Air Command 532 Elite, G-BOVP, 20 April 1996

AAIB Bulletin No: 7/96 Ref: EW/C96/4/7Category: 1.3

Aircraft Type and Registration: Air Command 532 Elite, G-BOVP

No & Type of Engines:1 Rotex 532 piston engine

Year of Manufacture:1989

Date & Time (UTC):20 April 1996 at about 1455 hrs

Location: Long Marston Airfield, Warwickshire

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 (Gyroplanes)

Private Pilot's Licence (Aeroplanes)

Commander's Age:64 years

Commander's Flying Experience:646 hours (of which 40 were on gyroplanes)

Last 90 days - 5 hours (2:30 on gyroplanes)

Last 28 days - 3 hours (2:30 on gyroplanes)

Information Source: Field Investigation

History of flight

The pilot was taking part in a gyroplane rallyat Long Marston Airfield. He arrived at about 1400 hrs withthe gyroplane on a trailer; with the assistance of another participanthe unloaded it and fitted the rotor blades. The engine startedafter about six pulls and was run briefly to check that it wasfunctioning correctly. Some time later, probably at about 1430hrs, the gyroplane took off from grass runway 20 and was seento climb to about 1,000 feet agl and head north, towards Stratford-upon-Avon.

The gyroplane returned some 20 minutes later,heading south, at a height variously estimated as between 1,000and 2,000 feet agl; the wind at 2,000 feet was about 220°/15kt. It was reported to

have been flying slowly when it entereda right turn which continued through 360° back to the startingpoint. It was then that observers noticed that the rotor appearedto be turning very slowly; it was possible to discern the individualblades. The subsequent manoeuvre was variously described butthe gyroplane appears to have descended, rotated to the rightfor 2 or 3 turns and then tumbled to an almost inverted attitude. A witness from a group flying model aircraft heard a "metallicbang"; this was also described by another as "like astarting pistol". He saw the gyroplane tilt initially about45° to the right and as it fell, the tilt appeared to increaseto 90°; it was difficult to determine precisely when thebang occurred but the witness thought it may have been at thepoint of, or shortly after the initial tilt to the right. A flyinginstructor who had just taken off in a microlight saw the gyroplanepass on his right side, going vertically downward in an almostinverted but stable attitude with the rotor blades bent upwardstowards the body; he was climbing through about 400 to 500 feetagl at the time. The gyroplane struck the asphalt perimeter trackin the south west corner of the airfield.

The pilot held a current class 3 medical with the limitation thatthe holder must wear spectacles which correct for near/distantvision; he wore suitable contact lenses. The pilot's medicalrecords and post mortem examination revealed no pre-existing medicalcondition which would have contributed to the accident. He worea motor cycle type crash helmet, however, the severity and attitudeof the impact were such that it would have had no effect on theoutcome of the accident, in which he died instantly.

The pilot started flying in 1953 with a University Air Squadronand by 1956 he had flown 135 hours in the Chipmunk. His nextrecorded flying was in May 1974, and he gained a PPL (Aeroplanes)in July 1975. He started training to fly gyroplanes, at Coventry,in August 1988; from May 1990, the training was done in G-BOVPand he gained a PPL (Gyroplanes) in August 1990. By October thatyear he had flown a total of 36 hours in gyroplanes. His flyingwas then exclusively in fixed wing aircraft until November 1995when he again flew G-BOVP for 1:30 hours. No further flightson gyroplanes were recorded until 3 April 1996, 1:00 hour and6 April 1996, 1:30 hours; all his gyroplane flying was on theAir Command and the flight on 6 April was the last recorded flighton any type before the accident.

The aircraft's logbook was not recovered, but the documentationheld by the PFA indicated that the modifications required underAirworthiness Approval notice PFA-G/04-325 to regain the Permitto Fly - revoked in 1991 as a result of earlier accidents - wereembodied. A flight test had been completed by 13 September 1995. One of these modifications was the installation of horizontalstabilisers added to the all moving rudder. The Permit was grantedon 18 October 1995. The hours counter on the instrument panelrecorded 24.1 hours.

The accident site comprised an area of old tarmac with a new 3.3mwide tarmac road passing through it. The gyroplane had descendedalmost vertically into the road, and most of the wreckage wascontained within a 7m square; the furthest piece of debris foundwas a tubular section of landing gear structure 10m from the primaryimpact point. At impact with the ground the gyroplane had a rollangle

of approximately 120_ to the right, and was slightly nose high. The first impact was probably on the rotor blade advancing fromthe fore-and aft position, the right side of the engine, nacelleand landing gear then took the brunt of the impact. There wasa heavy impact mark on the ground from the leading edge of oneblade (the rotor revolves anticlockwise when viewed from above),and both blades were bent and delaminated. An examination bya materials laboratory confirmed that the joints between the upperand lower halves of the rotor blades had been satisfactory; itwas therefore

concluded that the rotor blades had delaminatedon impact. There had not been any impact by the rotor on therudder or propeller.

