

AAIB Bulletin No: 1/94

Ref: EW/G93/09/13

Category: 1.3

Aircraft Type and Registration: Denney Kitfox Mk 3, G-BUDR

No & Type of Engines: 1 Rotax 582 piston engine

Year of Manufacture: 1992

Date & Time (UTC): 24 September 1993 at 1700 hrs

Location: Westcott Airstrip, Devon

Type of Flight: Private

Persons on Board: Crew - 1 Passengers - None

Injuries: Crew - None Passengers - N/A

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

Commander's Licence: Private Pilot's Licence

Commander's Age: 39 years

Commander's Flying Experience: 181 hours (of which 44 were on type)
Last 90 days - 13 hours
Last 28 days - 7 hours

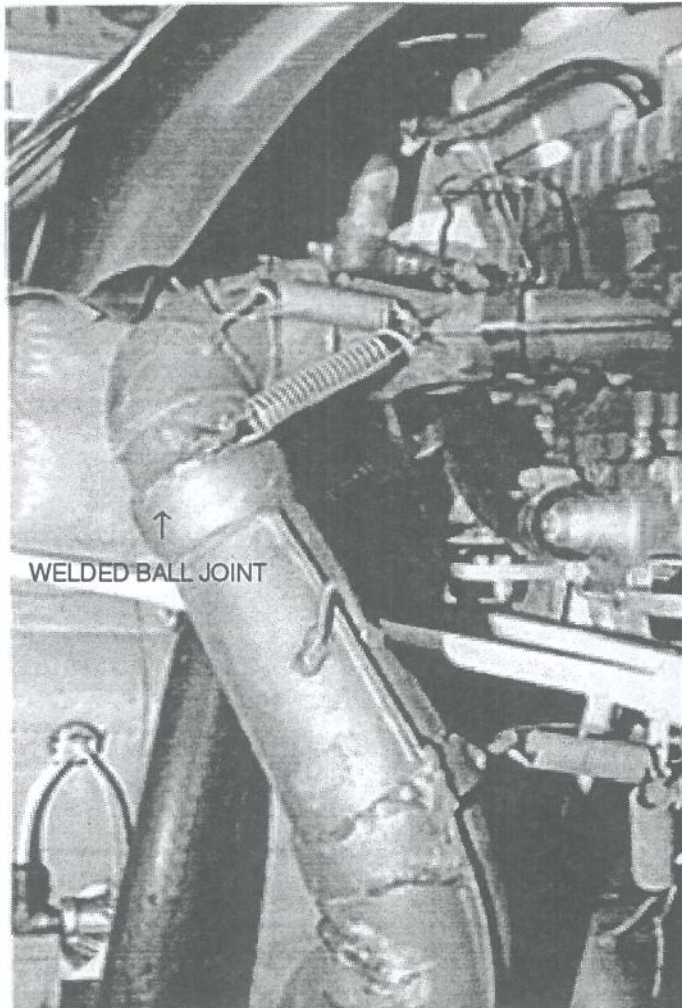
Information Source: Aircraft Accident Report Form submitted by the pilot and enquiries by the AAIB

After a normal take off the pilot became aware of fumes in the cockpit and, as the aircraft had a history of carbon monoxide (CO) leaking into the cockpit, he decided to land ahead. During the course of the landing the aircraft sustained damage due to obstructions in its path.

The pilot and others who had flown in the aircraft had experienced severe headaches attributed to CO poisoning from exhaust fumes finding their way into the cockpit. Various changes had been made to the exhaust system to prevent leaks; these included, in chronological order:

