

## AIRCRAFT ACCIDENT REPORT NO 2/90

### REPORT ON THE ACCIDENT TO BOEING 747-121, N739PA AT LOCKERBIE, DUMFRIESSHIRE, SCOTLAND ON 21 DECEMBER 1988

The Inspector's report on this accident was submitted to the Secretary of State for Transport on 6 August 1990. He has agreed to its publication and the report is now available from HMSO Bookshops and accredited agents.

#### History of the Flight

Boeing 747, N739PA, arrived at London Heathrow Airport from San Francisco and parked on stand Kilo 14, to the south-east of Terminal 3. Many of the passengers for this aircraft had arrived at Heathrow from Frankfurt, West Germany on a Boeing 727, which was positioned on stand Kilo 16, next to N739PA. These passengers were transferred with their baggage to N739PA which was to operate the scheduled Flight PA103 to New York Kennedy. Passengers from other flights also joined Flight PA103 at Heathrow. After a 6 hour turnaround, Flight PA103 was pushed back from the stand at 18.04 hrs and was cleared to taxi on the inner taxiway to runway 27R. The only relevant Notam warned of work in progress on the outer taxiway. The departure was unremarkable.

Flight PA103 took-off at 18.25 hrs. As it was approaching the Burnham VOR it took up a radar heading of 350° and flew below the Bovingdon holding point at 6000 feet. It was then cleared to climb initially to flight level (FL) 120 and subsequently to FL 310. The aircraft levelled off at FL 310 north west of Pole Hill VOR at 18.56 hrs. Approximately 7 minutes later, Shanwick Oceanic Control transmitted the aircraft's oceanic clearance but this transmission was not acknowledged. The secondary radar return from Flight PA103 disappeared from the radar screen during this transmission. Multiple primary radar returns were then seen fanning out downwind for a considerable distance. Debris from the aircraft was strewn along two trails, one of which extended some 130 km to the east coast of England. The upper winds were between 250° and 260° and decreased in strength from 115 kt at FL 320 to 60 kt at FL 100 and 15 to 20 kt at the surface.

The wings impacted at the southern edge of Lockerbie, producing a crater whose volume, calculated from a photogrammetric survey, was approximately 560 cubic metres. The weight of material displaced by the wing impact was estimated to be well in excess of 1500 tonnes. The wing impact created a fireball, setting fire to neighbouring houses and carrying aloft debris which was then blown downwind for several miles. It was subsequently established that domestic properties had been so seriously damaged as a result of fire and/or impact that 21 had to be demolished and an even greater number of homes required substantial repairs. Major portions of the aircraft, including the engines, also landed on the town of Lockerbie and other

large parts, including the flight deck and forward fuselage section, landed in the countryside to the east of the town. Lighter debris from the aircraft was strewn as far as the east coast of England over a distance of 130 kilometres.

### **Examination of wreckage**

The debris from all areas was recovered by the Royal Air Force to the Army Central Ammunition Depot Longtown, about 20 miles from Lockerbie. Approximately 90% of the hull wreckage was successfully recovered, identified, and laid out on the floor in a two-dimensional reconstruction. The reconstruction revealed the presence of damage consistent with an explosion on the lower fuselage left side in the forward cargo bay area. A small region of structure bounded approximately by frames 700 & 720 and stringers 38L & 40L, had clearly been shattered and blasted through by material exhausting directly from an explosion centred immediately inboard of this location.

All immediately identifiable parts of the forward cargo containers were segregated into areas designated by their serial numbers. Two adjacent containers, one of metal construction the other fibreglass, were identified as exhibiting damage likely to have been caused by the explosion. Those parts which could be positively identified as being from these two containers were assembled onto wooden frameworks. From this it was positively determined that the explosion had occurred within the metal container (serial number AVE 4041 PA), the direct effects of this being evident also on the forward face of the adjacent fibreglass container (serial number AVN 7511 PA) and on the local airframe on the left side of the aircraft in the region of station 700. While this work was in progress a buckled section of the metal container skin was found by an AAIB Inspector to contain, trapped within its folds, an item which was subsequently identified by forensic scientists at the Royal Armaments Research and Development Establishment as belonging to a specific type of radio-cassette player and that this had been fitted with an improvised explosive device.

### **Fuselage three-dimensional reconstruction**

The two-dimensional reconstruction successfully established that there had been an explosion in the forward hold; its location was established and the general damage characteristics in the vicinity of the explosion were determined. However, the mechanisms by which the failure process developed from local damage in the immediate vicinity of the explosion to the complete structural break-up and separation of the whole forward section of the fuselage, could not be adequately investigated without recourse to a more elaborate reconstruction.

To facilitate this additional work, wreckage forming a 65 foot section of the fuselage (approximately 30 feet each side of the explosion) was transported to AAIB Farnborough, where it was attached to a specially designed framework to form a fully three-dimensional reconstruction of the complete fuselage between stations 360 & 1000 (from the separated nose



section back to the wing cut out). The support framework was designed to provide full and free access to all parts of the structure, both internally and externally. Because of height constraints, the reconstruction was carried out in two parts, with the structure divided along a horizontal line at approximately the upper cabin floor level. The previously reconstructed containers were also transported to AAIB Farnborough to allow correlation of evidence with, and partial incorporation into, the fuselage reconstruction.

## Conclusions

It was established that the detonation of an improvised explosive device, loaded in a luggage container positioned on the left side of the forward cargo hold, directly caused the loss of the aircraft. The direct explosive forces produced a large hole in the fuselage structure and disrupted the main cabin floor. Major cracks continued to propagate from the large hole under the influence of the service pressure differential. The indirect explosive effects produced significant structural damage in areas remote from the site of the explosion. The combined effect of the direct and indirect explosive forces was to destroy the structural integrity of the forward fuselage, allow the nose and flight deck area to detach within a period of 2 to 3 seconds, and subsequently allow most of the remaining aircraft to disintegrate while it was descending nearly vertically from 19,000 to 9,000 feet.

## Summary

The detonation of an improvised explosive device led directly to the destruction of the aircraft with the loss of all 259 persons on board and 11 of the residents of the town of Lockerbie. Five recommendations are made of which four concern flight recorders, including the funding of a study to devise methods of recording violent positive and negative pressure pulses associated with explosions. The final recommendation is that Airworthiness Authorities and aircraft manufacturers undertake a systematic study with a view to identifying measures that might mitigate the effects of explosive devices and improve the tolerance of the aircraft's structure and systems to explosive damage.

**No: 10/90**

**Ref: EW/C1167**

**Category: 1a**

**Aircraft Type  
and Registration:**

BAe 146-200 series, G-PRIN

**No & Type of Engines:**

4 Lycoming ALF 502-R5 turbofan engines

**Year of Manufacture:**

1988

**Date and Time (UTC):**

16 June 1990 at 1332 hrs

**Location:**

Jersey Airport, Channel Islands

**Type of Flight:**

Public Transport

**Persons on Board:**

Crew - 4

Passengers - 93

**Injuries:**

Crew - None

Passengers - None

**Nature of Damage:**

Damage to underside of rear fuselage with minor perforation of the pressure hull

**Commander's Licence:**

Airline Transport Pilot's Licence

**Commander's Age:**

36 years

**Commander's Total  
Flying Experience:**

8,223 hours (of which 63 were on type)

**Information Source:**

AAIB Field Investigation

**History of Flight**

The aircraft was scheduled for a 1205 hrs departure from Southend to Jersey. The calculated take-off weight was 35,033 kg which, using the standard data card for 35,000 kg, gave the following take-off speeds and bug settings:

White outer bug	V1	101 kt
Yellow outer bug	VR	105 kt
Orange inner bug	V2	111 kt (Command bug)
Orange outer bug	V2+10	121 kt
Red outer bug	VFTO	169 kt

The aircraft took-off at 1249 hrs with the commander acting as handling pilot. Shortly before the top of descent he made several unsuccessful attempts to contact the Jersey handling agent on 130.6 MHz. The difficulty was experienced because of the high volume of traffic on the frequency, which is common to handling agents at several airfields.



Descent started over Cherbourg and the Descent Check was initiated. A call from the handling agent interrupted the checklist at the LANDING DATA item. The commander having indicated to the first officer that he would come back to the check, answered the call.

The calculated landing weight was 33,472 kg which, using the standard data card for 33,500 kg, gave the following landing speeds and bug settings;

White outer bug	VREF33	113 kt
Orange inner bug	VREF+5kt	118 kt (Command bug)
Yellow outer bug	VREF+20kt	133 kt
Orange outer bug	VFTO	170 kt
Red outer bug	VFTO+15kt	185 kt

Once the call to the handling agent was complete the commander's concentration was focussed on instructions from ATC and the further conduct of the flight. He stated that he thought that he may have repositioned the yellow outer bug but could not recall moving the others from their take-off settings. The first officer recalled that, at some stage, he looked across at the commander's ASI and thought that the bugs looked to be correctly set. The setting of the commander's orange inner command bug is not visible from the normal righthand seating position.

The aircraft was cleared for a visual approach to runway 09. The commander reported that, at about 800 ft amsl, the aircraft was established on the final visual approach path with 33° flap, 56% N1 and at a reducing airspeed of "VREF+15kt". At about 500 ft amsl the first officer noticed that the airspeed which should have been 118 kt, had reduced to 1 or 2 kt below his VREF33 bug which was set at 113 kt. He called "Speed" to which the commander replied "On bug", meaning his orange inner command bug which was set at 111 kt. At about 400 ft amsl the airbrakes were selected out and the aircraft encountered a slight sink as it passed over the cliff on short final. The airspeed was allowed to reduce in order to cross the threshold at about 106 kt, the value the commander had set on his VREF33 bug.

The commander assessed that the aircraft was slightly low as it crossed the threshold, but considered that the landing flare would lead to a touchdown about 200 metres in from the runway end. The throttles were closed and the flare was initiated, however, there was no noticeable decrease in the rate of descent and the aircraft struck the ground, firmly, in a high nose-up attitude. The aircraft was taxied to the ramp and the passengers were disembarked in the normal manner. An external inspection subsequently revealed that the lower aft fuselage was damaged.

#### **Aircraft Examination & Ground Marks**

When the aircraft was examined by the AAIB, later the same day, the lefthand ASI orange inner command bug was found to be set to 111 kt and the righthand to 118 kt. The remaining bugs had been 'stacked', as required by company standard operating procedures.

The tail bumper had contacted the ground hard, compressing the aluminium honeycombe shock absorber by several inches, and the aft water drain mast had been scraped. The lower fuselage in the region between the freight door and the drain mast was damaged by contact with the paved runway surface, producing a region of localised skin damage and frame buckling over an area approximately 2.3 metres by 0.3 metres, with abrasion and penetration of the skins in several areas local to the frames. The frames over this same region also displayed signs of slight generalised distortion extending up to the level of the cabin floor.

Scrape marks produced by the lower fuselage and tail bumper, together with the mainwheel touchdown marks, were identified in the paved undershoot beginning approximately 24 metres before the threshold 'piano key' markers. The marks were consistent with a moderately heavy touchdown in a very nose high attitude, wings level, and with about 2 degrees of right yaw.

### Flight Recorders

The Flight Data Recorder fitted was a Plessey PV1584 J1 recorder which has 32 analogue parameters and 29 discrete events. This was removed and returned to AAIB for replay where a satisfactory readout was obtained except around touchdown where approximately one and a half seconds of data was lost, probably due to the impact. The Cockpit Voice Recorder was not removed as following the accident power had been applied to the aircraft so the relevant period during the approach and landing would have been erased.

The FDR calibration figures taken in November 1989 for this particular aircraft were obtained from the manufacturer and were used to obtain engineering units from the raw data. To confirm the IAS calibration a check was made by AAIB on the aircraft pitot/static system, for both the captains and co-pilot's instruments (connected to P1/S1 and P2/S2 systems respectively) and the flight recorder system which takes IAS values from a transducer connected to the P3/S3 system.

The results of these tests showed that the captains ASI over-read by approximately 2-3 kt when the IAS was between 80 and 120 kt. The co-pilots ASI over-read by about 1 kt in the same speed range. The manufacturers maintenance manual allows for a tolerance of 4 kt on the ASI reading from the reference value (ie  $\pm 2$  kt).

Testing of the flight recorder system showed that the calibration had changed since November 1989. The maintenance manual quotes an acceptable range for the FDR reading against the reference IAS value, the latest calibration showed the readings were no longer within limits at IAS values between 80 and 100 kt. The new calibration was used to obtain the FDR IAS values quoted below.

There are no position error differences between the standard system supplying the cockpit instruments (P1/S1 and P2/S2) and the P3/S3 systems used for the FDR.

The attached figure shows the approach, with a selection of the relevant FDR parameters plotted. It should be noted that the ALT trace is referenced to the standard pressure of 1013 mb. The following

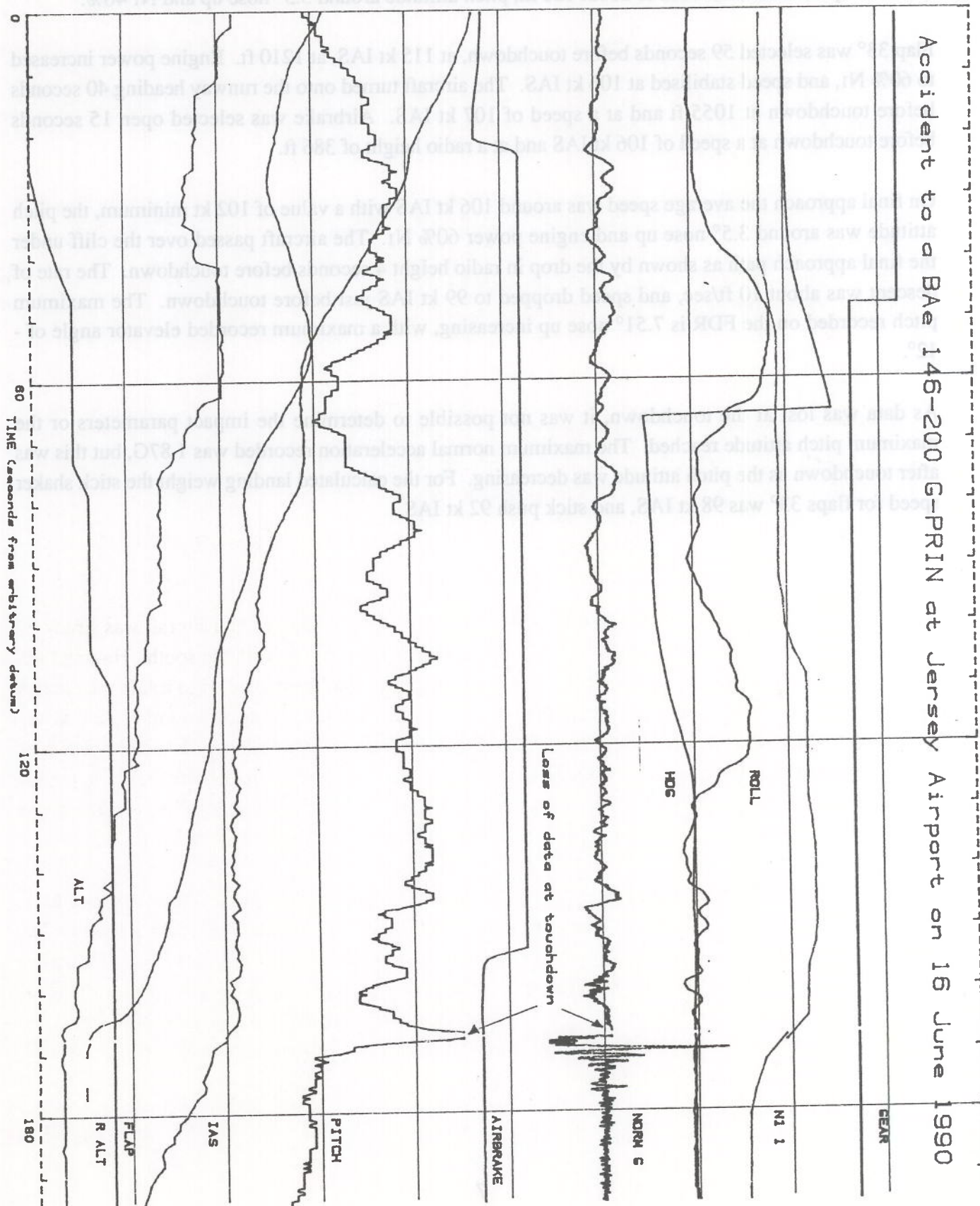
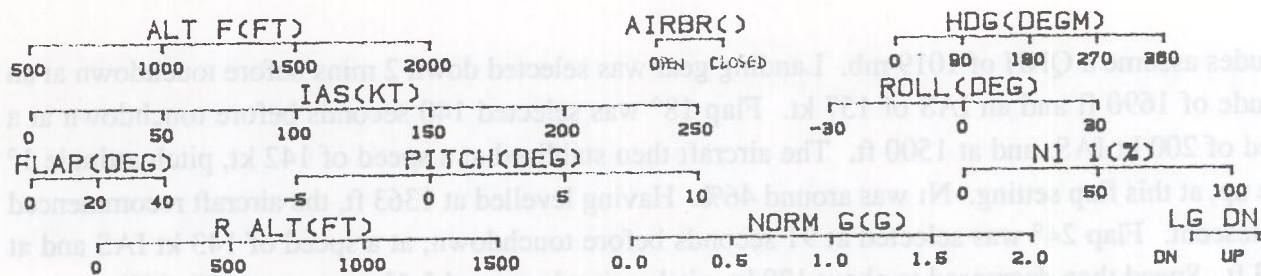


altitudes assume a QNH of 1019 mb. Landing gear was selected down 2 mins before touchdown at an altitude of 1690 ft and an IAS of 157 kt. Flap 18° was selected 140 seconds before touchdown at a speed of 200 kt IAS, and at 1500 ft. The aircraft then stabilised at a speed of 142 kt, pitch attitude 1° nose up, at this flap setting. N1 was around 46%. Having levelled at 1363 ft, the aircraft recommenced the descent. Flap 24° was selected at 91 seconds before touchdown, at a speed of 143 kt IAS and at 1183 ft. Speed then decreased to about 120 kt, pitch attitude around 3.5° nose up and N1 46%.

Flap 33° was selected 59 seconds before touchdown, at 115 kt IAS, at 1210 ft. Engine power increased to 60% N1, and speed stabilised at 106 kt IAS. The aircraft turned onto the runway heading 40 seconds before touchdown at 1055 ft and at a speed of 107 kt IAS. Airbrake was selected open 15 seconds before touchdown at a speed of 106 kt IAS and at a radio height of 386 ft.

On final approach the average speed was around 106 kt IAS with a value of 102 kt minimum, the pitch attitude was around 3.5° nose up and engine power 60% N1. The aircraft passed over the cliff under the final approach path as shown by the drop in radio height 4 seconds before touchdown. The rate of descent was about 10 ft/sec, and speed dropped to 99 kt IAS just before touchdown. The maximum pitch recorded on the FDR is 7.51° nose up increasing, with a maximum recorded elevator angle of -12°.

As data was lost at the touchdown, it was not possible to determine the impact parameters or the maximum pitch attitude reached. The maximum normal acceleration recorded was 1.87G, but this was after touchdown as the pitch attitude was decreasing. For the calculated landing weight the stick shaker speed for flaps 33° was 98 kt IAS, and stick push 92 kt IAS.



Accident to a Bae 146-200 G-PRIN at Jersey Airport on 16 June 1990



**No:** 10/90      **Ref:** EW/G90/08/21      **Category:** 1a

**Aircraft Type and Registration:** Boeing 747 -300, ZS-SAT

**No & Type of Engines:** 4 Pratt & Whitney JT9D-7R4G2 turbofan engines

**Year of Manufacture:** 1983

**Date and Time (UTC):** 20 August 1990 at 1725 hrs

**Location:** London Heathrow Airport

**Type of Flight:** Public Transport

**Persons on Board:** Crew - 27      Passengers - 309

**Injuries:** Crew - None      Passengers - None

**Nature of Damage:** Rear underside fuselage skin including both APU doors, rear pressure bulkhead and flap 'canoe fairing' damaged

**Commander's Licence:** Airline Transport Pilot's Licence (SA)

**Commander's Age:** 44 years

**Commander's Total Flying Experience:** 12,066 hours (of which 613 were on type)

**Information Source:** Aircraft Accident Report Form and other information submitted

At 1725 hrs, during a normal take-off from runway 27L and, shortly after  $V_1$ , the aircraft was struck by 3 Canada geese which were flying across the mid-section of the runway from the south. Having seen the skein at the last moment, the commander, in an attempt to avoid them, elected to rotate the aircraft slightly earlier and rather more positively than normal and, in so doing scraped the tail section of the aircraft fuselage on the runway. The take-off was continued and the aircraft departed to dump fuel over the sea. Having reduced to an acceptable landing weight, the aircraft returned to Heathrow and landed without further event at 1833 hrs. The following day, when temporary repairs had been effected, the aircraft took off without passengers to return to its base at Jan Smutts Airport, South Africa.

Heathrow Airport operates a bird deterrent and scaring unit throughout the 24 hour day and as is required by special circumstances. They are equipped with a Sherpa van fitted with a loud hailer, enabling the broadcast of recorded bird alarm-cries, and supplied with a Davis bird gun, firing star/cracker shells, and a shot gun. The members of the team are well versed in the migratory patterns and local settling areas of any birds which have been seen in the area and are hazardous to aircraft. To date, this scheme has been successful and, although remaining alert to possible improvements or new ideas, there are no immediate plans to change it.

Following report of the birdstrike, whilst the aircraft was dumping fuel the team discovered 3 Canada geese on Block 81 of the runway and a 36m scrape, including a broken centreline light fitting, some 2325m from the runway threshold. It is stated that on that day the team were very busy with flights of seagulls and, although the normal flight patterns of Canada geese are well known to them, these geese not only arrived from an unusual direction but crossed the centre section of the runway rather than the distant extended runway centrelines where they usually cross. Consequently, they were not sighted before becoming a hazzard to flight safety.

Information Source:	Aircraft Accident Report Form and other information submitted
Commander's Flying Experience:	12,066 hours (of which 613 were on type)
Commander's Total:	
Commander's Age:	44 years
Commander's Licence:	Airline Transport Pilot's Licence (2A)
Nature of Damage:	Rear underside fuselage skin including both APU doors, rear pressure bulkhead and flap 'canoe' failing, damaged
Injuries:	Crew - None Passengers - None
Persons on Board:	Crew - 27 Passengers - 309
Type of Flight:	Public Transport
Location:	London Heathrow Airport
Date and Time (UTC):	30 August 1990 at 1725 hrs
Year of Manufacture:	1983

At 1725 hrs, during a normal take-off from runway 31L and, shortly after V<sub>L</sub>, the aircraft was struck by 3 Canada geese which were flying across the mid-section of the runway from the south. Having seen the skin at the last moment, the commander, in an attempt to avoid them, elected to rotate the aircraft slightly earlier and rather more positively than normal and, in so doing scraped the tail section of the aircraft fuselage on the runway. The take-off was continued and the aircraft departed to dump fuel over the sea. Having reduced to an acceptable landing weight, the aircraft returned to Heathrow and landed without further event at 1833 hrs. The following day, when temporary repairs had been effected, the aircraft took off without passengers to return to its base at Jan Smuts Airport, South Africa.

Heathrow Airport operates a bird detection and scanning unit throughout the 24 hour day and as is required by special circumstances. They are equipped with a Shetex van fitted with a loud hailer, enabling the broadcast of recorded bird alarm-cries, and supplied with a Davis bird gun, firing stun/cracker shells, and a shot gun. The members of the team are well versed in the migratory patterns and local settling areas of any birds which have been seen in the area and are hazardous to aircraft. To date, this scheme has been successful and, although remaining alert to possible improvements or new ideas, there are no immediate plans to change it.



