Cessna 172P, G-BMZV

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Aircraft Type and Registration:	Cessna 172P, G-BMZV
No & Type of Engines:	1 Lycoming O-320-D2J piston engine
Year of Manufacture:	1981
Date & Time (UTC):	21 November 1996 at 1353 hrs
Location:	Nr Compton Abbas Airfield, Dorset
Type of Flight:	Private
Persons on Board:	Crew - 1 - Passengers - None
Injuries:	Crew - 1 fatal - Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	42 years
Commander's Flying Experience:	See text
Information Source:	AAIB Field Investigation

History of flight

The aircraft took off from Bournemouth International Airport at1311 hrs and, at about 1350 hrs, joined the circuit for Runway26 at Compton Abbas. The surface wind was calm and the weatherwas CAVOK; the grass runway surface was wet.

No witnesses were found to the aircraft's approach or initiallanding roll. It was first reported as it passed abeam the clubhouse,travelling at a relatively high speed along the runway. Whenit was about 90 metres from the end of the runway the engine powerwas heard to increase. It continued along the ground in a gentleleft turn into the adjacent stubble field. After some 30 metresit became airborne and tracked left towards a small copse, adoptinga steep nose-up pitch attitude. The left wing then dropped andthe aircraft descended rapidly to crash in a steep nose down attitude.

Pilot's flying experience

The pilot started flying in May 1988 and gained a PPL in December1991. He had flown a total of 104 hours, all but 30 minutes ofwhich were on Cessna 150 type aircraft or variants of that type. Over the previous 90 days he had flown 6 hours, 3 of which wereduring the previous 28 days. His last flight before the accidentwas on the 18 November 1996 when he successfully completed a

checkflight with a flying instructor. His log book showed that hehad landed at Compton Abbas on six occasions, the last of whichwas in January 1994.

Medical and pathology

Post mortem examination revealed no pre-existing medical conditionwhich could have contributed to the accident.

Compton Abbas airfield

Compton Abbas is a licensed airfield situated on a hill top, 810feet amsl, 3 nm south of Shaftesbury. The landing distance availableon Runway 26 is 803 metres and the surface condition was generallygood with areas where holes or ruts have formed. The grass surfacewas wet, however, the pilots of other aircraft which arrived shortlybefore the accident reported that they had no braking problems. The ground falls away steeply to both the east and west of theairfield.

Impact features

The aircraft had struck the ground in an adjacent field on a headingof about 345° (magnetic) having turned some 275° tothe left. Ground marks indicated that at first contact with theground, the heading was about 020°, with the remaining 35°of left turn occurring during impact. The aircraft had been nearlyvertical in pitch at impact, with the left wing low. There wasno significant 'throw' of the wreckage indicating that the groundspeed was very low, however the vertical speed had been high enoughto cause major disruption to the nose of the aircraft. Therewas evidence of high engine power from the condition of the propeller. The flaps were set at about 30°, which on this particularaircraft represented the maximum available. The pilot had receivedfatal head and neck injuries in the impact, and both the frontseats had moved forwards as far as the distortion to the frontof the cabin would permit. Although the seats had moved forward,they had remained attached to their seat rails. The pilot's seatback was in a partially collapsed position as examined, howeverthe mechanism was undamaged and photographs confirmed that, immediatelyafter the accident and before the wreckage had been disturbed,the seat back had been upright.

Detailed examination

The flying control runs were checked and it was found that theassociated cables and chains had remained on the column system; the aileron control system had been intact until the wing wasremoved, although it was distorted around the columns. The aileronsystem could only be partly functioned due to the distortion ofthe nose which had caused the yoke to jam. The elevator systemwas intact, but due to distortion of the fuselage and floor aroundthe column, it could not be moved after the impact. The ruddercables were intact and connected, but the structural damage precludedfunctioning of the rudder pedals. The flaps had been selectedto 30° and were found at that position. Although the flapelectrical system could not be functioned, no associated faultswere found. This aircraft type is capable of performing a go-aroundmanoeuvre with full flap selected and one person on board. Itwas found that slight nose down elevator trim was selected, butit could not be determined if this was an impact feature. Thewheels, brakes and associated discs were visually satisfactory. The discs had a light tarnish from the use of extinguishant. The left brake functioned when the brake pedal was depressed,however the right brake did not operate due to loss of hydraulicfluid. This was found to be due to internal damage to a flexiblehose which had been crushed in the impact. No other defect wasfound associated with the right brake.

