AAIB Bulletin No: 4/2005 **Ref: EW/G2004/07/13** **Category: 1.2**

INCIDENT

Aircraft Type and Registration:	North American P-51D-20, G-BIXL
No & Type of Engines:	1 Packard Merlin V1650-7 piston engine
Year of Manufacture:	1944
Date & Time (UTC):	17 July 2004 at 1908 hrs
Location:	East Garston, Near Hungerford, Berkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Propeller and fuselage belly panels
Commander's Licence:	Private Pilot's Licence
Commander's Age:	63 years
Commander's Flying Experience:	2,000 hours (of which 200 were on type) Last 90 days - 26 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft had just completed some low altitude aerobatics and was climbing away when the engine lost power. Despite switching fuel tanks the pilot was unable to regain power and so he carried out a forced landing in a field.

History of the flight

Having just conducted a flying display at a nearby air show, the pilot was returning the aircraft to its home airstrip, located on a farm at the edge of a village. The weather was fine, with good visibility, little if any cloud and a westerly wind of about 10 to 15 kt. When overhead the airstrip the pilot flew a short series of aerobatic manoeuvres, culminating in a roll to the right. Whilst climbing away in a moderately steep climb, and at an altitude stated by the pilot to be below 1,000 feet agl, the aircraft's engine suddenly lost power.

The pilot estimated that at this point the aircraft had a 20º to 30º degree nose up attitude, a 20º to 30º right bank and a speed of about 200 kt. He maintained the climbing attitude whilst increasing the angle of bank in order to remain in the vicinity of the airstrip. The pilot stated the propeller was windmilling at 2,650 RPM and that he switched the fuel selector from the left tank to the right tank.

Surprised that the engine did not restart, the pilot put the propeller into full coarse pitch and prepared to carry out a forced landing. The aircraft stopped climbing and the pilot was alarmed at the subsequent rate of descent, which made him think he was unlikely to make it back to the airstrip. He also noted that the airspeed had decayed to 135 kt. He therefore decided to abandon his attempt to make the forced landing on the airstrip, and continued in a gentle right-hand turn, with the aircraft at a height of 700 to 800 feet agl over the bottom of a small valley.

The pilot lowered the aircraft's nose significantly in order to recover the airspeed and he banked steeply to avoid a hill and power lines. With the speed increased to 150 kt at about 200 feet agl, the pilot levelled the aircraft and headed north along the left-hand side of the valley. As he did so, he checked again for a response from the engine and saw the manifold pressure fluctuating in the region of 40 inches Hg (mercury). However, despite opening the throttle, the engine RPM failed to increase. At this point the engine emitted a series of "bangs", similar to a car backfiring, described by the pilot as the "over-boost death rattle".

Due to the terrain ahead the pilot then turned left, into wind, passing over the crest of a small hill. He then identified two large fields in which he could land. The airspeed had by that time decayed again to about 120 kt and the pilot selected full flaps, heading for the farther of the two fields. Deliberately keeping the landing gear retracted and with the airspeed at about 80 to 85 kt, the pilot rounded out gently, whilst maintaining the wings parallel to the sloping field surface. The aircraft touched down in a tall crop of broad beans, coming to rest upright, and the pilot was then able to vacate the cockpit as normal.

He had not been in contact with ATC at the time of the accident but was able to use his mobile telephone to contact members of his family who had been watching the aircraft from the airstrip. He also contacted his colleagues with whom he had been flying in the display and who were still at the air show. They took it upon themselves to summon the air show's emergency response helicopter to come to the pilot's aid. The helicopter arrived at the aircraft about 35 minutes after it had forced landed in the field, followed shortly afterwards by the local police who arrived by road vehicle.

Aircraft examination

An examination of the aircraft by the owner's own maintenance organisation has, at the time of this report, failed to reveal the cause of the power loss, although the description given by the pilot indicates it was most likely to be due to fuel starvation.

After the forced landing it was noted that the throttle was about half open, the fuel selector was to RIGHT TANK, the mixture was still at RUN and the fuel booster pump was ON. The pilot had not found time to switch off the fuel supply, electrical master and magneto switches before touch down, nor had he jettisoned the canopy. The engine exhaust port deposits were white in colour and all four propeller blades were bent rearwards.