**No: 10/90**

**Ref: EW/G90/07/07**

**Category: 1a**

**Aircraft Type  
and Registration:**

Cessna 550, G-BNSC

**No & Type of Engines:**

2 Pratt and Whitney JT15D-4 turbofan engines

**Year of Manufacture:**

1987

**Date and Time (UTC):**

12 July 1990 at 1727 hrs

**Location:**

Bournemouth International Airport, Dorset

**Type of Flight:**

Public Transport

**Persons on Board:**

Crew - 2

Passengers - None

**Injuries:**

Crew - None

Passengers - N/A

**Nature of Damage:**

Abrasion damage to flaps and fuselage underside

**Commander's Licence:**

Airline Transport Pilot's Licence

**Commander's Age:**

37 years

**Commander's Total  
Flying Experience:**

6,000 hours

**Information Source:**

Aircraft Accident Report Form submitted by the pilot

Following take-off from Olbia, Sardinia, en route for Hurn, the pilot retracted the gear and flaps. On passing 2000 ft the crew noticed the Hydraulic Low Level light flickering, although this later extinguished. The aircraft continued the climb, and at approximately 25,000 ft the Hydraulic Low Flow lights for both engines started to flicker, although the Low Level light remained out.

During the cruise the captain decided it was probable that most, if not all, of the hydraulic fluid had been lost, and so he and the co-pilot ran through the checks, including those for extending the landing gear. They also considered the possibility that the thrust reversers and airbrakes might not work. During the

flight, the captain contacted his Operations Department at Hurn on high frequency radio, informing them of the problem and requesting that engineers be made available to provide advice if necessary.

On passing 8000 ft during the descent, the Hydraulic Low Level light illuminated again. While on right base for runway 17 at Hurn the captain selected the landing gear handle down at 140 kts, with the flaps retracted. However nothing happened. He then checked the circuit breakers and recycled the landing gear lever, with no effect. The emergency system was then operated. This is activated by a red 'T handle', which when pulled, allows the landing gear to 'free-fall'. The handle moved about 1 inch and the red GEAR Unsafe light illuminated, followed by the nose landing gear green light. The captain

reported that it required several attempts, using all his strength, to pull the handle fully out and twist it into its locked position. The main landing gear still failed to extend and so the crew resorted to yawing the aircraft from side to side. However this had no effect and so the pneumatic "blow down" system, operated by pulling a red knob on top of the T handle was used, still to no avail. For the next hour, following advice from the engineers on the ground, the crew tried positive and negative G, low airspeed, more yawing from side to side, and relaxing pneumatic pressure by using the emergency brake (which used the same reservoir as the blow-down system). Finally, with only 30 minutes of fuel remaining, the aircraft was landed at Hurn with full flap and at a speed of approximately 85 kts. The aircraft came to a standstill halfway along runway 17, with minimal damage.

Subsequent examination of the aircraft revealed that the original loss of hydraulic fluid was due to the left hand main landing gear retract line having been chaffed-through by the right hand rudder control cable, at a point 5 inches aft of the rear pressure bulkhead. The line had been distorted downwards, either during aircraft build or maintenance. The maintenance organisation informed the manufacturer of the problem, suggesting that the line be re-routed.

A mechanical lock in the emergency landing gear control is designed to prevent the pneumatic system from operating before the uplocks are released, *ie* with the T handle in its pulled and twisted position. Otherwise the problem is compounded by pneumatic pressure forcing the uplock roller against the uplock hook, jamming the latter and thus preventing its release via the T handle. However, in this case it was clear that the T handle had been moved far enough to allow the pneumatic system to operate, even though the landing gear uplocks had not released.

The free-fall system on the landing gear operated satisfactorily after the accident although it was clear that the main landing gears had not previously released from the uplocks. The reason for this was not positively established although it was surmised that the rigging may have been on the tolerance limit. However, the system met the maintenance manual requirements in this respect and had operated successfully on a test flight in October 1989.



No: 10/90

Ref: EW/G90/08/04

Category: 1a

<b>Aircraft Type and Registration:</b>	Mustang P51D, N51JJ
<b>No &amp; Type of Engines:</b>	Packard V-1650-11 Merlin engine
<b>Year of Manufacture:</b>	1944
<b>Date and Time (UTC):</b>	9 August 1990 at 1730 hrs
<b>Location:</b>	Stapleford Airfield, Essex
<b>Type of flight:</b>	Private
<b>Persons on Board:</b>	Crew - 1                      Passengers - None
<b>Injuries:</b>	Crew - None                      Passengers - N/A
<b>Nature of Damage:</b>	Propeller, spinner, air scoop and radiator duct damage
<b>Commander's Licence:</b>	Commercial Pilot's Licence
<b>Commander's Age:</b>	52 years
<b>Commander's Total Flying Experience:</b>	1159 hours (of which 195 were on type)
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot

The pilot was conducting an airstest upon the aircraft's complete avionics installation which had been repaired and, during the test, the entire installation except for the gyro compass proved to be unserviceable. However, during a 'run-in and break' manoeuvre prior to landing, the gyro compass warning flag went to OFF and the compass card stopped rotating. During the subsequent circuit, the pilot omitted to lower the landing gear and the aircraft landed in this configuration. There was no fire and the pilot vacated the aircraft without further incident.

The pilot states that the distraction caused by the total avionics failure, and the fact that the landing gear indicator lights had recently been changed in both type and location, possibly contributed to his omission to extend the gear.

**No: 10/90****Ref: EW/G90/03/22****Category: 1b****Aircraft Type  
and Registration:**

Piper PA-23-250, G-VHFA

**No & Type of Engines:**

2 Lycoming IO-540-C4B5 piston engines

**Year of Manufacture:**

1971

**Date and Time (UTC):**

27 March 1990 at 1232 hrs

**Location:**

Lydd Airport, Kent

**Type of Flight:**

Private (training)

**Persons on Board:**

Crew - 2                      Passengers - 1

**Injuries:**

Crew - None                      Passengers - None

**Nature of Damage:**

Fuselage underside skin, landing gear doors and propellers damaged, engines shock loaded

**Commander's Licence:**

Private Pilot's Licence with IMC and Instructor's ratings

**Commander's Age:**

37 years

**Commander's Total  
Flying Experience:**

1,880 hours (of which 16 were on type)

**Information Source:**

Aircraft Accident Report Form submitted by the pilot

The pilot was conducting an airtest upon the aircraft's complete avionics installation which had been board. The take off and climb to the downwind position were normal but, during the downwind checks, the landing gear indication lights showed that both main landing gears were down and locked but the nose landing gear was not. The instructor asked the student to check the position of the nose landing gear in the mirror on the left engine cowling. The student thought it was extended but the instructor decided to ask ATC to check the landing gear position. ATC informed the pilot that although at first sight the landing gear appeared to be down, as the aircraft passed close to the tower the position of the nosewheel seemed not to be correct. The landing gear was then selected 'up' and then reselected 'down'. After this only the left main landing gear down-and-locked indication was showing and a check by the tower confirmed this situation.

After recycling the landing gear again, the student was instructed to operate the emergency gas extension system. This action again resulted in only the left main landing gear indicating down-and-locked.



After trying, unsuccessfully, several ways to get the landing gear to lock-down, the instructor elected to retract the landing gear and make a wheels-up landing. ATC informed him that the nose landing gear was partially extended but the wheels-up landing was executed without causing injuries or fire.

Initial investigation showed that, after lowering the landing gear by hand it would retract normally but only the left main landing gear would extend. Further investigation showed that the emergency gas bottle was extremely loose in its mounting and had not sealed against the discharge tube. The interior of the bottom fuselage panels around the gas bottle were wet with hydraulic fluid. It was also found that the spools in the normal/emergency shuttle valves of the main landing gears had swollen and the left valve had stuck in the normal position and the right in emergency.

After replacing the shuttle valves and the emergency CO<sub>2</sub> bottle, the system appeared to work normally but certain characteristics were observed. The left main landing gear locked down easily and unlocked to retract, followed by the nose landing gear and the right main landing gear, whose lock engaged and disengaged with audible effort. Also, the pressure required to lock the nose landing gear down rose very sharply as rearward force, to simulate air resistance, was applied to the nose-wheel. It was also noted that the maximum pressure obtainable on the test rig, which used an identical hydraulic pump to that on the aircraft, was very sensitive to system leakage, as simulated by the manual spill-back control.

**No: 10/90**

**Ref: EW/G90/07/23**

**Category: 1c**

**Aircraft Type  
and Registration:**

Avions Pierre Robin DR400/180, G-FTIL

**No & Type of Engines:** 1 Lycoming O-360-A3A piston engine

**Year of Manufacture:** 1988

**Date and Time (UTC):** 27 July 1990 at 1846 hrs

**Location:** Biggin Hill Airport, Kent

**Type of flight:** Private

**Persons on Board:** Crew - 1 Passengers - 1

**Injuries:** Crew - 1 (minor) Passengers - 1 (minor)

**Nature of Damage:** Severe to engine, propeller, fuselage and wings

**Commander's Licence:** Private Pilot's Licence with IMC and Night ratings

**Commander's Age:** 44 years

**Commander's Total  
Flying Experience:** 140 hours (of which 7 were on type)

**Information Source:** Aircraft Accident Report Form submitted by the pilot

The wind was reported as 200°/10 kt and the aircraft made an uneventful landing on runway 21, maintaining the centreline throughout. Whilst on the taxiway leading to the west apron, the pilot saw his marshaller ahead and to his right at the southern end of the apron, necessitating a right and then left turn to travel towards him. The right turn was successfully achieved but, as the aircraft did not seem to respond to the left brake, applied in order to turn back towards the marshaller, the pilot applied some engine power to increase the effectiveness of the rudder. In spite of the application of full left rudder, the engine power only accelerated the aircraft on its original track. Reaching the edge of the apron, the right wheel struck a rubber tyre, protecting an edge-marker light, swinging the aircraft further right, across a grass strip and directly into the control tower wall on the west side of the apron. The aircraft sustained considerable damage. The pilot and his passenger, also a pilot, immediately switched off the fuel and electrical systems and vacated the aircraft. There was no fire.

Although the pilot stated that he had full left pedal applied, and this is verified by his passenger who augmented his action, both left and right brakes were successfully used during the removal of the aircraft and subsequent examination revealed no indication of abnormality.



**No: 10/90****Ref: EW/G90/08/06****Category: 1c**

<b>Aircraft Type and Registration:</b>	Beech A23-19, G-AVHF	
<b>No &amp; Type of Engines:</b>	1 Lycoming O-320-E2C piston engine	
<b>Year of Manufacture:</b>	1967	
<b>Date and Time (UTC):</b>	1 August 1990 at 1900 hrs	
<b>Location:</b>	Spanhoe Airfield, Northamptonshire	
<b>Type of Flight:</b>	Private	
<b>Persons on Board:</b>	Crew - 1	Passengers - None
<b>Injuries:</b>	Crew - None	Passengers - N/A
<b>Nature of Damage:</b>	Damaged beyond economic repair	
<b>Commander's Licence:</b>	Private Pilot's Licence	
<b>Commander's Age:</b>	45 years	
<b>Commander's Total Flying Experience:</b>	137 hours ( none on type)	
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot and subsequent AAIB enquiries	

Spanhoe Airfield had a concrete runway, designated 09, which was 500 metres long and 10 metres wide. To the north of the runway, about 200 metres from the threshold and 15 metres from the edge, was a windsock. Running north from the windsock, at right angles to the runway, was a tall, mature hedge. To the south of the runway were various buildings and hangars. The surface wind was light from the south-east and the temperature was about 18° C.

It was the pilot's first flight on type and, on the first circuit, everything appeared normal until shortly before touchdown. He reported that a gust of wind, from the south, caused the aircraft to veer to the left and leave the runway. The right wing struck the windsock pole, about a metre from the top, and the left wing went through the hedge. The aircraft came to rest on rough ground, north of the runway, beyond the hedge. The pilot, who was wearing a lap strap only, escaped without injury.

No: 10/90

Ref: EW/C1150

Category: 1c

**Aircraft Type  
and Registration:**

Brooklands Aerospace Group plc OA7 Optica, G-BMPL

**No & Type of Engines:**

1 Lycoming 10.540 V4A5D piston engine

**Year of Manufacture:**

1987

**Date and Time (UTC):**

11 March 1990 at 1045 hours

**Location:**

Royal Navy Air Station, Lee-on-Solent, Hampshire

**Type of Flight:**

Commercial (Observation)

**Persons on Board:**

Crew - 2                      Passengers - None

**Injuries:**

Crew - None                      Passengers - N/A

**Nature of Damage:**

Damage to fan and hub assembly; minor airframe damage

**Commander's Licence:**

Commercial Pilot's Licence

**Commander's Age:**

44 yrs

**Commander's Total  
Flying Experience:**

Approximately 2500 hrs

**Information Source:**

AAIB Field Investigation

**Circumstances**

The aircraft, which was operated by the Hampshire Constabulary, commenced its take-off roll with pilot and an observer onboard from approximately one third along runway 23 (due to the activities of a gliding club operating from the same runway). All relevant checks had been completed without any problem and there was no discernible vibration from the engine.

The take-off and initial climb (at an airspeed of 70kts) were normal until, at an altitude of approximately 160ft, there was a loud "bang" followed by a severe vibration. The pilot immediately lowered the nose of the aircraft and throttled the engine back to idle in order to reduce the vibration. It was apparent that a forced landing was necessary but the pilot assessed that the remaining runway ahead was insufficient and would result in an overrun onto a public road. He therefore put the aircraft into a 30° banked turn to the left with the intention of making a downwind landing on runway 10. The observer made a radio call informing the tower of the pilot's intentions. With full flap selected, the aircraft touched down two thirds along runway 10, although not aligned with it, at an airspeed of 60kts. With a wind of 230/15kts, this resulted in a groundspeed of approximately 75kts. The engine was still at idle rpm as the aircraft rolled onto the grass on the left side of the runway and came to a stop. There were no injuries and no apparent additional damage, although a small amount of fuel was observed to be leaking from the bottom of the engine pod.



A quantity of debris was recovered from the runway close to where the bang had been heard; this consisted mainly of fan and shroud fragments, together with two fairing plates which had come from the hub assembly.

### **Examination of the aircraft**

It was quickly apparent that although the wooden fan blades had been severely damaged, this had resulted from one of the two fairing plates that had been released becoming trapped between a blade tip and the shroud, the ensuing debris causing consequential failures of the remaining blades. The plate was badly damaged and exhibited black marks that were later considered to have come from heavy contact with the rubber seal between the engine pod and the airframe, this junction being immediately forward of the fan shroud. Approximately 25% of the seal was missing between the 12 and 3 o'clock positions, viewed from the rear of the aircraft. Pieces of the seal were found among the debris on the runway.

The fan shroud, which consisted of a foam abrasion strip on a light alloy backing, had been penetrated in a number of places, leading to debris being found within the inboard wing structure. One small alloy fragment had become trapped between a cable and pulley in the flap operating circuit, although the operation of the system had not in fact been impeded.

The fuel strainer was located on the underside of the airframe immediately forward of the shroud. Damage to the latter had resulted in the fuel strainer mounting plate being deflected downwards slightly which had in turn caused minor distortion in an associated length of pipe, together with a small amount of fuel seepage from a nearby pipe union. At the time of inspection there was in fact no leak. However it was considered that this had been the source of the fuel leak observed after landing.

The remainder of the damage was confined to small indentations on two of the stators (which mount the engine to the inside of the pod) and a partially failed exhaust manifold mounting where it attached to the oil cooler at the rear of the engine, the latter most probably having occurred as a result of the severe vibration following the fairing plate separation and blade failures.

### **Detailed examination of the fan assembly**

The pod was removed from the airframe to allow access to the fan/hub assembly. A diagram of the latter is presented at Figure 1. The assembly essentially consists of fixed pitch blades attached to a fabricated hub. The hub is built up from front and rear alloy ring plates held together by five steel flanged webs arranged radially in line with, but not attached to, the blades. The sheet alloy fairing plates are riveted to the ring plates. Access to the hub interior is gained via cut-outs in the ring plates, each being fitted with five lightweight cover plates. Once these were removed, it was observed that one of the radial webs had failed along two of the three flanges and most of the third, only being retained by a small uncracked portion close to the hub. A photograph of the web is presented at Figure 2, and it can be seen that it has hinged about the rear flange into the plane of hub rotation. It had been prevented from lying flat against the ring plate by a bolt tail, the fretting mark it had made on the web displaying evidence of corrosion, indicating that the condition had existed for some time. In addition, it was observed that three of the remaining four webs displayed cracks at the outer ends of their flanges. The detached fairing plates had come from the positions either side of the failed web.

The hub was removed from the engine and disassembled into its component parts. The torque settings of the bolts retaining the blades and webs were checked during this process and most were found to be in excess of the values specified by the manufacturer. Slightly low values were recorded for the outermost bolts of each radial web.

The webs were subjected to a detailed metallurgical examination by the Materials and Structures Department at RAE Farnborough where it was discovered that all the cracks had developed by fatigue. On the forward side of the failed web the crack had started close to the outermost bolt hole, but the fracture had occurred along the flange radius. On the rear side, the crack had started close to the bolt hole and then run into the bend. The general appearance of the fractures and the evidence of cracking in other webs suggested that failure had originated at the outer ends of the flanges but, because of heavy rubbing damage in these areas, it was not possible to identify the precise positions of crack initiation. However, away from the outer ends, multiple origins were visible along both surfaces of each flange, indicating that crack growth had occurred under reverse bending conditions.

The cracks in the other webs typically passed close to the outermost bolt holes, forming tangents to the outer rims of the washers. On all the webs, fretting was observed along the lines of the cracks between the flanges and ring plates.

When the cracks were broken open, the surface features were consistent with fatigue growth from multiple origins on one or both surfaces of the flanges. Metallographic examination of a section from the region of a short crack in one of the webs revealed a number of microcracks originating from small, oxide filled pits in both surfaces. A hardness test showed that the tensile strength of the material was

slightly in excess of the maximum for British Standard S515 steel from which the webs had been manufactured.

The fracture faces of the 12 rivets that had retained each of the fairing plates were examined and it was found that there was an approximately even split between fatigue and overload. Although some smearing had occurred during the separation, the remaining evidence indicated that the fatigue fractures were of high cycle type.

The rivets retaining the remaining three fairing plates were examined by filing off the heads and pressing the shanks out. One rivet, in an end position, was in two halves as a result of a fatigue failure. Four others, all in end positions, after being sectioned longitudinally, were found to have short cracks or crack-like defects. Three of these were considered to have been initiated by a shearing effect and showed some fatigue growth. The cracks in the remaining rivet were characteristic of fretting damage. All the rivets, cracked or otherwise, were generally tightly fitting and the low number of defects suggested that the fatigued rivets in the separated fairing plates were consequent upon the web failure. However, when the manufacturer carried out a similar examination on another hub, it was found that most of the fairing plates had one or more cracked rivets. None of the webs had failed, although some had small cracks.

Finally, two each of the forward and rear cover plates were found to have cracks in the outboard lobes in which were drilled 5mm holes for the attachment bolts (see Fig 3). The cracks varied in length between 8.5 and 23mm and all initially followed the line of the edge of the washer beneath the bolt head, suggesting that their growth had been influenced by the local change of stiffness, particularly where the washer crossed an adjacent 3mm tab washer hole.



## Hub history

The hub had achieved 1320 hours at the time of the incident. A 250 hour inspection had been carried out 160 hours previously, although this was basically an in-situ examination of the blades, the engine pod not having been removed. New blades had been fitted 307 hours before the incident, which coincided with a 500 hour check. The hub had been subjected to a visual internal inspection following removal of the engine pod and cover plates.

Since this incident the manufacturer has found cracks in the webs of two hubs that had achieved 50 and 900 hours respectively.

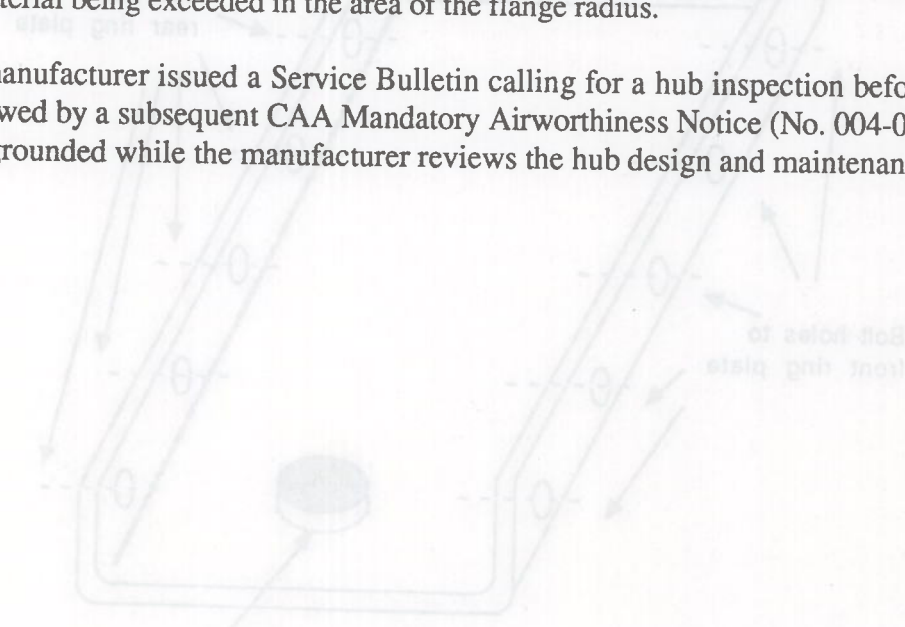
## Summary

The two separated fairing plates came from positions either side of the failed web, suggesting that these events were associated. Crack initiation and growth in all the webs was caused by reverse bending, aided by the pitted condition of the surfaces. The bending implied a lack of stiffness, resulting in relative rotational movement between the front and rear ring plates. The degree of relative movement is clearly greatest at the circumference, and indeed this was where the cracks in the webs originated. The generally good fit of the rivets in the remaining fairing plates and the fact that only one rivet was deeply cracked implied that the web failure occurred first, the resultant loss of stiffness causing the fatigue in the rivets of the adjacent fairing plates. However, this theory is apparently contradicted by the manufacturer's experience with another hub, in which most of the fairing plates had cracked rivets.

