1 (Serious)
Nature of Damage:	Severe damage to wings, moderate damage to fuselage and undercarriage
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	30 years
Commander's Flying Experience:	3,927 hours (of which 295 were on type) Last 90 days - 195 hours Last 28 days - 36 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquires by the AAIB

Synopsis

While cruising at approximately 1,000 ft agl, with the passenger in the front seat flying the aircraft, the engine failed. The commander took control and flew a forced landing into a grass farm strip obstructed by scattered hay bales. Just before the aircraft landed the passenger unstrapped, stood up and jumped over the right side of the aircraft. After landing the commander ground looped the aircraft in order to stop it before the field boundary and a large tree. The aircraft however, hit a hay bale and came to a halt.

Background information

The aircraft was used by the operator to fly passengers on trial flying lessons from airfields in southern England. On the day of the accident the aircraft had finished operating out of Andrewsfield Airfield, Essex and was being positioned to Redhill Airfield, Surrey.

The passenger, in the front cockpit, held a FAA Private Pilot's Licence but was not qualified on type. He was employed by the aircraft's operator as a member of the ground crew. He flew regularly in the front seat on positioning flights and was given the opportunity to practise manoeuvres including practice forced landings.

About four weeks before the accident, on another positioning flight with a different pilot, the passenger had closed the throttle without warning and asked the pilot what action he would take if he had a passenger on board. The pilot carried out a practice forced landing and go-around but did not comment to the passenger about his actions although he thought it was "a strange thing to do."

History of the flight

The aircraft took off from Andrewsfield for the flight to Redhill with full fuel tanks at 1620 hrs. Soon after takeoff the pilot gave control to the passenger. South of Sevenoaks, Kent, the pilot briefed the passenger about executing a forced landing and then allowed him to practise one. After going around from the practice forced landing, the passenger maintained control and set course for Redhill. Approximately 5 nm east of Redhill, at about 1,000 ft agl, the passenger said "engine failure" and the engine rpm reduced. According to the pilot, the passenger called the failure "extremely calmly" leading him to believe that this was a simulated rather than real emergency. The pilot said this was not the time to do this due to their proximity to Redhill but the passenger repeated "engine failure." Realising it was a genuine failure the pilot took control and advanced the throttle from cruise to full power. Although the propeller was rotating, the engine did not respond so the pilot prepared for a forced landing.

The pilot briefly tried to ascertain the reason for the failure by checking the position of the rear cockpit engine ignition switches and the remaining fuel quantity but could not find an obvious reason for the failure. Fortunately he noticed a farm strip close by with two marked grass runways orientated 17/35 and 14/32. The runways appeared clear but the rest of the field was scattered with hay bales. The pilot transmitted a MAYDAY call to Redhill ATC and attempted to position the aircraft for an approach to Runway 35 knowing that the forecast winds were light. However he had insufficient height to land on Runway 35 and instead landed across the runways, heading approximately 040º, to avoid the hay bales. After flaring the aircraft and just prior to touchdown, the passenger, without warning, unstrapped, stepped onto the right wing and jumped from the aircraft. The pilot stated that the aircraft was one or two feet above the ground and at about 35 kt. After the aircraft touched down, the pilot realised he was not able to stop before the field boundary and a large tree. To avoid these obstacles he deliberately ground-looped the aircraft to the left and in doing so, the aircraft's lower left wing hit a hay bale and stopped.

He turned off the ignition switches in the rear cockpit, vacated the aircraft and ran to assist the passenger. The passenger was approximately 50 m behind the aircraft and in considerable pain having broken his right leg. Emergency services arrived on the scene approximately 15 mins after the accident.

At the time of the accident the wind was from 280º/6 kt, the temperature was +20ºC and the dew point was +14ºC.

Pilot's comments

The pilot stated that the passenger had previously closed the throttle without warning on another flight with him about three weeks before accident. On this occasion he did comment to the passenger about his actions but "did not make a big deal of it." The pilot commented that he did not check the position of the front cockpit ignition switches, which are visible from the rear cockpit, during the forced landing or after he had landed. However he had asked the front seat occupant to check the position of the front cockpit ignition switches which were confirmed as being ON. He added that he had flown G-ANDE 80 times in the past year and the engine always performed "perfectly". The engine operated smoothly throughout the accident flight before it stopped.

Passenger's comments

The passenger admitted that he had previously closed the throttle without warning on two occasions. He stated that he had overheard some of the operator's pilots saying they did not get many chances to practise emergencies and believed this would give them the opportunity to practise unplanned forced landing procedures. He also reported that he did not close the throttle or turn off the ignition switches on the accident flight.

The passenger commented that the engine failure produced a sharp reduction in power, as if the throttle had been closed. He added that as the aircraft was about to land he "became panicky" as hay bales were passing close to the aircraft. He was concerned that if the aircraft hit a hay bale, the engine would be pushed into his cockpit causing him serious injury. It was for this reason that he decided to jump from the aircraft.

Engineering investigation

The operator's engineers carried out an initial investigation into the cause of the engine failure. They confirmed that the fuel vent and fuel filter were clear, there was no fuel contamination and the engine had good compression on all four cylinders. The engine subsequently started on the second swing of the propeller and ran smoothly. The engine was subsequently stripped for a more detailed examination but nothing was found that might have caused the failure.

Follow up action

As a result of this accident, the company's Operations Manual now states:

> *'commanders are not to tolerate unusual actions by subordinate crew members: for example the initiation of simulated engine failures. Such indiscretions are to be reported to a standardisation pilot.'*

ACCIDENT

Aircraft Type and Registration:	Europa, G-HOFC
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	1996
Date & Time (UTC):	1 June 2007 at 1445 hrs
Location:	Near Magor, Gwent
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Fatal) Passengers - 1 (Fatal)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	66 years
Commander's Flying Experience:	1,631 hours (of which 1,054 hours were on type) Last 90 days - 17 hours Last 28 days - 8 hours
Information Source:	AAIB Field Investigation

Synopsis

The pilot and a friend were returning from Bodmin Airfield in Cornwall to Uckfield Farm strip near Newport, Gwent. The aircraft was seen by witnesses flying at approximately 500 ft in a wings-level attitude, possibly in a gentle descent. The engine sounded normal, running at a medium to high speed. Witnesses on the ground saw the tail move up and down rapidly, and debris was seen to fall from the aircraft before the wings and horizontal tailplanes detached. The fuselage came down in a grass field, fatally injuring both occupants. The investigation has found that a structural failure of the right wing trailing edge retaining pin mechanism had initiated the in-flight break-up of the aircraft.

At an early stage of the investigation the AAIB issued a Special Bulletin to publicise the factual information available at that time. As a result of those initial findings, immediate and repetitive inspections of other aircraft of the type were mandated.

History of the flight

On the day of the accident the pilot and a friend were to fly to Bodmin Airfield in Cornwall for the aircraft to have an annual permit inspection. Following the inspection they were then to return to the Newport area. During the return flight it is believed that the pilot intended to carry out the required annual Permit-to-Fly air test.

The aircraft was based at Kemeys Commander, which is a grass farm strip close to the pilot's home. It was kept in a secure, weather proof trailer similar in design to a glider trailer, which required the wings and stabilizers to be fitted prior to flight and removed for storage.

In the late morning, the pilot was seen at the strip assembling his aircraft. His normal procedure was to withdraw the fuselage from the trailer and support it in an upright position before attaching the wings and stabilizers. Two trestles were used to take the weight of the wings whilst he manoeuvred them into position before inserting locating pins. Having assembled the aircraft the pilot was seen to depart Kemeys Commander at about 1100 hrs to fly to Uckfield Farm to collect his passenger. Uckfield Farm is located to the east of Newport and has a single concrete runway orientated 05/23, 650 metres long by 10 metres wide, which the pilot preferred to use for collecting his passenger. The passenger also held a Private Pilot's Licence and had flown with the pilot on previous occasions.

The aircraft departed from Uckfield Farm at about 1130 hrs and flew to Bodmin Airfield in Cornwall arriving at 1215 hrs. It was taxied to the maintenance hangar where the pilots met with the Popular Flying Association (PFA, now renamed the Light Aircraft Association or LAA) inspector and the annual inspection was carried out. Following the inspection the pilots had lunch before departing at 1330 hrs. At 1410 hrs the pilot contacted the Cardiff Radar controller when 5 nm south-west of Linton and stated his intention to route from Minehead to Newport. His altitude was given as 2,200 ft on a mean sea-level pressure setting (QNH) of 1024 hPa and Cardiff issued a clearance to orbit initially before the aircraft was cleared to transit the zone at 2,500 ft on the QNH of 1019 hPa. With 5 nm to run to Uckfield Farm, the pilot was cleared to change to the Uckfield Farm radio frequency of 130.4 mHz. No further radio calls were heard from the aircraft.

Radar data obtained from the Cardiff radar site recorded the aircraft track and ground speed. No Mode C (altitude) information was received and therefore no height information was available. The aircraft track is shown at Figure 1. From this information the aircraft flew north-east, away from Uckfield Farm and then made a sharp left turn onto a south-westerly heading. No reason for this turn was identified.

Witnesses in the vicinity of the accident site saw the aircraft heading to the northeast at a height of approximately 1,000 to 2,000 ft before turning left and heading south-west. The aircraft had by then descended to approximately 500 ft. The engine sounded normal at a medium to high rpm setting but with a constant and regular sound. It was observed flying in a wings-level attitude, possibly in a slight descent. The tail section was then observed to move up and down rapidly and at the same time papers and other loose articles fell from the aircraft and streamed back in the airflow. The aircraft then broke up in what some witnesses described as being like an explosion but without fire and smoke. Other witnesses described the horizontal tailplanes detaching and the wings folding up before breaking away. Some witnesses thought the wings broke off first before the tail structure separated. All the witnesses heard the engine stop co-incident with the break-up.

The fuselage, wings, stabilizers and other aircraft components were scattered over a wide area with both occupants suffering fatal injuries on impact.

