Statens haverikommission
Swedish Accident Investigation Board

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Report RL 2007:20e

Accident to the aircraft SE-GAV at Norra Djurgården, Stockholm, AB county, on 12 April 2007

Case L-05/07

SHK investigates accidents and incidents with regard to safety considerations. The sole objective of the investigations is the prevention of similar occurrences in the future. It is not the purpose of the activity to apportion blame or liability.

The report is also available on our web site: www.havkom.se.

Translated by Interpreter Centre, City of Göteborg from the original Swedish at the request of the Swedish Accident Investigation Board.

In case of discrepancies between the English and Swedish texts, the Swedish text is to be considered the authoritative version.

Statens haverikommission (SHK) Swedish Accident Investigation Board

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Statens haverikommission
Swedish Accident Investigation Board

2007-12-10 L-05/07

Swedish Civil Aviation Authority

601 73 NORRKÖPING

Report RL 2007:20e

The Swedish Accident Investigation Board (Statens haverikommission, SHK) has investigated an aircraft accident that occurred on 12 April 2007 at Norra Djurgården, Stockholm, AB County, involving an aircraft with registration SE-GAV.

In accordance with section 14 of the Ordinance on the Investigation of Accidents (1990:717) the Board herewith submits a final report on the investigation.

Göran Rosvall Henrik Elinder

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Report finalised 2007-12-10

Aircraft; registration and type	SE-GAV, Piper PA-28-180
Class, airworthiness	Normal, valid Certificate of Airworthiness
Owner/Operator	Stockholms-Flyg EK FÖR, c/o Stockholms Flygklubb, Bromma Flygplats, 168 67 BROMMA
Time of occurrence	12 April 2007, 15:22 hrs, in daylight *Note*: All times are given in Swedish summer time (UTC+ 2 hours)
Place	Norra Djurgården, Stockholm, AB county, (pos. N59°21.71N 018°05.09E; approx. 10 m above sea level)
Type of flight	Private
Weather	According to SMHI's analysis: Wind, west, approx. 10 kts, visibility > 10 km, cloudbase at 5000 ft, temp./dp +12/ -5 °C, QNH 1024 hPa
Persons on board:	
Crew members	1
Passengers	3
Injuries to persons	Minor
Damage to aircraft	Substantially damaged
Other damage	Damage to tree, fuel and oil fouling of ground
Pilot:	
Sex, age, licence	Male, 54 years, PPL
Total flying time	992 hours, of which 600 hours on type
Flying hours previous 90 day	2,5 hours, all on type
Number of landings previous 90 days.	4, of which all on type

The Swedish Accident Investigation Board (SHK) was notified on 12 April 2007 that an aircraft with registration SE-GAV had an accident at Norra Djurgården, Stockholm, AB county on that day at approximately 15:30 hrs.

The accident has been investigated by SHK represented by Göran Rosvall, Chairperson, Henrik Elinder, Investigator In Charge, and Stefan Christensen, Operational investigator.

The investigation was followed by Gun Ström, Swedish Civil Aviation Authority.

Summary

The pilot, with three passengers on board had made a local flight over the Stockholm archipelago and was to land at Bromma Airport. When the aircraft was in position over Frihamnen the engine suddenly began to run roughly and lose power. The altitude was then approximately 1200 ft. With increasing engine malfunction and loss of altitude, the pilot headed towards a small open field close by on the mainland.

On the way there the engine stopped completely. The pilot then made a gliding left turn to the field for an emergency landing in westerly direction. The touchdown was made approximately in the middle of the field. When

the aircraft reached the end of the field the speed was high and it collided with two trees and an outcropping rock before it stopped. Those on board the aircraft were not seriously injured and helped each others to leave the aircraft.

The technical investigation has revealed that a plug to one of the piston-pins had broken away some hours prior to the engine failure. The damage resulted in production of aluminium fragments to be spread in the oil system damaging the connecting rod bearings. The final engine failure was caused by a connecting rod no. 2 failure.

The engine manufacturer has taken measures to eliminate the technical inadequacies which probably caused the primary material damage.

The accident was caused by the inadequate design of the piston-pins and the piston-pin plugs in this type of engine. A contributory factor may have been a defect in the crankshaft as manufactured and low oil pressure.

Recommendations

None.

1 FACTUAL INFORMATION

1.1 History of the flight

The pilot, with three passengers on board was to make a local flight over the Stockholm archipelago, taking off from and landing at Bromma Airport. The pilot performed the standard pre-flight check before starting, observing no abnormalities.