As previously stated, the front seats had both moved forwardsin the impact. The seats are normally prevented from movingfore and aft by two pins in each seat which engage in holes inthe seat rails, and which can be removed by means of a lever toallow the seat position to be adjusted. The seats are preventedfrom vertical disengagement from the seat rails by retaining claws. In the case of the unoccupied passenger seat, one pin was bentrearwards with corresponding damage to the rail, and the otherpin had no damage. This indicated that at least one of the rightseat pins had been engaged at impact, but that the impact forceshad been sufficient to force the seat out of engagement, eventhough it was not occupied. On both seats the claws were stillengaged. On the pilot's seat the pins were both bent slightlyforwards, not aft, and there was no corresponding damage to therails. The forwards bending could not have occurred in the impactsince it would have required the seat to have been loaded in anaft direction. This forwards bending was attributed to previouscareless adjustment of the seat, probably over a period of time. The rails had no damage other than impact damage, except fora very slight 'burr' on the rear edges of holes 5 and 6 (numberingfrom the front of the rails). Both rails were in fairly goodcondition, but some wear patterns were evident. Dimensionalchecks of the holes were carried out in accordance with the informationcontained in Airworthiness Directive (AD) 87-20-03 R2, which requiresthe holes to be measured in the fore and aft plane, 0.020 inchbelow the surface of the rail. The AD states that the nominaldiameter is 0.28 inch and that if the wear dimension exceeds 0.36inch, the rail must be subject to repetitive inspections. Ifthe wear dimension exceeds 0.42 inch, the rail must be rejected. On the pilot's seat rails the greatest wear had occurred aroundholes 4,5,6 and 7. The diameter of these holes was difficultto measure, due to distortion of the rails in the impact, butthe maximum dimension in any direction was less than the 0.36inch specified in the AD.

A close examination of the geometry of the pins of the left seatshowed that they were bent through about 4° in one case andover 6° in the other. They also had conical tapers on thelast 0.25 inch, amounting to some 5° taper angle on eachside of the pin, and local wear patterns. AD 87-20-03 R2 alsoshowed that the minimum permissible seat pin engagement in therail was 0.15 inch, after all vertical seat movement is takeninto account. As supplied by the manufacturer, the pin engagementwould have been in excess of these minimum dimensions, and onthe seat in question a total engagement of about 0.31 inch wasmeasured, although this made no allowance for free movement vertically. When the seat pins were inserted in the rails up to the wearmarks on the pins, about 0.05 inch of free play was observedin the fore and aft direction. The pin engagement mechanism wasfound to exert a combined force of around 35 lbs on both pins,to keep them engaged.

Data supplied by the Cessna Aircraft Company showed that the pinsfitted to the pilot's seat were of a design which had been changedin 1983. The modified new pins were chamfered on the sides only,so that the 0.15 inch of engagement, as specified in AD 87-20-03R2, gave good penetration of the parallel edges of the pin intothe rail holes. In the light of this information, this AD isnot appropriate to seats with pre-1983 pins, as the engagementcriteria therein would leave the pins engaged only by their taperedsections. As manufactured by Cessna, the pin engagement (pre-1983)was about 0.31 inch. This allowed only about .063 inch ofengagement of the parallel portion of the pin, less any reductionfor vertical movement of the seat, and wear.

Examination of other aircraft

Several other Cessna 172 aircraft were examined, including a similaraircraft of the same operator's fleet. On that aircraft it wasfound that the left seat had a pin which was slightly bent forwards,by perhaps 2°, *ie* in a similar direction to the pilot'sseat pins on the crashed aircraft. It was also noted that, withthe seat normally positioned and the diagonal safety strap adjustedfor comfort, a pilot's

head could come very close to the leftpillar and windscreen. With the seat slid back until the feetwere barely on the rudder pedals, the yoke and throttle couldbe pushed forward, if the pilot leaned forward, but it could bedifficult to reach the flap lever.

Modification action

Cessna Single Engine Service Bulletin SEB 89-2, Revision 2, dated4 September 1992 and entitled "Pilot seat secondary stopinstallation" described a modification to fit a secondaryseat stop to the pilot's seat. The purpose of this modificationstated in SEB 89-2 was as follows:

"The secondary seat stop is designed to assist in providingan additional margin of safety by limiting the aft travel of theseat in the event the primary latch pin is not properly engagedin the seat rail/track. Seat slippage could result in the pilotnot being able to reach all the controls and subsequently losingcontrol of the airplane".