Initial impact and wreckage distribution

The wreckage trail continued for 430 metres on an approximate heading of 170° immediately to the south of a railway line, see Figure 2. The first items recovered were flight documentation and some personal effects. Approximately 35 metres south of the railway

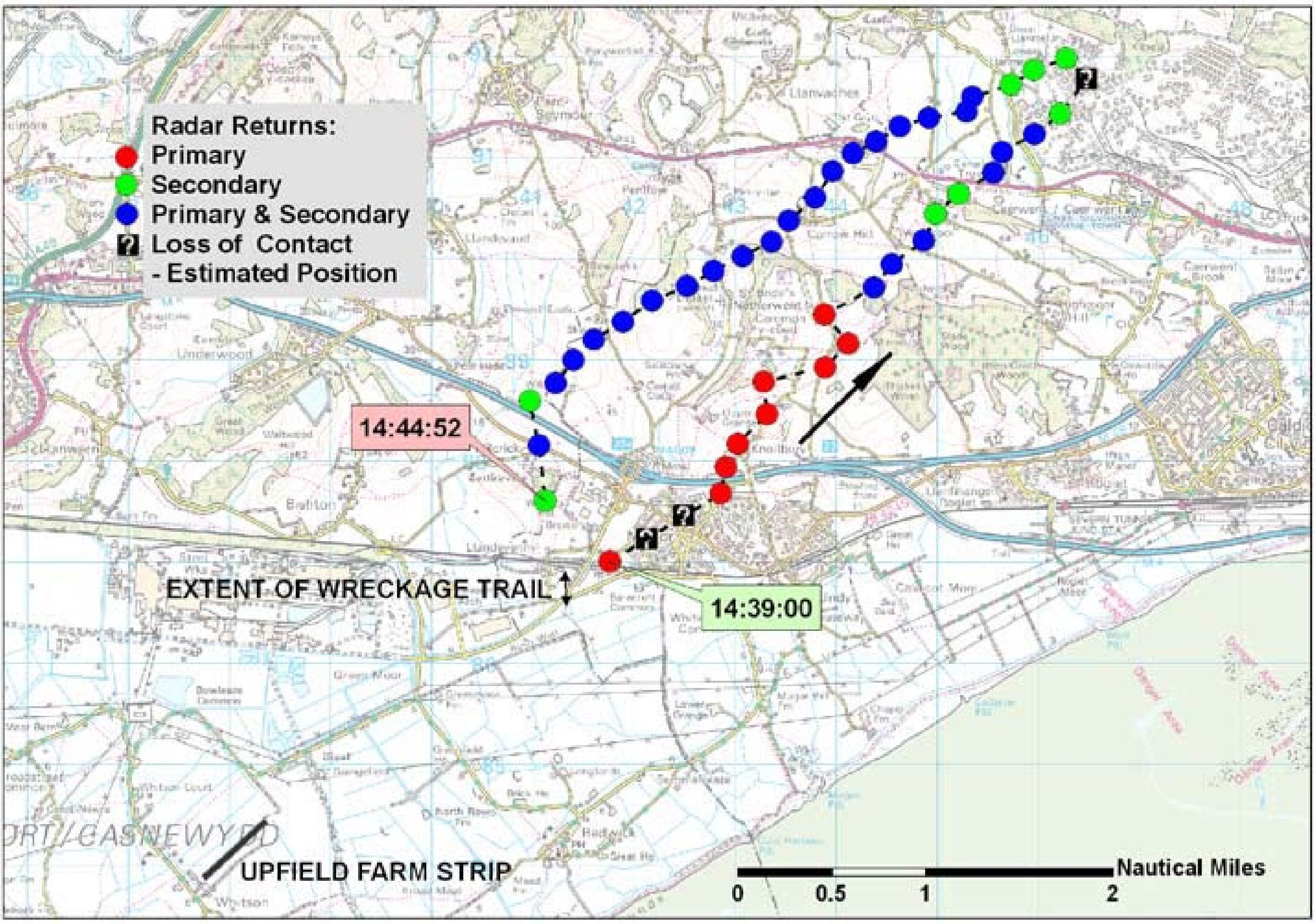

Figure 1

embankment small fragments of blue foam were found, which were later identified as being part of the internal structure of the right wing. As the trail of foam fragments continued southwards, the size and frequency of these fragments increased. A significant amount of the cockpit glazing was also found in the field. A fragment of the right inboard upper wing skin about 1.5 metres square was found close to an electricity pylon within the field. The remains of the right wing were found on the verge as the wreckage trail passed over a road. The left tailplane and sections of the cockpit doors and rear right wing root lay on the road, together with the left wing. The remains of the cockpit roof and the right tailplane lay 25 metres beyond the left wing at the road junction.

The fuselage had struck the ground in a steep nose-down attitude in a field immediately to the south of the junction. The engine and cockpit sections had both come to rest close to the point of impact. The rear fuselage and fin structure had broken away from the cockpit section and come to rest 15 metres from the initial impact point. The fin and rudder were found in a water-filled ditch 15 metres beyond the rear fuselage. The aircraft's fuel tank had been thrown from the aircraft and was also found in the ditch. Examination of the overhead power lines by the local electricity company confirmed that the aircraft had not struck the overhead cables.

Figure 2

The distribution of the wreckage confirmed that the aircraft had suffered from a catastrophic in-flight structural failure which had resulted from the separation of the mainplanes and tailplanes prior to the fuselage impacting the ground. Initial examination of the wreckage confirmed that it was probable that the propeller had not been rotating at the time of ground impact. The tailplane torque tube, together with the tailplane bushes, pip pins and balance weight remained attached to the fin structure. The left wing was found to be intact but the right wing was found to be severely disrupted, with peeling of the aft sections of the inboard wing skins and the loss of a substantial amount of foam infill. The right wing spar had failed and a section of spar which extended from the wing root into the fuselage had separated. Despite a search of the surrounding ditches by police divers, it was not recovered. A section of the right wing root which contained the rear drag pin mount was recovered from the roadway. The pin, together with a section of the mounting structure, was found attached to the remains of the fuselage. The remains of the aircraft were recovered and transported to the AAIB for detailed examination.

As a result of these initial findings, the AAIB published Special Bulletin S3/2007, and the PFA issued two Airworthiness Bulletins which required both immediate and repeated inspections. These inspections were made mandatory in the UK by the issue of Mandatory Permit Directives 2007-005 and 2007-006.

Aircraft description

The aircraft was a Europa 'Classic' powered by a Rotax 912S engine, and it had been built from a kit in 1996. It had been operated for approximately 50 hours prior to being sold to the pilot in February 2000. At the time of the accident it had operated for approximately 1,125 flight hours. The aircraft had a valid Permit-to-Fly and had successfully completed an annual permit renewal inspection at Bodmin immediately prior to the accident flight. The aircraft kit was of a type which required the builder to construct the complete aircraft, including the wings; later kits providing the builder with a set of partially completed wings.

The fuselage of the Europa is made up of a series of Glass Reinforced Plastic (GRP) mouldings fitted out and bonded together by the builder. Each wing of the 'Classic' consists of a single GRP spar, to which is attached a series of ribs. The profile of the wing is produced through the use of shaped medium density foam 'infill' and bonded GRP skins. The wings are secured to the fuselage at three points; the spar, a 'lift' pin and also by a rear 'lift/drag' pin, see Figure 3. The wing spars, which carry the majority of the flight loads, pass through a slot in the fuselage where they are connected to each other and to the fuselage by stainless steel 'rigging' pins. The lift pin is located towards the leading edge of the wing and the drag pin just forward of the trailing edge flap. The lift and drag pins are secured to the wing by a mount bonded to the face of the inboard wing rib. The mount consists of a laminated structure made up of three aluminium alloy plates, 25 mm wide and 3 mm thick, and layers of GRP cloth. (Later versions of the Europa, with factory assembled wings, made use of plates which were 50 mm wide.) The drag pins are designed to stabilise the wings in a fore and aft direction. The lift pin transmits some of the wing's lift load to the fuselage and maintains its torsional stiffness. At high angles of attack the lift distribution on the wing is such that the drag pin and its mounting are in tension. The aircraft is fitted with flaps which are connected to an actuation beam within the fuselage. The 'Classic' makes use of a mono-wheel main landing gear, with two 'outrigger' wheels mounted on the outboard end of the flaps. The flaps and landing gear cannot be lowered independently and are operated by a single lever in the cockpit.

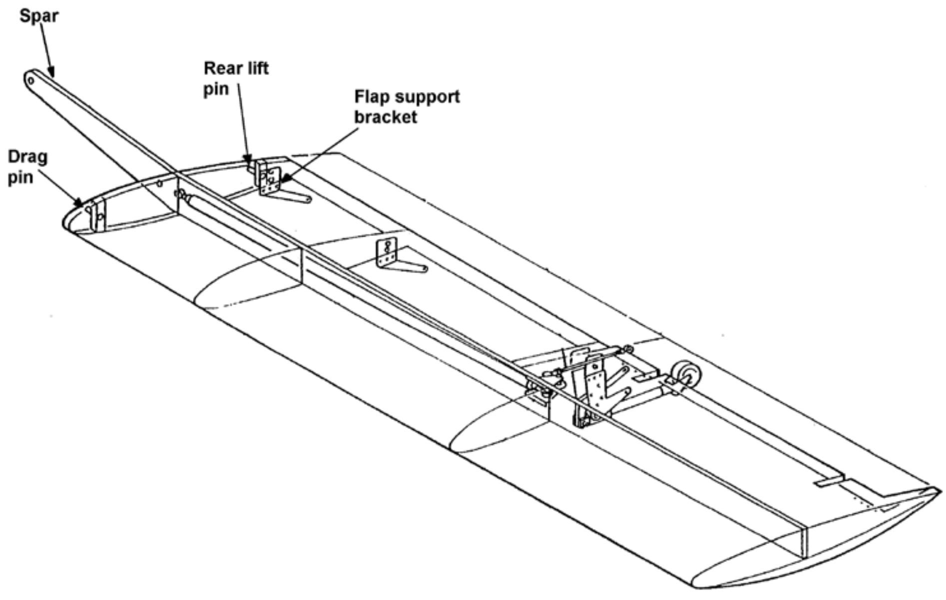

Figure 3

The Europa is fitted with an 'all flying' tailplane with an anti-balance/trim tab fitted to both the left and right surfaces. As with the wings, the tailplanes can be removed for transportation, being held in place on the tailplane torque tube by steel pip pins which pass through holes in metallic sleeves bonded in the tailplanes, (see Figure 4). Control inputs are transmitted by four pins, two on each side of the fin, which locate in bushes set into the inboard rib of each tailplane. The tailplane incorporates a mass balance weight which is connected to the tailplane torque tube by an arm within the fuselage. The mass balance is located between two vertical members bonded within the fuselage; these members restrict lateral and vertical movement. Tailplane deflection in pitch is restricted by lateral stops secured between the two members.