The aircraft has two fuel tanks, one in each wing, each with a capacity of 95 US gallons. When the aircraft was still in the bean field the fuel gauges indicated 17 US gallons in the left tank and 55 US gallons in the right tank. After the aircraft had been recovered to its hangar the tanks were drained; 12 US gallons were found in the left tank and 50 US gallons in the right tank.

Various fuel system components were tested, but no faults were identified and no water was found in either the fuel filters or the fuel. The pilot did, however, comment that he had had considerable difficulty starting the aircraft prior to the flight, although at no time during the flight did he recall seeing any of the fuel pressure warning lights illuminate.

Analysis

Fuel starvation can be caused by a number of phenomena such as a vapour lock or collapse in a fuel line. The pilot was concerned by the ageing rubber of the fuel tank walls and although a blockage caused by debris from a tank, or elsewhere, cannot be ruled out, no blockages were found. Another possible cause was fuel 'sloshing', whereby the fuel remaining in a partially empty tank moves as a result of the aircraft being subject to longitudinal acceleration or an out of balance force during a turn. In some instances this can lead to the fuel uncovering the outlet from the tank and starving the engine.

In this case the flight had been conducted solely on the left tank until the engine lost power. During the aerobatic manoeuvres the fuel level in this tank was relatively low and it is possible that forces applied during the manoeuvres led to the fuel moving away from the tank outlet momentarily. With a break in the fuel flow, the engine would have cut out, although this would not have occurred until some seconds after the outlet had been uncovered. With the propeller still turning at speed, once the fuel flow was restored the engine should have regained power.

The pilot states that he expected the engine to have regained power within seconds, especially as he had switched to the right tank which he knew to be full. He also stated that it was hard to see the fuel tank selector due to its position behind the control column, and that he moved the selector a few times to ensure it was correctly located. His perception of time may also have been distorted by the fact that he was at low altitude and so concentrating more on flying the aircraft than on trying to resolve the engine problem. It is possible, therefore, that in switching tanks and moving the tank selector to ensure it was properly engaged, the pilot did not allow sufficient time for the engine to restart.

It is advisable to set the propeller pitch to COARSE after an unexplained engine failure to reduce propeller windmilling drag but if the propeller still rotates, it drives the engine and its geared supercharger. This explains why the engine manifold pressure, at about 40 inches was some 10 inches above ambient air pressure. However, if an apparent engine failure is due to a temporary fuel starvation, when the fuel supply is restored, with the throttle partially or fully open and the propeller RPM low, the internal combustion conditions may be conducive to detonation or backfiring. This probably explains the series of repetitive loud reports from the engine described by the pilot as the "over-boost death rattle".

Conclusion

Circumstantial evidence suggests the engine power loss was caused by a short period of fuel starvation. The temporary fuel starvation was probably caused by aerobatic manoeuvring, momentarily uncovering the outlet in the left fuel tank, which was selected at the time. Insufficient time was then allowed for the fuel flow to be restored from either the left tank or the right tank before the propeller was put into coarse pitch. Once the fuel flow was restored, when the throttle was opened, the engine was unable to respond as the pilot had hoped, due to the relatively low RPM effect of the propeller in coarse pitch. Had the pilot selected FINE pitch when he heard the engine misfiring, it might have recovered power.

The situation was aggravated by the fact that the aircraft was at low altitude when the incident occurred. Had it been at a higher altitude it is possible that the pilot would have allowed more time to try and restore engine power before selecting coarse pitch. Similarly, he might have had sufficient altitude remaining to allow him to select fine pitch when subsequently checking for engine response during the aircraft's descent.

A further causal factor was the relatively low fuel quantity in the tank selected. The pilot is not aware of any minimum fuel requirement for conducting aerobatics but it would seem prudent to select the fuller tank before engaging in aerobatic manoeuvres, especially at low altitude.

Finally, it is to the pilot's credit that, faced with the situation described, he managed to carry out a successful forced landing with minimal damage to the aircraft. The successful outcome was positively influenced by the pilot's top priority of flying the aircraft and only troubleshooting the problem when he could. Although he had considerable experience in flying low level aerobatics, this accident highlights the safety benefit afforded by increasing the altitude at which aerobatics are performed.