The throttle was found in the closed position, the fuel was onand the filter/sight glass was full. The propeller and finaldrive had separated from reduction gearbox, but only two propellerblades were damaged - by lengthwise splitting on one leading andone trailing edge consistent with hitting the ground at low RPM. An engine strip did not reveal any pre-impact damage.

The right stabiliser was found to be broken in several piecesconsistent with a ground impact. The two extruded light alloybrackets attaching the stabiliser to the rudder had failed inthe right angle of the extrusion. Metallurgical examination ofthe failed brackets which had attached the right stabiliser tothe rudder showed that they had failed in a single applicationof overload; this indicated that the stabiliser had been in placeat impact. A strut, formed from a light alloy tube flattenedat both ends to accommodate a bolt, was used to brace each stabiliser. The right strut was still attached to the base of the rudder,but the upper end had become detached from the right stabiliser,and although the bolt was missing, there was minimal damage tothe bolt hole.

Photograph showing the rudderand right stabiliser bracing strut

This discrepancy was identified on receipt of the wreckage atFarnborough, and the bolt was found, loose *and withouta nut*, amongst the debris collected from the site. Comparisonsof lengths and gel coat traces confirmed that it had come fromthe right stabiliser. The bolt was 2BA and was worn and rusty,but otherwise undamaged. When the significance of the missingnut was realised, the accident site was searched again, this timeusing a sensitive metal detector, however the nut was not found.

Damage to the lower skin of the right stabiliser indicated thatthe bolt was still in place at impact - an area of the Glass-ReinforcedPlastic (GRP) located under the strut end had been pushed throughinto the backing foam, and the displaced section of GRP containeda witness mark showing the outline of the strut end in the blackpaint used on the strut. However, the end of the strut

aroundthe bolt hole showed insufficient signs of distress to accountfor the loss of the nut during the ground impact (see above photograph).

The length of the bolt (2BA) fastening the strut onto the leftstabiliser was excessive, and extra washers were packed underthe nut to prevent it bottoming on the unthreaded portion of theshank. The nut fitted to this bolt was cadmium plated, but twoof the four lock nuts used on the 'L'shaped brackets between the rudder and the stabiliser were rusty. The source of the used nuts and bolts in this area was not established,but the modification kit containing the stabiliser was suppliedwith new (UNF) nuts and bolts, and these had reportedly been usedin the original installation of the kit. The documentation coveringthe inspection of the aircraft before its test flight confirmedthat the stabilisers had been '*properly installed and inspected*'. The 2BA bolts are a British design and would not be suppliedwith a kit assembled in the USA. The type and condition of themissing nut was not known, but it was noted that a plain (ie notself locking) UNF nut with 32 threads per inch (tpi) could befitted to both 2BA bolts (31.4 tpi) recovered from the stabilisers,but that they made a very loose fit and could be spun off easily.

The AAIB were informed that shortly after the aircraft regainedits Permit to Fly it suffered a heavy, tail wheel first, landing. This caused damage to the mast and to the rudder pivot block,and during the repair the aircraft was dismantled and repairedby its owner. The dismantling involved the removal and refittingof the mast, rudder and tailplanes.

Other Accidents

Components which had exhibited characteristic witness marks onother crashed Air Commands were examined on VP:

In most accidents involving low rotor rpm the rotor has eitherstruck the rudder of the propeller. This has be ascribedıto a sudden upset in the balance of moments about the centre ofgravity (cg) between the propeller and rotor thrust. If the rotoris suddenly off loaded the resultant out of balance

couple causedby the propeller thrust acting about the cg can cause a self sustaining,irreversible forward buntover during which the gyroplane tailrotates upwards into the rotor at a faster rate than the rotorcan precess in the same direction.

There was no rotor strike in this accident. However, there appearsto have been a period when the gyroplane was neither completelyunder control nor out of control, but the rotor did appear tobe slowing. If the throttle was closed at this point, the effectof the couple would have been significantly reduced and with noother influence the nose would have pitched up slightly.

The washer under the rotor head retaining bolt had exhibitedfretting or concavity in the past. On VP this washer hadbeen replaced with a steel washer as specified by the additionalinspection requirements issued by the PFA.

Wear had been noticed on the shank of the rotor head retainingbolt. On VP the bolt had bent during impact, this had theeffect of increasing the clamping force and had consequently tightenedthe assembly. However, at some points the bolt shank had lostits cadmium plating and showed some signs of polishing. In viewof the work carried out after the heavy landing, it could notbe determined whether this wear was caused by the build stateimmediately prior to the accident.

Witness marks had been observed on the bell housing of thedrive unit caused by the teeth on the ring gear. On VP thetop of the bell housing showed a light circumferential rub, coveredby grease. The rub had removed the cadmium plating, but therewas no sign of any deeper mechanical erosion.