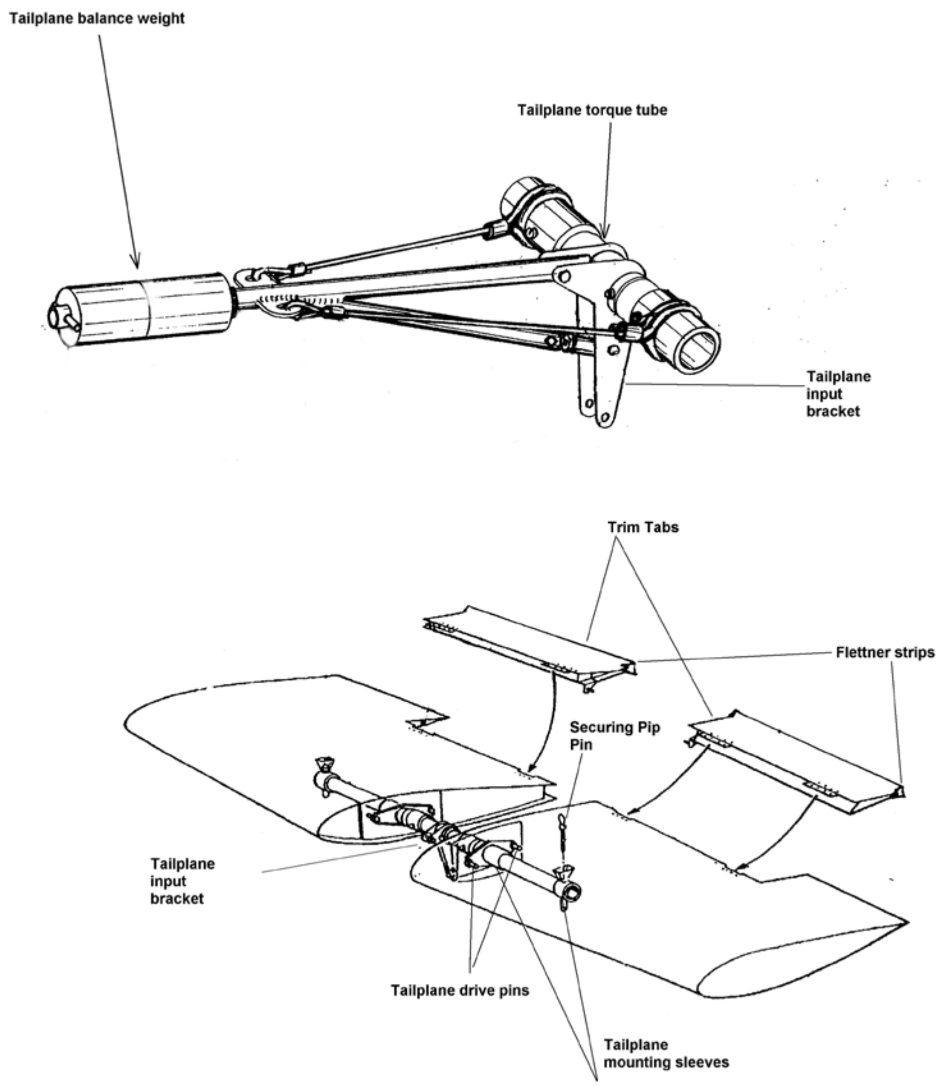

Figure 4

Meteorology

The Met Office provided an aftercast covering the route flown for the duration of the flights.

At 1450 hrs the Cardiff weather was recorded as surface wind 180° at 5 kt, variable between 120° and 230° with visibility in excess of 10 km. Cloud was FEW at 3,500 ft with temperature 19°C, dew point 12°C and QNH 1019 hPa. This also reflected the conditions in the immediate vicinity of the accident as described by the witnesses.

Weight and balance

The exact weight and balance of the aircraft could not be determined as it was not known what the total fuel was at the time of the accident. By using a simple calculation of the time flown of 2 hrs and 40 minutes multiplied by the minimum cruise consumption stated in the Europa Owners Manual of 18 litres per hour at 1.59 lbs per litre, approximately 48 litres or 76 lbs of fuel was used during the flight. Had the aircraft departed Kemeys Commander with a full fuel load of 70 litres, approximately 22 litres of fuel weighing some

35 lbs would have been onboard the aircraft at the time of the accident.

The maximum permitted gross weight was 1,370 lbs.

The centre of Gravity (CG) datum is located at the front face of the engine cowl and CG limits are defined as distances in inches aft of that datum. The limits remain constant for all weights with the forward limit at 58 inches and the aft limit at 62.5 inches aft of the CG datum point.

The following calculation is based on the known weights of the pilot, passenger, baggage and estimated fuel on board the aircraft at the time of the accident.

	Weight (lbs)	Arm (inches)	Moment
Aircraft Prepared for Service (APS)	789	59.4	46866
Pilot	222	56	12432
Passenger	246	56	13776
Baggage	20	88	1760
Zero Fuel Weight	1277	58.6	74834
Fuel	35	76	2660
Actual weight	1312	59	77494

At the time of the accident the aircraft estimated total gross weight was 1,312 lbs with the CG at 59 inches aft of the datum. The aircraft was, therefore, being operated within the permitted weight and balance limits.

Aircraft flight limitations

The following limitations are of relevance to the accident:

Condition	Limitation
Never Exceed speed (Vne)	165 kt
Stall speed (1,300 lbs) clean (Vs1)	49 kt
Max. flap/gear extension speed (Vfe)	83 kt
Structural Limit Loads (at 1,370 lbs)	+3.8g/-1.5g

Medical information

A post-mortem examination was carried out on the pilot. There was no evidence of any pre-existing disease or condition which could have had a bearing on the accident. The cause of death was a result of the injuries sustained in the accident.

Aircraft maintenance and records

The aircraft had been constructed in 1996 and flown for approximately 50 hours prior to its sale to the pilot in February 2000. Since that date the aircraft had been maintained by both the pilot and a PFA approved inspector based at Bodmin. The records kept by the pilot were found to be extremely thorough and appeared to detail all of the work carried out on the aircraft since its purchase, together with correspondence with both Europa and the PFA regarding potential modifications to the aircraft. The records held by the inspector were also found to be complete and thorough. Examination of the engine and airframe log books showed that the aircraft appeared to have been in compliance with all of the mandatory requirements in force at the time of the accident.

In November 2006 a log book entry stated that the pilot had re-built the Flettner strips which were fitted to the trailing edge of the tailplane tabs, and that in May 2007 the drive bushes within the tailplanes and been re-bonded. Records held at Bodmin confirmed that the aircraft had completed the 'technical' part of its permit renewal inspection without any defects being identified. The inspector stated that both tailplanes had been partially de-rigged to allow the tailplane drive bushes to be inspected as a result of the November 2006 log book entry; no defects were observed.

Detailed examination

Examination of the engine confirmed that it had not been operating at the point of impact but there was no evidence of any pre-impact failure or malfunction. The damage sustained to the fuel system prevented any samples of fuel being taken but there was a strong smell of fuel close to the fuselage together with discolouration of the surrounding grass, characteristic of a fuel spillage. The extent of damage to the cockpit instrumentation prevented any analysis of the flight or engine instrumentation. Based on the evidence of witness statements, further investigation then focused on the aircraft's tailplane system and wing structure.

Tailplane system

No evidence of an in-flight disconnection or restriction was found within the tailplane control system. All of the failures within the system were characteristic of 'overload' events and consistent with impact with the ground. The lower turnbuckle of the mass balance arm was found to have failed, which had allowed the mass balance weight to rotate and deform the tailplane input arm. Metallurgical examination of the fracture surfaces of the lower turnbuckle confirmed that it had fractured due to bending overload in the lateral plane. Approximately 2 mm of play was found between the tailplane input arm and the tailplane torque tube.

Both the left and right tailplane drive pins were found to be distorted, indicating the application of significant loads either through the control system or by the tailplanes. The bushes set into the inboard spar of each tailplane, which locate on these pins, had been distorted and become partially disbonded. Distortion of the drive pins and bushes would have led to the transmission of torque loads to the outboard sleeve and securing pip pin.

All four of the tailplane locating sleeves (see Figure 4) which had been bonded within the tailplanes, remained on the torque tube; the outer sleeve on each side was secured by its pip pin. Examination of the holes drilled into the outboard sleeves and the tailplane torque tube showed distortion and folding of the fore and aft edges of the holes which confirmed the application of a torque load between the sleeve and the torque tube. Discussions with both the Light Aircraft Association (previously the PFA) and Europa confirmed that the purpose of the outer sleeve and pip pin was to prevent the outboard movement of the tailplane and had not been designed to carry tailplane torque loads. Damage to the tailplanes confirmed that a failure had occurred in the bonding of the outboard sleeves. This had allowed both tailplanes to migrate outboard, disengaging both the tailplane drive pins and the trim tab drive pin and pulling the pip pins through the foam infill. Examination of the pip pin recesses in both tailplanes showed that they did not appear to have been constructed in accordance with the Europa Aircraft Build Manual, see Figure 5. The recesses in G-HOFC's tailplanes were significantly smaller than those shown in the manual; they consisted of a hole, and possibly an insert, of only slightly greater diameter than the pip pin whereas the build manual showed a significantly larger recess which made use of several layers of glass fibre cloth bonded to the sleeve. No abnormalities or inconsistencies which may have initiated the failure of the bond were found. Given that the bonded joint of the outboard sleeve had not been designed to carry torque loads even had it been constructed in the manner shown in the Build Manual, it is probable that it would also have failed due to the application of loads which it had not been designed to withstand.

Damage observed on the left side of the fin showed that the left tailplane trim tab had become disengaged from the 'T' bar mechanism which controlled it whilst the tailplane remained in position. It is therefore considered that the right tailplane must have moved outboard, either pulling the 'T' bar or allowing it to move to the right. This would happen if the bond between the outboard tailplane sleeve and the outboard rib failed, and this would also allow the tailplane drive pins to disengage.