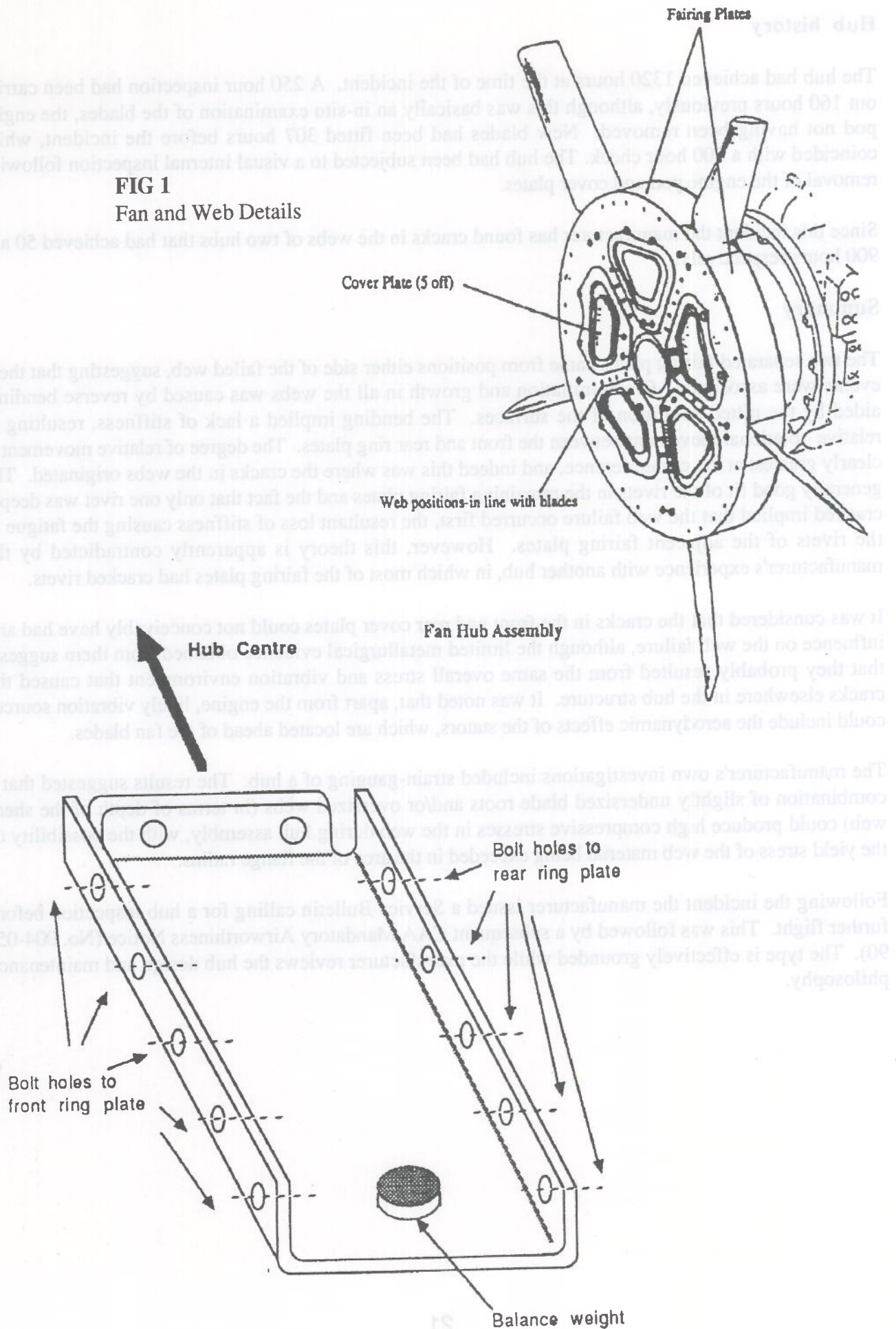
It was considered that the cracks in the front and rear cover plates could not conceivably have had any influence on the web failure, although the limited metallurgical evidence obtained from them suggests that they probably resulted from the same overall stress and vibration environment that caused the cracks elsewhere in the hub structure. It was noted that, apart from the engine, likely vibration sources could include the aerodynamic effects of the stators, which are located ahead of the fan blades.

The manufacturer's own investigations included strain-gauging of a hub. The results suggested that a combination of slightly undersized blade roots and/or oversized webs (in terms of depth of the shear web) could produce high compressive stresses in the web during hub assembly, with the possibility of the yield stress of the web material being exceeded in the area of the flange radius.

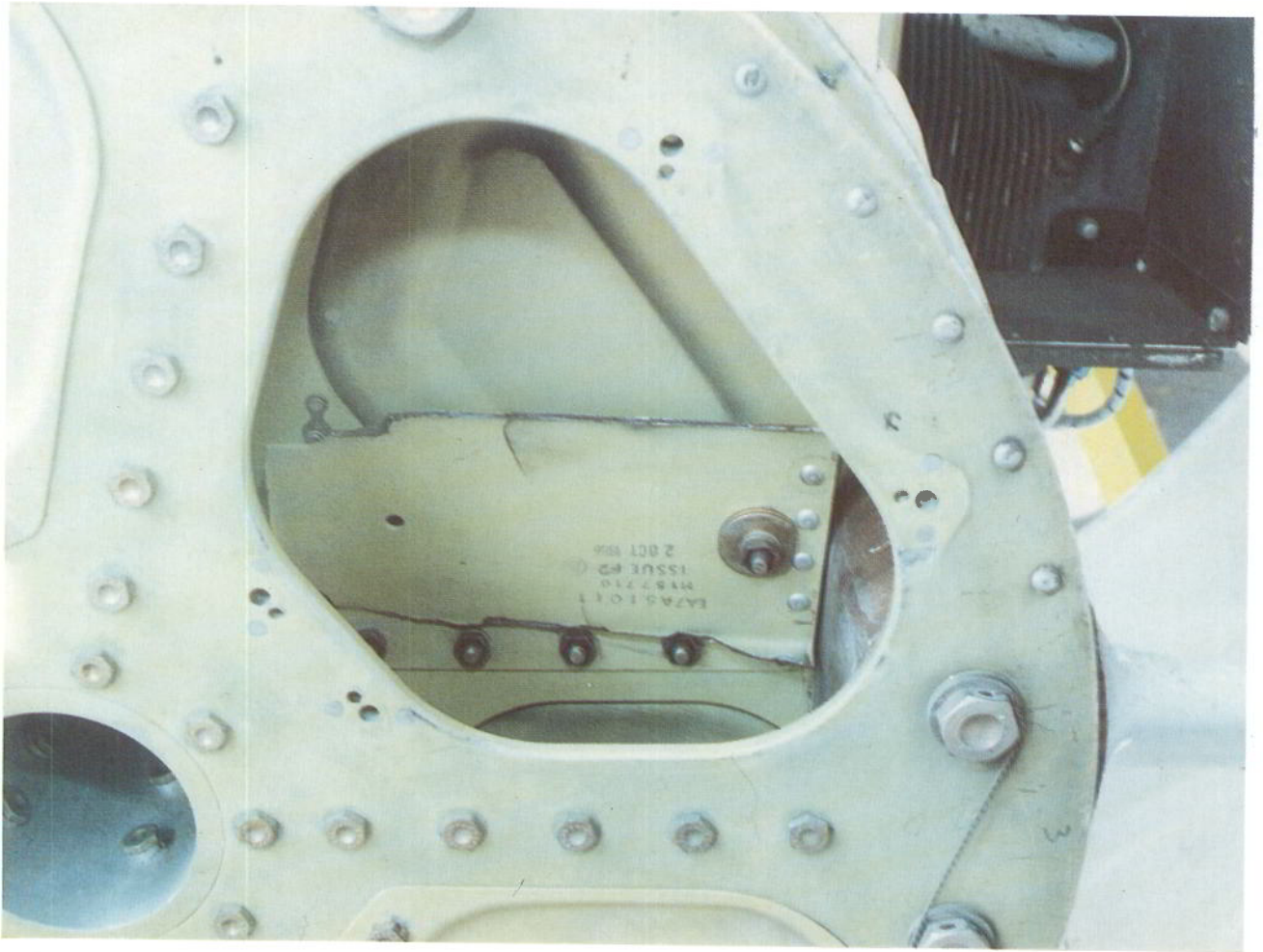
Following the incident the manufacturer issued a Service Bulletin calling for a hub inspection before further flight. This was followed by a subsequent CAA Mandatory Airworthiness Notice (No. 004-05-90). The type is effectively grounded while the manufacturer reviews the hub design and maintenance philosophy.



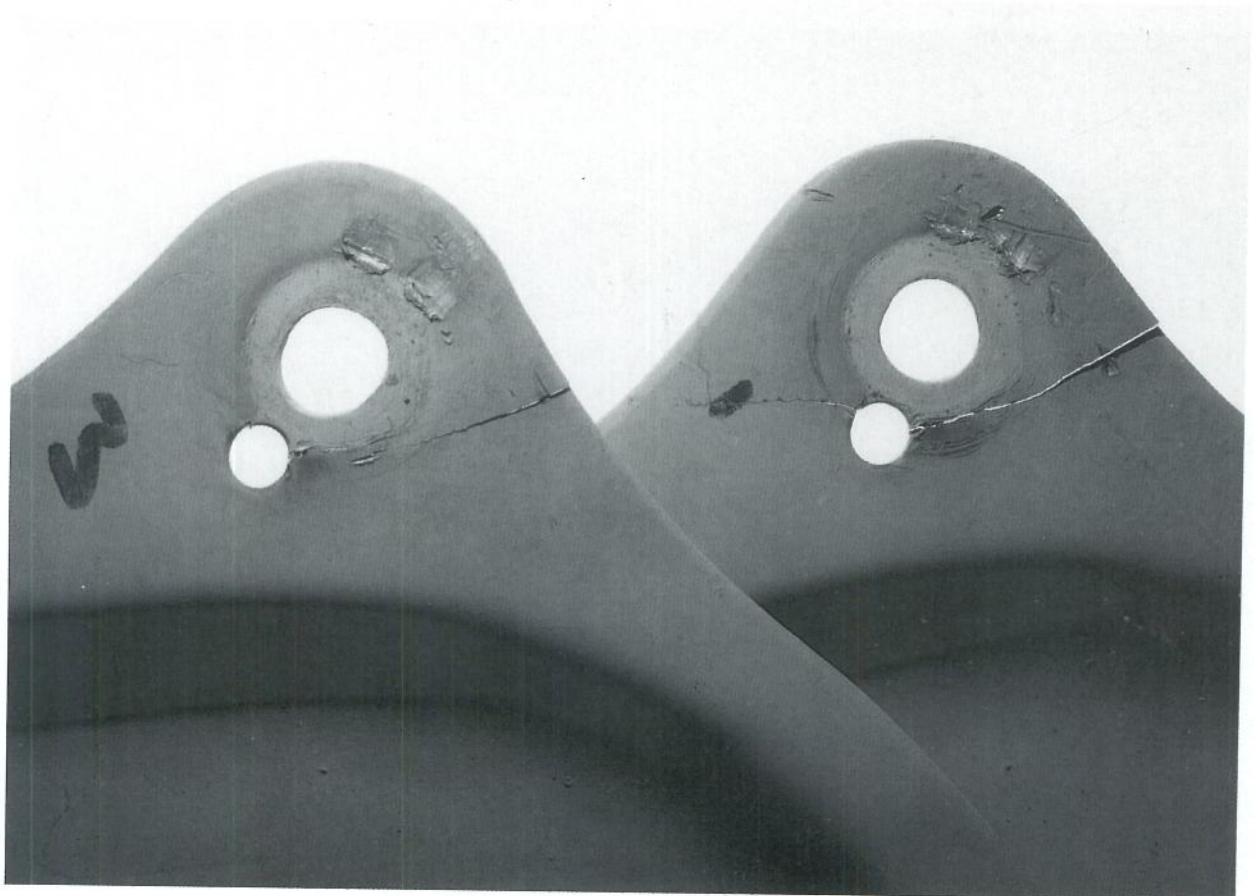
**FIG 1**  
Fan and Web Details







**FIG 2** View of failed web following removal of cover plate



**FIG 3** Cracks around cover plate bolt holes



**No: 10/90****Ref: EW/G90/08/11****Category: 1c**

<b>Aircraft Type and Registration:</b>	Cessna 152, G-BHEN
<b>No &amp; Type of Engines:</b>	1 Lycoming O-235-L2C piston engine
<b>Year of Manufacture:</b>	1980
<b>Date and Time (UTC):</b>	2 August 1990 at 1455 hrs
<b>Location:</b>	Leicester Airport
<b>Type of Flight:</b>	Private
<b>Persons on Board:</b>	Crew - 1                      Passengers - None
<b>Injuries:</b>	Crew - None                      Passengers - N/A
<b>Nature of Damage:</b>	Propeller bent, nose wheel collapsed, fuselage skin distorted and main landing gear attachment broken
<b>Commander's Licence:</b>	Student Pilot
<b>Commander's Age:</b>	17 years
<b>Commander's Total Flying Experience:</b>	13 hours (all on type)
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot

The aircraft had already flown for 3 hours and 15 minutes since refuelling when the instructor and student flew a 1 hour and 15 minute dual flight. The instructor then sent the student on his second solo.

The student completed one touch and go landing but, between 50 and 100 feet, the engine began to run roughly. When he lowered the aircraft's nose, the engine recovered but, on raising it again, the engine failed completely and so he picked a field ahead in which to make a forced landing. There was insufficient height remaining to reach the selected field and the aircraft passed through the airfield boundary hedge, crossed a road and came to rest on its nose in a ditch on the other side. There was no fire and the aerobatic safety harness fitted to the aircraft withstood the impact forces.

No traces of fuel were found at the accident site and subsequent examination of the fuel system revealed a total of just over 1 gall imp remaining in the fuel tanks. The unusable fuel is quoted as 1.25 gall imp (1.5 US).

**No: 10/90****Ref: EW/G90/06/21****Category: 1c**

<b>Aircraft Type and Registration:</b>	Cessna 152, G-BPLW
<b>No &amp; Type of Engines:</b>	1 Lycoming O-235-L2C piston engine
<b>Year of Manufacture:</b>	1981
<b>Date and Time (UTC):</b>	20 June 1990 at 1550 hrs
<b>Location:</b>	Culmore, near Londonderry, Northern Ireland
<b>Type of flight:</b>	Private
<b>Persons on Board:</b>	Crew - 1      Passengers - None
<b>Injuries:</b>	Crew - None      Passengers - N/A
<b>Nature of Damage:</b>	Damaged beyond economical repair
<b>Commander's Licence:</b>	Airline Transport Pilot's Licence
<b>Commander's Age:</b>	30 years
<b>Commander's Total Flying Experience:</b>	1,810 hours (of which 250 were on type)
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot

The aircraft had been flown to a private grass airfield which was evenly mown, with no defined runway. After a brief stop the engine was restarted and having completed the 'after start' and 'power' checks the aircraft was taxied, at about 15 knots with a low throttle setting, for about 400 metres before being turned into wind. After turning into wind, full throttle was applied immediately and slight back pressure applied to the control column. The aircraft accelerated and lifted-off normally.

After lift-off the pilot allowed the aircraft to accelerate in ground effect before raising the nose to climb away. As he did so, the engine lost power and the aircraft's nose dropped slightly. Despite attempting evasive action, the pilot was unable to prevent the left wing of the aircraft striking a hawthorn bush beside his selected take-off path. The aircraft slewed violently to the left and landed heavily on its right side, coming to rest facing the reciprocal of the take off direction. There was no fire and the pilot evacuated from the aircraft very quickly and without assistance.

The aircraft was beyond economical repair and no engine examination was reported. The temperature was reported as +15° C and the surface condition as dry. No information on the local relative humidity was available.

**No: 10/90****Ref: EW/G90/06/22****Category: 1c**

<b>Aircraft Type and Registration:</b>	Cessna T210N, G-BNZM
<b>No &amp; Type of Engines:</b>	1 Continental TSIO-520-R piston engine
<b>Year of Manufacture:</b>	1979
<b>Date and Time (UTC):</b>	21 June 1990 at 1241 hrs
<b>Location:</b>	Stansted Airport, Essex
<b>Type of flight:</b>	Private
<b>Persons on Board:</b>	Crew - 1      Passengers - 1
<b>Injuries:</b>	Crew - None      Passengers - None
<b>Nature of Damage:</b>	Nose landing gear, landing gear bay, propeller and engine cowl damaged, engine shock loaded
<b>Commander's Licence:</b>	Private Pilot's Licence with Instrument Rating
<b>Commander's Age:</b>	61 years
<b>Commander's Total Flying Experience:</b>	1,662 hours (of which 283 were on type)
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot

The accident followed a radar vectored ILS approach to Runway 23 at Stansted after a flight from Poitiers, France. The runway is tarmac, with a published Landing Distance Available of 2936 metres and a width of 46 metres, and was wet at the time of the accident. The reported meteorological conditions included a wind from 195°M at 14 kt and an ambient temperature of 14°C, and the cloud base was estimated at 6 oktas of stratus at 600 feet and the visibility at around 4000 metres. An observation after the accident, at 1250 hrs, recorded the wind as from 180°T (185°M) at 11 kt, but varying between 120-220°T, with 16 km visibility in rain.

The aircraft reportedly touched down after a normal approach, began a series of porpoising type pitch oscillations, and came to rest on the runway with the nose landing gear collapsed. The two occupants evacuated the aircraft and were joined by airport fire vehicles. There was no fire.

The pilot later reported that 'the approach was normal to the point of touchdown, but AFTER feeling the wheels rolling the nose of the aircraft appeared to drop below the normal "landed attitude" after which a pitch oscillation started to build and caused the aircraft to make a series of leaps which were uncontrollable, except for finally "holding back" on the last drop, after which the aircraft came to rest on the runway in a nose down attitude with the nose wheel collapsed'.

The damage characteristics indicated that the nose landing gear had failed due to overload upwards and to the right. No evidence of pre-accident defect was reported.



**No: 10/90****Ref: EW/G90/08/19****Category: 1c**

<b>Aircraft Type and Registration:</b>	Colibri MB2, G-BRAG
<b>No &amp; Type of Engines:</b>	1 Volkswagen piston engine
<b>Year of Manufacture:</b>	1979
<b>Date and Time (UTC):</b>	27 August 1990 at 1200 hrs
<b>Location:</b>	Mona Airfield, Holyhead, Gwynedd
<b>Type of Flight:</b>	Private
<b>Persons on Board:</b>	Crew - 1      Passengers - None
<b>Injuries:</b>	Crew - None      Passengers - N/A
<b>Nature of Damage:</b>	Tailwheel broken off, propeller and left landing gear bent
<b>Commander's Licence:</b>	Private Pilot's Licence with IMC rating
<b>Commander's Age:</b>	46 years
<b>Commander's Total Flying Experience:</b>	161 hours (of which 18 were on type)
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot

The pilot had carried out three successful touch and go landings on runway 22 at Mona, where the wind was 220°/20-24 kt with occasional gusts. On the final approach of the fourth circuit, at an indicated airspeed of 53 kt and about 20 feet above the ground, the aircraft suddenly began to sink rapidly. The pilot raised the nose and applied full engine power but was unable to prevent the aircraft from striking the ground with considerable force, firstly with the tailwheel and then with each mainwheel in turn, causing the aircraft to tip forwards and bend the propeller tips on the runway. When the aircraft fell back onto its tail the pilot steered it off the runway, breaking a runway light, and shut down the engine.

The pilot's full upper torso restraint harness remained secure throughout the sequence of events.

**No: 10/90****Ref: EW/G90/07/19****Category: 1c**

<b>Aircraft Type and Registration:</b>	Colomban Cri-Cri, G-CRIC
<b>No &amp; Type of Engines:</b>	2 JPX PUL 212 piston engines
<b>Year of Manufacture:</b>	1988
<b>Date and Time (UTC):</b>	17 July 1990 at 1905 hrs
<b>Location:</b>	Manchester (Barton) Airfield, Eccles, Manchester
<b>Type of Flight:</b>	Private
<b>Persons on Board:</b>	Crew - 1                      Passengers - None
<b>Injuries:</b>	Crew - None                      Passengers - N/A
<b>Nature of Damage:</b>	Substantial damage to airframe and engines
<b>Commander's Licence:</b>	Private Pilot's Licence with IMC and Night ratings
<b>Commander's Age:</b>	32 years
<b>Commander's Total Flying Experience:</b>	575 hours (of which 47 were on type)
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot

The pilot reports that he took off from Barton aerodrome with the intention of carrying out a circuit and low approach and flypast along the active runway before flying to Blackpool. During the flypast, which was carried out at about 100 feet and 105 knots, the left engine failed, probably as the throttles were opened to climb away. The pilot's initial reaction was to land on the runway and he therefore closed the throttles and selected the flaps fully down. However it was soon apparent that there was insufficient landing distance remaining and he was left with no alternative but to attempt a single engine circuit and landing. Full power was selected on the live engine and the flaps selected up. The pilot states that he found some difficulty in establishing a single engine climb and, as the aircraft was heading towards some power cables and due to the close proximity of buildings on his left, he initiated a turn to the right which had to be progressively steepened as the aircraft neared the cables. (It was subsequently found that the flaps had only been raised to the 12 degree position.) Thereafter height was progressively lost and the aircraft landed heavily in a cultivated field. Rapid deceleration was experienced resulting in substantial damage to the airframe and engines. There was no fire and the pilot, who had been wearing full restraint harness which held during the impact, was able to vacate the aircraft without injury.

Although the cause of the failure of the left engine could not be positively established, the pilot considers it likely to have been due to a carburettor mixture problem. He had experienced a similar problem on a previous occasion however, after adjustment, the engine had completed a further 30 hours without any defect.

**No: 10/90****Ref: EW/G90/05/27****Category: 1c**

<b>Aircraft Type and Registration:</b>	Evans VP1, G-BIFO
<b>No &amp; Type of Engines:</b>	1 Volkswagen 1834 Type 3 piston engine
<b>Year of Manufacture:</b>	1982
<b>Date and Time (UTC):</b>	31 May 1990 at 1320 hrs
<b>Location:</b>	Doyniton, Avon
<b>Type of Flight:</b>	Private
<b>Persons on Board:</b>	Crew - 1      Passengers - None
<b>Injuries:</b>	Crew - None      Passengers - N/A
<b>Nature of Damage:</b>	Left main landing gear failure and damage to the propeller and lower engine cowling
<b>Commander's Licence:</b>	Private Pilot's Licence
<b>Commander's Age:</b>	42 years
<b>Commander's Total Flying Experience:</b>	58 hours (of which 3 were on type)
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot, report from the materials department of the RAE Farnborough and enquiries with the Meteorological sections of Bristol (Lulsgate) and RAF Lyneham

During the landing roll on runway 20 the pilot felt a vibration on the left side of the aircraft. The pilot increased the engine power slightly and then cut the power. He held the stick back and balanced the weight of the aircraft on the right landing gear. As the speed decreased however the left landing gear then failed causing the aircraft to pitch nose down and pivot to the left. It came to rest on the runway on a heading at 90 degrees to the landing direction.

The fractured landing gear was examined by the materials department of the Royal Aerospace Establishment at Farnborough. Their examination concluded that the landing gear fractured under overload conditions after experiencing excessive bending that took it beyond the elastic limit of the aluminium alloy plate from which it had been manufactured. There was no evidence on the fracture of any pre-existing fatigue cracks or corrosion damage and the features were wholly consistent with fast, ductile rupture. The force that precipitated the failure was from the forward left hand side of the aircraft.

The wind reported by the pilot was 200 degrees, light. Subsequent enquiries with the meteorological sections of Bristol (Lulsgate) and RAF Lyneham indicated that at the time of the accident the wind was 170-180 degrees, 12-13 knots and 180-200 degrees 10 knots, gusting 15-16 knots respectively.



**No: 10/90**

**Ref: EW/G90/07/09**

**Category: 1c**

<b>Aircraft Type and Registration:</b>	Glos Airtourer Super 150, G-AZOF	
<b>No &amp; Type of Engines:</b>	1 Lycoming O-320-E2A piston engine	
<b>Year of Manufacture:</b>	1970	
<b>Date and Time (UTC):</b>	15 July 1990 at 1220 hrs	
<b>Location:</b>	Park Farm, Oaksey, Wiltshire	
<b>Type of flight:</b>	Private	
<b>Persons on Board:</b>	Crew - 1	Passengers - None
<b>Injuries:</b>	Crew - None	Passengers - N/A
<b>Nature of Damage:</b>	Wing, fuselage, propeller and landing gear damage, minor damage to tailplane	
<b>Commander's Licence:</b>	Private Pilot's Licence with IMC rating	
<b>Commander's Age:</b>	25 years	
<b>Commander's Total Flying Experience:</b>	352 hours (of which 135 were on type)	
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot	

The pilot reported that he carried out a normal flight from Sleaf, passing Cirencester at 2500 feet. He joined the circuit at Park Farm at 1500 feet then began a descent using 1,500 RPM with Carburettor Heat selected. On initiating the turn from base leg to final, the pilot wished to reduce the rate of descent. He therefore advanced the throttle, but this had no apparent effect. A further advance of the throttle produced no power increase. It thus became necessary to carry out a forced landing in a field of corn short of the airstrip.