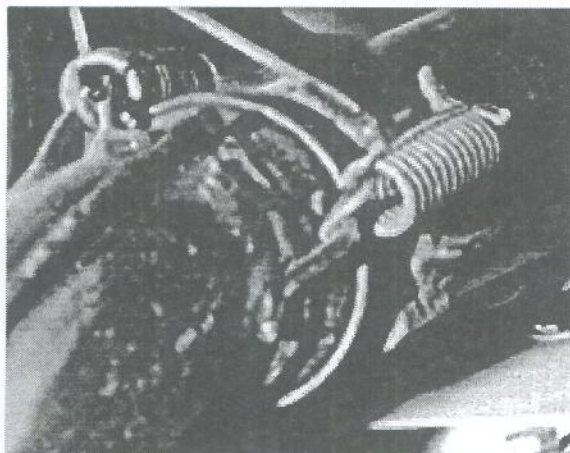
Exhaust System Ball Joints

The original design of the exhaust pipe between the manifold and the exhaust box included one ball joint to reduce the transmission of movement and vibration to the exhaust system. The single ball joint allowed simple installation, but it was found that the exhaust system life was too low due to vibration. Consequently a double ball jointed system was introduced to improve exhaust component lives.



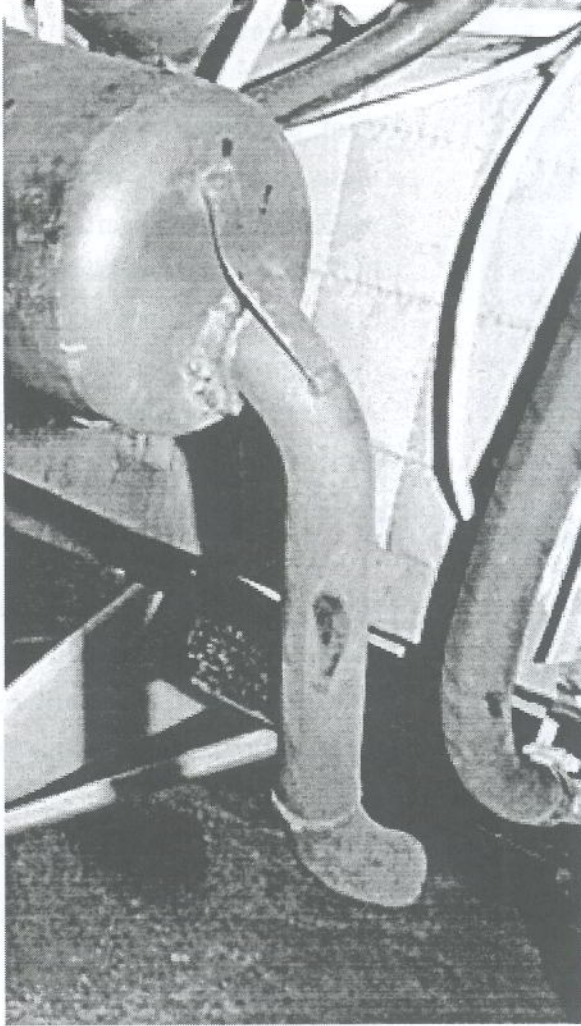
On 'DR' the ball joints were originally located by two diametrically opposed springs located at positions around the joint, and experience showed that these springs were unable to stop the joint vibrating apart. The lower ball joint was therefore welded, effectively returning the exhaust to the original state of one ball joint, and the springs on the remaining joint were doubled up to provide more positive location.

A Rotax Service Information publication requires that all ball joints should be lubricated regularly with heat resistant grease, however the remaining ball joint on 'DR' was dry when inspected by the AAIB.



The UK engine distributor strongly recommends the use of three springs to retain each ball joint and stated that engine kits supplied to the aircraft manufacturers had three springs per exhaust joint, but that the suspension hooks are supplied loose, not welded onto the pipes, allowing individual aircraft types to specify different hook locations.

Extension to exhaust pipe

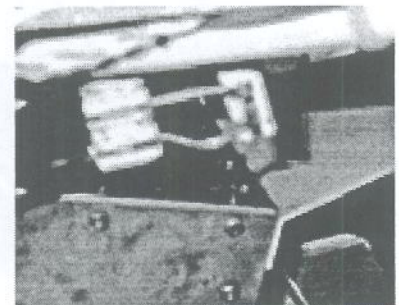


Faced with continued fumes in the cockpit the owner consulted the PFA who liaised with the distributor. The problem was ascribed to too short an exhaust pipe allowing fumes to enter the cockpit through gaps in the cabin door.

