Aviation Safety Investigation Report 199700744

North American Aviation Inc Harvard

06 March 1997

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Occurrence Number: 199700744 **Occurrence Type:** Accident
Location: Tindal, Aerodrome
State: NT **Inv Category:** 3
Date: Thursday 06 March 1997
Time: 1531 hours **Time Zone** CST
Highest Injury Level: Fatal
Injuries:

	Fatal	Serious	Minor	None	Total
Crew	1	0	0	0	1
Ground	0	0	0	0	0
Passenger	0	0	1	0	1
Total	**1**	**0**	**1**	**0**	**2**

Aircraft Manufacturer: North American Aviation Inc
Aircraft Model: T-6 MK IV
Aircraft Registration: VH-YES **Serial Number:** 14482
Type of Operation: Non-commercial Pleasure/Travel
Damage to Aircraft: Destroyed
Departure Point: Tindal NT
Departure Time: 1531 CST
Destination: Tennant Creek NT

Crew Details:

Role	Class of Licence	Hours on Type	Hours Total
Pilot-In-Command	Private	238.0	4080

Approved for Release: Thursday, July 9, 1998

FACTUAL INFORMATION

History of the flight

Following a re-build of the aircraft, VH-YES was to be flown from Darwin to Melbourne, with the first overnight stop planned for Tennant Creek. The owner of the aircraft was to travel as passenger in the rear cockpit. The pilot in command owned the organisation in Darwin which had overhauled the airframe. The engine was reconditioned by another organisation which was based in Melbourne.

The aircraft departed Darwin in the early afternoon of 6 March 1997 for Tindal. However, about 15 minutes after departure, the pilot in command diverted to Batchelor aerodrome, 74 km south of Darwin, due to a low engine oil pressure indication. He telephoned his organisation in Darwin and reported that the engine oil pressure had fallen to about 60 psi during the flight. (The post-overhaul ground test record for the engine showed that the oil pressure was 70 psi at 1600 RPM and 75 psi at 1800 RPM. The normal cruise engine RPM setting is 1600-1800 RPM.) The organisation then instructed an aircraft maintenance engineer at Batchelor to adjust the oil pressure back to within the normal range. No other checks were conducted. There was no contact at this time concerning the oil pressure with the organisation which had reconditioned the engine. The pilot in command then conducted an engine ground run and reported that the oil pressure indication was normal. The flight continued and the aircraft arrived at Tindal at about 1500 CST. The passenger later reported that the engine had operated normally during this flight.

The aircraft was refuelled with sufficient fuel for the planned flight to Tennant Creek and taxied for departure. The pilot in command had initially requested takeoff from runway 14 but the request was denied by Tindal Air Traffic Control due to other traffic considerations. The pilot then backtracked along the runway and was cleared to take off from the midpoint of runway 32. The runway length available from this position was approximately 1,350 m. The aircraft flight manual listed a take-off distance of 465 m for the existing meteorological conditions.

In recounting the accident, the passenger said that, soon after lift-off, he saw white smoke trailing along the right side of the fuselage. When the aircraft was 200-300 ft above the ground, he heard the engine cough or misfire. This was followed by a loud squeal. At the same time, the passenger sensed a loss of engine thrust. He recalled that the aircraft then changed from the climb attitude to about a level flight attitude and saw that the pilot's head was down as if his attention was directed into the cockpit. During this time the passenger noticed the airspeed fall below 75 kts. The aircraft then began to vibrate before rolling left and descending steeply to the ground. The passenger said that there had not been any indication from the pilot in command that he was attempting to turn back towards the runway.

Witnesses to the accident reported that, after what appeared to be a normal takeoff, white smoke began trailing from the aircraft when it was over the upwind threshold at an estimated height of 300 ft. The volume of smoke then increased rapidly and the aircraft began to roll left. It continued to roll left into a steep nose-down attitude and struck the ground.

The impact position was some 230 m beyond the north-western threshold of the runway and approximately 80 m left of the extended centreline. The fuselage came to rest on its left side and the passenger was able to egress from the wreckage and pull the pilot clear. A fire had started in the engine bay and spread rapidly to the separated wing structure. Fire and rescue services were at the scene within a short time and extinguished the fire.

