Pierre Robin R1180TD, G-CRAN, 15 June 1996

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Aircraft Type and Registration:	Pierre Robin R1180TD, G-CRAN
No & Type of Engines:	1 Lycoming O-360-A3A piston engine
Year of Manufacture:	1980
Date & Time (UTC):	15 June 1996 at 0955 hrs
Location:	Staden Industrial Estate, Buxton, Derbyshire
Type of Flight:	Private
Persons on Board:	Crew - 1 - Passengers - 3
Injuries:	Crew - 1 (Fatal) - Passengers - 3 (Fatal)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	45 years
Commander's Flying Experience:	865 hours (of which 4 hours were on type)
	Last 90 days - 34 hours
	Last 28 days - 4 hours
Information Source:	AAIB Field Investigation

The day of the accident was the eleventh birthday of one of thepilot's daughters and as a birthday treat he organised to takeher, together with her twelve-year-old sister and an eleven year-oldgirl friend on a flight around the local area. The Robin aircraftwas booked for 0900 hrs, but when the party arrived at TatenhillAirfield they found that it was airborne for a short familiarisationflight for another pilot, this lasted approximately 15 minutes.

By observation of photographs taken by the girls during the flightand some correlation with radar track evidence, it has been possibleto reconstruct the route flown by the aircraft. The pilot andhis passengers took-off from Tatenhill at approximately 0930 hrsand flew first to Alton Towers Adventure Playground, 12 nm tothe north. The aircraft flew past Alton Towers on the westernside at a height above the ground of approximately 500 to 1,000feet and turned north-east. It then flew 16 nm on that tracktowards Riber Castle where it turned and flew past Matlock onthe southern side on a westerly track, keeping to the same approximateheight throughout. From Matlock it flew 8 nm to the ancient stonecircle at Arbor Low, around which it made a right-hand orbit beforesetting off north-westerly to the village of King Sterndale inDerbyshire, six miles away.

After completing an orbit to the right around King Sterndale,the aircraft then made another orbit around the village of Cowdalewhich is 1 nm further to the north-west. The aircraft was observedcompleting this second orbit at a somewhat lower height and thencontinuing north-west towards Buxton where the pilot and his familylived. It then flew over Slade Hill Farm at a very low height,of the order of two hundred feet or less. Slade Hill Farm waswell known to the pilot and his daughters and a young friend ofthe girls waved to them as the aircraft flew past, dipping a wingtowards him as it did so.

Slade Hill Farm is situated on the 350 metre contour line of aridge running north to south, one mile to the south-east of Buxton.Beyond the farm to the north-west, the ground falls away in avalley which at its lowest point is at a height of approximately290 metres above sea level before the ground begins to rise againtowards Buxton. A line of trees marks the road which leads tothe farm and the aircraft was seen to pass low over these beforedescending into the valley. Two eyewitnesses in particular, onein the garden of his house further along the lane from Slade HillFarm, and another whose garden looks out across the valley fromthe west, were able to provide a clear picture of the flight ofthe aircraft from the time that it left Cowdale until its conclusion.

At about the time the aircraft entered the valley, its enginewas heard to misfire and lose power and the aircraft was seento turn to the left through 180º onto a heading of approximately150ºM to line up with a service road on an industrial estate.As the aircraft descended towards this service road, and havingreached a height of considerably less than 100 feet, the enginewas heard to pick up and fire normally once again.

With power restored, the aircraft was then seen to climb steeplyaway. However, before it had reached sufficient height to clearthe ridge the engine was heard to cut out once again and the aircraftentered a tight descending spiral to the left before crashingonto an area of waste ground in the industrial estate. The pilotand his passengers were killed instantly when the aircraft hitthe ground. There was no fire and the rescue services arrivedat the scene shortly afterwards.

Examination of the Wreckage

The aircraft examination commenced in the afternoon followingthe accident. It lay in Staden Industrial Estate which compriseda number of widely spaced industrial units situated on otherwisefairly rough, unprepared ground. The aircraft had not struck anybuildings, being about 20 metres from one of the installations.It was quite evident that it had struck the ground in a steep(approximately 60°) nose-down attitude with a moderatelyhigh rate of descent but with little forward speed, consistentwith a stalled condition. It was also apparent that it was rotatingto the left at impact. There were no signs of fire but the impactwas non-survivable.

