No: 12/90 **Ref: EW/C1169** **Category: 1c**

Aircraft Type and Registration:	Piper PA-28-140 Cherokee, G-AYIH
No & Type of Engines:	1 Lycoming O-320-E2A piston engine
Year of Manufacture:	1970
Date and Time (UTC):	7 July 1990 at 1230 hrs
Location:	Cranfield Village, Bedfordshire
Type of flight:	Private
Persons on Board:	Crew - 1 Passengers - 2
Injuries:	Crew - 1 (Fatal) Passengers - 2 (Fatal)
Nature of Damage:	Forward fuselage and landing gear severely damaged, centre and rear fuselage and wings moderately damaged
Commander's Licence:	Private Pilot's Licence (Group A) with IMC and Night ratings
Commander's Age:	41 years
Commander's Total Flying Experience:	366 hours (of which 319 were on type)
Information Source:	AAIB Field Investigation

History of the flight

The accident occurred on the Saturday of the annual Popular Flying Association (PFA) rally at Cranfield. On the previous day the pilot completed fitting a drag reduction kit to G-AYIH, his own aircraft (see below). That evening he flew solo for 25 minutes before returning to his home base of Elstree where the aircraft fuel tanks were filled to full capacity with 100LL AVGAS.

On Saturday morning the pilot was asked by an acquaintance if he would fly him to Biggin Hill where the acquaintance was to collect another aeroplane. The pilot agreed and together they took off at 1047 hrs. En-route the flight progressed normally and they landed at Biggin Hill at 1111 hrs where the passenger disembarked. The pilot took-off again, alone, at 1127 hrs en-route for Blackbushe, where he intended to collect two friends and take them to Cranfield. Although the pilot was not a member of the PFA, he was aware of the requirement to land at Cranfield by 1230 hrs - an air display was due to start at 1300 hrs (1400 hrs local).

At about 1150 hrs the pilot called Blackbushe and requested joining instructions. After some initial difficulty in discriminating between Blackbushe and Farnborough (135°(M) / 3.7 nm from Blackbushe), he landed normally at Blackbushe at 1155 hrs. The pilot was instructed to taxi along the southern taxiway passing to the north of the refuelling pumps and to park on the main apron. He did not do so but remained on the southern taxiway, embarked his passengers with the engine running and then executed a wide left turn through 180° to face west back down the taxiway. He then requested departure. He was given instructions to taxi to the holding point for runway 26 and subsequently took-off normally at 1202 hrs. At the time of take-off the aircraft's weight was close to the maximum authorised weight and the centre of gravity was within limits.

A map recovered from the wreckage showed a direct track drawn between Blackbushe and Cranfield which passed through the north west corner of the Luton special rules zone. At 1213 hrs the pilot contacted Luton Approach; he gave his position as passing High Wycombe and requested VFR clearance through the corner of the zone at 2000 feet whilst transponding on code 4321. Clearance was given and at 1225:39 hrs the pilot reported "FIVE DME TO RUN TO CRANFIELD". He was warned of at least 15 contacts in the Cranfield overhead by the Luton Approach controller and instructed to contact Cranfield by radio which he did at 1227:05 hrs, stating his altitude as 2000 feet.