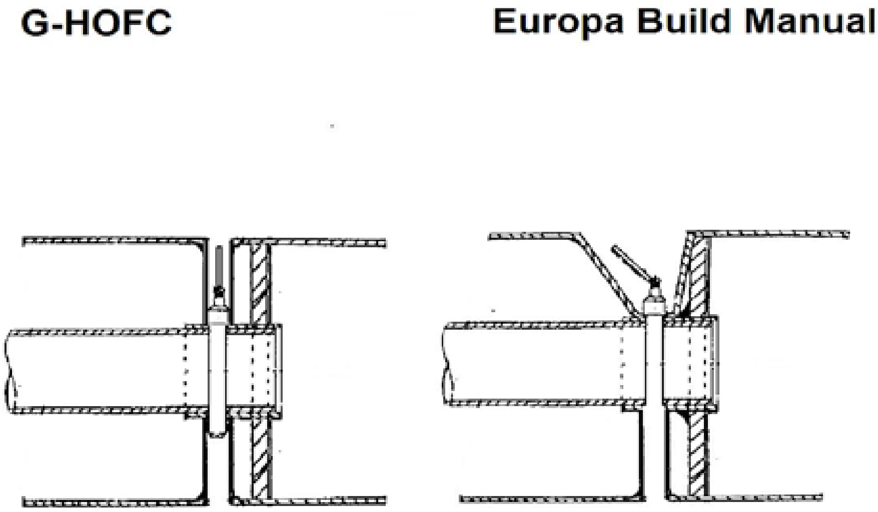

Figure 5

Disengagement of the drive pins would have caused the tailplanes to become free to rotate about their hinges, making the aircraft uncontrollable in pitch. This would have also subjected the airframe to significant loads beyond its design limitations. Scoring on the left side of the fin structure above and below the trim tab drive slot indicated that the left tailplane tab drive pin had become disconnected from the 'T' bar within the fin and had been moving beyond its normal range of movement prior to the tailplane becoming detached. Given that the tailplanes has been partially de-rigged at Bodmin, tests were carried out on another Europa to determine if it would have been possible to re-rig the tailplanes without engaging the trim tab drive, allowing the tab to be unrestrained. These test showed that the pin on the inboard edge of the tab could sit on top of the input drive 'T' bar and, when the tailplane was moved, the tab would move in a manner similar to that when properly engaged. The application of a very small load (a gentle push with a finger) caused the tab pin to slide off the 'T' bar, allowing the tab to drop. Discussions with pilots involved in the flight testing of the Europa confirmed that in cases where this has happened, pilots have become aware of a significant change in the control forces either during or shortly after takeoff but have also been able to land the aircraft successfully. Significant damage was found on the tailplane tab hinges and the tab drive pins, which appeared to be characteristic of the presence of a vibratory load. The Flettner strips on the trailing edge of the tailplane tabs were measured and found to be at or just below minimum depth requirements of the Build Manual. In view of the rebuilding of the Flettner strips and the re-bonding of the tailplane drive bushes, together with the play found between the tailplane input arm and the torque tube, a microscopic examination of the tailplanes, tabs and torque tube was carried out to determine if aerodynamic flutter or another vibratory condition had been present in the tailplane system. This examination confirmed that all the damage identified on the tailplane input arm, the tab hinges and the tab drive pins was caused by the break-up of the aircraft and there was no evidence of aerodynamic flutter originating within the tailplane system.

Wing

The left wing, together with its flap, was found to be complete; however the right wing had suffered from significant 'peeling' of the inboard rear skins, together with the loss of approximately 35% of its foam infill. The right flap had failed 280 mm from its inboard edge and had separated from the remains of the right wing. The damage observed to the aileron control circuits was consistent with the break-up of the aircraft and no evidence of restriction or pre-accident disconnection was found. The left wing spar was found to be intact but the right spar had failed at the point where it entered the fuselage, the failure being characteristic of torsional overload.

Both the left and right wing lift pins had failed together with the drag pin of the left wing. The mountings for these pins, together with the threaded portion of the pins, remained in place in their respective wing ribs. Examination of the fracture surfaces of the pins showed that they had all failed due to the application of large cyclic bending loads. A section of the right wing inboard rib which contained the right drag pin mounting was recovered from the accident site some distance from the remains of the right wing. The mounting structure of the pin, which consists of several aluminium plates laminated together (including the one which hinges the flap), appeared to have failed due to the application of a tensile load. The innermost (closest to the wing rib) plate and flap plate remained in situ, but the outer two plates (closest to the fuselage) had been deformed and pulled away from the structure, see Figure 6. The outermost plate together with the right drag pin remained attached to its mounting point on the fuselage. The corresponding mount was removed from the left wing for comparison. This showed that whilst the left wing mount had been constructed in accordance with the Europa Build Manual, the right mount had not. The laminated plates of the right drag pin mount had become staggered during the lay-up, so that the forward edge of the outermost plate (closest to the fuselage) had been placed 5.5 mm ahead of the edge of the plate immediately below it, and that plate was 3 mm further forward of the innermost (closest to the rib) plate. The forward edge of the innermost plate was aligned with the forward edge of the flap hinge plate. The hole had also been drilled 2.5 mm forward of the vertical centreline of the outermost plate. This had reduced the edge clearance of the hole in that plate from 7.5 mm to 5 mm.

Due to the staggered lay-up of the mount, the edges of all of the subsequent laminations had been breached. The edges of the innermost plate and flap hinge plate had been breached to the extent that the hole consisted of little more than a semi-circular cut-out of the forward edge. The description of how to assemble the lift and drag pin mounts, given in the Europa Build Manual issued at the time of the aircraft's construction, requires that all three plates are laid up at the same time and does not show any method of maintaining the alignment of the assembly while it cures. It does however provide the following advice:

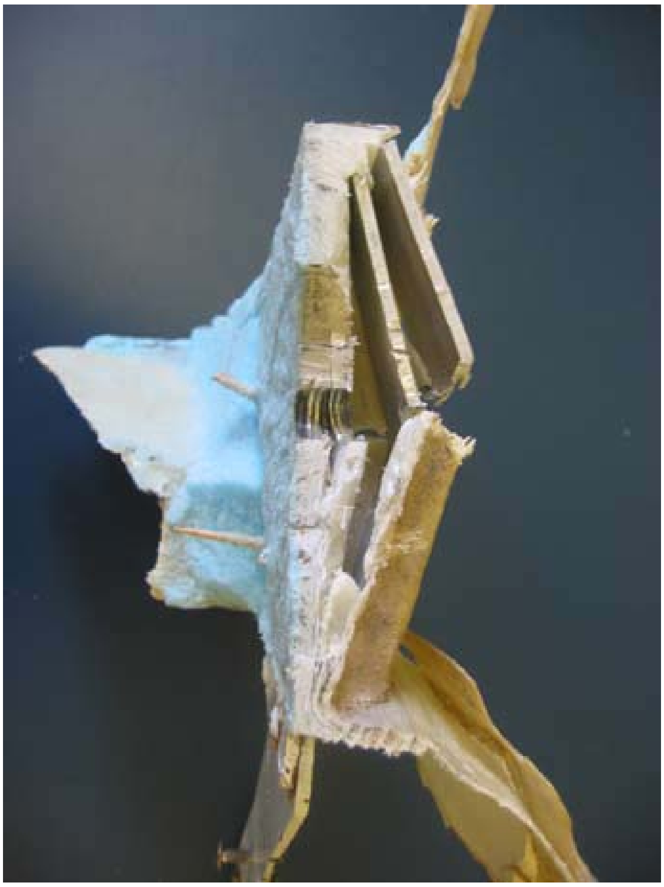

Figure 6

'Make sure that the plates don't move until the layup has cured. If there has been some displacement of the plates during layup, carefully reposition them through the laminate before it starts to harden'.

The method detailed in the Europa Build Manual chapter 29 for drilling and tapping the completed mount to accept the threaded lift pin, places reliance upon sighting the drill against visual markers on the wing spar and a straight edge taped to the upper surface of the wing to ensure that the hole is drilled correctly. The accuracy of such methods can vary depending on the degree of accuracy of the position of the eye line, drill and visual marker. Comparison of the left and right lift pin mounts confirmed that in their completed state both mounts would have looked identical, with no evidence of internal misalignment. The PFA confirmed that these mounts would only have been inspected on completion of the wing, when it would have been difficult to detect any misalignment of the plates.

In order to determine the load-carrying capability of the incorrectly built joint, a tensile load test was carried out using two test specimens, one replicating the construction of G-HOFC's right drag pin mount, and one constructed in accordance with the build manual. Due to the limitations of the test equipment the full range of loads experienced by the drag pin could not be reproduced and the tests were limited to the determination of the ultimate tensile strength of the specimens. The results from the test confirmed that both test specimens were capable of holding the unfactored tensile design limit load of 10.03 kN without failure. The test was then repeated and both specimens loaded until they failed. Examination of the specimen replicating G-HOFC's right rear pin mount showed that the innermost (closest to the rib) plate had pulled away from the GRP surface of the specimen, bending under the load, which had disrupted the bond with the next plate, see Figure 7. This showed that the inner plate of the test specimen had carried a significant load prior to disbonding. The damage observed to G-HOFC's right

Figure 7

rear lift pin mounting suggested that it had not been subject to a similar load. Therefore measurements were taken of G-HOFC's rear right lift pin and lift pin mount. These measurements showed that the lift pin was dimensionally correct (12 mm diameter) and that the thread had been cut to the required depth of 2 mm through all of the lamination plates. The diameter of the hole in the outer plate of the mount met the requirements of the Europa Build Manual. Measurement of the second plate confirmed that the partially complete hole within it had been 10 mm in diameter. However, there was some distortion and 'opening' of its circumference where the hole breached the edge of the plate. The partial holes through the innermost plate and the flap plate had become distorted and were found to have a diameter of 11.62 mm. The magnitude of this distortion would have significantly reduced their ability to carry loads from the drag pin and allowed a degree of movement of the pin within the mounting. This, together with the distortion to the second plate, would have meant that the majority of the tensile loads within G-HOFC's right drag pin mounting would have been carried by the outermost plate alone, whereas the undistorted holes in the test specimen allowed load to be carried by all the plates.

At the time of the accident, the pilot was properly licensed and qualified to conduct the flight and the aircraft was being operated within the permitted weight and balance limits. So far as could be determined, the aircraft was compliant with all of the applicable mandatory requirements and had been maintained in accordance with the requirements laid down by the PFA.