Detailed examination did not reveal any signs of pre-impact structuralfailure nor any anomalies with the flying controls. The conditionof the propeller suggested that the engine was delivering lowto moderate power at impact and this was reinforced by the tachometer,which was found with the needle jammed at 1,600 RPM. Althoughthe disruption to the airframe precluded rapid estimation of theflap position, subsequent inspection of the actuator after theaircraft had been recovered to the AAIB hangar at Farnborough,showed conclusively that the flaps had been close to the fullyextended stop.

On the Aiglon and many other low-winged light aircraft, the fueltanks are in the wings and therefore lower than the carburettorsuch that, in the absence of any other pump, the mechanical diaphragmfuel pump has to suck fuel under negative pressure from the tanks.The Aiglon also, as is commonplace, has an electric boost pumpwhich, when switched on, supplies fuel under positive pressureto the mechanical pump. The Flight Manual only requires operationof the electric pump during take off and landing, as the mechanicalpump is quite capable of supplying the required amount of fuelon its own and the former becomes a 'back-up' at critical phasesof flight. It was not possible to tell if the electric pump onG-CRAN had been selected on prior to impact, although it did functionduring testing after the accident despite being damaged.

A strip of the engine was undertaken in the AAIB hangar with arepresentative of Textron Lycoming present. The engine itselfwas an overhauled unit fitted to G-CRAN in March 1995 when theaircraft had been acquired by its present owner. The overhaulhad been carried out by Lycoming themselves in the USA and theengine had run some 120 hours since then. The strip inspectionrevealed no abnormalities and the engine condition was consistentwith such a recently overhauled unit, although an anomaly wasnoted in the fuel supply system.

The anomaly concerned the flexible hoses connecting the electricboost pump to the mechanical pump and the mechanical pump to thecarburettor. During strip of the mechanical pump (with which nodefects were found) it was noticed that the pump-carburettor hoseunion (outlet) was lacking the 'O' ring and washer whichare intended to be part of such a union (see photograph). In theirplace the joint had been made with a sticky green sealant whichis not specified in any technical reference. The mechanical pumpto electrical boost pump (inlet) union possessed both a washerand 'O' ring. Moreover, both fittings were of a type which werenot advocated by Lycoming for use in connections to the mechanicalpump.

Lycoming do not supply these fittings either on new or overhauledengines as it is the responsibility of the airframe manufacturerto specify and supply them. However, a Lycoming Service Bulletin(SB) No 374 entitled 'Fuel Pump Inlet Inspection' dated 15 March1974 was cited as relevant. This SB commences with the followingjustification for issue:-

"Loss of fuel pressure may be due to leakage at the inletport of the diaphragm fuel pump. Leakage at this location maybe caused by ageing of the 'O' ring seal or improper installationof the adapter fitting that connects the fuel line to the pump".

The SB essentially continues with an inspection procedure followedby installation of a new 'O' ring seal *"anytime fuel pressurefluctuates or deteriorates with increase in altitude".*

A further note appears on the SB diagram which shows a typical37° angle 9/16 in x 18 UNF fitting which has one plain endand one tapered end. The note refers to the tapered end and states:-

Note. This end of fitting is designed to attach flared tubefitting. Do not install this end in fuel pump

Both ends of both fittings from G-CRAN were tapered. As alreadynoted, the outlet fitting lacked both the 'O' ring and washerbut, even though present on the inlet, the 'O' ring appeared badlydeformed and scored, an appearance not consistent with it havingbeen renewed when the engine was installed about 15 months before(see Photograph). It was decided to test the integrity of sealingof the inlet connection using the original parts but the outletfitting had been broken during impact and had to be substitutedfor a similar component, omitting the washer, the 'O' ring andthe sealant. To do this it was necessary to re-assemble the fittingsin the knowledge that it would be impossible to re-create withconfidence the exact state of the seals as it existed prior tothe accident. A vacuum rig was used to apply negative pressureroughly equivalent to that expected across the inlet fitting assumingno boost pump was running. It was found that the assembly failedto hold the vacuum, but only indicated a small leak. In orderto see where this leak originated, both unions were sprayed withred penetrating dye whilst still under vacuum and then disassembled.The dye had penetrated into the pump only through the inlet fitting,showing that this was the source of the leak.