At Cranfield the wind was 260°/15 kt gusting to 25 kt and the visibility was 8 to 10 km. The surface temperature was 19°C and the cloud had lifted into broken strato-cumulus base 1800 feet tops 3000 feet with more scattered strato-cumulus between 5000 and 6000 feet. For the duration of the PFA rally, normal Air Traffic Control at Cranfield had been replaced by an AFIS. The pilot was informed "INDIA HOTEL LANDING RUNWAY TWO SIX LEFT HAND QFE ONE ZERO ZERO ONE". The pilot repeated this information and stated that he had the airfield in sight. The AFISO then replied "ROGER, KEEP A SHARP LOOKOUT FOR TRAFFIC". At 1228:23 hrs the pilot reported downwind and this was the last recorded radio transmission from the aircraft. There were between 10 and 20 aircraft in the circuit at the time and G-AYIH was seen by witnesses and on radar to join the circuit at the beginning of the downwind leg about one mile south of runway 26. The primary radar return from the aircraft faded as it turned left on to base leg at 1229:16 hrs. Eye witnesses reported that at this time there were between 6 and 12 aircraft established on final and long final approach. The pilot of G-AYIH turned on to base leg with the apparent intention of joining this stream at or about the number 4 to land position. The pilot of a Fuji aircraft at about 500 feet agl on finals, who believed he was number 4 to land, saw a Cherokee type aircraft approaching him on a collision course from his 10 o'clock; to him the aircraft appeared to be level or slightly high and under power, and his passenger saw the Cherokee's landing light flash. As the Fuji pilot was about to take avoiding action, the Cherokee turned right to pass behind the Fuji. This turn was observed by several witnesses who saw the Cherokee turn to face towards the remaining traffic on finals and then, almost immediately, reverse direction into a left turn through about 180° using approximately 60° angle of bank. On completion of this turn the Cherokee was north of the extended centreline and tracking towards the airfield at a height estimated to be between 100 and

300 feet. Several people saw the aircraft recover from the turn to an essentially wings-level attitude with small erratic oscillations in bank angle. Two witnesses thought they saw the aircraft's nose rise slightly before they and many other witnesses saw the nose and left wing drop almost simultaneously. Eye witnesses close to the crash site saw the aircraft spiral to the left in a 40° to 45° descent with between 60° and 90° of left bank and noticeable sideslip. Some witnesses heard an engine begin coughing and spluttering and some heard an engine increase from low power to a higher power setting before they and other witnesses heard an impact a few seconds later.

The aircraft crashed at approximately 1230 hrs with no injury to anyone on the ground. All three occupants suffered multiple injuries and were certified dead at the crash site by a medical practitioner. A postmortem examination of the occupants revealed nothing which contributed to the accident. The pilot's class three medical certificate was endorsed with the requirements to wear spectacles to correct distant vision and to carry spare spectacles. No positive evidence of corrective lenses was recovered from the wreckage but one pair of spectacle frames was recovered which could have contained corrective lenses.

Examination of Wreckage

Examination of the wreckage and the accident site showed that the landing gear of the aircraft had struck the upper parts of two 7-8 foot high greenhouses situated near the rear wall of a house in Cranfield Village. There followed a secondary impact of the left wing with a chain link fence, before the fuselage nose suffered major impact with the corner of a brick-built single storey conservatory, near to ground level. At initial impact the aircraft was heading approximately 185°M on a flight path descending at around 15° to the horizontal, whilst essentially level in pitch and rolled around 10° left. Forward speed was estimated at 40-50 kt.

The left wing impact caused the aircraft to yaw sharply left and it came to rest erect on a heading of 150°M around 3.5 metres beyond the initial impact point, with the nose embedded 1.3 metres into the demolished lower corner of the building. The forward fuselage suffered longitudinal crushing damage back to the area of the rudder pedals. The remainder of the fuselage sustained deformation in some areas, but was not grossly damaged and the empennage was virtually unmarked. There was no structural incursion into the cabin space except to some degree in the instrument panel and rudder pedal areas. Both wings remained attached to the fuselage. The left wing sustained localised leading edge damage and this caused significant rupture of the left wing fuel tank and major fuel release. The right wing did not suffer gross damage, but the right fuel tank water drain valve protruding from the undersurface of the wing was forced and held open by impact damage, resulting in release of most of the gasoline in the tank. There was no fire.

It was not possible to establish the history of the aircraft and its maintenance status as the Aircraft and Engine Log Books could not be located. The aircraft had valid Certificates of

Airworthiness (Private Category), Registration and Approval of Aircraft Radio Installation. The pilot at the time of the accident was the registered owner.

Detailed inspection of the aircraft included examination of the structure, the seats and seat belts, the flying control system, the instrumentation and the fuel system, and strip examination of the engine. No evidence of pre-impact defect or malfunction of the structure or engine was found, and analysis of samples of fuel and engine oil from the aircraft by the Ministry of Defence Directorate General of Defence Quality Assurance, Woolwich, showed that both were consistent with approved specification requirements. Markings indicated that the propeller was rotating at the time that the aircraft struck the greenhouses. The evidence indicated that the powerplant was not delivering high power at impact but this could not be quantified, given the nature of the impacts. A placard on the instrument panel cautioned "Do not open the throttle rapidly (idle to full throttle in 2 seconds minimum)".