Up until the point when the aircraft made a sharp left turn some 3.5 nm north-east of Magor, the flight appears to have been uneventful. The pilot had not reported any abnormalities either at Bodmin or during radio communications with Cardiff. He had extended his flight beyond the point where he would normally have joined the circuit to land at Uckfield Farm. The reason for this is not known but it is possible that he simply wanted to extend the flight in the local area.

No apparent reason was established for the sharp left turn. No other aircraft were known to be in the area at that time or were observed on radar. A scatter of radar returns were seen simultaneously at a position 30 seconds before the turn and at the time the aircraft manoeuvred into the turn. It is possible, therefore, that the pilot may have been avoiding a flock of birds. It is also possible that the pilot, seated on the left, may have made a steep turn to the left in order to check the airspace below visually prior to his descent. The aircraft maximum positive load factor is restricted to +3.8g and the load experienced during the tight left turn should not have exceeded that limit. The V_{NE} limit of 165 kt was not exceeded and the speed did not reduce below the stalling speed.

The wreckage trail confirmed that the aircraft had suffered a catastrophic in-flight structural failure. The aircraft had not struck the nearby overhead electricity lines. There was no evidence of a pre-accident restriction or disconnection of the flight control circuits. The engine showed no evidence of mechanical failure and the staining of grass and the strong odour of fuel at the crash site confirmed that fuel had been present in the aircraft at the time of the accident.

The width of the plates used in G-HOFC to make up lift and drag pin mounts provided little margin for error in either the lay-up of the joint or the subsequent drilling and tapping. The method detailed in the build manual to ensure that the hole drilled in the mount was correctly aligned was reliant on alignment with visual cues and therefore open to some inaccuracy. The forward stagger of the right wing drag pin mounting had resulted in the formation of incomplete holes in all but one of the plates. When the lay-up was completed there would have been no means of identifying the defects within the right wing drag pin mount prior to its failure. Whilst tests confirmed that it was probable that the mounting would have been able to carry its designed load when originally constructed, distortion of the mis-formed holes, due to normal loads experienced during the aircraft's operation, would have resulted in the progressive weakening of the internal structure of the mount.

Failure of the right wing drag pin mounting would have allowed the rear portion of the wing to become unrestrained. This would have allowed the rear portion of the wing to move both vertically and, to some degree, fore and aft. The lack of torsional stiffness would also have resulted in variations in the lift developed by the inboard section of the right wing, with resulting changes in the aircraft's pitch and roll. As the right wing flap was connected to its fuselage mounted actuation bar, any vertical movement of the wing trailing edge would result in a change in the relative angle of the flap and wing increasing the forces acting on the aircraft. These conditions would have introduced large static and dynamic forces in the wing which would have resulted in the aircraft oscillating violently in pitch, and would also have generated large forces within the tailplane system. The evidence suggests that these forces were of sufficient magnitude to distort the tailplane drive pins, causing the failure of the tailplane retention system which allowed first the right and then the left tailplane to become uncontrollable. The subsequent torsional load on the wing resulted in the failure of the right wing spar. Examination of the tailplanes, trim tabs and the torque tube confirmed that aerodynamic flutter did not appear to have originated in these components.

Whilst the sharp left turn would have increased forces on the wing, the catastrophic failure did not occur at that point in the flight. The position of the aircraft relative to Uckfield Farm was close to the point where the combined flap/landing gear would be lowered. The maximum flap extension speed is promulgated as 83 kt. It is possible that the flap/landing gear selector operating handle was moved to the DOWN position and, as a result of the change in aerodynamic forces the first stages of the break-up may have occurred at that point. If so, releasing the operating handle before it was in the DOWN position would cause the flaps and landing gear to retract and the handle to move to the UP position, where they were found.

Alternatively the pilot may have experienced the first indications of the break-up as an airframe vibration or some form of flutter and made the sharp left turn to return to Uckfield Farm. Whatever the indications or lack of them in the last few minutes of the flight, the break-up was sudden, catastrophic and rendered the aircraft uncontrollable. The accident was not survivable.

Safety action

Following the release of AAIB Special Bulletin S3/2007, and discussions between the AAIB and PFA, the PFA issued two Flight Safety Bulletins, PFA247/FSB006 '*Europa Classic And Europa Xs Tailplane Flutter Avoidance And Integrity Of Tailplane Attachment*', and PFA 247/FSB007 '*Europa Classic Integrity Of Wing Attachment*' , which were subsequently supported by the CAA Mandatory Permit Directives MPD 2007-005 and MPD 2007-006.

In addition to the above, in August 2007, Europa Aircraft issued two mandatory modifications to address the issues identified in the investigation, Modification No 73, 'Improved bonding of tailplane sleeves' and Modification No 74, 'Improved rear lift pin mounting'. As a result of these actions, which adequately addressed the build problem and mandated inspections of aircraft already completed, no further safety recommendations are made.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-161 Cherokee Warrior II, G-BODC
No & Type of Engines:	1 Lycoming O-320-D3G piston engine
Year of Manufacture:	1988
Date & Time (UTC):	17 November 2007 at 1025 hrs
Location:	Sherburn-in-Elmet Airfield, Yorkshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Burst nosewheel tyre, damage to nose leg and engine frame
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	25 years
Commander's Flying Experience:	746 hours (of which 430 were on type) Last 90 days - 226 hours Last 28 days - 66 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The instructor was demonstrating a short field landing in a crosswind. The aircraft encountered windshear on short finals and landed heavily on all three wheels. The nosewheel tyre burst and some damage occurred to the nosewheel assembly and engine frame.

History of the flight

At the end of a training flight the instructor was demonstrating a short field approach and landing onto the asphalt surface of Runway 29; the aircraft weight was 960 kg. The weather conditions were good with the surface wind estimated to be from 250º at 11 kt. The approach was flown with the aircraft heading offset to the left to compensate for the crosswind. The instructor reported that during the last 300 ft of the approach he reduced the airspeed to around 55 kt, at which speed the stall warning horn was initiated. Just prior to touchdown the aircraft encountered windshear and the rate of descent increased. The pilot eased the control column back but there was little elevator authority remaining and the aircraft landed heavily on all three wheels, facing to the left of the runway heading. The aircraft was brought to a halt, but the pilot experienced some difficulty in steering the aircraft and the nose appeared lower than normal. He radioed for assistance and shut the aircraft down. An inspection revealed that the nosewheel had burst causing some damage to the nosewheel assembly and engine frame.

Comment

The pilots' operating handbook for the PA-28-161, states that the initial approach speed should be about 70 kt, with a final approach speed of 63 kt. During the landing flare the speed should then be reduced to the minimum possible safe speed consistent with the existing conditions. The recommended technique for a short field landing is to maintain the final approach speed until the flare, and reduce speed during the flare to close to the stalling speed. There is a graph which provides the best approach speed, and the stalling speed, for various weights. At 960 kg, the recommended approach speed, which should be maintained until the flare, is 62 kt.

ACCIDENT

Aircraft Type and Registration:	Reims Cessna FRA150M Aerobat, G-BFGZ
No & Type of Engines:	1 Continental Motors Corp O-240-E piston engine
Year of Manufacture:	1977
Date & Time (UTC):	10 February 2008 at 1140 hrs
Location:	Popham Airfield, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Collapsed nose leg, bent propeller and damaged cowling
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	38 years
Commander's Flying Experience:	9,312 hours (of which 20 were on type) Last 90 days - 223 hours Last 28 days - 80 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The nose gear collapsed after landing.

History of the flight

The pilot, who was very experienced on large public transport aircraft, had recently returned to light general aviation and had only 20 hours on type. Popham is an unlicensed, grass airfield with two runways: 08/26 and 03/21. Following a normal approach to Runway 08, the aircraft landed and, during the deceleration, the aircraft bounced and the nose leg collapsed. The airfield was operational again approximately 15 minutes after the accident, with no significant damage to the runway. The pilot attributed the accident to the uneven and soft runway surface.

Weather

The pilot reported the weather as being CAVOK with the wind calm. This concurs with an aftercast supplied by the Met Office, in which the wind was estimated to be from 100º at 5 kt at the time of the accident, and with no cloud below 25,000 ft.

AAIB comment

The pilot was operating in a very different environment from that which he encountered in airline operations. His lack of recent experience with light general aviation aircraft, and his few hours on the aircraft type might have been factors in this accident, particularly when the demands of grass field operations are taken into consideration.

ACCIDENT

Aircraft Type and Registration:	Robinson R22 Beta, G-DODR
No & Type of Engines:	1 Lycoming O-320-B2C piston engine
Year of Manufacture:	1990
Date & Time (UTC):	14 December 2007 at 1125 hrs
Location:	Cranfield Aerodrome, Bedfordshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Substantial
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	33 years
Commander's Flying Experience:	447 hours (of which 340 were on type) Last 90 days - 26 hours Last 28 days - 15 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The student pilot was conducting an early hovering exercise when the aircraft's right skid came into contact with the ground and the aircraft rolled over. The aircraft was extensively damaged. The student pilot was uninjured and his instructor received only minor injuries.

History of the flight

The student pilot and his instructor were conducting an early hovering exercise. The weather conditions were described as suitable, and the aircraft was positioned over a large clear area with good visual references. The student had already demonstrated his ability to control simultaneously the aircraft's heading with the yaw pedals and its height with the collective, when he progressed onto cyclic control. For this exercise the student had control of the cyclic and attempted to maintain his position over the ground, whilst the instructor had responsibility for maintaining the aircraft's height and heading.

The instructor described the student's progress as good. Whenever the student drifted from the allocated area the instructor took full control and repositioned the aircraft in the centre of the area, allowing the student to take control of the cyclic again, from a stable hover. During this hover exercise the right skid made contact with the ground and the aircraft rolled over, coming to rest on its left side. The instructor switched the aircraft battery power off, selected the fuel mixture to lean and both occupants then exited the aircraft. The emergency services were quickly on the scene and took the crew to hospital where they were released a short time later. The aircraft suffered substantial damage.

Comment

The primary responsibility of an instructor is, as the captain of the aircraft, to ensure the safety of the aircraft and its crew. From this safe environment the instructor must then teach the student. It appears that, on this occasion, the instructor allowed himself to become overly focussed on the training.

