INCIDENT

Aircraft Type and Registration:	DHC-1 Chipmunk 22A, G-AORW
No & Type of Engines:	1 De Havilland Gipsy Major 10 Mk 2 piston engine
Year of Manufacture:	1950
Date & Time (UTC):	25 February 2006 at 1340 hrs
Location:	Prestwick Beach, Ayrshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Engine crankshaft failure
Commander's Licence:	Private Pilot's Licence
Commander's Age:	46 years
Commander's Flying Experience:	775 hours (of which 103 were on type) Last 90 days - 5 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft was returning to Prestwick from the northwest when, without warning, the engine stopped. It was approximately 0.5 miles offshore with insufficient height to glide to the runway and, with a built up area immediately ahead, the pilot elected to carry out a forced landing on Prestwick Beach. Later examination revealed that the engine had suffered a failure of the crankshaft and that, possibly, this had been influenced by the aircraft's previous use for aerobatics and in air racing.

History of the flight

The aircraft had departed Prestwick earlier in the day for a flight to the island of Islay with two on-board; the passenger was also an experienced Chipmunk pilot. The aircraft returned to Prestwick from the northwest with the intention of joining base leg for Runway 03. During the completion of the pre-landing checks, all engine temperatures and pressures were observed to be normal, but a slight vibration was felt through the airframe. Approximately 15 seconds later, without warning, the engine stopped. The aircraft was too low to glide to the runway, and the presence of buildings precluded a landing 'straight ahead', so the pilot carried out an forced landing on an unoccupied section of Prestwick Beach. The aircraft was later recovered to a hangar on the airfield where it was determined that the engine's crankshaft had failed close to the No 2 piston location. The engine was removed and transported to a repair agency where it was stripped in the presence of the AAIB.

Gipsy Major 10 Mk 2 history

In the late 1950's, Bristol Siddeley Engines Ltd, the Type Certificate holder at that time, carried out a series of tests to determine the cause of numerous crankshaft failures on civil and military registered Chipmunks. The test reports indicated that engines subjected to *'comparatively short periods of abnormal operation'* (eg, aerobatic manoeuvres) were susceptible to cracking and failure in the region of the No 2 or No 3 crankpin webs. The average crankshaft life at failure was 850 hours. Three modifications (Mods) were introduced to minimise the possibility of further failures:

- Mod 2602 introduced a crankshaft of different material and surface hardened.
- Mod.2661 retarded the ignition timing of engines fitted with the original crankshaft.
- Mod 2675 introduced a slow running cut off valve to prevent backfiring during shutdown.

All three modifications were embodied on civilian engines passing through Bristol Siddeley's facilities from 1960 but only Mod 2675 was embodied on military engines, until late 1967, when the remaining two modifications began to be embodied.

During the 1960's and 1970's large numbers of Chipmunks entered civilian hands as military operators disposed of their aircraft. The modification embodiment policy for military engines meant that a large number of engines probably entered civilian operation without Mods 2602 and 2661 incorporated. As military operation of the type decreased, spares provisioning was scaled down and production of new crankshafts for this engine ceased in the early 1970's. Replacements can now only be obtained from spares holdings or recovered from dismantled engines. Present day maintenance organisations involved with the engine type have confirmed that crankshafts introduced by Mod 2602 are particularly scarce.

There are currently 125 Gipsy powered Chipmunks on the UK register and, based on information provided by overhaul agencies, it is estimated that approximately 50% of these may have pre-Mod 2602 crankshafts installed. The Type Certificate holder for this model of engine are aware of two similar failures in the last ten years.

Engine examination

The crankshaft had failed immediately aft of the second main-bearing journal. An initial assessment indicated that the failure initiated in the radius between the second main journal and the forward web of the No 2 crank throw. Oil was present on all of the bearing surfaces, the oil passageways were free from obstruction and the crankshaft journals showed no evidence of overheating. Mechanical damage to No 2 and No 3 bearings prevented any assessment of their pre-failure condition; however, the condition of the remaining bearings indicated that that they had been serviceable prior to the failure. Dimensional checks of the crankshaft journals confirmed that the crankshaft had not been re-ground since manufacture. Damage to the accessories drive gear train prevented the ignition timing from being checked but records confirmed that the timing had been retarded in accordance with Mod 2661. Due the scarcity of new spares, crankshafts are usually re-worked rather than replaced, and it is standard practice for engine overhaul organisations to retard the ignition timing, in accordance with Mod 2661, whenever a pre-Mod. 2602 crankshaft is installed. The part number of the crankshaft from G-AORW confirmed that it was of the type superseded by Mod 2602.

The current overhaul life of a Gipsy Major engine is 1,500 hours, with aircraft utilisation typically between 40 and 100 hours per year. This can, as in this case, result in a calendar time between overhauls of over 20 years. A review of the engine log book showed that it had been installed in May 1984 and that the engine had operated for approximately 1,000 hours prior to the failure. The total life of the crankshaft at the time of installation was not determined

Laboratory analysis revealed that the crankshaft failure resulted from crack progression by a high cycle fatigue process. However, the initiation site could not be identified due to smearing of the fracture surface as the failure occurred. Microsections taken from the crankshaft showed that there were no material abnormalities or corrosion present, and also that the crankshaft had not been subject to surface hardening.

The current aircraft owners reported that, prior to its purchase, the aircraft been used for performing aerobatics manoeuvres and had taken part in 'air races'. Due to a combination of airframe g loading, high power demands and gyroscopic forces from the propeller disc, such flights dramatically increase the bending loads experienced by the crankshaft.

Conclusions

Despite the calendar time since the engine last overhauled, there was no evidence, particularly the absence of any corrosion associated with the fracture, to suggest that this extended period contributed to the crankshaft failure. However, the results of the tests carried out in the late 1950's indicated that pre-Mod 2602 crankshafts, of the standard fitted to G-AORW, were susceptible to cracking, and subsequent failure, when subject to *'comparatively short periods of abnormal operation'*. Although the operational history of the crankshaft fitted to G-AORW could not be fully established, it is possible that the aircraft's earlier operation in air races and use for aerobatics contributed to the failure.