The evidence indicated that all parts of the flying control system had been connected at the time of the accident, and no evidence of a control restriction or jam were found, although such a possibility could not be totally dismissed, given the degree of disruption in some areas. The evidence indicated that wing flaps were in the retracted position at the time of impact.

It was found that the stall warning detector microswitch was intermittent in operation. Strip examination revealed that this was the result of slight corrosion on the contacts, and the evidence suggested that this may well have been present at the time of the accident. The switch was designed to be operated by a small vane located in the leading edge of the left wing when the airflow around the wing approached the aerodynamic stalled condition and thereby caused the vane to pivot upwards. Switch operation completed an electrical circuit that illuminated a small red warning light on the instrument panel, however, the system on this aircraft model did not include an audio warning, as commonly fitted to many similar aircraft.

It was also found that the aircraft was fitted with an aerodynamic drag reduction kit. It comprised, for each wing, a 2½ inch wide curved aluminium strip fastened chordwise to the upper and lower wing surfaces to cover the inboard and outboard attachments for the wing fuel tank; shaped fairings covering the three flap hinges beneath the wing lower surface; a 2 inch wide thin aluminium sheet pop-riveted to the wing undersurface and covering the gap between the flap and the wing undersurface; and a similar 4 inch wide sheet covering the gap between the aileron and the wing undersurface. The flaps on this aircraft model are of the single slotted type and the ailerons of the frise type. The kit was reportedly supplied by Laminar Flow Systems Inc., St Thomas, Virgin Islands and fitted by the aircraft owner during the week preceding the accident. It was approved for installation on United States registered aircraft of this type under a Federal Aviation Administration (FAA) Supplemental Type Certificate (STC). Application has reportedly not been made for CAA approval for the kit for G-AYIH or for any other UK registered aircraft. A Certificate of Release to Service issued by the holder of an Aircraft Maintenance Engineer's Licence is required (Air Navigation Order, Article 11) before flying

after making a modification such as the drag reduction kit. Reportedly, the owner's intention was to fit additional drag reduction fairings, to the landing gear, when the aircraft was on jacks at an approved maintenance organisation for its Annual Inspection, due shortly after the accident. After this, a CAA Surveyor was to be asked to inspect the modifications to determine whether the CAA would categorise them as Minor or a Major Modifications and to establish the details of the flight testing required. The effect of the drag reduction kit modifications on the aircraft's pre-and post-stall behaviour could not be documented precisely but it is unlikely that their effect on the stall speed and characteristics would have been significant.

The two forward seats distorted, but remained attached to the floor rails, and the rear seats were undamaged. Forward seat belts each comprised a two-piece lap strap, fastened by a buckle, and an inertial reel diagonal shoulder strap. The shoulder strap terminated in a steel attachment fitting with a keyhole slot which could be clipped to a shouldered spigot (or post) forming part of the buckle (Fig 1). Lap straps and the diagonal strap inertial reel were anchored directly to the aircraft structure. Both sets of belts remained intact and attached to the aircraft and there was no sign of distress or marking of the straps, buckles or anchorages indicative of either belt having been highly loaded. Checks indicated that both forward belts functioned correctly except that, for each set, the diagonal strap (Pacific Scientific Co. Part No. (PN) 0107116-9) tended to readily disengage from the lap strap buckle (American Safety Equipment Corp. Model 9600-22, PN 500567) unless under constant tension. With this method of diagonal strap attachment, the shouldered portion of the spigot is commonly fitted with an elastomeric bush which assists in retention of the diagonal strap fitting onto the spigot. Such bushes tend to wear out and detach after a period of use. No bush was present on either front seat buckle of G-AYIH. Information is awaited on whether the model of buckle fitted was required to be fitted with such a bush, and on whether the model of diagonal strap fitted was approved by CAA for use with the model of lap strap fitted.