After approximately 50 minutes flying time, with the aircraft in a holding pattern over Frihamnen prior to approaching Bromma for landing, the engine began to run roughly and lose power. The altitude was then approximately 1200 ft. The pilot informed the flight controller at Bromma of this problem and was cleared to make a direct approach for landing. The pilot attempted to regain engine power by advancing the throttle control, activating the fuel pump and carburettor preheater and switching fuel tanks but without result.

With increasing engine malfunction and loss of altitude, the pilot headed towards a small open field close by on the mainland in order not to be forced to land in the water, if the engine problem should escalate. On the way there the engine stopped completely. The pilot then made a gliding left turn to the field for an emergency landing in westerly direction. The field was short and surrounded by trees. When the pilot judged the aircraft to have cleared the trees east of the field, he gave full flaps.

The touchdown was made approximately in the middle of the field. Despite the pilot's full application of brakes and retraction of the flaps, the speed was high when the aircraft reached the end of the field. There the aircraft bounced over a roadway and the right wing was teared off at collision with a tree, before the aircraft stopped abruptly against a tree and an outcropping rock.

Fuel was spread over the site but did not ignite. Those on board the aircraft were not seriously injured and helped each others to leave the aircraft.

The accident occurred at position N59°21.71N 18°05.09E; approx. 10 m over sea level.

1.2 Injuries to persons

	Crew members	Passengers	Others	Total
Fatal	–	–	–	–
Serious	–	–	–	–
Minor	–	2	–	2
None	1	1	–	2
Total	1	3	–	4

1.3 Damage to the aircraft

Substantially damaged.

1.4 Other damage

The ground at the site was contaminated with petrol and oil.

1.5 Personnel information

1.5.1 Pilot in command

The pilot, male, 54 years at the time, had a valid PPL.

Flying time (hours)			
Latest	24 hours	90 days	Total
All types		2,5	992
This type		2,5	600

Number of landings this type previous 90 days: 4.
Flight training on type concluded 1976-11-23.
Latest PC (proficiency check) carried out 2007-02-28 on Piper PA-28.

1.6 Aircraft information

AIRCRAFT	
Manufacturer	Piper
Typ	PA-28-180
Serial number	28-7405203
Year of manufacture	1974
Gross mass	Max authorised start/landing mass 1110 kg, actual approx. 1000 kg
Centre of mass	Within authorised limits.
Total flying time	13441 hrs
Flying time since latest inspection	40 hrs
Fuel loaded before event	AVGAS 100LL

ENGINE	
Manufakturer	Textron Lycoming
Model	O-360-A4A
Number of engines	1
Motor	
Total operating time, hours	11751
Operating time since overhaul, hours	1979

PROPELLER	
Manufakturer	Sensenich
Operating time since latest over-haul	438 hrs

The aircraft had a valid Certificate of Airworthiness

1.7 Meteorological information

According to SMHI's analysis: Wind West approx. 10 kts, visibility > 10 km, cloudbase at 5000 ft. temp./dp +12/-5 °C, QNH 1024 hPa.

1.8 Aids to navigation

Not applicable.

1.9 Communications

The pilot had radio contact with the flight controller at Bromma Airport as normal before landing.

When the engine malfunction began, he informed Bromma of this and was cleared for a direct approach to the airport. Shortly after, the pilot informed Bromma of his intention to make a forced landing and had chosen a place immediately north of the gasworks.

The flight controller directed a police helicopter in the vicinity to the place. The helicopter crew localised the aircraft quickly and could see that those on board had survived without serious injury.

1.10 Aerodrome information

Not applicable.