This modification restricts free movement of the seat to the rearto a maximum of 4 inches, unless the pilot operates the stop assemblyand releases the locking pins together. This Service Bulletinstates that compliance is "Mandatory", with embodimentto be accomplished within 400 hours or 12 months, however it isnot mandated by the UK CAA. The Service Bulletin also statesthat "FAA approval has been obtained on technical data inthis publication that affects airplane type design"; and"For Reims Aviation Airplanes; DGAC approval has been obtainedon technical data in this publication that affects airplane typedesign." This SEB 89 was originally issued on 14 April,1989. Revision 1 was issued on 26 October, 1990.

This question of regulatory response to manufacturers' ServiceBulletins which strongly recommend modification action on theirproducts also arose during the AAIB Inspector's Investigationof the accident to Piper PA-31-325 C/R Navajo, G-BMGH, which suffereda serious loss of control in flight, due to detachment of itsright engine following loss of a propeller blade, and conducteda forced landing 4 nm southeast of King's Lynn, Norfolk, on 7June 1993 (Aircraft Accident Report 6/94). This 1994 report includedthe following finding:

(ix) The presence of the fatigue cracking from one of the greasenipple holes in the right propeller hub was not detected duringa mandatory visual inspection of this hub 10.35 hours beforethis accident due to the inadequacy of the visual inspection requirementin FAA AD No 89-22-05. This AD had not been revised to reflectthe introduction of eddy current inspection by the propeller manufacturer,or to reflect the latter's strong recommendation to replace suchhubs with an improved design.

This report also included the associated Safety Recommendation:

4.3 The CAA and FAA should seriously consider issuing AirworthinessDirectives to make manufacturers' strong recommendations to replacecomponents a mandatory requirement where it is apparent that failureto replace such components could result in a potentially majorhazard to the safety of affected aircraft.

(Safety Recommendation No 94-30, made September 1994).

Discussion

The lack of damage to the left seat rails and the absence of rearwardsbending of the associated pins indicated that the pins had notbeen properly engaged in the rails at impact. The forward bendingfound on these pins could not have occurred during the impactif they had been properly engaged. It follows that either (a)something very unusual happened to them during the flight, forcingthe seat rearwards or (b) they were bent before the commencementof the flight. The conclusion that the pins were bent beforethe start of the flight is supported by the similar damage foundon the other aircraft in the same fleet. It was considered thatthe most likely reason for this type of bending was associatedwith previous adjustment of the seat rearwards, when the pinshad been allowed to engage and arrest the aft motion of the seat. This damage may have occurred on a single occasion, or may haveaccumulated over a period.

It was not possible to determine if the seat pins had been properlyengaged during the accident flight. Failure of the seat pinsto fully engage is often due to obstruction of the holes, butno evidence of such obstruction was found. If the pilot's seatlocking was properly engaged during the flight, the evidence clearlyindicated that the associated pins had disengaged, however, beforeimpact. It is relevant, therefore, that the highest loads onthe seat can be generated during braking. The loads which a pilotcan generate on foot pedals are in the order of several hundredpounds and could be capable of releasing the seat pins, giventhe engaging force from the springs and the combined taper andbend angles. In view of the unremarkable nature of the flightuntil the go-around at Compton Abbas, it was concluded that thepilot's seat had moved rearwards during the landing roll. Itwould thus appear that the pilot was unable to bring the aircraftto a halt in the remaining runway distance available and so initiateda go-around. The subsequent apparent over-pitching of the aircraftwould be consistent with his loss of control due to aft displacementof the seat.

In the light of these findings, the following Safety Recommendationsare made:

96-84: In order to restrict sudden inadvertent aft movement ofpilots' seats on Cessna 172 aircraft with the attendant possibilityof over-pitching of such aircraft the CAA, in conjunction withthe FAA, should expedite the following:

(1) re-assessment of the seat track pin engagement dimensionalcriteria for Cessna 172 aircraft fitted with the pre-1983 typepins and formulation, in conjunction with the manufacturer, ofurgent corrective action to achieve safe and reliable seat positionlocking in service.

(2) a review of the status of Cessna SEB 89-2 Revision 2 witha view to making the embodiment of the secondary seat stop mandatory,as clearly intended by the manufacturer in this Service Bulletinof 1989.

(3) alert associated aircraft maintenance engineers of the potentialfor deflection of seat track locking pins to occur in serviceand require associated inspection and replacement of any bentpins found pending the outcome of (1).

(4) alert Cessna 172 pilots of the need for care when adjustingtheir seat positions on the associated tracks in order to avoidbending of the seat track locating pins.

97-11: The CAA and FAA should seriously consider issuing AirworthinessDirectives to make manufacturers' strong recommendations to modifycomponents a mandatory requirement where it is apparent that failureto modify such components could result in a potentially majorhazard to the safety of affected aircraft.