Personnel information

The pilot in command held a private pilot licence. He was appropriately endorsed to fly T-6 aircraft and had a total flying experience of 4,080 hours, of which 3,953 were as pilot in command. He had recorded 238 flying hours in T-6 aircraft. In the previous 30 days he had flown a total of 27 hours, four of which were in the T-6 aircraft. His last aeroplane flight review was undertaken on 21 July 1996.

During his flying career, the pilot in command had experienced a number of engine failures in single-engine aircraft. As far as could be ascertained, none of these had occurred shortly after takeoff. The amount of training and practice the pilot had completed in simulated engine failure after take-off exercises, when he may have last practised the procedure, and whether this was in a T-6 aircraft, was not determined.

The passenger also held a private pilot licence and had a total flying experience in excess of 1,500 hours. He had not flown YES and stated that he did not touch or manipulate any of the aircraft controls during the accident flight. His flying experience included about 10 hours in other T-6 aircraft.

Aircraft information

A supercharged, nine-cylinder Pratt & Whitney radial engine, Model R-1340-S3H1, powered the aircraft. The engine arrived in Darwin in August 1996 after being overhauled in Melbourne. All engine parameters were reported to have been within normal limits during post-assembly test runs. Two ground runs of the engine were conducted after it had been installed in the aircraft on 8 February 1997. The engine was reported to have operated normally on both occasions. The aircraft was then transferred to an approved aircraft maintenance organisation to undergo airworthiness certification procedures. (The organisation which rebuilt the aircraft was approved to rebuild aircraft in the War Bird category but was not approved to conduct airworthiness certification procedures required to place the aircraft on the Australian Register of Aircraft.)

Before leaving Darwin, the engine was operated for 4 hours 40 minutes, including ground runs and test flights. The engine oil was changed and the strainer cleaned. No contamination was observed in the oil or the strainer.

Weight and balance

The aircraft weight at takeoff was approximately 2,300 kg. The centre of gravity and the weight of the aircraft were within limits.

Meteorological information

The weather conditions at Tindal were suitable for flight under visual meteorological conditions. The sky was clear and the surface wind was from 200 degrees M, at 6-10 kts. The ambient air temperature was 33 degrees C.

Medical and pathological information

The pilot in command held a valid class-2 medical certificate which required him to wear correcting lenses while flying. He was wearing spectacles at the time of the accident.

The injuries sustained by the pilot in command were consistent with his hands and feet being on the flying controls when the aircraft struck the ground.

Communications

Transmissions to and from the aircraft were recorded by automatic voice recording equipment at the control tower. The recording showed that the pilot made no further transmissions after acknowledging the take-off clearance. The passenger said that the intercommunications system between the front and rear cockpits was operating normally.

Aerodrome information

Katherine/Tindal aerodrome has a single runway, designated 14/32, which is 2,744 m long and 443 ft above mean sea level. There were areas beyond the end of runway 32 which were suitable for an emergency landing.

Wreckage and impact information

The left wingtip and propeller struck the ground almost simultaneously. The aircraft was in a very steep nose-down attitude at the time and had turned left, through approximately 200 degrees, from the take-off direction. The wing structure separated from the fuselage in one piece and came to rest about 11 m from the initial wing-impact point. A fire started in the rear of the engine bay and quickly spread to the separated wing section. The majority of the wing was destroyed by fire. The forward fuselage was severely disrupted by impact forces. Damage to the propeller indicated that it was rotating under low power at impact.

At impact the landing gear was fully retracted and the wing flaps were extended 10 degrees.

Examination of the airframe did not reveal any pre-existing failures or defects which might have contributed to the accident.

Engine examination

The engine was removed from the wreckage and dismantled for examination. The examination revealed the following:

1. The supercharger impeller had abraded heavily against the supercharger impeller and scroll housing. This had created a non-ferrous metallic paste-like substance which was present throughout the crankcase, the induction system and cylinder combustion chambers.

2. The electrodes of both number-6 cylinder spark plugs were contaminated by the paste to an extent which precluded normal operation. One of the two spark plugs in cylinders number 3, 4, 7 and 8 was similarly contaminated.