CAA General Aviation Safety Information Leaflet (GASIL) 10/90 (Engineers' Supplement, page f) describes a method of renewing such buckle bushes, proposed by a member of the USA Cessna Pilots' Association, using soft clear plastic automotive fuel hose. No information has been found to suggest that there is a CAA approved repair scheme but further details are awaited from the CAA.

Autopsy evidence of the injuries to the front seat occupants, together with the lack of markings on them from diagonal shoulder strap restraint, suggested that the upper torso restraint of both front seat occupants had not been effective.

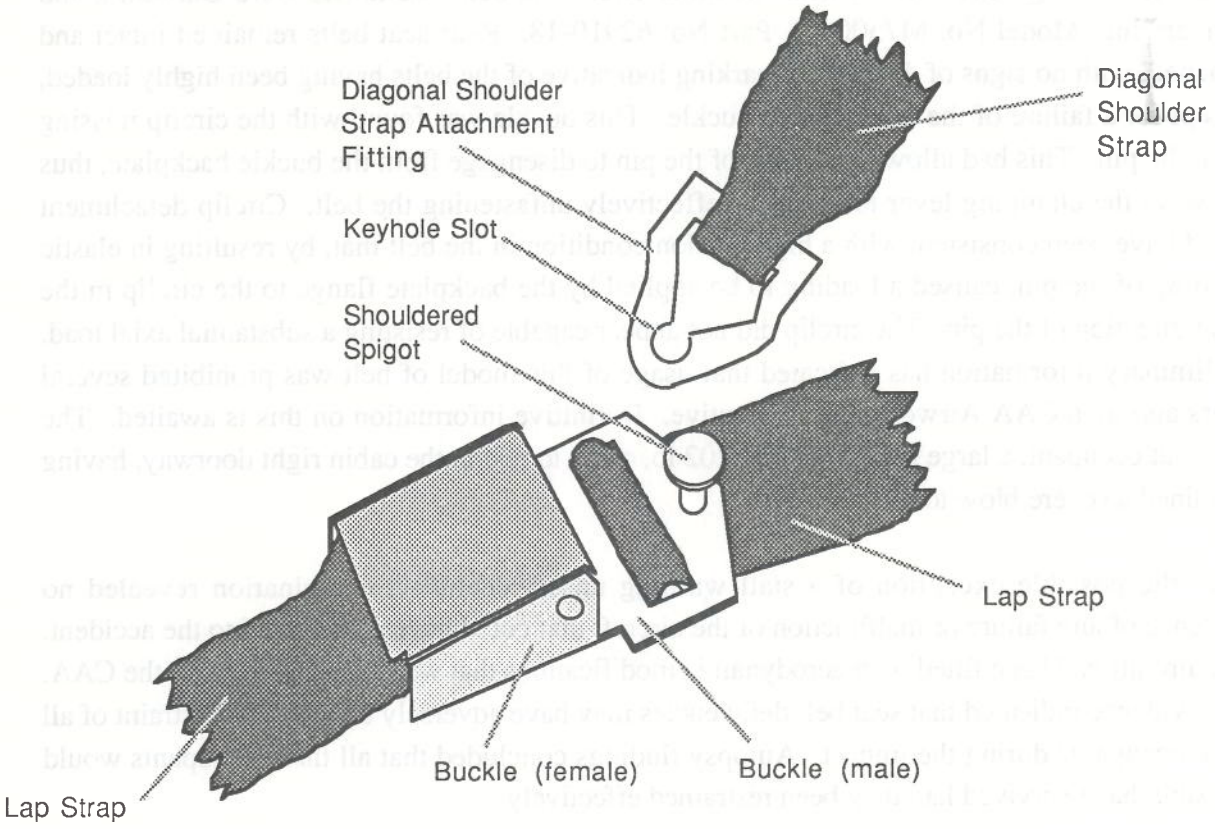
Rear seat belts each consisted of a two-piece webbing lap strap anchored to the aircraft structure. One of the straps passed through a metal buckle fastened to the end of the other strap, and could be clamped in the buckle by rotation of a clamping lever forming part of the buckle. The pivot for the clamping lever consisted of a 0.25 inch diameter pin located at either end in a hole in the flanges of the buckle backplate. Axial restraint of the pin in the back plate flanges was by means of a shoulder formed on one end of the pin and by a small circlip located in a shallow