Additional Information

The aircraft technical records were examined and the only entriesconsidered potentially relevant to the power loss were the enginereplacement already mentioned and the replacement of the fuelpressure transmitter the day before the accident, following aforced landing the week before.

The aircraft had its newly overhauled engine fitted in March,1995, at which time the company that fitted the engine also tookover responsibility for maintenance of the aircraft. When questioned,their Chief Engineer said that, to the best of his recall, thenew engine was fitted using new fuel hoses but using the unionsfrom the original installation. He said that, although he hadpersonally not performed much of the work, as the Licensed Engineerresponsible he had done a complete check of the installation includinga particularly thorough leak check of the fuel system before signingfor it. He acknowledged (correctly) that it would be difficultto spot the missing 'O' ring and washer from the outlet of thepump but was at a loss to explain the green sealant applied inits place. He said he had no knowledge of any such material beingused in his workplace. He was not aware of the Lycoming SB 374,although the company had a copy in their technical library.

In addition, he gave details of the events which led to the replacementof the fuel pressure transmitter which took place the day beforethe accident as recorded in the aircraft log book. It transpiredthat, following an engine off landing about a week before, itwas found that the fuel pressure gauge was registering a readingeven though no pumps were running. Diagnosed as a faulty pressuretransmitter, this had no connection with the engine failure, whichwas due to fuel mishandling and the faulty part had merely beenfound as a result of the diagnostic process. It had taken abouta week to obtain a kit of parts which not only included a newtransmitter but also a new gauge and wiring. The transmitter islocated on what is effectively a TEE fitting between the outletside of the mechanical pump and the hose to the carburettor butthere was no requirement to breakdown the fuel union into thepump because the transmitter is designed to be fitted into theTEE without the need to disturb the direct fuel flow path. Again,the Licensed Engineer said that he had checked thoroughly forleaks and the aircraft was test flown for about 1 hour 15 minutesbecause some radio replacement work had been done concurrentlywhich required this. The engine and fuel system were apparentlyperforming faultlessly throughout.

Contact was made with Avions Pierre Robin concerning their drawingspecifications for the subject unions. They confirmed that theyappeared to be correct to their drawing and were also not awareof Lycoming SB 374, which they were, like the maintenance organisation,able to subsequently locate in their technical library. They refutedthat use of tapered fittings was inappropriate and said that suchfittings had been used by them for decades without any known problemssuch as those inferred in the SB.

Conclusions

It has not been possible to positively identify positively thecause of the loss of engine power which was heard by the eye-witnesses.Although the leak at the inlet to the mechanical fuel pump demonstratedin testing appeared not to be of such a magnitude as to have causeda problem in the fuel supply, the pre-accident condition of theinlet fitting could not be accurately reproduced with confidence.Lycoming said that they knew of several cases from their experiencewhere air induction into fuel lines had caused engine problemsand stated that this was the reason for issuing SB 374. However,they were unable to provide any documented cases from their servicerecords. Analysis also suggested that, were this a cause of anengine loss of power, it could become a function of aircraft attitudesince a nose-high attitude would increase the depression on theinlet side of the pump (and hence increase the tendency to drawair) whilst a nose-low attitude would decrease such tendency.In either case, switching-on the boost pump should rapidly clearany such problems.

It would appear that the pilot decided to carry out an emergencylanding when the power loss occurred and had selected the serviceroad on the industrial estate for this purpose, making best useof the local terrain. Unfortunately, a restoration of engine powershortly before his planned touchdown probably persuaded him thatwhatever fault there had been with the engine had cleared itself.It would seem that a further loss of power occurred while he wascarrying out a missed approach from the forced landing when theaircraft had reached a height of the order of 100 feet and wasstill climbing at a steep angle to clear the approaching highground. The aircraft would have had very little margin of speedabove the stall at this stage and this combined with the aircraftconfiguration of landing flap down would cause the aircraft tostall unless immediate corrective action were taken. However,due to the nature of the terrain there were now few or no optionsremaining to the pilot.

Owing to the low height at which the latter stage of the flightwas conducted, little safety margin existed to enable the pilotto select a suitable emergency landing area in the event of anengine failure.