No: 6/91 **Ref: EW/G90/12/13** **Category: 1c**

Aircraft Type and Registration:	Denny Kitfox Mk 1, G-BPKK
No & Type of Engines:	1 Rotax 532 piston engine
Year of Manufacture:	1989
Date & Time (UTC):	16 December 1990 at 1350 hrs
Location:	Near Hougham, Nottinghamshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Right wing damaged, right main landing gear detached, fuselage and propeller damaged.
Commander's Licence:	Private Pilot's Licence with Instructor rating
Commander's Age:	41 years
Commander's Flying Experience:	569 hours (of which 3 were on type)
Information Source:	Aircraft Accident Report Form submitted by the pilot

The Denney Kitfox aircraft is marketed as a comprehensive kit of parts to be assembled and finished by the purchaser. It is of conventional, high-wing, strutted monoplane appearance and features side-by-side accomodation for two people. Roll control is achieved by full-span "flapperons" which are mounted behind and below the wing trailing edges on aft extensions of five plywood wing ribs. The design features rearward-folding wings which pivot around the rear spar and thus the flapperon control linkages contrive to position the surfaces fully up (90°) as the wings reach the stowed position. In this condition they rest very close to the fin of the aircraft. After rigging the wings for flying, it is necessary to instal a thin metal and plastic rear window using "camloc" fasteners. This window, (also referred to as the "turtle-deck") incorporates plastic blocks which form the upper half of the two piece flapperon torque-tube bearings (see picture).

G-BPKK was completed by its constructor in 1989 and sold to its current owners without a Permit o Fly and without having flown. It was then intended to deliver the machine to the U.K. main agents for Denney Aerocraft for completion of the Permit process. Unfortunately, whilst being towed on a trailer with the wings folded, it was involved in a road accident which resulted in substantial damage to the rear fuselage. The agent therefore undertook repair of the damage in addition to the scheduled work

which included mass-balancing of the flapperons - a Popular Flying Association Permit requirement. This work took approximately a year to complete before the Permit to Fly was issued.

The method of mass-balancing used was not that currently employed by Denney Aerocraft, which used a weight on a horn mounted externally on the flapperons. Instead, an alternative was locally devised which used metal rods inserted internally along the leading edges to achieve the same effect. This deviation was approved by the PFA.

The aircraft flew for approximately three hours following issue of the Pemit to Fly although many of these flights were reportedly curtailed due to engine overheating problems. Rectification of these problems seems to have been successful, however, and no engine-related defects were reported to have been present during the accident flight.

On the accident flight, the pilot reports that he was in level flight at 2000 feet at an airspeed of 85 mph and in a shallow turn to port when there was a sudden bang followed by severe control judder. The pilot closed the throttle and raised the nose of the aircraft to achieve 50 mph at which point the juddering stopped. The passenger reported that the middle three of the five starboard flapperon mountings had failed. In order to increase rate of descent and to reduce vibration, the pilot shut down the engine and selected a field straight ahead for a forced landing. Although the touch-down was normal the aircraft ran into a hedge/fence causing substantial damage to the wings, starboard undercarriage and propeller. It was also noted that two of the port wing flapperon attachments had failed leaving only the outer, inner and centre ribs intact, although there was no confirmation available that this had occurred in flight.

Following an inspection by the PFA, AAIB requested that the aircraft be brought to Farnborough for detailed examination and this was carried out in conjunction with the aircraft's designer and an expert in the field of structural wood. It was felt necessary to try to determine whether the attachment failures were the result of pre-existing damage possibly caused by the road accident or whether it was due to an aerodynamic effect such as flutter. In the event it proved impossible to state categorically whether either or both these factors precipitated failure but the following points were noted:-

1) Several areas of poor construction were evident, potentially the most significant concerning the flapperon torque tube bearings described above. The design itself did not appear conducive to positive location of the torque tube but it had been particularly poorly rendered in this case. There were clearly visible gaps between the tube and the plastic bearing halves with the turtle-deck installed and clear signs of much rough trimming of both the metal and plastic resulting in mis-shapen and oversized profiles (see photograph). Excessive play in control runs can be a

contributory factor to aero-elastic effects such as flutter. Although not relevant to the accident, it was noted that there was also considerable free play in the elevator hinges as if undersize hinge-pins had been used or possibly liners were missing.

2) The altimeter, vertical speed indicator (VSI) and airspeed indicator still had blanking plugs fitted in their static ports and had apparently completed all its approximately 8 hours total flying time (including 5 hours test-flying for the Permit to Fly) in this condition. The pilot said that the altimeter had appeared somewhat sluggish and that the VSI was more steady than he would have expected which would appear to indicate that there was some leakage past the plugs. Although complete sealing of the airspeed indicator static port could lead to significant errors in the indication with changes in altitude the pilot was of the opinion that this had not been the case because tests such as stalling speeds had correlated with the designers published figures. In any event, he reasoned that the power settings used at the time the flapperon supports broke were consistent with normal cruising speed in level flight. It was not possible to test the sealing qualities of the plugs.