The solution agreed upon by all three parties was to extend the exhaust pipe with a welded-on pipe. This change was embodied, but the pipe was found to vibrate excessively, possibly exacerbated by the effects of the welded lower ball joint. For this reason the extended tail pipe was subsequently shortened by 3 to 4 inches.

A further problem then appeared when the outlet face of the exhaust box failed just above the weld locating the outlet pipe, this was repaired by welding with the addition of a bracket to stiffen the joint.

After the accident a kink in the oil control cable at the throttle bellcrank between the nipple and the outer sleeve was discovered, it was not determined whether the kink was caused by the oil valve sticking, or whether the kink caused the oil valve to remain in the open position. However this may have made the fumes entering the cockpit more noticeable.



After the accident the exhaust system on 'DR' was pressure checked by a PFA Inspector, who found it to be free from leaks.

The following table describes the effect of various concentrations of CO in parts per million. It does not take account of the effects of incapacitation whilst airborne.

Concentration	Symptoms
100	No poisoning symptoms even for long periods of time, allowable for several hours.
200	Headache after 2 to 3 hours, collapse after 4 to 5 hours.
300	Headache after 1.5 hours, distinct poisoning after 2 to 3 hours, collapse after 3 hours.
400	Distinct poisoning, frontal headache and nausea after 1 to 2 hours, collapse after 2 hours, death after 3 to 4 hours.
500	Hallucinations felt after 30 to 120 minutes.
800	Collapse after 1 hour, death after 2 hours.
1000	Difficulty in ambulation, death after 2 hours.
1500	Death after 1 hour.
2000	Death after 45 minutes.
3000	Death after 30 minutes.
8000 or above	Immediate death by suffocation.
12800	Unconsciousness after 2 or 3 breaths, death in 1 to 3 minutes.

(Flammability Handbook for Plastics by K.J. Hilado, Technomic Publishing Co. Inc. Westport, Conn. 06881)

PFA Advice

The PFA has issued two letters to Kitfox owners, advising them of, amongst other things, problems associated with carbon monoxide. The relevant extracts are reproduced below:

'Carbon Monoxide Indicators (issued 5 August 1992)

It seems that some Kitfoxes suffer from exhaust gases entering the cockpit if the aircraft is not flown accurately in balance. Since the Kitfox requires careful footwork to keep the ball centred, owners should be wary of the potential dangers of carbon monoxide poisoning, particularly whilst they are initially getting used to the aircraft and may not be flying accurately. All Kitfoxes should be fitted with a turn and slip indicator/skid ball and a carbon monoxide 'dead stop' type detector.'

A CO indicator fitted in the cockpit of DR had turned black by the time the ball joint had been welded. It was removed and had not been replaced in time for the accident flight.

'Carbon Monoxide Problems (issued 10 August 1993)

We have received a report of one newly completed Kitfox which suffered from very bad exhaust fume entry into the cockpit, to the extent that the pilot was badly affected by CO poisoning. At the time there was no indication that CO had reached an unacceptable concentration. The first signs observed were smarting eyes after approximately 30 minutes in the air. A very bad headache followed.

CO poisoning is particularly dangerous because:

- a) It can take place slowly without your being aware that it is happening to you, leading to loss of consciousness.
- b) The effects are cumulative, i.e. it can build up in the bloodstream over many flights over a number of months. It takes a long time for the body to recover.

We have recommended in our previous letter to Kitfox owners that CO indicators should be fitted in the cockpits of all Kitfoxes and steps taken to correct any ingress of exhaust smoke. We now consider this to be essential.

On some aircraft it has been found that exhaust smoke enters through the main undercarriage bungee holes in the fuselage bottom or curls back through gaps around the removable turtle-deck or the cabin doors. Addition of domestic brush type seals around the undercarriage bungee openings has been found to be helpful in some cases, other members have solved the problem by fitting a short exhaust pipe extension (about 4 ") to discharge further away from the fuselage. The more recent kits with the side mounting engine mount have been fitted with a longer exhaust stub as standard.'