circumferential groove formed near the other end. The belt assemblies were Cumming and Sanders Inc. Model No. M7500-S2, Part No. 62910-18. Rear seat belts remained intact and attached, with no signs of distress or marking indicative of the belts having been highly loaded, except for a failure of the left seat belt buckle. This buckle was found with the circlip missing from the pin. This had allowed one end of the pin to disengage from the buckle backplate, thus allowing the clamping lever to displace, effectively unfastening the belt. Circlip detachment could have been consistent with a high tension condition in the belt that, by resulting in elastic bending of the pin, caused a loading to be applied by the backplate flange to the circlip in the axial direction of the pin. The circlip did not appear capable of resisting a substantial axial load. Preliminary information has indicated that usage of this model of belt was prohibited several years ago by a CAA Airworthiness Directive. Definitive information on this is awaited. The rear seat occupant, a large man weighing 202 lb, came to rest in the cabin right doorway, having sustained a severe blow to the chin.

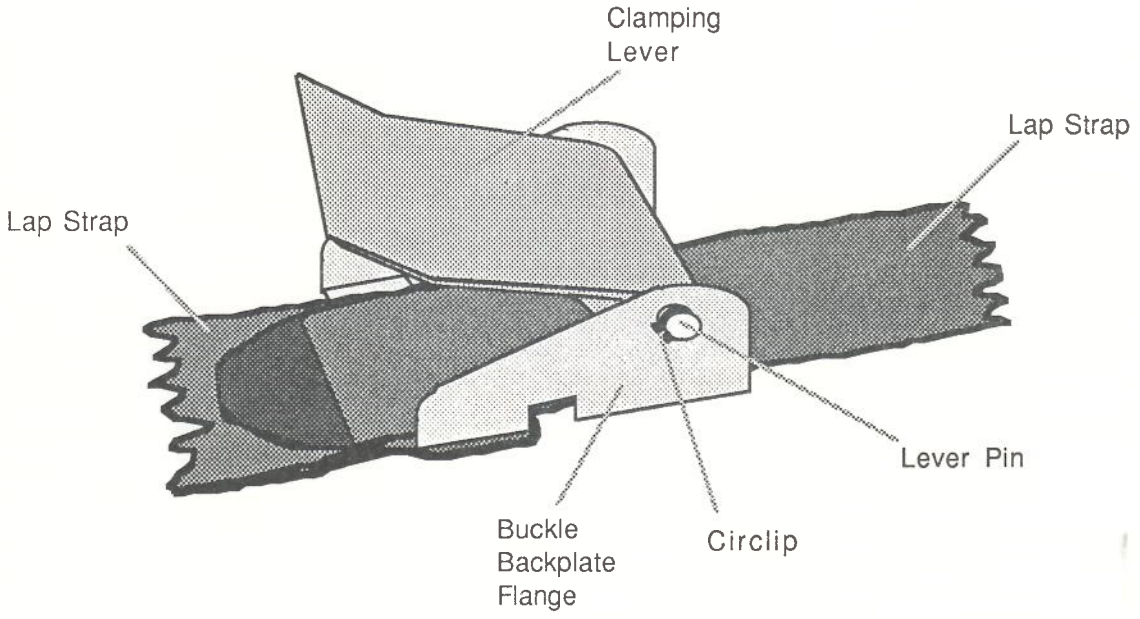
With the possible exception of a stall warning unserviceability, examination revealed no evidence of any failure or malfunction of the aircraft that could have contributed to the accident. The aircraft had been fitted with aerodynamic modifications that were not approved by the CAA. The evidence indicated that seat belt deficiencies may have adversely effected the restraint of all three occupants during the impact. Autopsy findings concluded that all three occupants would probably have survived had they been restrained effectively.

A number of recommendations are under consideration, but further information is awaited from the CAA before they are finalised.

SEAT BELT SCHEMATICS



FRONT SEAT BELT



REAR SEAT BELT

FIG 1