ACCIDENT

Aircraft Type and Registration:	Pegasus Quantum 15, G-BZJF
No & Type of Engines:	1 Rotax 582-40 piston engine
Year of Manufacture:	2000
Date & Time (UTC):	26 August 2007 at 1920 hrs
Location:	Knotting Wood, near A6 Northamptonshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Fatal) Passengers - 1 (Fatal)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	38 Years
Commander's Flying Experience:	37 hours (all of which were on type) Last 90 days - 8 hours Last 28 days - 2 hours
Information Source:	AAIB Field Investigation

Synopsis

The microlight aircraft suffered an in-flight break-up, causing fatal injuries to the two occupants. Examination of the wreckage revealed damage consistent with the aircraft having entered a tumble; a rapid, uncontrolled pitch rotation usually resulting in structural failure. Insufficient evidence was available to allow the cause of the tumble to be determined, although mechanical failure could be ruled out as a contributory factor.

History of the flight

The pilot arrived at Sackville Farm Airstrip at approximately 1600 hrs with three acquaintances. With their assistance he moved G-BZJF from its hangar, where it was kept fully rigged, and prepared it for flight, including refuelling the fuel tank to full. He then flew three flights, one with each of his acquaintances. The accident flight departed Sackville Farm at 1850 hrs with approximately half a tank of fuel remaining. The passenger on this flight knew the pilot well and had flown with him before. At 1920 hrs the aircraft was seen manoeuvring approximately two miles west of the airfield. This series of manoeuvres ended in a turn during which the wing and trike separated and the pilot was ejected from the trike. Several witnesses to the accident went immediately to the scene and called the emergency services. Both occupants were fatally injured in the accident.

Previous flights

The passengers from the flights conducted on the day of the accident were interviewed. They believed the pilot of G-BZJF carried out thorough checks of the microlight before departure. During both previous flights the pilot conducted a series of manoeuvres including steep turns, climbs and dives. The overriding impression of the passengers was that the pilot was confident and enjoying his flying.

Witnesses to the accident flight

An eyewitness in the village of Sharnbrook, two miles south of the accident site, saw G-BZJF executing pitching and turning manoeuvres that appeared well controlled. As it turned towards the witness it seemed to be descending and then pulled up into a climbing left turn. This turn continued through 360° and as G-BZJF began a second turn, the microlight trike and the wing separated. The trike and the pilot were seen to fall to the ground with the wing descending separately in a porpoising motion.

Other witnesses described hearing a loud bang similar to a gunshot which attracted their attention to the microlight. They saw a black object falling vertically to the ground followed by the wing. The wing was described as "folding a couple of times" before spiralling downwards. Further witnesses report the wing spiralling down separately from the trike.

Weather

Several pilots who flew from Sackville Farm that evening described the weather conditions as excellent visibility and light winds. The weather report for Luton Airport (approximately 20 miles to the south) at 1920 hrs was a wind of 210º/6 kt, no cloud below 5000 ft, greater than 10 km visibility and a temperature of 23ºC.

Pathology

Post-mortem examination confirmed that the occupants died of multiple injuries sustained on impact. The accident was considered non-survivable and it is unlikely that any additional or alternative restraint would have saved the occupants' lives.

Pilot history

The pilot commenced NPPL (M) training at Sackville Farm in November 2006. He completed the training in May 2007 having achieved a consistently high standard throughout. As part of his training he had conducted turns of up to 60º angle of bank with an instructor on 21 April 2007 and "unusual and dangerous attitudes training" on 22 April 2007 . He was cleared for solo practice of steep turns although there is no record of him doing so during the remainder of his training. He again demonstrated both steep turns and unusual attitude recovery as part of his General Skills Test (GST) for issue of his licence on 22 May 2007 . The instructor who had conducted his training was also qualified as an examiner and carried out the GST on the pilot. The GST requires turns with 60º bank in both directions and recovery from two unusual attitudes. The first unusual attitude was nose-high with some bank applied and the second was a spiral dive. During the pilot's training, the tumble condition was briefed as part of unusual and dangerous attitude training. The pilot's licence was issued on 7 June 2007 and he had flown 10 flights since, all of which were on the accident aircraft. The owner of the flying school had been impressed with his ability during training and had suggested to the pilot that when he gained sufficient experience he should consider becoming an instructor.

Training notes

Students at the pilot's training school are provided with a copy of "*Briefing Notes – Flexwing*". Exercise 14

'Advanced Turning', states:

> *'Significant wake turbulence is produced in a steep turn – above 45 degrees of bank in a level turn limit the heading change to 270 degrees.'*

Exercise 15 lists a range of general flexwing limitations and the likely consequences of exceeding these. It also mentions the likely causes of unusual/dangerous attitudes. These include wake turbulence, mishandling of controls during stall recovery or a steep turn, and deliberately attempting manoeuvres outside the limits of the aircraft and/or pilot.

Pegasus Quantum flight manual

The Pegasus Quantum flight manual states that the aircraft must be operated in compliance with the following limitations:

> *'Do not exceed more than 60° of bank.*
> *Do not pitch nose up or nose down more than 45° from the horizontal.*
> *ALL aerobatic manoeuvres... are prohibited.'*

Aircraft information

Background information

The aircraft was a Pegasus Quantum 15 microlight aircraft, serial number 7696, manufactured in July 2000. It held a current Permit to Fly, valid until 20 July 2008 and had completed approximately 1,060 flying hours since new.

Aircraft description

General

The Pegasus Quantum 15 is a two-seat, weight shift controlled flexwing microlight aircraft (Figure 1). It consists of a wing, constructed of fabric and aluminium alloy tubing and braced by steel cables, and a 'trike' unit incorporating a tricycle undercarriage, rear-mounted engine and seating for two occupants in tandem configuration. The aircraft is normally flown from the front seat. The limitations placard on the aircraft states that the aircraft is non-aerobatic and that positive 'G' loading must be maintained at all times.

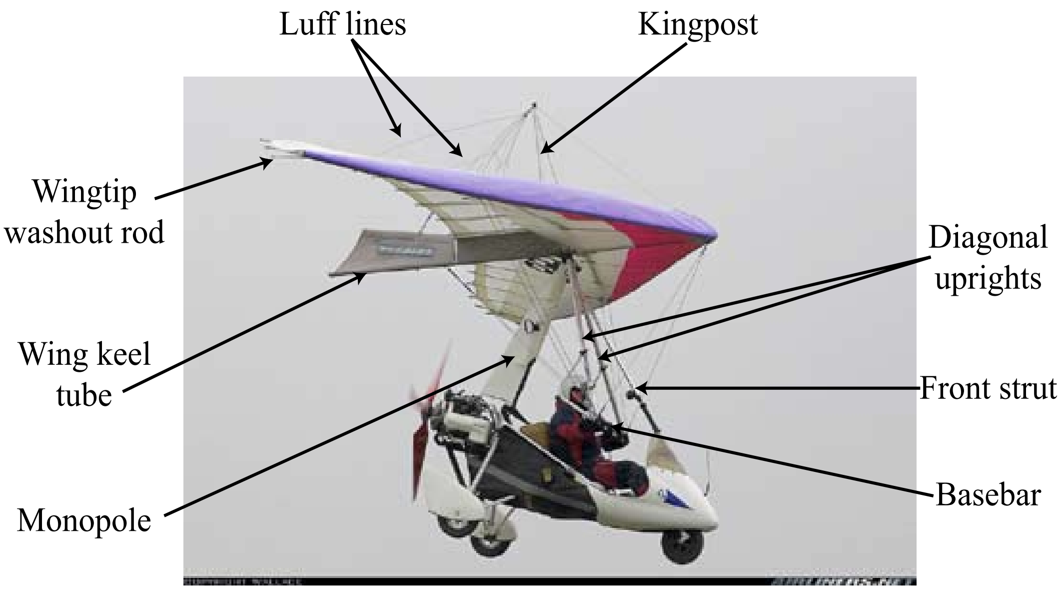

Figure 1

Pegasus Quantum 15 Microlight

Trike construction

The trike is constructed of extruded aluminium alloy box sections, with a fabricated steel engine mounting frame and undercarriage. The main structural elements comprise the keel tube, to which the major components are attached and the monopole, which is enclosed within an aerodynamic fairing. The keel tube and monopole are braced by a tubular aluminium alloy front strut, which is made up of inner and outer tubes. An instrument panel is incorporated in a moulded fibreglass fairing at the front of the trike. The pilot is secured by a three-point harness and the rear occupant by a four-point static harness.

The wing is attached to the top of the monopole by a U-shaped 'hang' bracket, which allows the wing to articulate in pitch and roll. A safety strap running inside the monopole further connects the wing to the trike and is intended to prevent the two from separating if the monopole fails. The monopole can be folded down for transport and it is locked in the upright position by an overcentre clamp incorporating a nylon roller which bears on the front face of the monopole.

Wing construction

The primary structure consists of a series of aluminium alloy tubes, the main elements being the central keel tube and the leading edge tubes, with bracing provided by cross tubes. The leading edge and keel tubes are attached to an aluminium alloy noseplate fitting at the apex of the wing. Upward loads are opposed by steel cables attached between the wing tubes and the ends of the basebar of the 'A' frame below the wing. Downward loads are opposed by cables between the wing tubes and a kingpost above the wing. The wing skin is formed from polyester fabric stretched over the tubes and obtains its curved profile from pre-shaped fibreglass and tubular aluminium alloy battens inserted into pockets in the fabric. A vertical fabric 'fin' extends aft of the wing.

Aircraft controls

The pilot controls the aircraft via the 'A' frame, which comprises a horizontal basebar and two diagonal uprights attached to the hang bracket. Steel cables are attached between the ends of the basebar and the front and rear of the wing keel tube, so that moving the basebar fore and aft causes the wing to tilt up and down, changing the amount of lift produced. The aircraft is turned by moving the basebar to the left or right. The range of forward movement of the basebar and thus the degree of upward tilt of the wing is limited by the presence of the front strut. The geometry is such that even with the basebar fully forward and in contact with the front strut, the rear of the wing keel tube remains clear of the propeller arc.

The engine speed is controlled via a foot operated throttle pedal. A hand throttle on the left side of the trike allows a constant throttle setting to be selected without the need to maintain pressure on the throttle pedal.