A subsequent examination of the carburettor air box revealed that the butterfly valve was free to rotate on its shaft thus permitting the effective carb-heat setting to differ from that selected in the cockpit.

Examination of the valve and shaft revealed the absence of the two tubular pins normally securing the valve to the shaft.

**No: 10/90****Ref: EW/G90/07/34****Category: 1c****Aircraft Type  
and Registration:**

Gulfstream AA-5B, G-NGBI

**No & Type of Engines:**

1 Lycoming O-360-A4K piston engine

**Year of Manufacture:**

1979

**Date and Time (UTC):**

12 July 1990 at 2033 hrs

**Location:**

Thurrock Airstrip, Essex

**Type of Flight:**

Private

**Persons on Board:**

Crew - 1

Passengers - 1

**Injuries:**

Crew - None

Passengers - None

**Nature of Damage:**

Damage to mainplanes and tailplane

**Commander's Licence:**

Private Pilot's Licence

**Commander's Age:**

25 years

**Commander's Total  
Flying Experience:**

76 hours (of which 16 were on type)

**Information Source:**

Aircraft Accident Report Form submitted by the pilot

The aircraft arrived overhead the aerodrome at dusk. As he was unable to see any wind indication on the ground, the pilot obtained the surface wind from Stansted, which was reported to be 090°/5 kt. He decided, however, to land on runway 27 because he had taken off from runway 23 at Stansted. Aware of a line of pylons at the eastern end of the aerodrome, he flew a high approach using two-thirds flap. He reported that the landing flare lasted longer than expected and, after touchdown, the aircraft bounced. There was then insufficient runway left in which to stop the aircraft, which overshot the runway, crossed a road and came to rest in a hedge.



**No: 10/90****Ref: EW/G90/07/21****Category: 1c**

<b>Aircraft Type and Registration:</b>	Luscombe Silvaire 8E, G-NIGE
<b>No &amp; Type of Engines:</b>	1 Continental C85 12F piston engine
<b>Year of Manufacture:</b>	1946
<b>Date and Time (UTC):</b>	20 July 1990 at 2000 hrs
<b>Location:</b>	Low Farm, Scholar Green, Congleton, Cheshire
<b>Type of Flight:</b>	Private
<b>Persons on Board:</b>	Crew - 1      Passengers - 1
<b>Injuries:</b>	Crew - None      Passengers - None
<b>Nature of Damage:</b>	Minor damage to propeller tips, tailplane and rudder
<b>Commander's Licence:</b>	Private Pilot's Licence
<b>Commander's Age:</b>	31 years
<b>Commander's Total Flying Experience:</b>	93 hours (of which 25 were on type)
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot

The pilot reports that following a normal landing and as he was taxiing the aircraft across a grass field, the right side main landing gear went into a rut approximately 10 inches deep. This caused the aircraft to tip forward and the propeller struck the ground. As it tipped back again, the tailplane and rudder sustained minor damage.

**No: 10/90****Ref: EW/G90/08/02****Category: 1c**

<b>Aircraft Type and Registration:</b>	Monnett Sonerai II L, G-BKDC
<b>No &amp; Type of Engines:</b>	1 Volkswagen 1834 piston engine
<b>Year of Manufacture:</b>	1987
<b>Date and Time (UTC):</b>	7 August 1990 at 1103 hrs
<b>Location:</b>	Brighton Airfield, Yorkshire
<b>Type of Flight:</b>	Private
<b>Persons on Board:</b>	Crew - 1      Passengers - None
<b>Injuries:</b>	Crew - None      Passengers - N/A
<b>Nature of Damage:</b>	Severe damage to landing gear and propeller, some damage to airframe
<b>Commander's Licence:</b>	Private Pilot's Licence
<b>Commander's Age:</b>	21 years
<b>Commander's Total Flying Experience:</b>	83 hours (none on type)
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot

The pilot had purchased the aeroplane the previous day and this was to be his first flight on the type, although he was in current flying practice. The pilot reports that the engine started with some difficulty but then ran smoothly. The engine run-up checks were satisfactory, with a small rpm drop with carburettor heat, negligible magneto drop, quick throttle response and a smooth idle. Full throttle gave a steady 3,150 rpm, which was satisfactory.

On the take-off run the aircraft became airborne at about 300 to 350 yards and at about 500 yards the aircraft was at 30 feet and 65 to 70 kt. The engine speed suddenly dropped to 2,400 rpm and the pilot decided to land straight ahead, in the stubble in the field beyond the runway.

Just before round-out the pilot noticed a piece of rubble just below the wing and pulled up hard; a moment later the right-hand landing gear leg hit another piece of rubble, removing the wheel. The pilot corrected the attitude of the aeroplane, cut the power and made a belly landing some 30 yards further on. There was no fire but, due to the crash loads, the canopy release mechanism jammed and the pilot had to smash the canopy to get out of the aircraft.



The pilot comments that his lack of familiarity with the aircraft cockpit meant that he had to look back into the cockpit to locate the magneto switches and the fuel and carburettor heat controls. As a result, he did not notice either the clear area to his right or the pile of rubble the landing gear struck.

Subsequent examination by the pilot did not reveal any apparent cause of the engine power loss. The engine was being run on Mogas obtained from a local garage and the pilot considers that, at the reported 20°C, vapour lock should not have been a problem. The pilot assesses the probable cause as having been water or dirt in the fuel but it was not possible to obtain a sample for analysis.

Location:		Churn Farm Estates, near White Waltham, Berkshire	
Type of Flight:		Private	
Persons on Board:		Crew - 1	Passengers - 1
Injuries:		Crew - None	Passengers - None
Nature of Damage:		Right wing leading edge and lift strut damaged	
Commander's Licence:		Private Pilot's Licence	
Commander's Age:		36 years	
Commander's Total Flying Experience:		163 hours (of which 38 were on type)	
Information Source:		Aircraft Accident Report Form submitted by the pilot and AAIB telephone inquiries	

The pilot reportedly initiated a practice forced landing from 1500 feet above ground, choosing a large horse gallop area as his target. After throttling back the engine he selected carburettor heat on, and during the descent briefly opened the throttle to warm the engine three times. When at 100 feet agl, approaching the selected landing site, the planned go-around was initiated. The engine at first responded normally but then began to run roughly and loose power. Carburettor heat was reselected on, but without apparent effect.

Finding that the aircraft was unable to maintain height above the now rising terrain, the pilot decided to land. As he had by now overflown most of the originally selected site he chose a second horse gallop area orientated 45° right, and achieved a satisfactory touchdown. However, during the landing roll on the rough ground the right wing leading edge and lift strut struck a bush. The aircraft stopped and both occupants evacuated.

Inspection reportedly found that the lower sparking plug of the forward left cylinder was fouled. After plug swapping and replacement of the lift strut and a lengthy ground run of the engine, the aircraft was flown out the following day. The pilot believes that carburettor icing may have been a factor. The Meteorological Office indicated that at ground level in the area at the time of the accident the ambient temperature was 16-17°C and the relative humidity around 75%. Icing probability charts indicate that in such conditions there is likely to be a high risk of serious carburettor icing at descent power.

**No: 10/90**

**Ref: EW/G90/05/16**

**Category: 1c**

**Aircraft Type**

**and Registration:**

Piper J3C-65 Cub, G-BILI

**No & Type of Engines:**

1 Continental A65 piston engine

**Year of Manufacture:**

1944

**Date and Time (UTC):**

9 May 1990 at 1815 hrs

**Location:**

Churn Farm Estates, near White Waltham, Berkshire

**Type of Flight:**

Private

**Persons on Board:**

Crew - 1

Passengers - 1

**Injuries:**

Crew - None

Passengers - None

**Nature of Damage:**

Right wing leading edge and lift strut damaged

**Commander's Licence:**

Private Pilot's Licence

**Commander's Age:**

26 years

**Commander's Total  
Flying Experience:**

163 hours (of which 28 were on type)

**Information Source:**

Aircraft Accident Report Form submitted by the pilot and AAIB telephone inquiries.

The pilot reportedly initiated a practice forced landing from 1500 feet above ground, choosing a large horse gallop area as his target. After throttling back the engine he selected carburettor heat on, and during the descent briefly opened the throttle to warm the engine three times. When at 100 feet agl, approaching the selected landing site, the planned go-around was initiated. The engine at first responded normally but then began to run roughly and loose power. Carburettor heat was reselected on, but without apparent effect.

Finding that the aircraft was unable to maintain height above the now rising terrain, the pilot decided to land. As he had by now overflowed most of the originally selected site he chose a second horse gallop area orientated 45° right, and achieved a satisfactory touchdown. However, during the landing roll on the rough ground the right wing leading edge and lift strut struck a bush. The aircraft stopped and both occupants evacuated.

Inspection reportedly found that the lower sparking plug of the forward left cylinder was fouled. After plug swopping and replacement of the lift strut and a lengthy ground run of the engine, the aircraft was flown out the following day. The pilot believes that carburettor icing may have been a factor. The Meteorological Office indicated that at ground level in the area at the time of the accident the ambient temperature was 16-17°C and the relative humidity around 75%. Icing probability charts indicate that in such conditions there is likely to be a high risk of serious carburettor icing at descent power.



**No: 10/90****Ref: EW/G90/05/12****Category: 1c**

<b>Aircraft Type and Registration:</b>	Piper J3C-65, G-TAFY
<b>No &amp; Type of Engines:</b>	1 Continental A65 piston engine
<b>Year of Manufacture:</b>	1940
<b>Date and Time (UTC):</b>	5 May 1990 at 1310 hrs
<b>Location:</b>	Near March, Cambridgeshire
<b>Type of Flight:</b>	Private
<b>Persons on Board:</b>	Crew - 1      Passengers - 1
<b>Injuries:</b>	Crew - None      Passengers - 1 (serious)
<b>Nature of Damage:</b>	Aircraft damaged beyond economic repair
<b>Commander's Licence:</b>	Private Pilot's Licence
<b>Commander's Age:</b>	43 years
<b>Commander's Total Flying Experience:</b>	377 hours (of which 103 were on type)
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot

The aircraft was en route from Nayland to Fenland, cruising at 1500 feet, when the engine suddenly lost power. The pilot immediately applied carburettor heat but the engine would not develop more than 1800 rpm. A Mayday call was made on 121.5 MHz, but this was not acknowledged. The pilot tried another call on the RAF Honington frequency, which was answered immediately. A field northeast of March was chosen as the landing site. The pilot noted that this had ditches and power cables at each end. Being rather high on approach, the pilot turned the aircraft through 360° in order to lose height. However on approach the tail of the aircraft subsequently struck the cables, and this pitched the aircraft nose-down into the ground with the engine still running at approximately 1800 rpm. The aircraft cartwheeled before coming to rest substantially damaged and with fuel pouring from the ruptured fuel tanks. Fortunately there was no fire. The harnesses held during the impact although the passenger received injuries to her left hand and suffered bruising and shock.

No investigation has yet been conducted into the reason for the power loss. The pilot considered that a fuel vapour lock may have been a possibility, as the weather was hot at the time of the accident. Although the aircraft had previously run without problems on motor fuel, on the day in question the pilot had had to purchase fuel from a source other than that which he normally used.

**No: 10/90****Ref: EW/G90/08/07****Category: 1c**

<b>Aircraft Type and Registration:</b>	Piper PA-28-180, G-BODM
<b>No &amp; Type of Engines:</b>	1 Lycoming O-360-A4A piston engine
<b>Year of Manufacture:</b>	1973
<b>Date and Time (UTC):</b>	1 August 1990 at 1805 hrs
<b>Location:</b>	Compton Abbas, Wiltshire
<b>Type of Flight:</b>	Private
<b>Persons on Board:</b>	Crew - 1      Passengers - 1
<b>Injuries:</b>	Crew - None      Passengers - None
<b>Nature of Damage:</b>	Propeller and nose landing gear (NLG) bent, NLG wheel-spat broken and steering spring detached
<b>Commander's Licence:</b>	Private Pilot's Licence
<b>Commander's Age:</b>	41 years
<b>Commander's Total Flying Experience:</b>	73 hours (all on type)
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot

A landing on the aircraft's main wheels, at an unspecified speed, resulted in a short ground run and an involuntary resumption of flight. Fearing that the aircraft would stall, the pilot pushed the control column forward, causing the aircraft to land on the nose wheel and bounce a number of times. He immediately applied full engine power for a go-around and was informed by 'Compton Radio' that he had lost a wheel, which he acknowledged, telling them that he had also lost the use of his rudder.

As there was the possibility of further damage to the aircraft, the pilot decided to fly-past the 'tower' so that they could carry out an inspection. Following this he asked which wheel he had lost and was advised that only the nose wheel spat was missing. Therefore, considering that he appeared to have full landing gear but had lost use of the rudder and may have damaged the propeller, he decided to land at Compton Abbas rather than return to his base at Bristol.

Following an extended circuit, to give himself time to adjust to the difficult circumstances, the pilot carried out a landing on the main wheels and was subsequently just able to keep the aircraft on the runway by use of differential braking. He brought the aircraft to a stop and shut it down without further event.

**No: 10/90**

**Ref: EW/G90/07/28**

**Category: 1c**

**Aircraft Type and Registration:** Piper PA-28R-180, G-AVWU

**No & Type of Engines:** 1 Lycoming IO-360-B1E piston engine

**Year of Manufacture:** 1968

**Date and Time (UTC):** 22 July 1990 at 1005 hrs

**Location:** Caernarfon Airport, Gwynedd

**Type of Flight:** Private

**Persons on Board:** Crew - 1 Passengers - 3

**Injuries:** Crew - None Passengers - None

**Nature of Damage:** Propeller tips and flaps bent, fuselage underside scraped

**Commander's Licence:** Private Pilot's Licence with IMC rating

**Commander's Age:** 47 years

**Commander's Total Flying Experience:** 207 hours (of which 88 were on type)

**Information Source:** Aircraft Accident Report Form submitted by the pilot

The aircraft (Piper) was cleared to join the downwind leg for runway 26 and advised that there was a Cessna on the final approach to land. When on finals, the Piper was requested to go around and consequently retracted the flaps and landing gear. On the subsequent downwind leg, the pilot omitted to lower the gear and did not notice the omission until the propeller struck the runway during the landing. There was no fire and all four occupants evacuated the aircraft without difficulty.

In May 1988, as a result of problems with the system, the landing gear automatic lowering had been disabled and there was no throttle-related landing gear warning horn on the aircraft.



**No: 10/90****Ref: EW/G90/08/18****Category: 1c**

<b>Aircraft Type and Registration:</b>	Piper PA-28R-200-2, G-BAIH	
<b>No &amp; Type of Engines:</b>	1 Lycoming IO-360-C1C piston engine	
<b>Year of Manufacture:</b>	1972	
<b>Date and Time (UTC):</b>	24 August 1990 at 1915 hrs	
<b>Location:</b>	Chester-le-Street, County Durham	
<b>Type of Flight:</b>	Private	
<b>Persons on Board:</b>	Crew - 1	Passengers - None
<b>Injuries:</b>	Crew - None	Passengers - N/A
<b>Nature of Damage:</b>	Propeller, nose landing gear and wing leading edges damaged	
<b>Commander's Licence:</b>	Private Pilot's Licence with IMC and Night ratings	
<b>Commander's Age:</b>	39 years	
<b>Commander's Total Flying Experience:</b>	518 hours (of which 223 were on type)	
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot	

Whilst established in the holding pattern, waiting for the weather to clear at both his destination and alternate airfields, the pilot was told by ATC that, if he wished to use it, there was a grass landing strip situated below the holding pattern. Wanting to land before the onset of darkness, the pilot accepted this offer and, having made an inspection of the strip, carried out a normal circuit and approach to land.

However, the presence of some street lights beneath the approach path obliged the pilot to land some 50 yards into the 600 yard strip, where the very wet grass allowed only limited directional control and provided poor braking action. In consequence, the aircraft, still travelling at about 15 mph, passed through a fence at the end of the strip, damaging the wings and collapsing the nose landing gear. There was no fire and the pilot left the aircraft without further incident.

**No: 10/90**

**Ref: EW/G90/08/15**

**Category: 1c**

**Aircraft Type**

**and Registration:** Piper PA-28R-200-2, G-BBZH

**No & Type of Engines:** 1 Lycoming IO-360-C1C piston engine

**Year of Manufacture:** 1973

**Date and Time (UTC):** 28 August 1990 at 1211 hrs

**Location:** Exeter Airport, Devon

**Type of Flight:** Private

**Persons on Board:** Crew - 1                      Passengers - 3

**Injuries:** Crew - None                      Passengers - None

**Nature of Damage:** Nose and right landing gear collapsed, propeller bent and engine exhausts crushed, skin damage to both wings, left outer stabilator tip crushed

**Commander's Licence:** Private Pilot's Licence with IMC and Night ratings

**Commander's Age:** 55 years

**Commander's Total Flying Experience:** 212 hours (of which 81 were on type)

**Information Source:** Aircraft Accident Report Form submitted by the pilot

The pilot states that, following a flight from Jersey Airport, he reported a position downwind left hand for runway 26 at Exeter Airport, and was instructed by Exeter ATC to "report final - number 2". When it was at about 300 feet on the final approach ATC gave landing clearance with the request that the aircraft vacate the runway at the 08 threshold. The pilot could see an aircraft waiting at the runway 26 holding point and states that, in order to expedite clearing the runway, he elected to fly along the runway and land deep. The aircraft made what he considered to be a normal touchdown at the recommended speed of 80 mph, at a position approximately 800 metres from the 08 threshold. (The total runway length is 2083 metres.) Almost immediately after touchdown and as the throttles were closed, the aircraft yawed violently to the left which the pilot was unable to contain with the application of right rudder. After the aircraft departed the left side of the paved surface the nose landing gear broke off, the right main landing gear collapsed and the propeller struck the ground as it slid to a halt. There was no fire and all occupants vacated the aircraft without injury.

The weather at the time was fine with a surface wind of 180/12 knots. During the short period before and after the accident the wind was recorded as variable between 150/210 at 10 to 12 knots. There were

no significant gusts however the pilot does report encountering what he describes as a fair amount of turbulence on the final approach.

Initial engineering examination has revealed no pre-existing faults to the nose landing gear or its steering mechanism. Photographs of ground witness marks were taken immediately after the accident. These show that the aircraft had touched down close to the runway centre line but with a considerable amount of yaw to the left, and that this had increased rapidly immediately after ground contact.

Aircraft Type		Date and Time (UTC):	
Year of Manufacture		28 August 1990 at 1211 hrs	
Location:		Exeter Airport, Devon	
Type of Flight:		Private	
Persons on Board:		Crew - 1 Passengers - 3	
Injuries:		Crew - None Passengers - None	
Nature of Damage:		Nose and right landing gear collapsed, propeller bent and engine exhausts crushed, skin damage to both wings, left outer stabiliser tip crushed	
Commander's Licence:		Private Pilot's Licence with IMC and Night ratings	
Commander's Age:		55 years	
Commander's Total Flying Experience:		212 hours (of which 81 were on type)	
Information Source:		Aircraft Accident Report Form submitted by the pilot	

The pilot states that following a flight from Jersey Airport, he reported a position downwind left hand runway 26 at Exeter Airport and was instructed by Exeter ATC to "report final - number 2". When it was at about 300 feet on the final approach ATC gave landing clearance with the request that the aircraft vacate the runway at the 08 threshold. The pilot could see an aircraft waiting at the runway 26 holding point and states that, in order to expedite clearing the runway, he elected to fly along the runway and land deep. The aircraft made what he considered to be a normal touchdown at the recommended speed of 80 mph, at a position approximately 800 metres from the 08 threshold. (The total runway length is 2083 metres.) Almost immediately after touchdown and as the throttles were closed, the aircraft yawed violently to the left which the pilot was unable to contain with the application of right rudder. After the aircraft departed the left side of the paved surface the nose landing gear broke off, the right main landing gear collapsed and the propeller struck the ground as it slid to a halt. There was no fire and all occupants vacated the aircraft without injury.

The weather at the time was fine with a surface wind of 18/12 knots. During the short period before and after the accident the wind was recorded as variable between 120/210 at 10 to 12 knots. There were



**No:** 10/90      **Ref:** EW/G90/08/05      **Category:** 1c

**Aircraft Type  
and Registration:**

Piper PA-32RT-300, G-BYBB

**No & Type of Engines:** 1 Lycoming IO-540-K1G5D piston engine

**Year of Manufacture:** 1978

**Date and Time (UTC):** 5 August at 1220 hrs

**Location:** Stapleford Tawney Airfield, Essex

**Type of flight:** Private

**Persons on Board:** Crew - 1      Passengers - 2

**Injuries:** Crew - None      Passengers - None

**Nature of Damage:** Extensive (aircraft assessed as beyond repair)

**Commander's Licence:** Private Pilot's Licence

**Commander's Age:** 28 years

**Commander's Total:** 65 hours (of which 12 were on type)

**Information Source:** Aircraft Accident Report Form submitted by the pilot and enquiries with numerous aviation organisations

During the morning on the day of the accident the pilot carried out some circuit flying with a check pilot. The aircraft performed satisfactorily. After a break away from the airfield, during which time the aircraft was not flown, the pilot returned with two adult passengers and prepared for a local pleasure flight. He refuelled the aircraft to full tanks which involved an uplift of 264 litres. The "pre-flight" and "after start" checks were carried out satisfactorily. The pilot then obtained permission to taxi to runway 28, which was a grass runway with an available take-off run of 715 metres. The wind was 300°/15 kts and air temperature +22.7°C. After taxiing to the hold for runway 28, the power and pre take-off checks, which included the selection of 10° flap, were carried out and everything appeared normal. Having obtained permission to take-off, the pilot lined up the aircraft on the runway, applied full power and commenced the take-off roll. The aircraft's speed built up normally and the engine temperatures and pressures were observed to be within the green indicated arc on the gauges. At approximately 65 to 70 kts, the pilot initiated rotation but the nose of the aircraft failed to rise. He then pulled the control wheel further back but the nose still failed to lift. Feeling that something was wrong the pilot shut the engine down and applied maximum braking. The aircraft failed to stop within the remaining runway available and continued into an adjacent field, causing detachment of the main landing gear.

The calculated take-off distances for this particular aircraft at its approximate weight under the prevailing conditions were:

Take-off Distance (TOD) (50 ft)	0° Flap	543 m (1,782 ft)
Ground Roll	0° Flap	392 m (1,287 ft)
TOD (50 ft)	25° Flap	520 m (1,705 ft)
Ground Roll	25° Flap	382 m (1,254 ft)

No engineering examination of the aircraft was reported to have been carried out.

**No: 10/90**                      **Ref: EW/G90/06/02**                      **Category: 1c**

**Aircraft Type and Registration:** Piper PA-34-200, G-BNNB

**No & Type of Engines:** 1 Lycoming IO-360-C1E6 piston engine (left)  
1 Lycoming LIO-360-C1E6 piston engine (right)

**Year of Manufacture:** 1973

**Date and Time (UTC):** 9 June 1990 at 1412 hrs

**Location:** Bournemouth International Airport, Dorset

**Type of Flight:** Commercial

**Persons on Board:** Crew - 2                      Passengers - None

**Injuries:** None - None                      Passengers - N/A

**Nature of Damage:** Nose, nose landing gear doors and propellers damaged

**Commander's Licence:** Commercial Pilot's Licence with Instrument and Instructor ratings

**Commander's Age:** 37 years

**Commander's Total Flying Experience:** 3,958 hours (of which 324 were on type)

**Information Source:** Aircraft Accident Report Form submitted by the pilot and telephone inquiries to the repair agency.