3) Microscopic examination of the fracture surfaces of the wooden ribs suggested that there was evidence of pre-existing compressive damage to the wooden fibres even in those areas of final tensile failure. It was considered that this may have been caused by the road accident but it was also acknowledged that severe vibratory stresses could have caused the observed damage. In any event it was emphasised that compressive damage to wooden structures may be invisible to the naked eye despite having the potential to reduce the toughness or impact resistance by up to 50%.

4) The designer and manufacturer of the kits is aware of only two cases worldwide of Kitfox flapperon support failure in-flight. Both of these were reported to be associated with manoeuvering at or above Vne, which on this model of Kitfox is 100 mph.

Arising from this investigation, the following recommendations have been made to the Civil Aviation Authority:

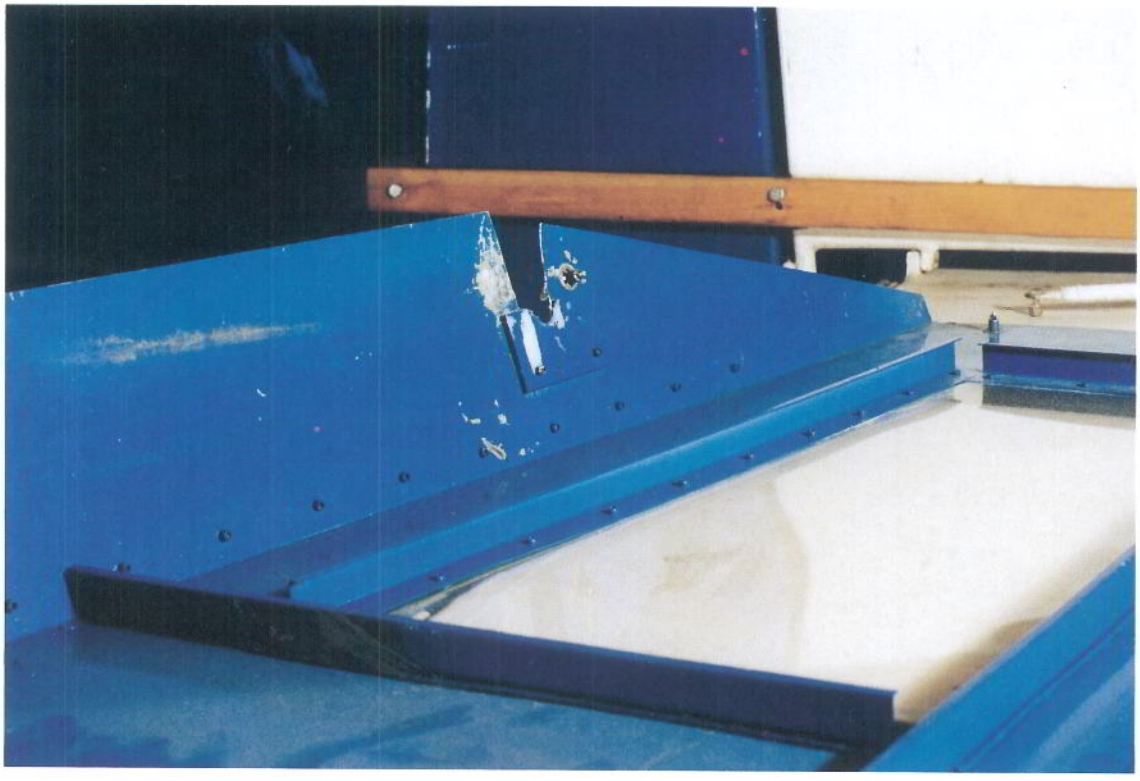
1) The procedures employed to issue G-BPKK with a Permit to Fly should be investigated.

2) Mass-balancing of the flapperons should be achieved only by using the Denney Aerocraft method of an external horn balance or other system devised by Denney Aerocraft. Aircraft which have been constructed using the PFA-approved alternative scheme should have their balance checked on a rig to ensure they meet the requirements.

3) Attempts should be made to quantify the forces acting on the flapperon supports to confirm that there is an adequate strength margin, particularly with the additional weight of the mass-balancing installed.

4) The design of the flapperon torque tube bearing should be reappraised with a view to requiring modification to a separate bearing assembly independent of the rear window installation.

5) Owners of aircraft constructed of wooden materials should be reminded of the potential loss of strength of components subjected to abnormal loading following ground or airborne incidents. It should be emphasised that latent damage may be invisible to the naked eye.



G-BPKK rear window assembly incorporating flapperon torque tube bearing half with evidence of rough trimming and mis-shapen profile