3. A piece of non-ferrous material about the size of a 20-cent coin was found in the combustion chamber of the number-2 cylinder. The piece was identified as being from the impeller scroll.

4. The impeller shaft was bent to an angle of 20-25 degrees and had been severely affected by heat. The impeller shaft bearing surfaces were deeply scored and blued as were the impeller shaft plain bearing supports. The impeller intermediate drive gear teeth were chipped and broken.

5. The engine crankshaft cavities were contaminated with particles of ferrous and non-ferrous metal from the impeller and its case, and the impeller bearing and bearing case. This contamination was readily evident.

6. The master connecting rod bearing had eroded to the extent that only the base metal remained. It appeared to have been operating in this condition for some time.

7. The supercharger drive shaft bearing-to-shaft oil seals were destroyed.

8. All other aspects concerning the components, assembly and clearances in the engine were within limits.

The damaged supercharger assembly underwent specialist failure analysis. The analysis confirmed that supercharger failure occurred when the forward plain bearing momentarily seized, shearing the pins which fix the bearing to its support housing. This allowed the bearing to rotate sufficiently to block one oil supply hole and partially block another. The blockage of these holes prevented sufficient lubrication between the bearing and its shaft, leading to failure of the bearing. While no foreign material was observed in the oil holes in the bearings, the holes were partially blocked by debris created during the destruction of the bearings.

The specialist examination was unable to reach any conclusion regarding the timing of the initial seizure of the forward bearing. Organisations which had extensive experience in overhauling R1340 engines advised that several hours of engine operation could pass after initial seizure of the bearing before it failed completely.

Other engine related information

Examination of the documentation from the engine overhaul showed that the previous roller type supercharger bearings were changed to plain bearings during the overhaul. This was accomplished in accordance with the instructions in Pratt & Whitney Service Bulletin Number 1658 Revision A, Plain Impeller Bearings. The service bulletin advised that "In-service experience has indicated that conversion to the plain impeller configuration has resulted in improved oil sealing in the supercharger area".

Section 10-3 of the engine manufacturer's overhaul and maintenance manual contained detailed instructions for the before-start handling of engines "inactive for 1-10 days". It stated:

"When it is known that an engine will be idle for more than one day but less than 10 days, rotate the engine on alternate days at least 20 propeller blades by means of the starter. Run-up the engine on the fifth day at 1,000 rpm until the oil temperature reaches 65 degrees C. If due to circumstances it is not possible to rotate or run-up the engine during this ten day period, pre-oil the engine prior to starting".

The manual also detailed the lubrication requirements at overhaul and before first engine start.

The engine overhaul facility reported that pre-assembly lubrication of the engine parts was in accordance with the engine overhaul and maintenance manual. The facility also had a standard workshop practice of lubricating all mating sub-assemblies before assembly. The engine was then pre-oiled in accordance with the manufacturer's procedures before being test-run.

The engine was mounted horizontally (i.e. with the propeller shaft vertical) during shipment to Darwin. This was the normal procedure. It was not fitted to the aircraft for some months after its arrival. The organisation which installed the engine in the aircraft reported that the manufacturer's procedures were followed prior to engine start and that, on each occasion where the engine had not been run for a number of days, it was pre-oiled, again in accordance with the required procedures.

The engine supercharger/crankshaft gearing ratio is 10:1. Consequently, at an engine-idle speed of 1,000 rpm, the supercharger impeller speed is 10,000 rpm. During a normal engine start, the engine accelerates to this idle speed within a few seconds. Since engine oil pressure is not normally available immediately after engine start, it is important to ensure that the engine is correctly pre-oiled.

The failure of supercharger bearings in R1340 engines is not uncommon. In most cases, the engine continues to develop sufficient power under normal aspiration to maintain flight and complete a safe landing. However, these cases did not involve significant destruction of the supercharger impeller.

The engine oil strainer consists of a coarse screen which is not designed to trap small particles of contamination.

Survival aspects

The impact loads caused severe disruption to the forward cockpit area. The side walls had buckled outwards and the floor had been forced into the cockpit, causing deformation of the seat base. The front seat safety harness had failed at the shoulder and lap attachment points on the left side. These failures were due to overload. The injuries sustained by the pilot in command were consistent with this damage.