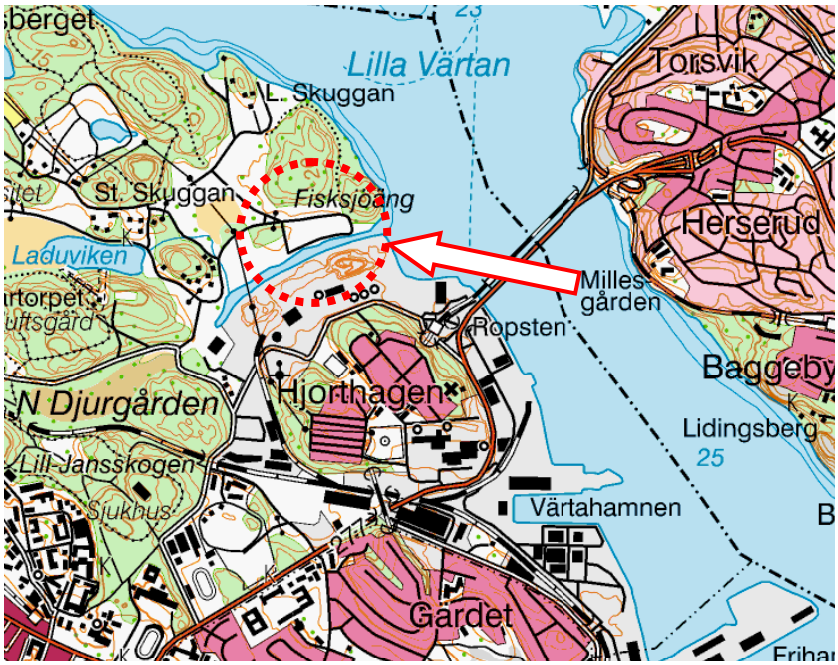
1.11 Flight recorders

Not installed. No requirement.

1.12 Accident site

1.12.1 Accident site

The aircraft was landed on an open field, approximately 100 x 300 m., between a channel and rising ground (see map). The undulating surface had a growth of unmown meadow grass. The direction of approach was approximately 280°.



Approach

1.12.2 Aircraft wreckage

The entire right wing of the aircraft was broken off by impact with a tree after which the aircraft skidded a further 10 m before being stopped by an outcropping rock and another tree.

Apart from the loss of the right wing, the aircraft suffered considerable damage to the left wing and the fuselage.

Accident site

1.13 Medical information

There were no indications that the mental or physical condition of the pilot was impaired before or during the flight.

1.14 Fire

There was no fire.

1.15 Survival aspects

1.15.1 General

The forced landing on the limited area available and the subsequent collision with trees and an outcropping rock which caused the spread of petrol over the site exposed the persons on board to appreciable risks. In this case, the situation was particularly critical because a passenger in the rear seat was physically handicapped after the accident and the aircraft type concerned had only one door which hampered the evacuation of the aircraft.

Due to fortunate circumstances and the pilot's handling of the situation the forced landing was performed without serious injury to those on board. That the aircraft type has one door only is a risk factor which can be minimized by means of information, training and routines in the placing of passengers in the aircraft before flights.

The EBC-102A emergency locator transmitter on board was activated by the accident and deactivated by the rescue personnel.

1.15.2 Rescue actions

When the pilot reported that he intended to make a forced landing, the Air Traffic Controller at Bromma directed a police helicopter known to be in the vicinity to fly to the site. The helicopter crew quickly located the aircraft and were able to assist those on board. The Air Traffic Controller also alerted the Rescue Services who were able to reach the site quickly and then sprayed the aircraft with foam to reduce the risk of fire.

1.16 Tests and research

1.16.1 Examination of the aircraft at the site of the accident

The aircraft was inspected at the site. It was found, inter alia, that the propeller could not be rotated on its shaft and it was apparent that a mechanical abnormality had occurred in the engine block. The damage to the propeller indicated that it was not rotating when the aircraft touched down. No other technical reason for the sequence of events could be seen. The engine was removed from the aircraft and has been examined at an authorized engine workshop.

1.16.2 General inspection of the engine

The internal damage to the engine was so extensive that it was not possible to dismantle it in the normal way. After the dismantling, it was seen, inter alia, that the cap on connecting rod no. 2 for the crankshaft bearing had fractured. Parts of the connecting rod had caused extensive damage in the crankcase.

1.16.3 Connecting rod bearing (Big-end bearing)

All of the crankshaft bearing surfaces for the connecting rods were dry and had been overheated and deeply scored. Some of the bearing material had melted and been pressed out between the crankshaft and the connecting rods. The no. 2 bearing race had been damaged extensively (see photo below).

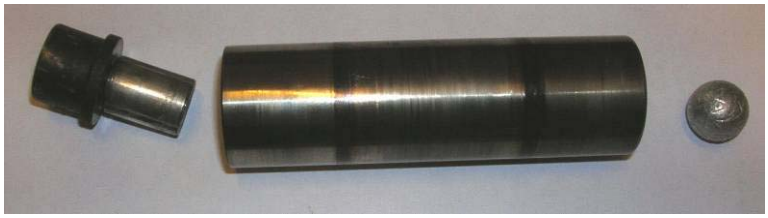
Bearing race no. 2

Bearing race no. 3

1.16.4 Piston-pin no. 4

The outer part of one of the two aluminium plugs in piston-pin no. 4 had broken loose. This had had then, during operations, mechanically worn a cavity in the piston-pin hole and itself been formed into a spherical ball (see photo on next page).