The aircraft had completed an instrument rating (IR) training sortie from Bournemouth Hurn Airport, followed by an uneventful rejoin downwind for runway 35 with the instructor handling the aircraft. The downwind checks were completed with no abnormality becoming apparent. The landing gear was selected down, the gear was heard to extend, and "3 greens" were obtained and verified by both crew members. Thereafter the base leg and finals proceeded without incident.

A smooth touchdown was made on the main wheels with engines at idle, and the nosewheel was lowered smoothly. However, the commander then sensed that the nose was lowering further than normal and immediately pulled both mixture controls to idle cut-off. The nose contacted the ground and the propellers struck the tarmac as the aircraft slid along the runway, coming to rest slightly to the left of centreline. On stopping, the aircraft was checked for safety and evacuated.

Once the aircraft had been confirmed as safe, but before it had been otherwise disturbed, the master switch was switched on and the landing gear indicator was still found to be showing "3 greens", despite the fact that the nose-leg was partially retracted into the bay. The "3 greens" indication was independently verified by the engineer who recovered the aircraft from the runway.



During recovery of the aircraft, the emergency lowering system was operated and the landing gear extended and locked-down normally. Examination of the system failed to identify any abnormality apart from a slight burr on one of the operating links, which it was believed was produced as the landing gear collapsed and would not have explained the spurious nose landing gear indication. However, repeated bench-checking of the nose leg *gear locked* microswitch failed to produce any malfunction. Both the microswitch and the damaged link were replaced and the aircraft has since flown without any further problem becoming apparent.

The engineer who repaired the aircraft pointed out that the landing gear hydraulic system supplies pressure to the *down* side of the landing gear hydraulic actuators until all three legs are down and locked; once all three *gear locked* microswitches are closed, the hydraulic pump is switched off. The main landing gear legs typically extend and lock before the nose leg, and it is therefore possible that a malfunctioning microswitch on the nose leg could switch off the hydraulic pump before the nose leg locks fully down, allowing the leg to fold when loaded during touchdown.

**No:** 10/90

**Ref:** EW/C1175

**Category:** 1c

**Aircraft Type**

**and Registration:** Piper PA-38-112, G-BNJY

**No & Type of Engines:** 1 Lycoming O-235-L2C piston engine

**Year of Manufacture:** 1979

**Date and Time (UTC):** 8 August 1990 at 1935 hrs

**Location:** 1nm east of Fairoaks Airport, Chobham, Surrey

**Type of flight:** Private

**Persons on Board:** Crew - 1 Passengers - 1

**Injuries:** Crew - 1 (serious) Passengers - 1 (serious)

**Nature of Damage:** Aircraft destroyed

**Commander's Licence:** Private Pilot's Licence

**Commander's Age:** 29 years

**Commander's Total Flying Experience:** 197 hours (of which 84 were on type)

**Information Source:** AAIB Field Investigation

The pilot and his passenger took off with full fuel tanks for an evening navigation flight which proceeded uneventfully for some two hours. After passing through the Biggin Hill overhead at 2400 feet altitude the pilot turned onto a westerly heading and was handed over by Biggin ATC to Heathrow radar. At about 2015 hours local time, in the vicinity of Leatherhead, the engine began to run roughly. The pilot changed fuel tanks, applied carburettor heat and checked the primer was locked in. Next he selectively switched the engine ignition from BOTH to LEFT and RIGHT systems in turn. With RIGHT selected the engine performance was unaltered but when LEFT was selected it was markedly worse. The pilot diagnosed a magneto failure, reselected BOTH on the ignition switch and informed Heathrow radar of his engine problem. Heathrow radar passed vectors for a diversion to Fairoaks and advised the pilot that although Fairoaks was closed the runway was still available for an emergency landing. The pilot accepted the diversion and maintained 70 kt IAS in a gentle descent. At 2022 hours he reported that he had Fairoaks in sight and requested the surface wind at Heathrow which was given as 240°/03. Radar recordings showed the aircraft track towards Fairoaks at 90 kt groundspeed before turning left to pass about ½ nm south-east of and parallel to the runway at a groundspeed of 77 kts. The aircraft then turned right onto base leg for runway 06 and right again onto finals at a groundspeed of 70 kt. Some 20 seconds later the aircraft disappeared below radar cover close to the 06 threshold. Eye witnesses on the airfield saw JY high on approach to runway 06 and continue descent almost to ground level at the eastern end of the runway. The aircraft was then seen to climb away and the witnesses, assuming they had seen a practice forced landing, stopped watching JY.



The aircraft was next seen about 1nm from the airfield on the extended centreline of runway 06 in a left turn at tree-top level. Witnesses at a nearby farm heard a loud crack and turned to see JY in a near vertical dive a few feet above the ground. They alerted the emergency services and administered first aid to the occupants who were both very seriously injured. Despite a strong smell of fuel there was no fire.

Neither the pilot nor his passenger could remember the crash sequence but the pilot recalled being too high on a precautionary engine-off approach, deciding to go-around and attempting to avoid trees after total power loss. A meteorological aftercast for the time of the accident assessed the surface wind as 230°/05 and the 2000 ft wind as 320°/10.

The aircraft had crashed in a field alongside a line of trees approximately 60' high; debris showed that the outer half of the right wing had removed some substantial dead branches of a willow tree before the wing and fuselage passed through the outer canopy of an oak tree. The aircraft had then rotated to face onto a reciprocal bearing and had struck the ground in an almost vertical attitude 288 feet beyond the first tree impact; the aircraft came to rest 27 feet beyond the initial ground impact point. Flaps were found to be selected fully down. No propeller strikes were found in the trees, nor was any evidence found to indicate that the engine had been under power at impact. The engine had detached and the front half of the cockpit had been extensively damaged, the rear fuselage had failed and the empennage had bent forward over the cockpit area. The remaining fuselage section and the wings were inclined forward at an angle of 44° below the horizontal.

The right fuel tank was intact and the remaining eight litres of 100LL fuel had accumulated in the leading edge of the right tank at a level well below the fuel outlet pipe which had been severed by the rescue crew. The left tank leading edge had ruptured and there were no indications of its contents at the time of the accident. The aircraft fuel cock was selected to the left tank.

The aircraft had been brought onto the UK register in July 1987 at a recorded life of 1252 hours, it had since flown approximately 1180 hours.

Slick 4200 series magnetos were fitted and there was no documentary evidence that the Slick Service Bulletin SB 2-80B, recommending maintenance intervals, had been carried out. The left hand magneto had been rebuilt by Slick December 1984 and both the internal condition and an intact seal indicated that the magneto had not been inspected internally since the rebuild by the manufacturer. On test the magneto misfired throughout the operating range. The internal condition was very poor with badly burnt points and HT rotor arm; the secondary coil was intermittently open circuit and the cam follower was worn beyond limits. The right hand magneto had been rebuilt by Slick in October 1986, its seal was also intact. On test the magneto was intermittent below 500 rpm but produced sparks throughout the operating range of the engine. Internally the magneto appeared cleaner than the left hand magneto but showed similar burning and carbon on the HT rotor arm.

The AAIB has made a recommendation that the CAA should consider making the 500 hour magneto internal inspection mandatory.



<b>No:</b> 10/90	<b>Ref:</b> EW/G90/05/21	<b>Category:</b> 1c
<b>Aircraft Type and Registration:</b>	Piper PA-38-112, G-BRNJ	
<b>No &amp; Type of Engines:</b>	1 Lycoming O-235-L2C piston engine	
<b>Year of Manufacture:</b>	1979	
<b>Date and Time (UTC):</b>	7 May 1990 at 1000 hrs	
<b>Location:</b>	6 nm east-south-east of Malvern, Worcestershire	
<b>Type of Flight:</b>	Private	
<b>Persons on Board:</b>	Crew - 1	Passengers - 1
<b>Injuries:</b>	Crew - None	Passengers - None
<b>Nature of Damage:</b>	Damage to nose landing gear	
<b>Commander's Licence:</b>	Private Pilot's Licence with IMC and Night ratings	
<b>Commander's Age:</b>	27 years	
<b>Commander's Total Flying Experience:</b>	104 hours (of which 13 were on type)	
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot	

Whilst on a local flight from Staverton, severe engine vibration was experienced. Recovery to Staverton was initiated immediately, but the vibration got worse and was accompanied by a loss of power. Checks were carried out for carburettor icing, fuel mixture and magnetos without effect. Eventually the vibration increased to a level where the artificial horizon toppled and the pilot considered it unsafe to continue the flight. A Pan call was made and a suitable field selected. However a downwind inspection revealed a number of obstructions in the field, necessitating an alternative field to be selected. At that point, all engine power ceased. The aircraft landed heavily from the resulting glide approach, and the nose landing gear collapsed immediately. The aircraft came to a halt in a nose down attitude and the occupants evacuated the aircraft without injury.

Subsequent investigation of the engine revealed that No. 1 cylinder had three cylinder hold-down nuts missing, the studs apparently having sheared. In addition, 2 nuts on the adjacent (No 3) cylinder were found to be finger tight. In the opinion of the maintenance organisation, the remaining cylinder nuts on the engine had been over torqued. The vibration had been due to the physical movement of the No. 1 cylinder such that a 1/8 inch gap existed between the cylinder flange and the crankcase.

The engine had been overhauled in the United States. No oil weeps from the cylinders, which would have indicated low torque settings on the nuts, had been found during successive 50 hour inspections; the actual torque settings are not normally checked.

**No: 10/90****Ref: EW/G90/06/01****Category: 1c****Aircraft Type  
and Registration:**

Pitts S-1S, G-IIIX

**No & Type of Engines:**

1 Lycoming O-360-A4A piston engine

**Year of Manufacture:**

1969

**Date and Time (UTC):**

10 June 1990 at 1134 hrs

**Location:**

Newcastle-upon-Tyne International Airport

**Type of Flight:**

Private

**Persons on Board:**

Crew - 1

Passengers - None

**Injuries:**

Crew - 1 (minor)

Passengers - N/A

**Nature of Damage:**

Left exhaust pipe fractured and left mainwheel bungees destroyed

**Commander's Licence:**

Private Pilot's Licence

**Commander's Age:**

42 years

**Commander's Total  
Flying Experience:**

1,108 hours (of which 510 were on type)

**Information Source:**

Aircraft Accident Report Form submitted by the pilot

The aircraft was flying in formation from Glenrothes to Newcastle when the pilot detected a minor change in engine note. He checked the engine instruments and noted a slight reduction in power. Through the transparent plexiglass floor panel the pilot saw that the left exhaust pipe was slightly displaced from its normal position and saw it move back onto the left mainwheel bungees, which separated under the heat.

The pilot decided to land at Newcastle and, when he detected hot fumes entering the enclosed cockpit, he put out a Pan call to Newcastle Approach, advising that the landing gear was likely to collapse on landing. The tower was informed and a Full Emergency was implemented.

Attempting to clear the fumes from the cockpit, the pilot opened the sliding canopy fully but this actually made the situation worse as additional fumes were drawn through the cockpit. He then moved the canopy to its first notch of opening and, applying a pronounced yaw, found this the most effective way of keeping the cockpit clear of fumes. On the approach he began to feel very ill but managed to land on the right mainwheel and the tailwheel and was able to keep the aircraft balanced down to a slow speed. The airport fire service was in immediate attendance and were able to assist the pilot out of the aircraft and revive him with oxygen before he was taken to hospital.

The examination of the aircraft showed that a crack had propagated across the left exhaust system, resulting in the lower portion moving back, attached to the aircraft only by the smoke injector fittings. Considering the loads applied to the exhaust system in a highly aerobatic aircraft, the pilot has fitted a stainless steel exhaust system to the aircraft and has been entirely satisfied with its performance.

Information Source:	Aircraft Accident Report Form submitted by the pilot
Commander's Flying Experience:	152 hours (of which 77 were on type)
Commander's Age:	49 years
Commander's Licence:	Private Pilot's Licence
Nature of Damage:	Substantial damage to fuselage, wings and landing gear
Injuries:	Crew - None Passengers - None
Persons on Board:	Crew - 1 Passengers - 1
Type of Flight:	Private
Location:	White Waltham Airfield, Maidenhead, Berkshire
Date and Time (UTC):	28 May 1990 at 1330 hrs
Year of Manufacture:	1968
No & Type of Engines:	1 Continental O-200-A piston engine

The aircraft took off from White Waltham for a two hour pleasure flight. After leveling off in the cruise however, the pilot noticed a roughness in the engine at cruise rpm. Recalling that other members of the flying group had made similar observations, the pilot elected to return to the airfield. The approach to runway 11 was made with 10° of flap selected. The aircraft bounced twice on touch-down and so the pilot decided to go-around. He retracted the flap and applied full power; however the aircraft failed to accelerate above approximately 50 mph, with the stall warning sounding. The pilot lowered the nose of the aircraft and it continued to roll, but with no increase in speed. By now the aircraft was approaching a hedge at the airfield boundary. The pilot pulled back on the controls and the aircraft clipped the top of the hedge, and another one on the far side of a public road, before landing in the field beyond. The aircraft came to rest upright but badly damaged; the harnesses held during the impact and the occupants were uninjured.

The aircraft owner was aware of the problem of intermittent rough running of the engine. Investigations had failed to identify the cause, although it was considered that plug fouling may have been a possibility. The pilot was unable to recall if the engine ran roughly after the application of power during his attempted go-around.



**No: 10/90**

**Ref: EW/G90/05/25**

**Category: 1c**

**Aircraft Type  
and Registration:**

Reims Cessna F150J, G-AXNK

**No & Type of Engines:**

1 Continental O-200-A piston engine

**Year of Manufacture:**

1968

**Date and Time (UTC):**

28 May 1990 at 1330 hrs

**Location:**

White Waltham Airfield, Maidenhead, Berkshire

**Type of Flight:**

Private

**Persons on Board:**

Crew - 1

Passengers - 1

**Injuries:**

Crew - None

Passengers - None

**Nature of Damage:**

Substantial damage to fuselage, wings and landing gear

**Commander's Licence:**

Private Pilot's Licence

**Commander's Age:**

49 years

**Commander's Total  
Flying Experience:**

152 hours (of which 77 were on type)

**Information Source:**

Aircraft Accident Report Form submitted by the pilot

The aircraft took off from White Waltham for a two hour pleasure flight. After levelling-off in the cruise however, the pilot noticed a roughness in the engine at cruise rpm. Recalling that other members of the flying group had made similar observations, the pilot elected to return to the airfield. The approach to runway 11 was made with 10° of flap selected. The aircraft bounced twice on touch-down and so the pilot decided to go-around. He retracted the flap and applied full power; however the aircraft failed to accelerate above approximately 50 mph, with the stall warning sounding. The pilot lowered the nose of the aircraft and it continued to roll, but with no increase in speed. By now the aircraft was approaching a hedge at the airfield boundary. The pilot pulled back on the controls and the aircraft clipped the top of the hedge, and another one on the far side of a public road, before landing in the field beyond. The aircraft came to rest upright but badly damaged: the harnesses held during the impact and the occupants were uninjured.

The aircraft owner was aware of the problem of intermittent rough running of the engine. Investigations had failed to identify the cause, although it was considered that plug fouling may have been a possibility. The pilot was unable to recall if the engine ran roughly after the application of power during his attempted go-around.

**No: 10/90**                      **Ref: EW/G90/03/09**                      **Category: 1c**

**Aircraft Type and Registration:**                      Reims Cessna F177RG, G-BFHK

**No & Type of Engines:**                      1 Lycoming IO-360-A1B6D piston engine

**Year of Manufacture:**                      1977

**Date and Time (UTC):**                      17 March 1990 at 0839 hrs

**Location:**                      In sea 15nm SE of Ramsgate, Kent

**Type of Flight:**                      Private

**Persons on Board:**                      Crew - 1                      Passengers - None

**Injuries:**                      Crew - None                      Passengers - N/A

**Nature of Damage:**                      Aircraft lost in sea

**Commander's Licence:**                      Private Pilot's Licence with IMC rating

**Commander's Age:**                      47 years

**Commander's Total Flying Experience:**                      725 hours (of which 242 were on type)

**Information Source:**                      Aircraft Accident Report Form submitted by the pilot, engineering records and telephone inquiries

The pilot reports that in November 1989 the engine had suffered a back-fire during pre-take-off power checks. Following the rectification work described below the engine performed satisfactorily during four flights carried out in January before the outbound flight to Ostend on 13 March 1990.

The engineering records show that in November a reported problem of high engine temperature had been addressed by restoring the engine oil level from a very low condition. The exhaust gas temperature (EGT) probe had been replaced to correct anomalies in EGT indication, cylinder compression had been checked and the propeller governor oil return pipe was found to be chafed and was replaced.

In December, in two separate programmes of work the sparking plugs, magnetos and ignition timing were checked, new HT leads were fitted and the fuel injector sent to a specialist company for bench testing. It was found that the wrong type of O-rings had been fitted to the venturi although no leaks had been actually detected. Correct O-rings were fitted and the unit's calibration checked. The fuel injector was refitted to the engine and a ground run was carried out satisfactorily.

During the flight to Ostend on 13 March, just before he was cleared to descend for landing, the pilot

noticed a slight engine miss-fire. The engine continued to run normally and during a ground run after landing it was satisfactory at high power but was slightly uneven at between 1200 and 1400 RPM. A local engineering company was asked to check the engine and fit a new set of plugs. A subsequent ground run was satisfactory as were the pre-flight checks prior to leaving Ostend on 17 March and initially the engine performed normally in flight.

At about 20 nm out from Ostend at 4500 feet the pilot noticed a slight loss of power, rising oil temperature, falling oil pressure and a higher than normal EGT. Following contact with Kent Radar he reduced power, returned the mixture control to rich, opened the cowl flaps and started a long descent to 2500 feet. Pressure and temperatures returned to normal and at 2500 feet he set power to 22 ins/2200 RPM to divert to Manston at a low power setting. Following an enquiry from ATC the pilot confirmed that he was declaring an emergency. Although pressures and temperatures remained normal the engine continued to lose power. The pilot tried various changes in throttle, mixture and fuel pump settings but no improvement was achieved and the aircraft continued to descend until the pilot was forced to ditch the aircraft at a position 15 nm southeast of Ramsgate.

The ditching, parallel to the wave crests, was smooth. The wheels were up, full flap selected and the aircraft close to the stall. The wind appeared to be as forecast at 190°/10 kts and the waves were estimated as 1 foot high. Weather was CAVOK, air temperature + 10°C and visibility 4 nm in haze.

The pilot was wearing a lifejacket. He had difficulty opening the door even when water levels inside and out appeared to be equal and he was unable to get his dinghy out of the aircraft. The ditching occurred just after 08.39 UTC, the Search and Rescue services had been alerted and, with the assistance of the pilot of another light aircraft who was vectored into the area and probably caught sight of the aircraft before it sank, the pilot was spotted in the water at 09.04 UTC, rescued and flown to hospital. The aircraft has not been recovered.



**No: 10/90**

**Ref: EW/C1171**

**Category: 1c**

**Aircraft Type  
and Registration:**

Reims Cessna FRA150L, G-BBKV

**No & Type of Engines:** 1 Continental O-200-A piston engine

**Year of Manufacture:** 1973

**Date and Time (UTC):** 17 July 1990 at 1755 hrs

**Location:** Skegness (Ingoldmells) Aerodrome, Lincolnshire

**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 Pilots' Licence with IMC Rating

**Commander's Age:** 27 years

**Commander's Total  
Flying Experience:** 290 hours (of which 104 were on type)

**Information Source:** AAIB Field Investigation

At the end of the day's flying the aircraft was to be moved from the flight line to overnight parking near the hangar. The pilot booked himself out for a short local flight and told the company operations officer that he would fly a circuit and then park the aircraft at the hangar. He invited a ground employee of the company to accompany him. The aerodrome had no air traffic control service and the air/ground station was not operating at the time.

The aircraft was seen to take-off on runway 11 and turn quickly to the left on to a heading which took it over the aerodrome offices and hangar. After passing the hangar it yawed and rolled to the right before taking up a normal circuit pattern. This manoeuvre was described by an experienced pilot as erratic and unorthodox. About two minutes later the attention of witnesses was drawn to the aircraft by the sound of an engine increasing power and they saw it approaching the centre of the aerodrome from the west at height estimated to be about 100 feet. It then pulled up into a vertical climb on full power. At the top of this climb, estimated to be between 300 and 400 feet, the engine note died away and the aircraft executed a stall turn to the right. As it descended steeply from the stall turn witnesses heard engine power increase and saw the nose begin to rise before the aircraft rolled quickly to the left and hit the ground at an angle of approximately 30 degrees to the vertical. A small fire that started

in the area of the cockpit was quickly extinguished by the aerodrome fire tender which reached the aircraft within one minute of the accident.

Examination of the wreckage at the accident site confirmed that the aircraft had struck the ground in a steep dive on a heading of 180° M. Subsequent examination of the structure and flying controls at the AAIB facility at Farnborough revealed no evidence of any pre-impact failure. An examination of the propeller confirmed that the engine had been delivering considerable power at impact. The aircraft had a valid Certificate of Airworthiness in the Transport Category (passenger) and the aircraft records showed that all the maintenance required to validate the certificate had been carried out.

Post-mortem examination of the pilot revealed no medical condition that could have contributed to the accident.

At the end of the day's flying the aircraft was to be moved from the flight line to overnight parking near the hangar. The pilot booked himself out for a short local flight and told the company operations officer that he would fly a circuit and then park the aircraft in the hangar. He invited a ground employee of the company to accompany him. The aerodrome had no air traffic control service and the airfield station was not operating at the time.

The aircraft was seen to take-off on runway 11 and turn quickly to the left on to a heading which took it over the aerodrome offices and hangar. After passing the hangar it yawed and rolled to the right before taking up a normal circuit pattern. This manoeuvre was described by an experienced pilot as strange and unorthodox. About two minutes later the attention of witnesses was drawn to the aircraft by the sound of an engine increasing power and they saw it approaching the centre of the aerodrome from the west at height estimated to be about 100 feet. It then pulled up into a vertical climb on full power. At the top of this climb, estimated to be between 300 and 400 feet, the engine note died away and the aircraft executed a stall turn to the right. As it descended steeply from the stall turn witnesses heard engine power increase and saw the nose begin to rise before the aircraft rolled quickly to the left and hit the ground at an angle of approximately 30 degrees to the vertical. A small fire that started

**No: 10/90****Ref: EW/G90/07/06****Category: 1c**

<b>Aircraft Type and Registration:</b>	Rockwell Commander 114, G-BIFD	
<b>No &amp; Type of Engines:</b>	1 Lycoming IO-540-T4B5D piston engine	
<b>Year of Manufacture:</b>	1977	
<b>Date and Time (UTC):</b>	17 July 1990 at 0810 hrs	
<b>Location:</b>	Wood Farm, Emberton, Buckinghamshire	
<b>Type of Flight:</b>	Private	
<b>Persons on Board:</b>	Crew - 1	Passengers - None
<b>Injuries:</b>	Crew - None	Passengers - N/A
<b>Nature of Damage:</b>	Aircraft destroyed	
<b>Commander's Licence:</b>	Private Pilot's Licence with IMC and Night ratings	
<b>Commander's Age:</b>	43 years	
<b>Commander's Total Flying Experience:</b>	227 hours (of which 84 were on type)	
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot	

The pilot reports that, prior to the flight, the aircraft had been parked for some time in a hangar with a sloping floor, in a position such that the left wing was below the right wing, and that during this time the fuel selector had been left to 'ON'. During his pre-flight checks before an intended flight to Cranfield aerodrome he noticed that the left tank fuel gauge was indicating between 3/4 and full, whilst the right tank fuel gauge indicated between 1/4 and empty. He states that he did not fully realise the possible implications of this fuel imbalance before commencing take-off using the short field technique, as the take off distance available was 350 metres on a level, dry grass surface. Using this technique the manufacturer's operating handbook advises the selection of 20 degrees of flap, obtaining take-off power before brake release, and accelerating to lift off at 66 knots.