The pilot can adjust the trimmed speed of the aircraft via a trim wheel on the right-hand 'A' frame diagonal upright. This varies the length of steel cables or 'luff lines' attached to the trailing edge of the wing, thus changing the wing's aerodynamic characteristics. The luff lines are routed through a group of pulleys attached to the top of the wing kingpost.

Wreckage and impact information

Accident site location

The aircraft wreckage was located in a partly ploughed field just to the east of the A6, approximately two miles southeast of the town of Rushden in Northamptonshire. From the wide separation of the wing, trike and pilot's body, it was evident that the aircraft had broken up in flight.

On-site wreckage examination

The trike came to rest approximately 93 m to the east of the pilot's body. The passenger was still securely strapped in the rear seat. The trike had impacted the ground inverted and tail first, with a high vertical speed, causing the engine to become deeply embedded in the soil. The contents of the fuel tank had leaked out, but a strong smell of fuel at the site suggested that there had been a significant quantity of fuel on board. The wing, which was largely intact with the 'A' frame and a large section of the monopole still attached to it, came to rest inverted, partly folded up, approximately 289 m to the south of the trike. The basebar and right-hand upright of the 'A' frame had failed. The trim control was at the 'TAKE OFF' (mid-range) setting.

Most of the damage to the aircraft was ground impact related, although other damage was found which, given the wide spread of the wreckage, could only have occurred in the air.

The front strut had failed, with the upper and lower portions remaining attached to the wing and the trike, respectively. The pilot had sustained a wound to the front of his head, consistent with having struck the fractured end of the upper portion of the strut. The monopole had failed at the locking clamp location, leaving an approximately 150 cm long section of it attached to the wing; the rest of the monopole was still attached to the trike. Multiple paint transfer marks, indentations on the rear of the wing keel tube and cuts in the fabric of the fin were indicative of the propeller blades having struck the rear of the wing whilst the propeller was turning (Figure 2).

All of the major components of the aircraft were accounted for and the aircraft appeared to have been correctly assembled.

Figure 2

Propeller strike marks on wing keel tube

Detailed wreckage examination

Trike examination

The aircraft wreckage was recovered to the AAIB's facility for more detailed examination. It was reconstructed to enable the in-flight damage to be correlated with the aim of determining the sequence of the break-up.

Examination of the 'A' frame basebar revealed that it had failed in bending after having struck the rear of the front strut with considerable energy. The force of this impact was sufficient to bend the front strut tubing. The failure of the right-hand upright of the 'A' frame was consistent with ground impact damage. The front strut had failed in compressive overload in the middle of the strut, some distance above the bend caused by the basebar impact.

From the deformation of the material in the area of the failure (Figure 3), it was evident that the monopole had been exposed to large bending loads in the fore and aft directions prior to failure. The stitching in the upper loop of the safety strap had subsequently failed in overload, causing the wing and trike to separate in the air.

The right-hand lap-strap of the pilot's harness had failed in overload where it passed through the seat pan. The buckle was still fastened and operated correctly when tested. The pilot had not worn the shoulder strap; this was found stowed inside the trike.

Wing examination

Distortion and fractures of the noseplate fitting indicated that the wing folded upwards following the failure of the basebar. It was also apparent that the wing had been exposed to very high negative (ie downward) loading at some point in the break-up sequence. This was indicated by downward distortion of the tip washout rods and 'kinking' of the luff line cables where they passed through

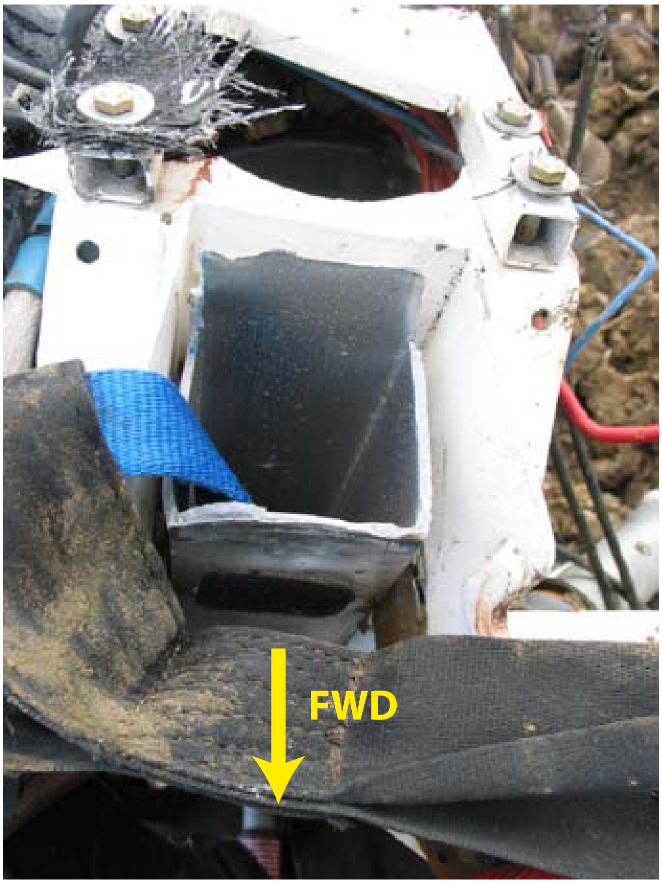

Figure 3

Monopole failure

the pulley wheels. The aft sections of the No 6 wing battens (left and right) were also bent upwards due to the rear of the battens having been restrained by the outer luff lines as the rest of the wing deflected downwards under the negative loading.

Engine and propeller examination

The damage suffered by the engine in the ground impact was such that it could not be run. It was therefore stripped as necessary to evaluate its mechanical condition.

Both the engine and gearbox rotated freely and both cylinders produced good compression. The spark plug electrodes were in good condition and their colour indicated that the air/fuel mixture was correct. No mechanical failures, evidence of excessive wear, overheating or seizure was found on the engine internal components. Significant quantities of clean oil were found in both the engine and the reduction gearbox. A small amount of residual fuel remained in the carburettor bowls and the inlet filters were clean. One propeller blade was completely severed at the blade root and another was almost completely severed. Two blades exhibited localised leading edge damage and deformation consistent with having struck the wing keel tube.

All the damage to the engine was consistent with ground impact and it appeared otherwise capable of running.

Metallurgy

The fractures of the monopole, front strut, basebar and right 'A' frame upright were examined. The failures were found to be consistent with rapid overloading of the structure. No pre-existing defects, such as fatigue, were found that could have contributed to the failure of these components.

Material properties tests were performed on samples taken from the basebar, monopole, front strut and right diagonal upright, all of which are manufactured of aluminium alloy equivalent to specification 6082-T6. The results showed that the material composition of the samples was consistent with that of a 6082-series alloy; however the 0.2% proof stress values for the monopole and inner front strut were slightly deficient, being 1.2% and 2.0% lower than the minimum specified value of 250 MPa. The results for the control bar and front strut outer tube were above the minimum specified value.

Aircraft maintenance history

A review of the airframe and engine logbooks showed that detailed, up-to-date maintenance records were kept by the owner. There were no recorded outstanding defects at the time of the accident. The aircraft was inspected and check flown on 13 July 2007 by a BMAA Inspector for the purposes of renewal of the Permit to Fly. No anomalies were noted during this inspection and the check flight was completed satisfactorily. The flight check included evaluation of the aircraft's handling characteristics at high and low speeds, its behaviour in wings level power-off stalls and in stalls in 30 degree banked turns to the left and right.

On 2 August 2007, the engine suffered a loss of power on climb out due to crankshaft and big end bearing damage, following which the engine was replaced. At the time of the accident, the aircraft had completed several flights since the engine replacement with no reported engine problems.

Microlight tumbling

The tumble is a departure from controlled flight whereby the angular momentum of the aircraft causes the microlight to rotate about its pitch axis with a very high angular velocity and acceleration; pitch rates of over 360° per second and transient accelerations of 8g are not unknown. During the tumble the forces are so great that the basebar normally hits the front strut with sufficient force to cause either the basebar or front strut to fail. A tumble normally results in the break up of the aircraft and the occupants to be fatally injured. There is no known recovery technique from a tumble. Mechanical failure aside, there are believed to be four ways of inducing a tumble:

- The whip-stall
- Spiral instability combined with loss of visual horizon
- Failed aerobatic manoeuvre
- Flight through severe turbulence or wake vortex

Previous events

The only other tumble event to a Pegasus Quantum is known to have occurred in Michigan USA in 2000. Approximately 800 Quantum aircraft have been produced to date.

Analysis

Wreckage evidence

From the site and wreckage examination it was determined that the aircraft had been correctly assembled, was structurally intact and that the engine was running at the time of the accident. Examination of the failed components did not identify any pre-existing defects that could account for the apparently sudden and violent break up of the aircraft in flight and there were no current defects recorded in the aircraft technical documentation.

Assessment of the in-flight damage suggested that the first event leading to the break up was the failure of the 'A' frame basebar due to impact with the front strut, which damaged the basebar tube and precipitated its failure in bending. This would have immediately rendered the aircraft uncontrollable and also have allowed the wing to tilt sufficiently nose-up to cause the rear of the keel tube to come into contact with the propeller. The multiple impact marks on the keel tube indicate that the propeller was turning at the time. To cause a compressive overload failure of the front strut, the wing must have experienced a high negative loading during the failure sequence and the monopole must have been intact in order to transfer the compression load into the front strut. The failure of the monopole must therefore have occurred after the failure of the front strut. The wound on the pilot's head caused by contact with the upper part of the front strut shows that he remained in the aircraft well into the breakup sequence. The subsequent overload failures of the pilot's lap strap, the monopole and the safety strap are further indications that the aircraft had entered an uncontrolled flight regime as it was being subjected to loads well in excess of those for which it had been designed.

The nature of the failures of the basebar, front strut and monopole and the distortion of the No 6 wing battens, washout rods and luff lines indicate that the aircraft was subjected to violent alternating upward and downward loading during the break-up sequence. These failures are characteristic of those produced in a tumble.

The basebar material strength was above the minimum specification value and given that this was the first component to fail, material deficiency could be ruled out as an initiating factor of the in-flight break-up. Although the strengths of the monopole and front strut inner tube were very slightly below the minimum specification, no evidence was found in either component of any pre-existing failures, such as fatigue. The slight deficiency is not thought to have been significant as the loads encountered during the break-up sequence were clearly grossly in excess of the design loads for these components.

