No: 12/92 **Ref: EW/G92/10/06** **Category: 1c**

Aircraft Type and Registration:	CASA 1-131E Series 2000 Jungmann, G-BECT
No & Type of Engines:	1 Enma Tigre G-IV-A5 piston engine
Year of Manufacture:	1957
Date & Time (UTC):	17 October 1992 at 1615 hrs
Location:	Shoreham, West Sussex
Type of Flight:	Test flight
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Substantial damage to the landing gear and both lower wings, lesser damage to propellor, cowlings and fuselage underside. Numerous fabric tears.
Commander's Licence:	Private Pilot's Licence
Commander's Age:	47 years
Commander's Flying Experience:	730 hours (of which 150 were on type) Last 90 days - 10 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot, engine strip examination in presence of AAIB, further laboratory examination organised by AAIB

The pilot reported that he was carrying out a Permit to Fly renewal test flight. After take-off, the aircraft climbed to a height of approximately 1,500 feet when the engine began to run very roughly before stopping completely. The pilot therefore selected a suitable field for a forced-landing. He stated that he believed the air speed indicator to be malfunctioning and consequently had difficulty in establishing his airspeed. At the end of the field was what he thought at first to be a footpath and some light shrubbery. It turned out, however, to be a recessed farm track, with a six foot bank on the far side; this was struck by the aircraft.

A strip-examination of the engine revealed extensive damage to components in the No 2 cylinder. In particular the piston crown was holed and its surface effecively destroyed by a large number of contacts with metalic debris, whilst the piston skirt was also in a largely disintegrated state. It was also found that the head of the sodium-filled exhaust valve had separated from the stem.

Examination of the piston and cylinder confirmed that the the engine had turned a number of times with the broken valve head trapped between the piston crown and the cylinder-head. Impacts on the separated valve head were responsible for both crushing it and destroying its fracture face. It was

noted, however, that the corresponding fracture face on the valve-stem exhibited a relatively undamaged surface which had evidence of brittle failure in an otherwise ductile material.

Laboratory examination confirmed this to be a fast fatigue fracture and that the failure had occured at a temperature below 300°C. Cracking of the valve head, resulting from the crushing between the piston and the cylinder-head after the failure, had also taken place below this temperature. Examination of an exhaust valve from an undamaged cylinder revealed temper colours on the stem which showed that temperatures of the order of 400°C were present at the head to stem junction during normal operation. Further examination of the stem of the damaged valve revealed evidence that at least partial seizure had occured between the valve stem and its guide as a result of corrosion products becoming trapped between the stem and the guide and/or lack of lubrication.

Seizure of the valve in the fully open position is just capable of allowing contact between the valve and the piston as the latter nears the end of its stroke. This imposes an axial compressive loading on the valve stem. Any off-set of this load from the valve axis will produce bending loads in the stem, repeated loading of this sort leading to a possible fatigue crack propagation across the section.

The laboratory analysis of the fracture face indicated that the number of fatigue cycles corresponds to a a small number of minutes operation, in the normal engine RPM range, with the piston striking the valve head. It thus appears that the engine ran for a short period with the valve stuck, either during this flight or during previous ground or flight operation and that the valve became stuck once again shortly before the head separated from the stem. Examination of other components from the engine revealed that considerable internal corrosion was present.

The owner of the aircraft reported that the engine was fitted around 1978 (at which time it was either new or just overhauled) and had completed some 320 hours operation up to 14 November 1991. The aircraft was then stored and the engine did not run until 8 October 1992, on which date the aircraft flew for 15 minutes. It was flown again for 25 minutes on 16 October 1992. The accident occured on the first flight of the following day. The owner stated that he experienced considerable difficulty in starting the engine after the storage period, and that during ground operation between then and the accident flight he encountered a brief period of power loss which he likened to an ignition problem. The engine then apparently reverted to normal operation.

Airworthiness of this aircraft is administered on behalf of the Civil Aviation Authority by the Popular Flying Association and it is understood that the Tigre engine type is no longer the subject of active product support from the manufacturer.