After brake release the aircraft accelerated and became airborne, wings level after about half the take off distance available. However immediately on becoming airborne the left wing started to drop and, despite the application of full right rudder and aileron, the pilot was unable to prevent the left wingtip striking the ground. This spun the aircraft around onto its nose, whilst at the same time the stall warning horn had been sounding. As the aircraft came to rest the pilot noticed fuel spurting from the left wing, and this quickly ignited. He was uninjured and vacated the aircraft via the right side door taking the fire extinguisher with him. He discharged the extinguisher onto the flames, but the charge was insufficient to extinguish the fire which subsequently destroyed the aircraft.

In a comprehensive and frank account of the circumstances of this accident, the pilot admits that he felt under some pressure to arrive at Cranfield for the start of the working day, and feels that this may have clouded his judgement in assessing the significance of fuel imbalance.



**No: 10/90****Ref: EW/G90/07/29****Category: 1c**

<b>Aircraft Type and Registration:</b>	Rollason Druine D.31 Turbulent, G-ARRZ	
<b>No &amp; Type of Engines:</b>	1 Ardem 4CO2 Mk 5 piston engine	
<b>Year of Manufacture:</b>	1962	
<b>Date and Time (UTC):</b>	21 July 1990 at 1450 hrs	
<b>Location:</b>	Hooley, near Croydon, Surrey	
<b>Type of Flight:</b>	Private	
<b>Persons on Board:</b>	Crew - 1	Passengers - None
<b>Injuries:</b>	Crew - None	Passengers - N/A
<b>Nature of Damage:</b>	Broken main spar and damage to aircraft nose	
<b>Commander's Licence:</b>	Private Pilot's Licence	
<b>Commander's Age:</b>	49 years	
<b>Commander's Total Flying Experience:</b>	757 hours (of which 97 were on type)	
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot	

When the pilot took the aircraft out of its hangar he found that the engine was warm, the aircraft having been flown previously that day. He checked that there were no defects recorded for the aircraft in the log and started the engine. Pre-flight checks and taxiing took about ten minutes and he then took off to the north, the downslope in this direction offering an advantage on a windless day. The climb rate was slow but not unexpected for such a warm day. At about 80 feet height with 55 kt airspeed the engine suffered a power failure. In executing a forced landing straight ahead the pilot managed to avoid and clear trees and rough ground at the airstrip boundary and land in a downsloping field beyond. The right wing touched first and the aircraft swung through 180 degrees and slid to a halt on its right side. The pilot got out uninjured.

To date the cause of the power failure has not been investigated but, given the conditions (air temperature over 20°C, heat soaked engine and aircraft) and the use of 4 star Mogas as fuel the pilot considers that the aircraft may have suffered a vapour lock condition.

**No: 10/90****Ref: EW/G90/05/06****Category: 1c****Aircraft Type  
and Registration:**

Socata Morane Saulnier MS.894A, G-BCAC

**No & Type of Engines:**

1 Franklin 6A-350-C1 piston engine

**Year of Manufacture:**

1973

**Date and Time (UTC):**

6 May 1990 at 1100 hrs

**Location:**

Sandown Airfield, Isle of Wight

**Type of Flight:**

Private

**Persons on Board:**

Crew - 1                      Passengers - 2

**Injuries:**

Crew - None                      Passengers - None

**Nature of Damage:**

Damage to nosewheel and noseleg, propeller tips bent

**Commander's Licence:**

Private Pilot's Licence with Night rating

**Commander's Age:**

50 years

**Commander's Total  
Flying Experience:**

294 hours (of which 168 were on type)

**Information Source:**

Aircraft Accident Report Form submitted by the pilot

A "precautionary" full flap approach was made to runway 05. After the initial touchdown which appeared normal the power was reduced to idle but the aircraft ran across a slight hump in the runway and became airborne again. Power was applied to check the descent but when the nose was lowered after the second touchdown the noseleg collapsed. The aircraft slid to a halt on the runway.

The airfield at Barnham Heath Farm was orientated approximately south-north and sloped steeply downwards in that direction; the difference in height between the southern and northern edge was of the order of 100 feet. The slope varied from one part of the field to another. There was no defined runway, consequently it was not possible to determine a take-off distance available, however, in the direction of the initial take-off of the accident flight the field was about 1750 feet long. The hard, dry surface was covered with short grass which was grazed by livestock.

The aircraft was not refuelled at the farm and, shortly before 0955 hrs, the pilot and three passengers boarded with the intention of flying to the Isle of Mull. The aircraft started the take-off roll from the

No: 10/90

Ref: EW/C1163

Category: 1c

<b>Aircraft Type and Registration:</b>	Socata TB10, G-BHID
<b>No &amp; Type of Engines:</b>	1 Lycoming O-360-A1AD piston engine
<b>Year of Manufacture:</b>	1980
<b>Date and Time (UTC):</b>	27 May 1990 at about 0955 hrs
<b>Location:</b>	Barnchallock Glen, Stoneykirk, Wigtown, Scotland
<b>Type of Flight:</b>	Private
<b>Persons on Board:</b>	Crew - 1                      Passengers - 3
<b>Injuries:</b>	Crew - 1 (fatal)              Passengers - 3 (fatal)
<b>Nature of Damage:</b>	Aircraft destroyed
<b>Commander's Licence:</b>	Private Pilot's Licence
<b>Commander's Age:</b>	53 years
<b>Commander's Total Flying Experience:</b>	1,372 hours (of which 1,100 were on type)
<b>Information Source:</b>	AAIB Field Investigation

On the morning of the 27 May, the aircraft left Wellesbourne Airfield, Warwickshire, at about 0535 hrs and flew to Barnchallock Farm where it arrived at about 0745 hrs. There were two people on board.

An aftercast obtained from the Meteorological Office at Bracknell indicated that, over the period of the accident, there was an anticyclone over the east of Scotland and that, in the area of the accident, the visibility was good and there was little or no cloud. The automatic weather station at West Freugh recorded the wind as calm, the temperature 17°C, dew point 8°C and pressure 1029.6 mb. In the immediate vicinity of the site the wind was reported, by a witness to the accident, as light from the north-east.

The airfield at Barnchallock Farm was orientated approximately south-north and sloped steeply downwards in that direction; the difference in height between the southern and northern edge was of the order of 100 feet. The slope varied from one part of the field to another. There was no defined runway, consequently it was not possible to determine a take-off distance available, however, in the direction of the initial take-off roll of the accident flight the field was about 1750 feet long. The hard, dry surface was covered with short grass which was grazed by livestock.

The aircraft was not refuelled at the farm and, shortly before 0955 hrs, the pilot and three passengers boarded with the intention of flying to the Isle of Mull. The aircraft started the take-off roll, from the



south-east corner of the field. The take-off was in a northerly direction and the wheel tracks in the grass faded after about 510 feet although this may not have been the full extent of the aircraft's initial ground roll. The weight would, by this stage, have been partially supported aerodynamically and, having had less pressure applied to it, the grass may have recovered by the time the observation was made. The tracks became evident again shortly before the apex of a small hillock. A ground scrape between the two wheel tracks was made by the tail of the aircraft, which indicated that it was in a high nose-up attitude. The ground dropped away steeply on the northern edge of the hillock and the aircraft became airborne again for a short time. The next time it struck the ground the tracks were orientated on about 035°(M) and there was evidence that the right wing had contacted the ground and that the tail had contacted sufficiently hard to detach the tail navigation light which was found in this area. The wheel tracks were about 39 feet long and finished 441 feet from the northern perimeter fence, in the direction of travel. The indications were that the aircraft had again become airborne in a steep nose-up attitude. None of the wheel tracks showed any evidence of the brakes having been applied.

There was a short tail scrape, orientated 040°(M), a few feet from the fence on the northern edge of the field. This fence consisted of wooden poles linked by barbed wire aligned at approximately 45° to the track of the aircraft such that the left wing struck two of the poles with a further two being dragged down, and a fifth, to the right of the others, being struck by the propeller. The positions of the left wing leading edge imprints on the two poles, plus the lack of any contact between the fence and the right wing indicated that the aircraft was banked slightly to the left as it went through the fence. Beyond the fence the aircraft had descended into a steep sided glen which bordered the field. The aircraft had then flown through a hawthorn tree and struck the northern bank of the glen. The orientation of the swathe through the trees indicated that the aircraft was rolled approximately 45° to the left at the instant before it struck the bank on which the trees grew. Shortly after impact the aircraft had burst into flames.

The ground impact marks plus the disposition of the wreckage showed that the aircraft had performed a cartwheel manoeuvre before coming to rest upright, facing approximately in the direction from which it had come and with the left wing pointing down the slope of the bank. The tail surfaces had become lodged in a tail-up attitude in another clump of small hawthorn trees to the rear of the main wreckage with the intervening fuselage together with the fin having been consumed by the post impact fire. The tail had suffered little mechanical damage in the impact although it had been blackened by the fire. The tie-down ring on the underside was covered in grass; this was thought to have been picked up from the tail scrape mark on the south side of the glen. It was evident that the initial impact with the trees had been made by the left wing, as pieces of tip fairing and the landing/taxi light in the leading edge were found in and below the branches. A length of barbed wire from the field perimeter fence was also found in the branches, with another piece found wrapped round the nose leg in the main wreckage.

The only large piece of airframe that had not been affected by the fire was a 4 feet section of the outboard left wing forward of the spar that was found close to the heavily disturbed earth where the engine and propeller had struck the ground. The leading edge bore the imprint of one of the fence posts. The intensity of the fire was such that little remained of the fuselage, cabin or flying control operating system. This plus the structural disruption that had occurred in the impact meant that it was not possible to identify each occupant with a seat position in the aircraft. In particular, as it was found that two of the passengers also possessed Private Pilot's Licences, it was not even possible to verify that the owner was the one flying the aircraft.

Following an on-site examination the wreckage was recovered to AAIB Farnborough for a more detailed analysis.

The fire damage meant that little meaningful information could be extracted from the cockpit instruments or flying controls. However it was considered that the presence of the tail scrape at the northern edge of the field suggested that the aircraft was in all probability reacting to an up-elevator input. The flaps on this aircraft were operated by an electric motor. The actuating shaft on the latter was discovered to be fully retracted, showing that the flaps were retracted at the time of impact.

The engine was subjected to a strip examination, with no evidence of any component failure or malfunction being found. The aircraft was equipped with a variable pitch propeller. The blades were considerably damaged around the tip areas which indicated that the engine was developing a high degree of power at the time of impact. The propeller hub was stripped and it was found that the pitch change pin of one blade had made an imprint in the preload plate of the other blade. The imprint took the form of a smear made in a fine-to-coarse direction and measurement showed that it started at a blade angle of around 17°, the fine and coarse stops being at 11.5° and 31° respectively. Thus the blade must have been at some point below 17° before it started to twist in a coarsening direction under impact forces. Reference to the propeller manufacturer confirmed that the pitch angle would normally be a few degrees off the fine stop during take-off.

Post mortem examination of the pilot revealed no pre-existing medical condition which could have contributed to the accident.

Performance data was obtained from the aircraft manufacturer. The following conditions were assumed for the calculation;

Aircraft weight	1,050 kg
Runway surface	Hard, dry, short grass
Initial runway slope	2% down
Temperature	17° C
Pressure(QNH)	1029.6 mb
Start of roll elevation	425 ft amsl
Pressure altitude	approximately sea level

The following data is for take-off with flap settings of 10° and 0°;

Flap 10°

Vs	54 kt
VR	56 kt
Ground roll	286 metres (938 feet)

Flap 0°

Vs	57 kt
VR	59 kt
Ground roll	339 metres (1,112 feet)

Take-off performance for the Socata TB10 is defined for 10° flap and the Flight Manual gives performance data only for this configuration at the MTOW of 1150 kg.



**No: 10/90**

**Ref: EW/G90/04/10**

**Category: 1c**

**Aircraft Type  
and Registration:**

Stolp Starduster Too SA300, G-BOBT

**No & Type of Engines:**

1 Lycoming O-360-A1F6 piston engine

**Year of Manufacture:**

1983

**Date and Time (UTC):**

16 April 1990 at 0920 hrs

**Location:**

Stapleford Aerodrome, Essex

**Type of Flight:**

Private

**Persons on Board:**

Crew - 1

Passengers - 1

**Injuries:**

Crew - None

Passengers - None

**Nature of Damage:**

Substantial to landing gear, propeller, lower wing and fuselage undersurface; engine shock loaded, engine mount deformed

**Commander's Licence:**

Private Pilot's Licence

**Commander's Age:**

34 years

**Commander's Total  
Flying Experience:**

97 hours (of which 35 were on type)

**Information Source:**

Aircraft Accident Report Form submitted by the pilot; examination of parts of aircraft by AAIB

The Stolp Starduster Too is a two place tandem biplane with fixed, tailwheel type, landing gear. The main structure of the fuselage is a welded tubular steel space framework clad with aluminium sheet. The framework section is generally square, but lightweight curved steel hoop formers fastened beneath the main framework provide a curved undersurface profile to the fuselage.

Each main landing gear wheel is mounted on a welded tubular steel leg assembly, which is pin jointed to two attachment fittings welded to the lower outboard corner of the fuselage structure (Fig 1). The assembly comprises a main tube carrying the axle assembly, stabilised fore and aft by a diagonal drag strut and laterally by a side brace. The upper ends of the main tube and the side brace are joined by a horizontal lateral tube. Lateral pivoting of the assembly, for shock absorption, is controlled by two shock cords anchored to fuselage structure and applying an upward load to the horizontal lateral tube.

The accident occurred when the aircraft was landing on grass Runway 28 at Stapleford Aerodrome after a flight from Manston Aerodrome, Kent. The runway was 698 metres long by 46 metres wide, level and smooth. The reported wind was from 270°M at 15 - 18 kt.



The pilot reported that, after a normal sideslipping approach to offset the slight crosswind and to improve forward visibility, he flared the aircraft, added a small amount of power to arrest the descent and achieved a fairly light touchdown. It then became apparent that the main landing gear was collapsing. The pilot pulled the mixture control to the cut-off position and, as the fuselage hit the ground, switched off the fuel pump, alternator and magnetos. After a ground slide of some 10 metres the aircraft came to rest in the centre of the runway, on runway heading and around 45 metres beyond the landing threshold. Both occupants were wearing five-point aerobatic harnesses and were unhurt. The pilot informed Stapleford Radio of his problem, received an acknowledgement, reportedly switched off the radio, master switch and fuel supply cock, and evacuated the aircraft along with the passenger. Both main landing gear legs remained attached but were found to have pivoted outwards and the aircraft was resting on the grass on its belly. After the accident the pilot was aware of fuel flowing from the underside of the aircraft. There was no fire.

The aircraft had been bought from a private owner in the USA and imported in April 1989. At the time of the accident it had accumulated 204 operating hours from new. It could not be established whether the main landing gear assemblies had been fabricated by the aircraft manufacturer or had been home-built from a kit.

Inspection of the aircraft by a maintenance organisation appointed to repair it revealed that for both main landing gears a fracture had occurred at the welds joining the horizontal lateral tube to the main tube. The horizontal lateral tube had also separated from the side brace. In addition, each of the horizontal lateral tubes had buckled upwards near its inboard end. Close examination revealed that, in the case of both landing gear assemblies, there was little penetration of the weld material into the failed welded joint and that the welds tended to form an external load path bridging the gap (Fig 2). The failure was generally in the weld material itself. However, in spite of the lack of penetration, an inspection by the Materials Department of Royal Aerospace Establishment, Farnborough, revealed no evidence of fatigue. It was to be expected that had fatigue damage occurred, it would have been evident. It was concluded that the failures were probably caused by overload, consistent with excessive vertical velocity on touchdown. Whether the damage had occurred on the accident flight or in the course of a previous landing could not be established. No evidence was found of previous similar failures on this type of aircraft.

Examination of the aircraft, in a partially repaired condition, also revealed that parts of the fuel system were particularly vulnerable in a situation where main landing gear legs failed. Fuel was contained in tanks in the upper wing and in a triangular section fuel tank located in the forward part of the fuselage, immediately behind the engine bulkhead. Tank selections were made by a fuel cock situated low down in the rear cockpit in the shallow interspace between the bottom of the main structural framework and the undersurface formers (Fig 3). Four rigid aluminium pipelines connecting the tanks and the engine to the fuel cock also ran in the undersurface interspace, generally over a distance of around 3-4 feet and around 2-3 inches above the undersurface fairing. Thus both the fuel cock and the pipelines, immediately below the cockpits, appeared vulnerable to damage in a case where the aircraft belly contacted the ground. Three of these pipelines cannot be shut-off by operation of the fuel cock. In this


FIG 1 MAIN LANDING GEAR SCHEMATIC

accident, at least one pipeline had sustained significant distortion (Fig 4), as a result of contact with distorted undersurface structural members, although rupture had not resulted.

It was also noted that a fuel filter located in the engine bay was situated low down on the engine bay bulkhead and incorporated a water drain that protruded below the bowl and hence below the fuselage main structural framework (Fig 5). The drain was of the spring loaded plunger type, opened by a light upward push with no twisting action required. In a case where the aircraft belly contacted the ground and the fuselage undersurface fairing distorted, the drain appeared vulnerable to being opened (Fig 6) or wiped off as a result of ground contact. In the case of G-BOBT the drain remained intact and it was probable that the fuel release noted after the accident had resulted from the drain valve being opened and held open by ground contact. It could not be established whether the fuel cock had indeed been selected off before evacuation, but no additional fuel system damage was reported.

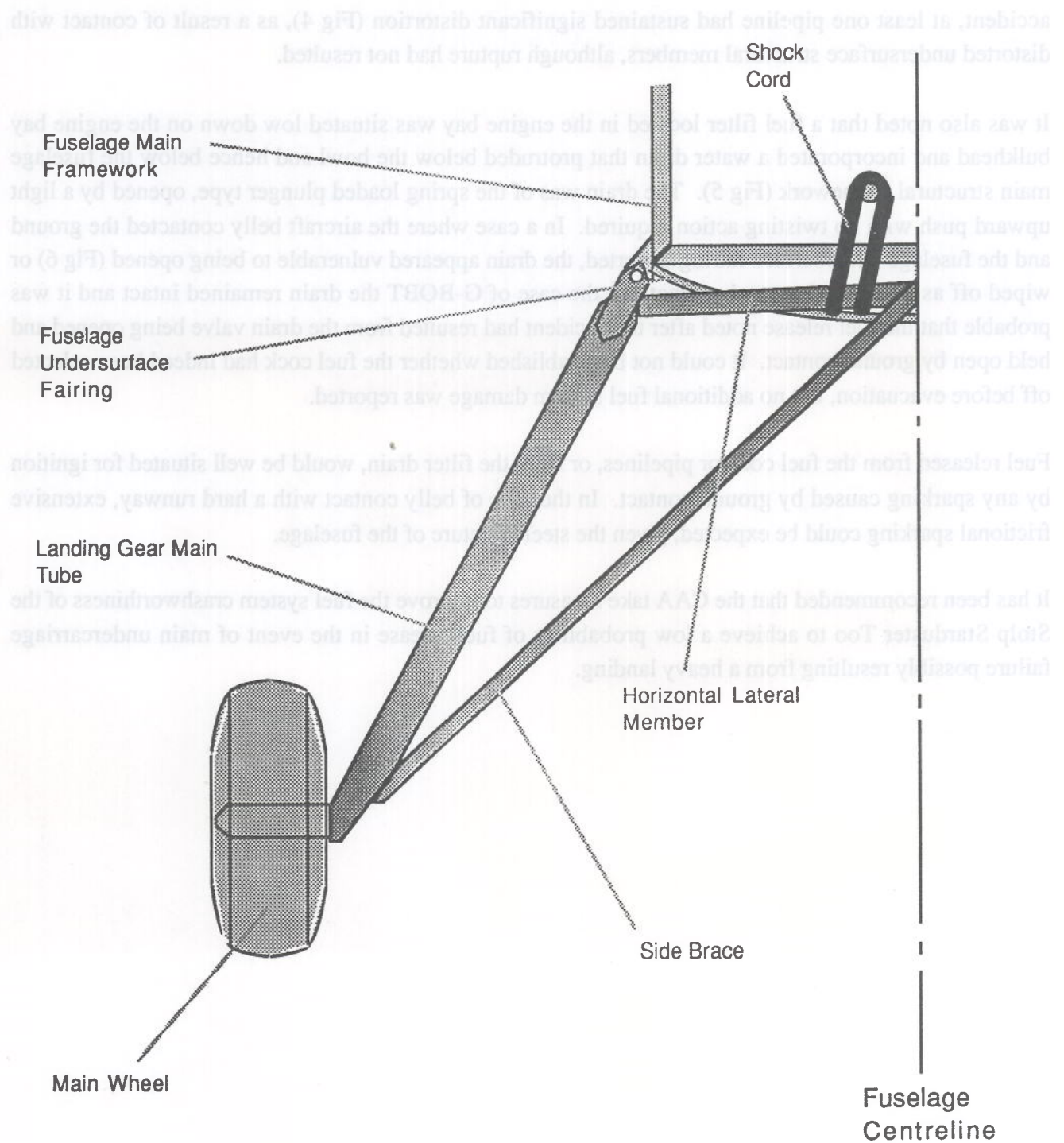
Fuel released from the fuel cock or pipelines, or from the filter drain, would be well situated for ignition by any sparking caused by ground contact. In the case of belly contact with a hard runway, extensive frictional sparking could be expected, given the steel structure of the fuselage.

It has been recommended that the CAA take measures to improve the fuel system crashworthiness of the Stolp Starduster Too to achieve a low probability of fuel release in the event of main undercarriage failure possibly resulting from a heavy landing.