There is insufficient evidence to ascertain what led to the tumble although there is no evidence of mechanical failure being the cause. The current BMAA syllabus covers unusual and dangerous attitudes and conditions which could lead to tumble entry and the pilot had received training in accordance with this syllabus. Witness evidence suggests that he may have turned through more than 270° and placed the aircraft in its own wake turbulence but the angle of bank used in that turn is not known and therefore the degree of turbulence cannot be assessed. However, the witness may have observed what was intended to be a spiral climb, which is an accepted method of gaining height. Flying through significant turbulence or wake vortex is though, one way of inducing a tumble. Training of the pilot and awareness of what can cause a tumble remain the primary means of defence against this condition.

AIRCRAFT ACCIDENT REPORT No 5/2008

This report was published on 29 April 2008 and is available on the AAIB Website www.aaib.gov.uk

REPORT ON THE ACCIDENT TO BOEING 737-300, REGISTRATION OO-TND AT NOTTINGHAM EAST MIDLANDS AIRPORT ON 15 JUNE 2006

Registered Owner and Operator:	TNT Airways Limited
Aircraft Type:	Boeing 737-300
Nationality:	Belgian
Registration:	OO-TND
Location of Accident:	Nottingham East Midlands Airport
Date and Time:	15 June 2006 at 0440 hrs All times in this report are UTC

Synopsis

The accident was reported to the AAIB by Air Traffic Control following the emergency landing of the aircraft at Birmingham International Airport. The investigation was conducted by:

Mr P T Claiden	(Investigator-in-Charge)
Ms G M Dean	(Operations)
Mr R W Shimmons	(Operations)
Mr J R McMillan	(Engineering)
Mr M P Jarvis	(Engineering)
Mr P Wivell	(Flight Recorders)

On a scheduled cargo flight from Liège Airport to London Stansted Airport the crew diverted to Nottingham East Midlands Airport[1] due to unexpectedly poor weather conditions at Stansted. The weather conditions at EMA required a CAT IIIA approach and landing. On approach, at approximately 500 feet agl, the crew were passed a message by ATC advising them of a company request to divert to Liverpool Airport. The commander inadvertently disconnected both autopilots whilst attempting to reply to ATC. He then attempted to re-engage the autopilot in order to continue the approach.

The aircraft diverged to the left of the runway centreline and developed a high rate of descent. The commander commenced a go-around but was too late to prevent the aircraft contacting the grass some 90 m to the left of the runway centreline. The aircraft became airborne again but, during contact with the ground, the right main landing gear had broken off.

The crew subsequently made an emergency landing at Birmingham Airport (BHX).

Footnote

[1] Commonly known as East Midlands Airport, and referred to as EMA in this report.

The investigation determined the following:

Causal factors:

1. ATC inappropriately transmitted a company R/T message when the aircraft was at a late stage of a CAT III automatic approach.
2. The commander inadvertently disconnected the autopilots in attempting to respond to the R/T message.
3. The crew did not make a decision to go-around when it was required after the disconnection of both autopilots below 500 ft during a CAT III approach.
4. The commander lost situational awareness in the latter stages of the approach, following his inadvertent disconnection of the autopilots.
5. The co-pilot did not call 'go-around' until after the aircraft had contacted the ground.

Contributory factors:

1. The weather forecast gave no indication that mist and fog might occur.
2. The commander re-engaged one of the autopilots during a CAT III approach, following the inadvertent disconnection of both autopilots at 400 ft aal.
3. The training of the co-pilot was ineffective in respect of his understanding that he could call for a go-around during an approach.

One Safety Recommendation is made.

Findings

1. The flight crew were properly licensed and medically fit to conduct the flight.
2. The flight crew flew the aircraft within the operator's normal Flight Time Limitations scheme limits.
3. The performance of both pilots may have been adversely affected by tiredness, as a result of the combined effects of their overnight periods on duty and the low point in their circadian rhythm.
4. The flight crew conducted their pre-flight planning thoroughly, taking into account the work in progress at Stansted and the weather forecasts for southern England.
5. A number of unusual events, from the flight crew's perspective, occurred during the flight prior to the accident, which contributed to an increased workload and their subsequent loss of situational awareness.
6. The weather forecasts for southern England did not correspond to the actual conditions. The possibility of fog or weather conditions, which would prevent an approach at Stansted or require a CAT III approach at EMA, was not forecast and was not a planning consideration for the crew.
7. The aircraft's documentation was in order and there were no outstanding defects recorded in the technical log.
8. The aircraft was loaded with sufficient fuel for the intended flight.

9. The aircraft was serviceable up to the moment it struck the ground at EMA.

10 Following deterioration of the weather conditions at Stansted, the decision to divert to EMA was taken in good time, and allowed for a possible second diversion to Liverpool Airport.

11. Additional pressure was placed upon the crew during the transit to East Midlands Airport as excessive time was taken to locate the approach plates as these were filed under N for Nottingham East Midlands Airport.

12. The weather conditions at EMA were such that a CAT IIIA approach and landing was required.

13. The recorded automated RVR at EMA was not incorporated into the latest weather reports, although it was passed to the pilots by ATC.

14 The CAT IIIA approach was the first to be carried out by the commander in actual conditions in the aircraft since he had been promoted from co-pilot some four months previously.

15 The aircraft intercepted the ILS to Runway 27 normally and became established on both the localiser and the glideslope by approximately 2,000 ft aal.

16 At a late stage in the approach, at around 530 ft aal, ATC transmitted a 'company message' to the aircraft, to the effect that they did not want the aircraft to land at East Midlands Airport. At the discretion of the crew, they were approved by ATC to go-around.

17 The commander's attempt to respond to, and clarify the contents of, the call from ATC, late in the approach, was an inappropriate action for the Pilot Flying.

18 In his attempt to clarify the ATC message, the commander inadvertently disconnected the autopilots.

19 The commander's attempt to re-instate the autopilots whilst replying to ATC was an inappropriate action and not in accordance with the company CAT III SOPs.

20. In attempting to reinstate both autopilots, the commander only succeeded in engaging one, and only in CWS P and CWS R modes.

21. The OM did not specifically state that a co-pilot should call GO-AROUND if he felt uncomfortable during an approach, although it was the operator's expectation that he should.

22. The co-pilot did not appear to have understood that he could make the call for a go-around.

23. The commander did not initiate a go-around until the EGPWS sounded a SINK RATE PULL UP warning at a radio altimeter height of between 87 ft and 59 ft, and he saw the green colour of the grass ahead.

24. The go-around was initiated too late to prevent the aircraft striking the ground. It made contact in the sterile grassed area to the left of Runway 27, abeam the threshold.

25. During the ground contact, the right main landing gear detached from the wing, causing damage to the right flaps and the loss of hydraulic System A.

26. After striking the ground, there was a short period of confusion on the flight deck, after which the commander resumed control as the aircraft climbed.

27. The flight crew had no knowledge of where the aircraft had struck the ground.

28. The aircraft was flown to Birmingham Airport with the nose and left landing gear down, and with the trailing edge flaps stuck at 32º and 40º, left and right, respectively; this produced a tendency to roll to the left.

29. The Runway 15 ILS glideslope transmitter remained switched off at Birmingham Airport following maintenance.

30. The commander decided to accept a longer route in order to be able to carry out an ILS approach for Runway 33.

31. The longer route to Runway 33 allowed an opportunity for the police helicopter to inspect the aircraft. In order for this to be done, the damaged aircraft flew over the city of Birmingham.

32. The inspection by the police was helpful to the pilots.

33. A successful partial gear up emergency landing was made at Birmingham.

Safety Recommendations

Although the circumstances of this event could easily have led to a catastrophic accident there are few safety recommendations which can be made. This is because actions by individuals which contributed to the accident were either inappropriate or were not in compliance with existing procedures. Non-compliance with procedures, whether inadvertent or deliberate, can be difficult to prevent and can only be addressed by effective training and maintaining a culture of adherence to SOPs within an organisation.

A large proportion of the operator's flying programme was carried out at night. Operational tasks carried out at night are subject to a greater number of human errors, because of the limitations of human performance. It is particularly necessary in these circumstances, therefore, that the operating procedures are robust and well understood by all concerned. This will help to ensure that when errors are made they are detected and appropriate corrective action is taken.

One of the causes of this accident was the lack of a decision to go-around when it was required. Therefore the following safety recommendation is made:

Safety Recommendation 2008-010

It is recommended that the Kingdom of Belgium Civil Aviation Authority require TNT Airlines in Belgium to carry out a review of their standard operating procedures to ensure that it is clear to all pilots when go-around action is required.

Safety action

The timing and content of the message passed by ATC to the aircraft when it was at 500 ft, was inappropriate and distracted the commander at a critical phase of flight. The revision to MATS Part 1, already underway at the time of the accident and effective from 31 July 2006, has addressed this problem. However, the CAA considers that it may be possible to give more specific guidance as to when messages may be passed, and proposes to undertake a study of this issue by establishing a working group.

The absence of RVR data in the METARs from East Midlands Airport around the time of the accident meant that forecasts for the area were not updated for several hours and did not reflect the actual conditions. The meteorological reporting system at EMA was upgraded in April 2007. The new system provides for automatic reporting of weather information, including RVR data, within the required criteria. Therefore, it is considered that this safety issue has been addressed and no safety recommendation is made.

FORMAL AIRCRAFT ACCIDENT REPORTS
ISSUED BY THE AIR ACCIDENTS INVESTIGATION BRANCH

2007

4/2007 Airbus A340-642, G-VATL
en-route from Hong Kong to
London Heathrow
on 8 February 2005.

Published September 2007.

5/2007 Airbus A321-231, G-MEDG
during an approach to Khartoum
Airport, Sudan
on 11 March 2005.

Published December 2007.

6/2007 Airbus A320-211, JY-JAR
at Leeds Bradford Airport
on 18 May 2005.

Published December 2007.

7/2007 Airbus A310-304, F-OJHI
on approach to Birmingham
International Airport
on 23 February 2006.

Published December 2007.

2008

1/2008 Bombardier CL600-2B16 Challenger
604, VP-BJM
8 nm west of Midhurst VOR, West
Sussex
on 11 November 2005

Published January 2008.

2/2008 Airbus A319-131, G-EUOB
during the climb after departure from
London Heathrow Airport
on 22 October 2005

Published January 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.

AAIB Reports are available on the Internet
http://www.aaib.gov.uk