Piper PA-38-112, G-BOYT, 27 May 1996

AAIB Bulletin No: 8/96 Ref: EW/G96/05/20 Category: 1.3

Aircraft Type and Registration: Piper PA-38-112, G-BOYT

No & Type of Engines: 1 Lycoming O-235-L2C piston engine

Year of Manufacture: 1981

Date & Time (UTC): 27 May 1996 at 1100 hrs

Location: Bangor University Farm Land, Abergyngregyn,

North Wales

Type of Flight: Private

Persons on Board: Crew - 1 Passengers - 1

Injuries: Crew - None Passengers - None

Nature of Damage: Damage to left wing, propeller and noselanding gear

Commander's Licence: Private Pilot's Licence with IMC andNight Ratings

Commander's Age: 42 years

Commander's Flying Experience: 210 hours (of which 136were on type)

Last 90 days -6 hours

Last 28 days -6 hours

Information Source: Aircraft Accident Report Form submittedby the pilot and examination of the aircraft's engine by AAIBand Lycoming

During a flight from Liverpool to Caernarfon at 2,000 feet, whenat a point approximately 5 nm east of Bangor, the pilot heardan unusual noise from the engine. Within a few seconds, thisnoise and an attendant vibration had increased in intensity tosuch an extent that the pilot could no longer read the instruments,and so he decided to shut the engine down. Faced with few optionsfor a suitable place to conduct a forced landing, he landed ina field approximately 300 yards in length but, despite the applicationof brakes, failed to stop before striking a dry stone wall ata speed of approximately 20 mph. The occupants, who sufferedminor injuries, evacuated the aircraft unaided, whereupon it becameapparent to them that the field was waterlogged.

After recovery, the engine was partially stripped by a maintenanceengineer. It was apparent that the No 3 big end bearing had failed,releasing the connecting rod from the crankshaft, and that theNo 4 bearing showed signs of having been extremely hot. The enginewas then transported to the AAIB at Farnborough where a completestrip examination was carried out. It was established that alldamage within the engine had occurred due to a lack of lubrication,despite sufficient oil reportedly being present in the sump immediatelyafter the accident. A strip examination of the oil pump, however,revealed a pre-accident failure.

Oil is supplied under pressure to the rotating elements withinthe engine from a gear pump at its rear, driven directly by thecrankshaft. The pump has two gears, a 'driven' gear and an idlergear, within a close tolerance housing. As the gears mesh whenrotating, their action draws oil from the sump by entrapment betweenthe cavities formed between the gear teeth and the housing, andpass it on to the oil gallery under pressure. The strip examinationrevealed that the driven gear had suffered a single transversefailure between two teeth and was jammed in the housing by a sectionof the idler gear, which had broken into several sections. Detailedmetallurgical examination revealed the following:-

the transverse failure on the driven gear had resulted froma tension fatigue mechanism, initiation having occurred alongthe root of one tooth. All other failures had occurred due tooverload.

both gears were made from iron and had been manufactured bya sintering process.

all thrust faces on both gear teeth were pitted and heavilyworn, to such an extent that the meshing teeth could 'hook' togetherand induce high tensile stresses at the root of each tooth.

This type of oil pump failure involving sintered iron gears hasbeen a known problem affecting a wide range of Lycoming four andsix cylinder engines since 1970. Early problems with excessivewear led to Service Bulletins 381 and 385, which changed the Woodruffkey drive to a 'flat' shaft drive for the driven gear, but whichretained sintered iron gears. This was mandated by FAA AirworthinessDirective (AD) 75-08-09 which, as with all FAA AD's, applied toUK registered aircraft and this was the standard of oil pump onthe subject Lycoming O-235 engine. Further problems involvingsintered iron gears led to FAA AD 81-18-04, which essentiallyformalised manufacturer's Service Bulletin 456 (1981), which itselfwas revised in 1993 to SB 456F, the intention being to removesintered iron gears from all specified engines and replace themwith steel components. FAA AD 81-18-04 called for compliancewith SB 456 (or an FAA approved revision or alternate), at "2000engine hours since new or last overhaul, whichever is later, orwhenever the accessory section is removed". In September1995, mandatory Service Bulletin 524 was issued by the manufacturerand superseded a range of SBs, including SB 456F, relating tothe replacement of sintered iron impeller-gears. Compliance timewas stated as "within 25 hours of operation for engines whichhave sintered iron impellers (gears) and have not complied withany revisions to SB's 454, 455 or 456". This Bulletin statesthat sintered iron gears can be identified by a porous surfacefinish on the gear faces, but this was not readily apparent onthe subject gears as both appeared to have a machined finish onthese faces. G-BOYT was imported from the USA in July 1988, withthe subject engine installed. Just prior to export, the enginehad been overhauled after reaching 2032 hours total time, itsAmerican log book recording the fact that all FAA AD's up to 88-14had been checked and that ,amongst many other new parts, new oilpump gears had been installed No reference was found to gearpart numbers and it appeared that the overhaul had been carriedout by a licensed mechanic, rather than by the manufacturer orspecialist overhaul organisation. At the time of the accident,the engine had accumulated some 2385 additional hours.

Examinationof the UK log book for this engine showed that the only referenceto the oil pump was that AD 81-18-04 had been complied with onoverhaul, this entry being dated 11 October 1988.