# **MAIN LANDING GEAR SCHEMATIC**

**FIG 1**

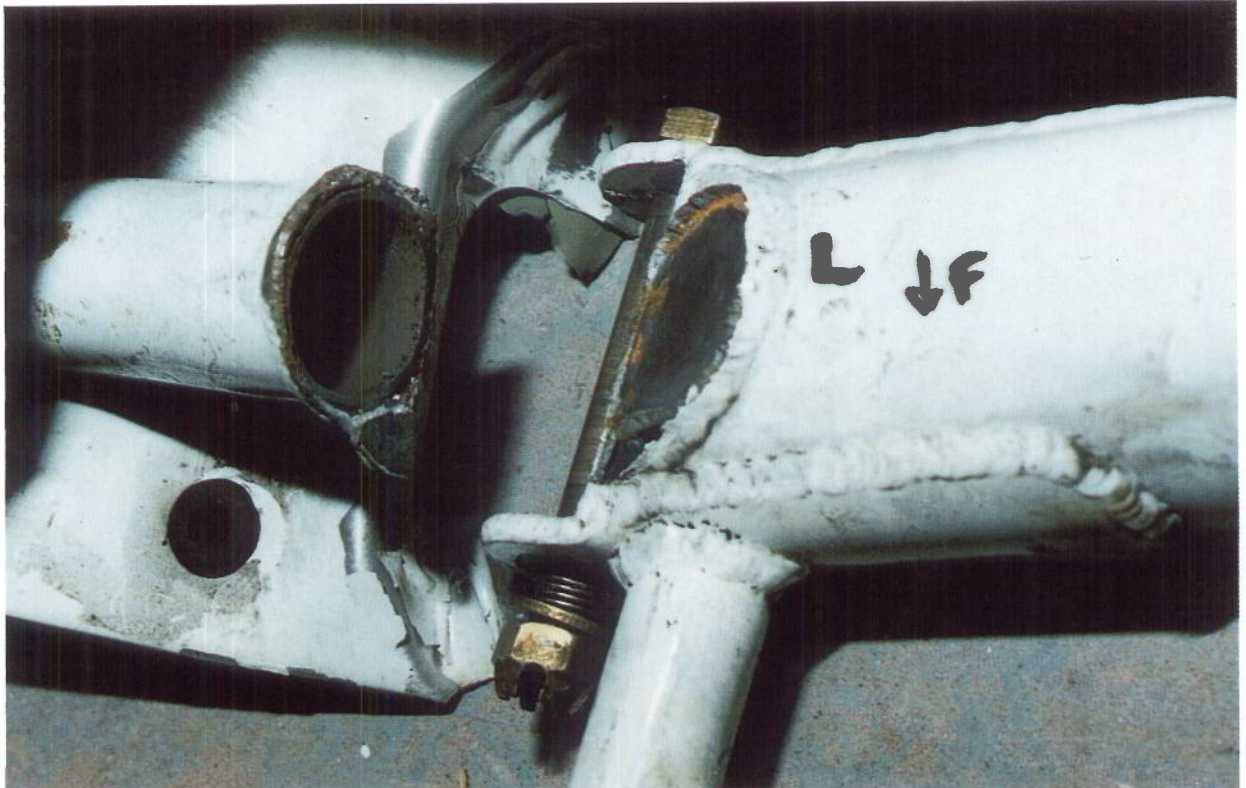


**VIEW ALONG FUSELAGE LONGITUDINAL AXIS**



Horizontal Lateral Tube

Failed Weld

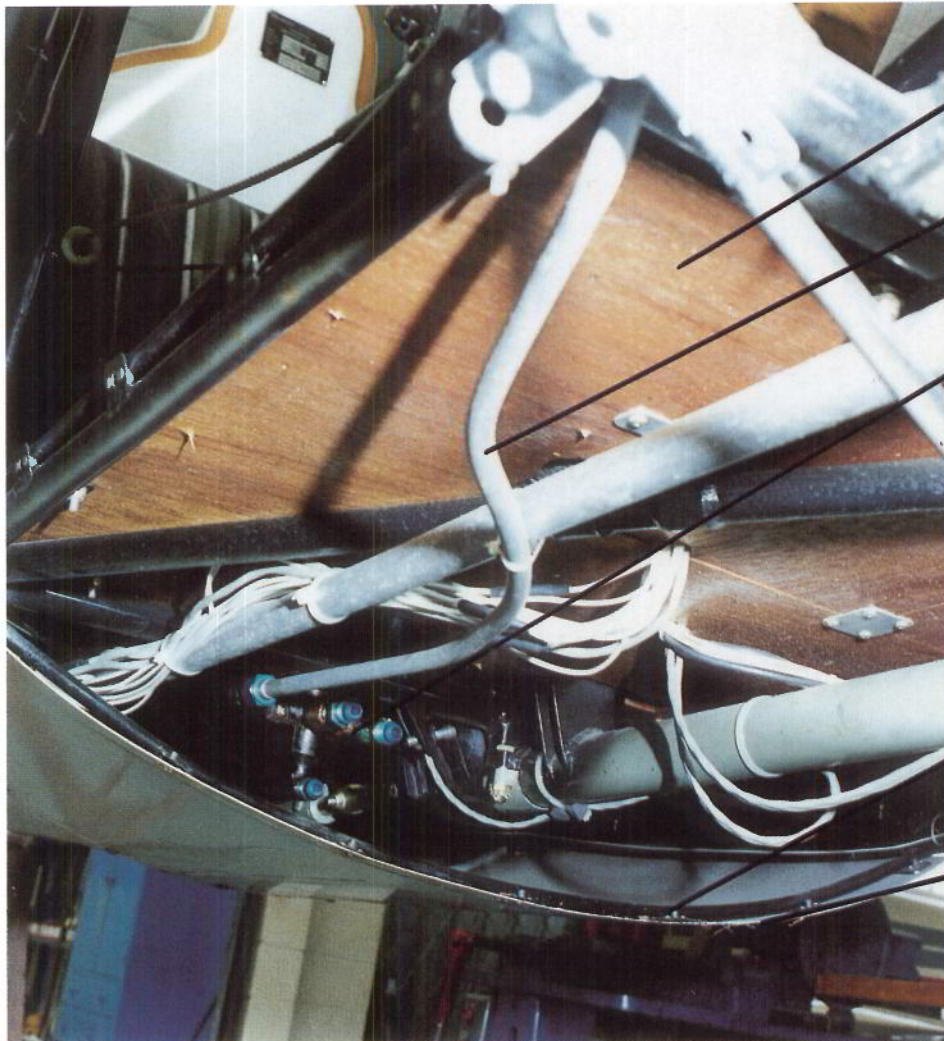


Main Tube



FUEL SYSTEM UNDER COCKPIT FLOOR

FIG 3/4



Seat Pan

Pipeline (three others absent)

Fuel Cock

FIG 3

Fairing Former

Fuselage Undersurface Fairing

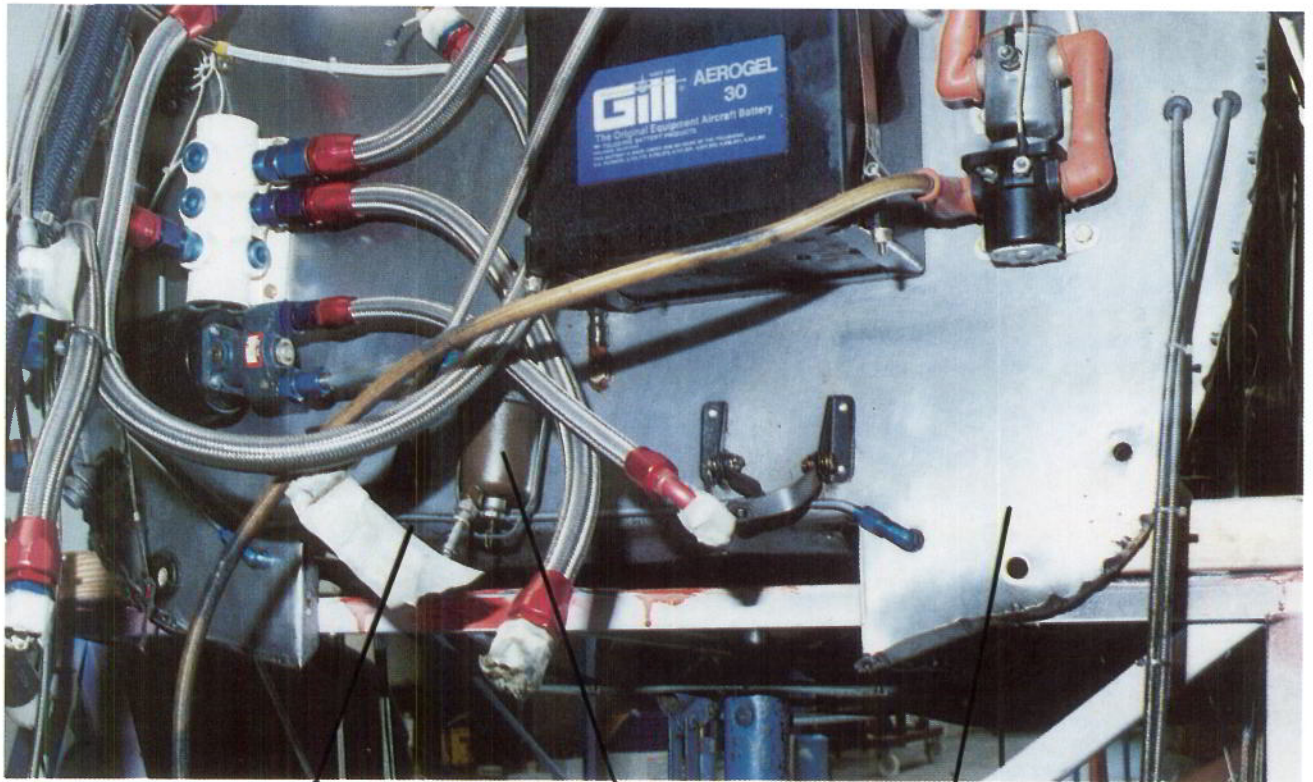


Damaged Pipeline

FIG 4





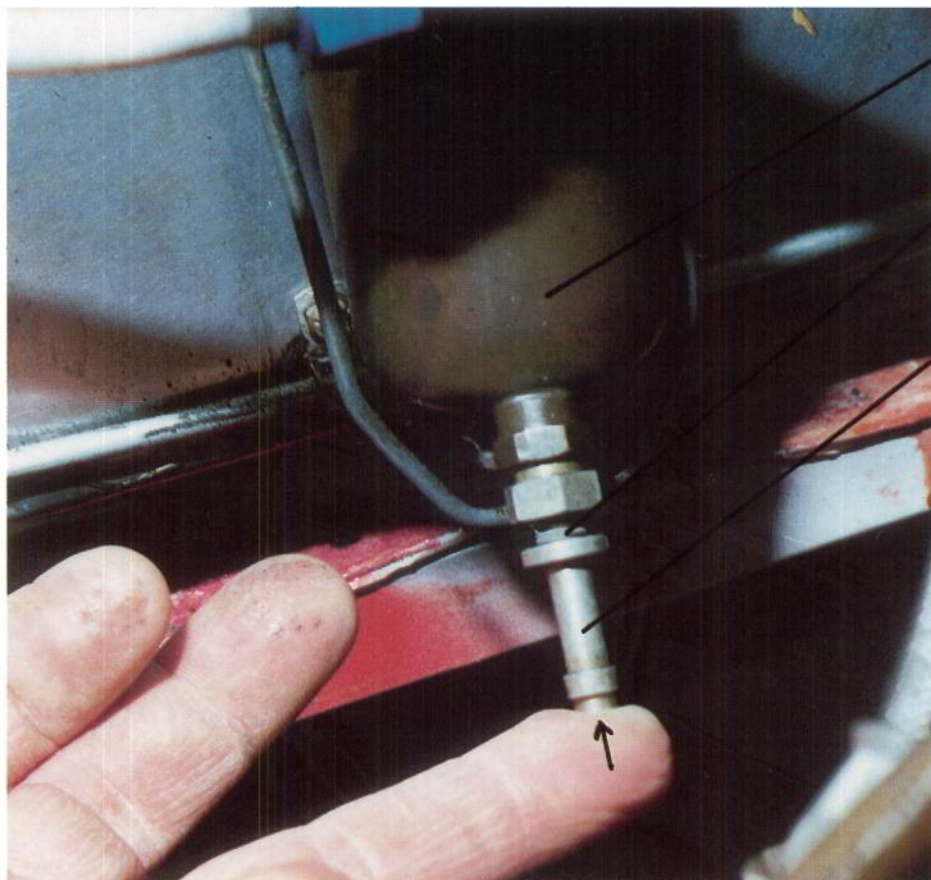


Bottom of Fuselage  
Main Framework

Fuel  
Filter

Engine  
Bulkhead

FIG 5



Fuel Filter  
Bowl

Spring

Drain  
(opened by  
upward push)

FIG 6





**No:** 10/90      **Ref:** EW/G90/06/04      **Category:** 1c

**Aircraft Type and Registration:** Taylor Monoplane, G-BILZ

**No & Type of Engines:** 1 Volkswagen 1600 piston engine

**Year of Manufacture:** 1982

**Date and Time (UTC):** 10 June 1990 at 2012 hrs

**Location:** Ingoldmells, Skegness, Lincolnshire

**Type of Flight:** Private

**Persons on Board:** Crew - 1      Passengers - None

**Injuries:** Crew - None      Passengers - N/A

**Nature of Damage:** Extensive damage to wing structure and to main and rear spar in centre section

**Commander's Licence:** Private Pilot's Licence

**Commander's Age:** 33 years

**Commander's Total Flying Experience:** 130 hours (of which 9 were on type)

**Information Source:** Aircraft Accident Report Form submitted by the pilot. Subsequent verbal report by person examining engine. Information obtained during AAIB examination of fuel pump

The pilot reported that the engine suddenly ran roughly before stopping abruptly during initial climb at 420-450 feet AGL. The ensuing forced landing took place necessarily at 90 degrees to the wind, in a field with a rough surface and a crop of tall rape-seed plants. The aircraft therefore suffered considerable damage.

The engine problem was reported initially to have been the result of a mechanical failure in one cylinder. A later report, however, indicated that a strip examination had revealed no evidence of internal failure.

This reporter also stated that the mechanical fuel pump appeared to be functioning incorrectly when the engine was rotated by hand. An examination of the fuel pump carried out subsequently by AAIB however, revealed no evidence of any defect in this unit.

No: 10/90

Ref: EW/C1159

Category: 2a

<b>Aircraft Type and Registration:</b>	Aerospatiale AS332L, G-PUMA	
<b>No &amp; Type of Engines:</b>	2 Turbomeca Makila 1A turboshaft engines	
<b>Year of Manufacture:</b>	1983	
<b>Date and Time (UTC):</b>	6 May 1990 at 1430 hrs	
<b>Location:</b>	Aberdeen Airport	
<b>Type of Flight:</b>	Ground run	
<b>Persons on Board:</b>	Crew - 1	Passengers - None
<b>Injuries:</b>	Crew - None	Passengers - N/A
<b>Nature of Damage:</b>	Fire damage to rotor brake, transmission bay and sliding cowling	
<b>Commander's Licence:</b>	Airline Transport Pilot's Licence (Helicopters)	
<b>Commander's Age:</b>	47 years	
<b>Commander's Total Flying Experience:</b>	Approximately 8000 hours (of which 1500 were on type)	
<b>Information Source:</b>	AAIB Field Investigation	

### Circumstances

After having flown earlier in the day, the aircraft was subjected to a standard chemical wash whereby the engines were turned by means of the starter while the cleaning agent was introduced into the intakes. During the washing process, the rotors were prevented from turning by means of the rotor brake. The compressor wash was carried out by ground engineers, but the subsequent engine drying run had to be done by a pilot. At approximately 1430 hrs, the pilot boarded the aircraft for this purpose. As no flight was intended, he did not examine the technical log, or follow the normal pre start checklist, but carried out an abbreviated checklist from memory. In fact there was a technical log entry to the effect that the utilities accumulator had become exhausted shortly after the aircraft was shut down. However, system pressure would still have been available from the electrical pump, had it been selected.

The pilot started the No.2 engine first and recalled that the rotors started turning at about 5000Ng (gas generator rpm). Shortly after this, the pilot was somewhat surprised to observe that the main rotor gearbox "P" (oil pressure) caption was still illuminated on the central warning panel, although the oil pressure gauge indication was satisfactory at 6 bar. Assuming a pressure switch malfunction, the pilot elected to continue, and so he started the No.1 engine and accelerated it to flight idle. However he



noted that the No.1 hydraulic system pressure had reduced to zero. He then observed the ground crewman outside signalling him to shut down. The pilot accordingly pulled back the speed select levers and additionally recalled operating the rotor brake, although the latter was ineffective. By this time, approximately 3½ minutes had elapsed since he had engaged the No. 2 engine starter motor. He was then informed that the aircraft was on fire, following which he discharged the engine fire bottles. The airport fire services arrived and the pilot left the aircraft without injury.

### **Examination of the aircraft**

It was apparent that the fire had been centred on the rotor brake, which is located immediately aft of the main rotor gearbox (MGB). There was considerable fire damage in this area of the transmission bay, with a large hole burnt through the sliding cowling aft of the rotor head. An alloy platform over the tail rotor drive shaft had partially melted and deposited molten metal onto the transmission deck. The associated heat had produced a 4 inch diameter hole in the roof of the aft part of the cabin, close to the MGB rear support frame. Droplets of hydraulic fluid were observed in this area and approximately 2.5 litres of fluid had been lost from the left hand hydraulic reservoir.

The engine fire bottles are located in the transmission bay and it was evident that these had discharged. The engines had not been affected by the fire. Part of the pipework running between the fire bottles and the engine bays had been burned through where they passed beneath the rotor brake assembly. It was thus probable that leaking extinguishant contributed to the containment of the fire in this area.

The rotor brake unit was still in position, although the alloy calliper had 'opened-out' due to a combination of heat and hydraulic pressure within the cylinders. This had caused the pistons to displace further than normal from the cylinders, almost to the point of disengagement. This displacement would have allowed fluid to be released from the cylinders to initiate the fire. Evidence of the high temperatures that were attained was provided by a partially melted brake pad steel backing plate. The remainder of the rotor brake operating system was intact, although much of the pipework in the area had been blackened from the effects of the fire.

### **Description of the rotor brake system**

The brake unit consists of a calliper bolted to the MGB above the tail rotor drive shaft. A fixed pad is attached to one side of the calliper, with opposing pads attached to hydraulically operated pistons on the other. Return springs pull the pistons, and hence the pads, away from the disc when hydraulic pressure is removed. A carbon disc is located between the pads and is attached to the tail rotor drive shaft. Hydraulic power is provided from the left hand pump on the MGB. When the rotors are stationary, the system is supplied from an electric pump. Pressure is maintained via the utilities accumulator, which can be recharged if necessary by means of a hand pump.

A schematic of the operating system is shown in the attached Figure and it can be seen that it consists of two levers, mounted on the overhead panel close to the top of the windscreen, operating on a



pressure reducing valve and a safety valve respectively. When the Safety Lever is in the "Flight" (ie fully forward) position, the safety valve is closed which allows no pressure to the brake unit even if the Brake Lever should inadvertently be pulled. When the Safety Lever is in the "Ground" (ie fully back) position, the **RB.SAFE** caption is illuminated, meaning that the Brake Lever can now be applied. Brake pressure progressively increases with lever movement up to the 21 bar detent. Further movement to the 100 bar detent is inhibited by a baulk which can only be removed by operation of an additional lever on the bulkhead behind the pilot. The latter position is used to maintain the rotors stationary whilst both engines are started in high wind conditions; brake release then results in rapid rotor spin-up, reducing the possibility of blade sailing.

A pressure switch illuminates a **ROT.BR** caption when the pressure in the brake line exceeds 2.5 bar.

### Examination and test of the rotor brake system

A new brake unit and disc were slaved into the system together with a pressure gauge immediately upstream of the brake unit. Electrical power was applied to the aircraft and the utilities accumulator was recharged using the handpump in the cockpit. When the Safety Lever was pulled back to the "Ground" position, the **RB.SAFE** caption illuminated as expected. Movement of the rotor Brake Lever towards the 21 bar position caused the **ROT.BR** caption to illuminate at around 2.5 bar. (It was subsequently found to extinguish at about 1.5 bar). No leaks were observed in the system. Some pressure remained when the Brake Lever was returned to within three quarters of an inch from the fully forward position. However, the lever had to be physically held in this position; when it was released, the spring attached to the lever appeared to be effective in returning it to the OFF (forward) end of the slot. It was found that pressures in excess of around 5 bar had to be applied to clamp the disc, ie to overcome the force exerted by the piston return springs.

Whilst this examination was in progress, it was found on another AS332 (G-PUMD) that if the Safety Lever was moved away from the "Ground" position by about half an inch before releasing the brake, then the **ROT.BR** caption remained lit regardless of the subsequent position of the Brake Lever. It was found possible to duplicate this condition on MA. The light remained on for several hours even if the accumulator was allowed to discharge, thus demonstrating that pressure was trapped between the valve and the brake unit. Problems with the pressure gauge prevented an accurate assessment of this pressure, although it was estimated to be around 5 bar.

In considering the possibility that trapped pressure in the brake line had caused this incident, it was noted that representatives from the helicopter manufacturers were of the opinion that the observed damage must have resulted from considerably higher pressures than 5 bar, and the compressor wash had been preceded by a fuselage and rotor wash which involved turning the tail rotors (and thus the main rotors) by hand. This clearly would have been impossible had the brake been on. None of the ground crew would have had reason to move the Safety Lever away from the "Ground" position where it was left after the earlier flight.

A subsequent incident occurred on another AS 332 whereby the **ROT.BR** caption illuminated when the Brake Lever was pulled back, even though the Safety Lever was fully in the "Flight" position. This was later found to be due to a missing component within the safety valve and thought to have been the result of unauthorised maintenance at some indeterminate time following build. The valve from MA had no such fault and apart from two minor excursions from the schedule, functioned satisfactorily on test. The two deviations were a slightly premature pressure build up with brake lever movement, and a high internal leak rate to return. The latter may have contributed to the exhaustion of the utilities accumulator.

### **Previous occurrences**

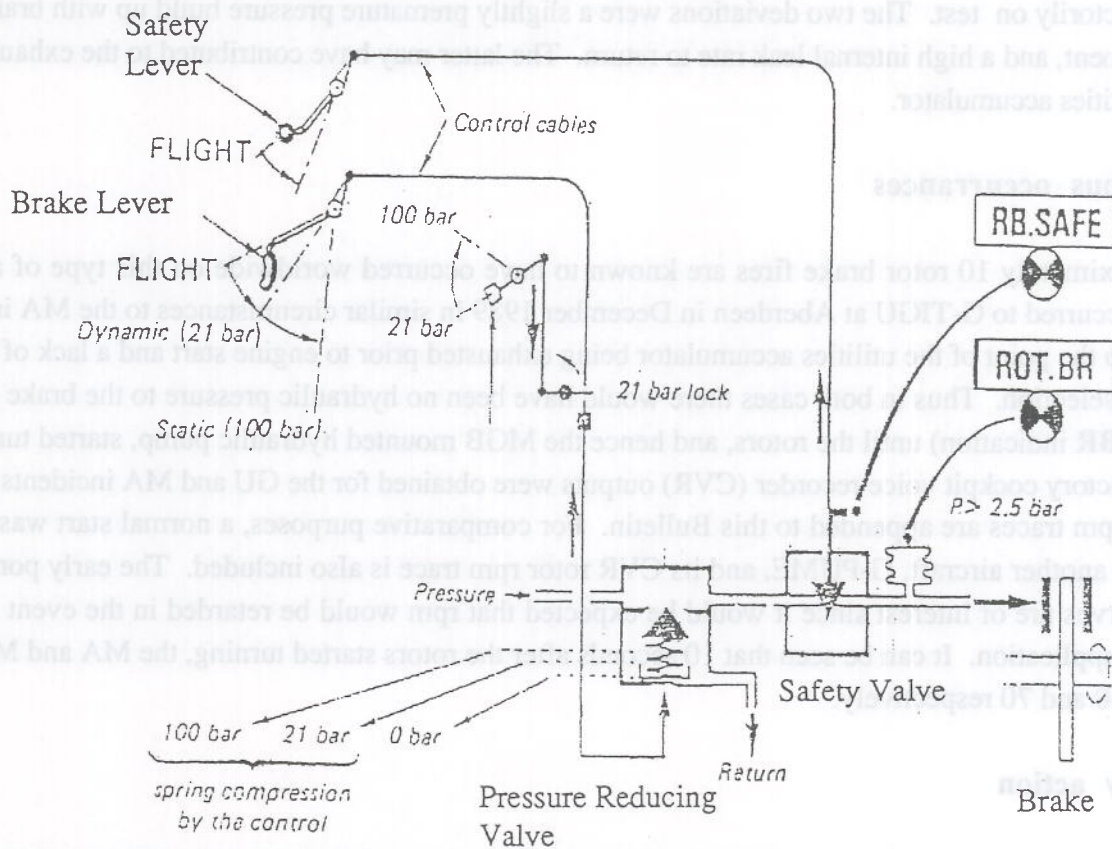
Approximately 10 rotor brake fires are known to have occurred worldwide on this type of aircraft. One occurred to G-TIGU at Aberdeen in December 1989 in similar circumstances to the MA incident, even to the point of the utilities accumulator being exhausted prior to engine start and a lack of electric pump selection. Thus in both cases there would have been no hydraulic pressure to the brake (and no **ROT.BR** indication) until the rotors, and hence the MGB mounted hydraulic pump, started turning. Satisfactory cockpit voice recorder (CVR) outputs were obtained for the GU and MA incidents and the rotor rpm traces are appended to this Bulletin. For comparative purposes, a normal start was carried out on another aircraft, G-PUME, and its CVR rotor rpm trace is also included. The early portions of the curves are of interest since it would be expected that rpm would be retarded in the event of rotor brake application. It can be seen that 10 seconds after the rotors started turning, the MA and ME rpms were 40 and 70 respectively.