Piston no. 4 with part of plug



Piston-pin no. 4 with plugs

The engine manufacturer, TEXTRON Lycoming, has been aware of a problem with piston-pin plugs in the engine type concerned and published the following instructions for solution of the problem.

Service Instruction No. 1267C - dated 26 Februari, 1999
The document requires, inter alia, the installation of newly manufactured piston-pin plugs as part of each regular overhaul.

- According to the workshop responsible for the overhaul, new plugs were installed in the engine during the overhaul performed 1979 flying hours before the accident

Service Instruction No. 1492C - dated 14 July, 2000
The document refers to the occurrence of abnormal piston-pin plug wear and the possibility of detecting such wear by careful checking of the oil and oil filter. The check should be performed in connection with the normal oil filter replacement after each 50 hours flying time.

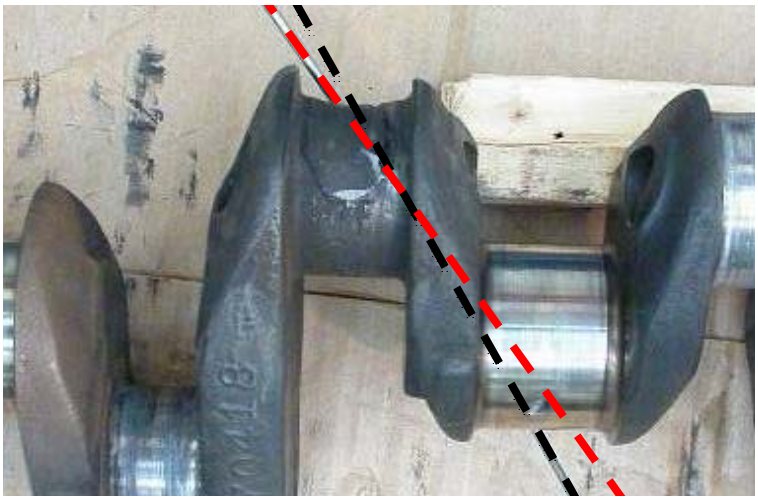
- According to the instance responsible for the maintenance, the oil and oil filter were checked in connection with the ordinary 50 hours inspection of the aircraft which was performed 40 flying hours before the accident.

Service Instruction No. 1340A - dated 25 May, 2006
This document requires the replacement of piston-pins in this type of engine with a new version as soon as the engine has been dismantled for any reason.

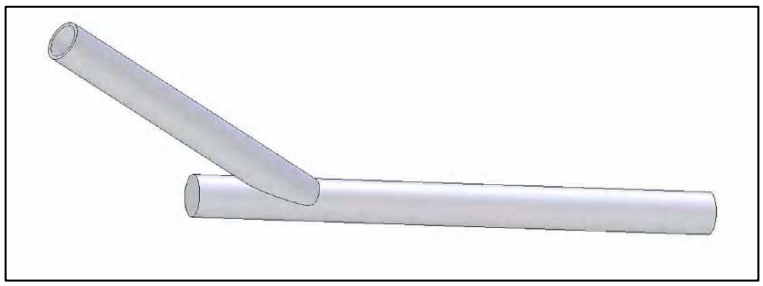
- The piston-pins in the engine concerned were of the old type.

1.16.5 Crankshaft

An inspection of the crankshaft showed that the oil supply channel to crankshaft bearing no. 2 had a manufacture defect. The hole was drilled from two sides. The holes did not meet in the centre and were not lined up.



Directions of two drill holes in the crankshaft



Principe drawing of the manufacturing fault

All races of the crankshaft bearings were excessively worn. The three races for the main crankshaft bearings were in good condition.

1.16.6 Oil system

A considerable volume of aluminium fragments was found in the bottom of the oil filter container and on the filter cartridge.

Oil filter

It was also observed that the force which could be exerted by the spring of the oil pressure regulator was less than that specified with the result that the oil pressure in the engine was lower than that required.

1.16.7 Oil pressure gauge

The function of the oil pressure gauge in the aircraft was checked in an instrument workshop and found to be in accordance with the relevant specifications.