The aircraft nose and forward cockpit sections had absorbed most of the impact loads. The rear cockpit area generally retained its shape, apart from some bending of the seat supports. There was no failure of the rear seat harness. As a result, the rear seat occupant survived the accident without sustaining serious injuries.

Aircraft flight manual extracts

The following extracts were taken from the Flight Manual, USAF Series, T-6G Aircraft.

Section III, page 42, ENGINE FAILURE AFTER TAKEOFF - AIRPLANE AIRBORNE, stated in part:

"If the engine fails immediately after take-off, land straight ahead, changing direction only enough to miss obstacles. Proceed as follows:

NOTE

Making a crash landing straight ahead with the airplane under control is much better than turning back and taking the chance of an uncontrolled roll".

Section VI, page 66, STALLS, stated in part:

"Stalls in this airplane are not violent. You can feel a stall approaching as the controls begin to loosen up and the airplane develops a sinking, "mushy" feeling. In addition, you can see the stalling attitude. When the stall occurs, there is a slight buffeting of the elevator and a vibration of the fuselage, and the nose or a wing drops".

The flight manual stated that, at a gross weight of 2,272 kg, the power-off stalling speed, with landing gear and flaps up, was 61 kts. With climb power in this configuration, the stalling speed was listed as 53 kts. With gear and flaps down, and power off, the stalling speed at this weight was 51 kts. The pilot in command conducted a test flight in the aircraft on 5 March 1997 and recorded the following stalling speeds:

- gear and flaps down: 51 kts;

- gear and flaps up: 53 kts.

The record did not indicate the engine power settings during these tests.

ANALYSIS

The amount of metallic contaminants found during the engine strip examination, and their distribution through much of the lubrication system, indicated that the contaminants had been circulating within the system for some time. These contaminants, which were introduced into the system by the failure of the supercharger forward plain bearing, almost certainly caused the erosion of the master connecting rod bearing surface. The fall in oil pressure that led to the diversion to Batchelor is consistent with erosion of this bearing surface. Although no contamination was observed in the oil before the aircraft left Darwin, it is likely that the initial seizure of the plain bearing had already occurred, but that the bearing had not deteriorated sufficiently by then to cause abrading between the supercharger impeller and the scroll housing.

From the results of the specialist examination, the initial seizure of the plain bearing was almost certainly caused by a lack of lubrication of the bearing surfaces during an engine start prior to the departure from Darwin.

The engine cough or misfire heard by the passenger shortly after takeoff from Tindal may have been caused by failure of the supercharger itself, or may have been a result of the excessive fouling of the spark plugs, notably in number-6 cylinder. It is unlikely that the plugs were fouled to this extent earlier as there would have been symptoms such as engine rough running or significant power loss.

The ultimate failure of the supercharger bearings would have caused the destruction of the oil seals and allowed oil to enter the combustion chambers via the induction system. This would have caused the smoke which was observed coming from the engine.

The failure of the supercharger, along with the spark plug fouling, would have caused a substantial engine power loss. Given the low altitude at which the failure occurred, the passenger's observations, and the experience level of the pilot in command, it is highly unlikely that he was attempting to turn back towards the runway. The observation of the passenger that the pilot in command had his head down as if his attention was directed inside the cockpit suggests that he was attempting to analyse the engine problem by reference to the engine instruments and/or controls. This may have distracted him to the extent that he did not adopt an aircraft attitude sufficiently nose-low to prevent the airspeed reducing to the stall speed. The roll to the left which witnesses observed was most probably caused by the left wing stalling. The low altitude at which this occurred was insufficient to allow recovery to normal controlled flight.

SIGNIFICANT FACTORS

1. Probably during an engine start sequence, the forward impeller drive shaft plain bearing rotated in its housing, blocking oil supply holes to the extent that there was insufficient lubrication between the bearing and the drive shaft during later operation of the engine.

2. The engine suffered a substantial power loss at low altitude shortly after takeoff from Tindal.

3. The aircraft stalled at a height which was insufficient to allow recovery to normal flight.