### **Safety action**

The operating company has issued a Flying Staff Instruction reminding pilots of the importance of correct operation of the rotor brake controls. The checklist has been amended to reflect this. A similar amendment has been made to the Flight Manual by the manufacturer.

As a result of the number of incidents around the world, the helicopter manufacturer has introduced a Service Bulletin (SB 7602) which gives operators the option of electrically inhibiting the engine start cycle when the brake lever is in the 21 bar detent. Following the incident to MA, the operator is progressively incorporating this modification into the AS332 fleet. The CAA are currently considering conferring mandatory status on this Service Bulletin as part of a continuing review of potential fire hazards in the transmission bays of large helicopters.

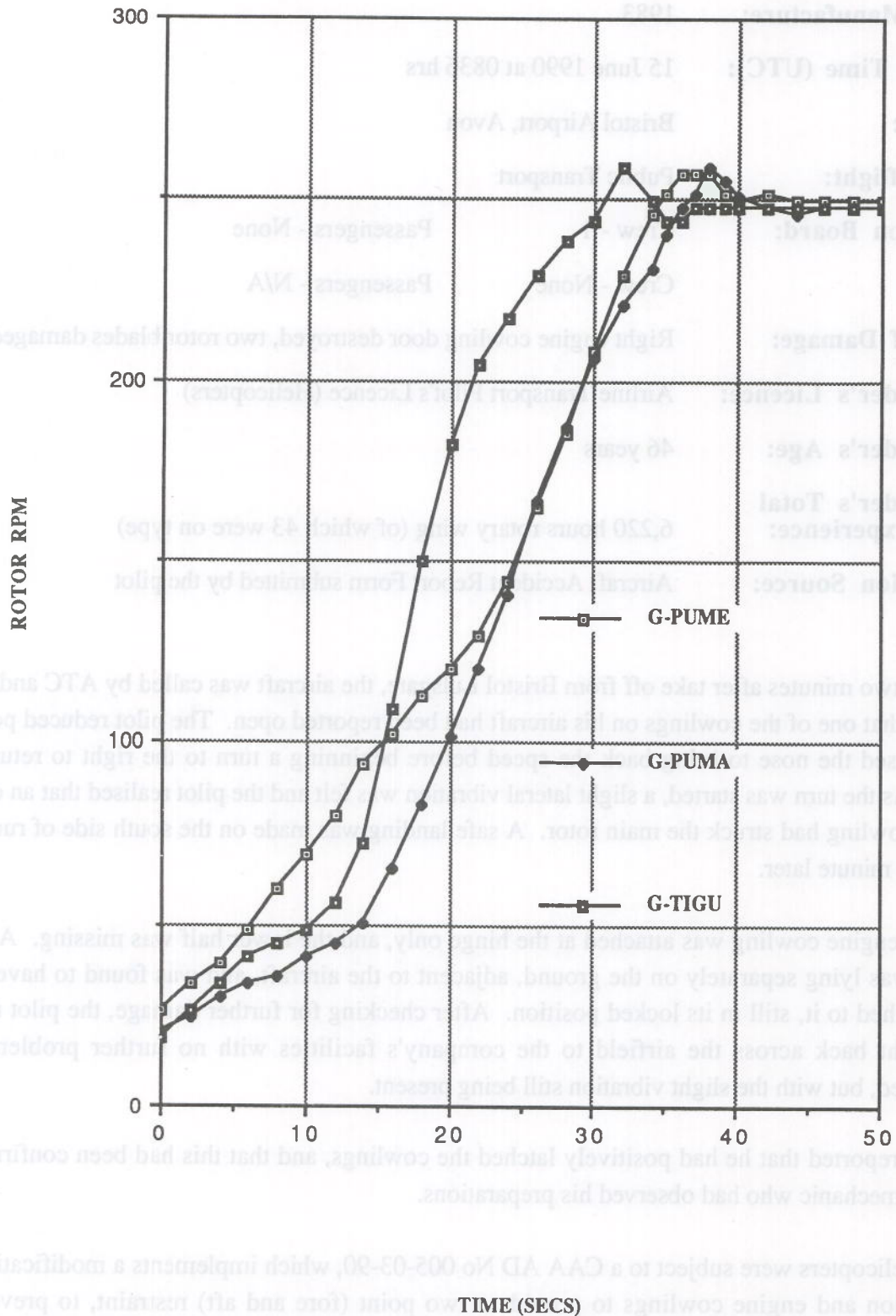




AS332 Brake System Schematic



# AS332L SUPERPUMA ROTOR RPM DURING START UP



**No: 10/90**

**Ref: EW/G90/06/19**

**Category: 2b**

**Aircraft Type and Registration:** Aerospatiale AS355F1, G-BPRJ

**No & Type of Engines:** 2 Allison 250-C20B turboshaft engines

**Year of Manufacture:** 1983

**Date and Time (UTC):** 15 June 1990 at 0836 hrs

**Location:** Bristol Airport, Avon

**Type of flight:** Public Transport

**Persons on Board:** Crew - 1                      Passengers - None

**Injuries:** Crew - None                      Passengers - N/A

**Nature of Damage:** Right engine cowling door destroyed, two rotor blades damaged.

**Commander's Licence:** Airline Transport Pilot's Licence (Helicopters)

**Commander's Age:** 46 years

**Commander's Total Flying Experience:** 6,220 hours rotary wing (of which 43 were on type)

**Information Source:** Aircraft Accident Report Form submitted by the pilot

Less than two minutes after take off from Bristol Lulsgate, the aircraft was called by ATC and the pilot informed that one of the cowlings on his aircraft had been reported open. The pilot reduced power and slowly raised the nose to bring back the speed before beginning a turn to the right to return to the airfield. As the turn was started, a slight lateral vibration was felt and the pilot realised that an engine or gearbox cowling had struck the main rotor. A safe landing was made on the south side of runway 27, less than a minute later.

The right engine cowling was attached at the hinge only, and the lower half was missing. A piece of cowling was lying separately on the ground, adjacent to the aircraft, and was found to have the rear latch attached to it, still in its locked position. After checking for further damage, the pilot made the short flight back across the airfield to the company's facilities with no further problems being encountered, but with the slight vibration still being present.

The pilot reported that he had positively latched the cowlings, and that this had been confirmed by a company mechanic who had observed his preparations.

AS 355 helicopters were subject to a CAA AD No 005-03-90, which implements a modification to the transmission and engine cowlings to provide a two point (fore and aft) restraint, to prevent them

contacting the main rotors should they open in flight. The AD was dated 2/4/90 and implementation was required within 2 months of that date. However the materials required for implementation of the modification were not available from the suppliers in time. For this reason the aircraft in question had been granted an exemption by the CAA on 13/6/90 and the modification had not been implemented at the time of the accident.

The materials required to implement the AD are still in short supply from the manufacturer and the pilot suggested that their production should be expedited in the light of this incident.

Location:	Buxton, Derbyshire
Type of Flight:	Commercial
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Slight damage to main rotor blade and to tubular member in tail boom
Commander's Licence:	Aviation Transport Pilot's Licence
Commander's Age:	42 years
Commander's Total Flying Experience:	2,450 hours rotary wing (of which 3,000 were on type) 120 hours fixed wing
Information Source:	Aircraft Accident Report Form submitted by the pilot and telephone conversation with company carrying out initial repairs

The aircraft was engaged on spraying operations. The pilot reported that after a run at 50 ft A.G.L. he began a climb during which he became aware of a loss of rotor rpm with an associated loss of performance. No satisfactory landing site was immediately available, so the aircraft was manoeuvred towards a more distant area for a run-on landing. A further loss of performance occurred during this manoeuvre and the left-hand spray boom struck a small tree. The pilot was nevertheless able to make a semi-controlled landing. After doing so he judged that no damage had occurred to the aircraft other than to the spraying equipment; the engine was running normally with no unusual instrument indications and no excessive vibration was present. At this stage the pilot considered the position of the aircraft to be unsuitable to carry out a shutdown, so he flew a short distance to a more suitable site and landed again.

On examination, minor damage to a main rotor blade was noted together with damage to a tubular member of the tail boom.

A detailed examination of the engine revealed no single problem which could account for a major loss of power. It was noted, however, that the hot-air valve was not moving correctly to the 'cold' position and the transition piece part of the induction system ducting in the area of the turbo-charger, appeared to have an incorrectly fitted seal which may have been allowing some air leakage. In addition, some slight adjustment was made to the setting of the density controller, after which it was judged by the company carrying out the work that an improvement of power output had been achieved.



**No: 10/90**

**Ref: EW/G90/07/36**

**Category: 2c**

**Aircraft Type  
and Registration:**

Bell 47 G3B1, G-BFJN

**No & Type of Engines:**

1 Lycoming TVO-435-B1A piston engine

**Year of Manufacture:**

1965

**Date and Time (UTC):**

23 July 1990 at 1600 hrs

**Location:**

Buxton, Derbyshire

**Type of Flight:**

Commercial

**Persons on Board:**

Crew - 1

Passengers - None

**Injuries:**

Crew - None

Passengers - N/A

**Nature of Damage:**

Slight damage to main rotor blade and to tubular member in tail-boom

**Commander's Licence:**

Airline Transport Pilot's Licence

**Commander's Age:**

42 years

**Commander's Total  
Flying Experience:**

5,450 hours rotary wing (of which 3,000 were on type)  
120 hours fixed wing

**Information Source:**

Aircraft Accident Report Form submitted by the pilot and telephone conversation with company carrying out initial repairs

The aircraft was engaged on spraying operations. The pilot reported that after a run at 50 ft A.G.L. he began a climb during which, he became aware of a loss of rotor rpm with an associated loss of performance. No satisfactory landing site was immediately available, so the aircraft was manoeuvred towards a more distant area for a run-on landing. A further loss of performance occurred during this manoeuvre and the left-hand spray boom struck a small tree. The pilot was nevertheless able to make a semi-controlled landing. After doing so he judged that no damage had occurred to the aircraft other than to the spraying equipment; the engine was running normally with no unusual instrument indications and no excessive vibration was present. At this stage the pilot considered the position of the aircraft to be unsuitable to carry out a shutdown, so he flew a short distance to a more suitable site and landed again.

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**No: 10/90**

**Ref: EW/G90/08/10**

**Category: 2c**

<b>Aircraft Type and Registration:</b>	Enstrom 280-UK, G-SHAA	
<b>No &amp; Type of Engines:</b>	1 Lycoming HIO-360-CIA piston engine	
<b>Year of Manufacture:</b>	1975	
<b>Date and Time (UTC):</b>	15 July at 0955 hrs	
<b>Location:</b>	Barton Aerodrome, Manchester	
<b>Type of flight:</b>	Private	
<b>Persons on Board:</b>	Crew - 1	Passengers - 1
<b>Injuries:</b>	Crew - None	Passengers - None
<b>Nature of Damage:</b>	Substantial to landing gear and cabin floor	
<b>Commander's Licence:</b>	Private Pilot's Licence	
<b>Commander's Age:</b>	36 years	
<b>Commander's Total Flying Experience:</b>	136 hours (of which 88 were on type)	
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot	

The aircraft was hovering at 10 feet adjacent to the runway-in-use awaiting the departure of 2 fixed wing aircraft. The pilot states that due to a momentary lack of concentration he allowed the rotor rpm to drop. The pilot was unable to recover the rotor rpm while in the hover and began to lose directional control. He then lowered the collective lever whereupon the helicopter struck the ground heavily. The aircraft sustained substantial damage but neither occupant was injured and they were able to evacuate the aircraft without difficulty.

**No:** 10/90

**Ref:** EW/G90/08/09

**Category:** 2c

<b>Aircraft Type and Registration:</b>	Hughes 269B, G-REBL	
<b>No &amp; Type of Engines:</b>	1 Lycoming HI0-360-A1A piston engine	
<b>Year of Manufacture:</b>	1967	
<b>Date and Time (UTC):</b>	12 August 1990 at 1259 hrs	
<b>Location:</b>	1 nm west of Oxenhope, Yorkshire	
<b>Type of Flight:</b>	Private	
<b>Persons on Board:</b>	Crew - 1	Passengers - 1
<b>Injuries:</b>	Crew - None	Passengers - None
<b>Nature of Damage:</b>	Damage to tail rotor and drive shaft	
<b>Commander's Licence:</b>	Private Pilot's Licence	
<b>Commander's Age:</b>	57 years	
<b>Commander's Total Flying Experience:</b>	32 hours Fixed wing 110 hours Rotary wing (of which 20 were on type)	
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot	

Shortly after setting course for Blackpool and reaching his intended cruise altitude of 2000 ft, the pilot reduced power and turned off the fuel boost pump. Shortly thereafter, the engine lost power. The pilot entered autorotation and transmitted a "MAYDAY" call. In the descent the fuel boost pump was turned on again and the engine began to recover, but as the helicopter was by now close to the ground the pilot elected to land, since he was unsure of regaining full power. Before touchdown he selected the engine to 'idle cut off' and turned off the fuel. There was no level ground locally so he was forced to attempt a landing on a steep slope, during which the tail rotor contacted the ground. However, the aircraft remained erect and the pilot and passenger were able to make a normal exit from the aircraft unaided.

A subsequent examination of the helicopter, during which the engine was successfully re-started with the fuel boost pump on, showed a serious fuel leak to be present in one of the engine injector lines. With the boost off, fuel is gravity fed to the engine.

The helicopter underwent its most recent maintenance inspection, a 50 hr check, 45 days before the accident.



No: 10/90

Ref: EW/G90/07/27

Category: 2c

<b>Aircraft Type and Registration:</b>	Hughes 269C, G-HUWS	
<b>No &amp; Type of Engines:</b>	1 Lycoming HIO-360-D1A piston engine	
<b>Year of Manufacture:</b>	1973	
<b>Date and Time (UTC):</b>	22 July 1990 at 2045 hrs	
<b>Location:</b>	Henbury Manor, Wimborne, Dorset	
<b>Type of Flight:</b>	Private	
<b>Persons on Board:</b>	Crew - 1	Passengers - 1
<b>Injuries:</b>	Crew - None	Passengers - None
<b>Nature of Damage:</b>	Serious damage to most of the airframe	
<b>Commander's Licence:</b>	Private Pilot's Licence (Helicopters)	
<b>Commander's Age:</b>	59 years	
<b>Commander's Total Flying Experience:</b>	80 hours (of which 78 were on type)	
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot	

The pilot had been taking a group of family and friends, one at a time, for local rides in this helicopter and was returning from a refuelling stop at Compton Abbas to his landing site with his ninth passenger. As he approached the site in front of his house, the pilot recollected that everything appeared normal. However, having made a slow turn to the left, at a height of about 10 feet, to point the helicopter into wind, it commenced an uncontrolled 360 degree turn to the right. The next recollection he reported was of the helicopter lying on its side. After closing the throttle and cutting off the fuel, he extracted himself from his harness whilst bystanders assisted his passenger. There was no fire.

Initial examination of the aircraft revealed it to be complete, with the exception of the tail rotor guard, a curved steel tube mounted beneath the tail rotor gearbox. This was found some 40 metres from the wreckage but a detailed examination of it, and the tail rotor blades, showed that it most probably had been knocked sideways by ground impact and subsequently struck by both tail rotor blades during the accident sequence. This guard had failed in the region of the two attachment bolt holes at its upper end. A close examination of the fracture surface, however, revealed a small area of fatigue cracking, emanating from one hole, which had been exploited by, but had not caused, the final failure.

An examination of the tail rotor drive and control systems was carried out shortly after the accident by an engineer from the helicopter's maintenance organisation. It was reported that no pre-impact defects were found present in these systems.

It is a feature of this helicopter that any loss of tail rotor effectiveness can result in a right yawing moment with the main rotor under power.

No: 10/90

Ref: EW/G90/07/35

Category: 2c

<b>Aircraft Type and Registration:</b>	Robinson R22 Beta, G-BOYX
<b>No &amp; Type of Engines:</b>	1 Lycoming O-320-B2C piston engine
<b>Year of Manufacture:</b>	1988
<b>Date and Time (UTC):</b>	18 July 1990 at 2005 hrs
<b>Location:</b>	Teesside Airport, County Durham
<b>Type of Flight:</b>	Private (pleasure)
<b>Persons on Board:</b>	Crew - 1                      Passengers - 1
<b>Injuries:</b>	Crew - 1 (minor)              Passengers - 1 (minor)
<b>Nature of Damage:</b>	Damaged beyond economic repair
<b>Commander's Licence:</b>	Private Pilot's Licence (A) with IMC and Night ratings Private Pilot's Licence (H)
<b>Commander's Age:</b>	41 years
<b>Commander's Total Flying Experience:</b>	196 hours which includes 56 hours rotary wing (all on type)
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot and subsequent AAIB enquiries.

The helicopter was hover taxed to the designated training area, on the southern side of the airfield, for a series of practice take-offs and landings. The surface wind was reported as 230°/10 kt and the temperature was 15° C. On approaching the area, the helicopter climbed to about 50 feet at a speed of about 20 kt. The height was increased to 80 to 100 feet in order to observe a specific part of the intended operating area. The passenger pointed out that the rotor rpm had increased to about 107%. The throttle setting was reduced and the collective lever was raised slightly. The pilot, having noted that this action had put the rotor rpm "in the green", continued to observe the area below. Shortly afterwards, the helicopter entered a descending right turn. The pilot was unable to say what specific control movements were made, but did recall that, when the collective lever was raised further, it had no effect on the rate of descent. An attempt was made to enter autorotation, but the aircraft continued to descend rapidly with no forward speed. The collective was raised to cushion the impact, and the helicopter came to rest on its righthand side.

The pilot carried out the shutdown checks and followed the passenger through a hole which he had made in the already cracked windscreen. It was later realised that the escape could have been made through the lefthand door which was unobstructed. Both occupants were wearing diagonal upper torso harness, which held on impact but did not restrain the passenger sufficiently to prevent his head striking the windscreen.

It was noted that, just prior to the accident, the helicopter had been operating in the avoid area of the height-velocity diagram for the Robinson R22.

## ADDENDUM

AAIB Bulletin 9/90, page 31.

### ACCIDENT TO PIPER PA24 G-ARIN AT BODMIN ON 20 MAY 1990

Since the publication of this bulletin further enquiries have revealed that the weights of the fuel and the occupants on board the aircraft at the time of the accident may have been underestimated by the pilot by as much as 350 lb.

Because of the nature of the damage to the engine the position of the carburettor heat control at the time of the accident could not be determined and there was thus no evidence to support the pilot's statement that it was found broken in the hot air position.

After the accident marks from all three landing gear wheels were found in the long grass on the left side of the runway.



# **LIST OF RECENT AIRCRAFT ACCIDENT REPORTS ISSUED BY AIR ACCIDENTS INVESTIGATION BRANCH**

3/89	Sikorsky S61N helicopter G-BDII near Handa Island off the north-west coast of Scotland on 17 October 1988	June 1989
4/89	Boeing 747 N605PE at Gatwick Airport on 1 February 1988	August 1989
5/89	Boeing 747-136 G-AWNM on approach to Runway 27L at London (Heathrow) Airport on 11 September 1988	December 1989
6/89	Concorde 102 G-BOAF over the Tasman Sea, about 140 nm east of Sydney, Australia on 12 April 1989	December 1989
1/90	Sikorsky S61N G-BDES in the North Sea, 90 nm north-east of Aberdeen on 10 November 1988	May 1990
2/90	Boeing 747 N739PA at Lockerbie, Dumfriesshire, Scotland on 21 December 1988	September 1990
3/90	Sikorsky S61N G-BEID 29 nm north-east of Sumburgh Shetland Isles on 13 July 1988	September 1990
4/90	Boeing 737 G-OBME near Kegworth, Leicestershire on 8 January 1989	

These Reports are available from HMSO Bookshops and Accredited Agents

## ABBREVIATIONS COMMONLY USED IN AAIB BULLETINS

<b>ADEL T</b>	automatically deployable emergency locator transmitter
<b>ADF</b>	automatic direction finding equipment
<b>AFIS(O)</b>	Aerodrome Flight Information Service (Officer)
<b>AFS</b>	Aerodrome Fire Service
<b>agl</b>	above ground level
<b>AIC</b>	Aeronautical Information Circular
<b>amsl</b>	above mean sea level
<b>ASI</b>	airspeed indicator
<b>ATC(C)</b>	Air Traffic Control (Centre)
<b>CAA</b>	Civil Aviation Authority
<b>CG</b>	centre of gravity
<b>°C,F,M,T</b>	celsius, fahrenheit, magnetic, true
<b>DME</b>	distance measuring equipment
<b>ETA</b>	estimated time of arrival
<b>ETD</b>	estimated time of departure
<b>FL</b>	flight level
<b>fpm</b>	feet per minute
<b>g</b>	normal acceleration
<b>gall imp/US</b>	gallons, imperial or United States
<b>hrs</b>	hours
<b>IAS</b>	indicated airspeed
<b>IFR</b>	Instrument Flight Rules
<b>ILS</b>	Instrument landing system
<b>IMC</b>	Instrument Meteorological Conditions
<b>IR</b>	Instrument Rating
<b>IRE</b>	Instrument Rating examiner
<b>kg</b>	kilogram(s)
<b>km</b>	kilometre(s)
<b>kt</b>	knot(s)
<b>lb</b>	pound(s)
<b>mb</b>	millibar(s)
<b>mm</b>	millimetre(s)
<b>MDA</b>	Minimum Descent Altitude
<b>MTWA</b>	Maximum Total Weight Authorised
<b>NDB</b>	non-directional radio beacon
<b>nm</b>	nautical mile(s)
<b>NOTAM</b>	Notice to Airman
<b>OCL</b>	Obstacle Clearance Limit
<b>PAPI</b>	Precision Approach Path Indicator
<b>PAR</b>	precision approach radar
<b>PIC</b>	pilot in command
<b>psi</b>	pounds per square inch
<b>rpm</b>	revolutions per minute
<b>RTF</b>	radiotelephony
<b>RVR</b>	runway visual range
<b>SSR</b>	secondary surveillance radar
<b>TAS</b>	true airspeed
<b>UTC</b>	Universal Time Coordinated
<b>VASI</b>	Visual Approach Slope Indicator
<b>VFR</b>	Visual Flight Rules
<b>VHF</b>	very high frequency
<b>VMC</b>	Visual Meteorological Conditions
<b>Vne</b>	never exceed airspeed
<b>VOR</b>	VHF omni range