1.16.8 The maintenance status of the engine

At the time of the accident, the engine had accumulated a total of 11751 hours of operations of which 1979 hours were operations since the most recent overhaul which had been performed by Aircraft Engineering in Norway. Previous to this, the engine had been overhauled by TEXTRON Lycoming in USA.

According to its technical documentation, the engine has been maintained in accordance with the relevant instructions. The most recent inspection, including replacement of the filter and its inspection for metallic fragments was performed 40 flying hours before the accident. There are no indications that the engine has been operated other than in accordance with the relevant instructions.

1.17 Organisational and management information

Not applicable. The aircraft has been used privately by a flying club.

1.18 Additional information

1.18.1 Questions relating to genus inequality

The accident has been studied from the perspective of equality between men and women i.e. if there were circumstances which indicate that the accident or its effects were caused by or were affected by any women and men concerned not having the same possibilities, rights and responsibilities in different respects. No such circumstances have been found.

1.18.2 Environmental aspects

Approximately 50 litres of aviation petrol and some litres of oil were spread over the site of the accident. The area affected was decontaminated by Environmental and Health Administration personnel.

2 ANALYSIS

2.1 History of the flight

Engine malfunction began when the aircraft was at a relatively low altitude over an urban area interspersed with areas of water which put the pilot in a difficult situation. It was natural for him as the first measure to request permission to make an emergency direct approach to Bromma which he could already see.

It was propitious that the he in an early stage of the engine malfunction choose an possible field for an emergency landing in case the engine malfunction should escalate.

When the engine finally failed he was mentaly prepared to make an emergency landing and had already chosen a place for it.

It is due to this and fortunate circumstances in combination with the skilful handling of the situation by the pilot that the emergency landing could be performed without serious injury to those on board.

2.2 Engine failure

The technical examination of the engine has shown that the connecting rod in cylinder no. 2 failed during operation and during some following seconds of continued operation, caused such extensive damage that the engine finally ceased operation. This sequence of events was confirmed by the pilot's narrative of the rough running and final seizing of the engine.

It has also been found that part of an aluminium plug to piston-pin no. 4 had broken away and lodged in the space between the piston-pin and the cylinder wall. It has there, during the operation of the motor, "bounced" backward and forward, mechanically abrading the piston. The damage to the piston and the form of the loose plug section indicate that it had broken away on a previous occasion and that the damage was caused progressively during a number of hours of operation before the engine failure.

As no other damage had been reported previously, the aluminium fragments found in the oil filter after the accident must have been the result of this abrasion.

The oil filter was to a great extent clogged by the aluminium fragments. It is therefore very likely that the pressure differential over the filter may have been so great that its bypass valve opened partially and allowed oil containing aluminium fragments to pass into the engines lubrication system.

Aluminium fragments in the lubrication system, insufficient lubrication and cooling are therefore the probable explanation to the seize of the crankshaft bearings and the final overheating and failure of the connecting rod in cylinder no 2. A factor contributing to this failure may have been the defect in the oil supply channel to the bearing. This defect may have restricted the oil flow thereby reducing its lubricating and cooling effects.

Even if the oil pressure was not so low that it became apparent to the pilot, the weak spring in the oil pressure regulator suggests that the oil pressure was low. This can also have caused a reduced flow of oil to the connecting rod bearing and thereby contributed to the damage to the bearing.

As explained in 1.16.4, the engine manufacturer is aware of the problem of the breaking away of part of the aluminium end plugs of the piston-pins in these engine type and has therefore issued certain instructions relating to their use and requiring periodic checking of the oil and oil filter for the presence of aluminium fragments.

SHK has found no evidence that these instructions have not been followed by those performing the maintenance of the aircraft. The latest check of the engine oil and oil filter was performed 40 flying hours before the engine failure and it is fully possible that the damage causing engine failure had not developed at that time.

The piston-pins in the engine concerned were of the earlier type and, according to Service Instruction No. 1340A, were to be replaced during the next overhaul with piston-pins of a different design, reducing the risk of the type of damage causing the accident.

SHK considers that the manufacturer has taken the necessary steps to successively eliminate the problem. There is still reason, however, to draw the attention of operators to the speed with which internal mechanical damage can result in engine failure and the importance of monitoring the oil pressure and checking for the presence of aluminium fragments in the oil and the oil filter.

3 CONCLUSIONS

3.1 Findings

a) The pilot was qualified to perform the flight.
b) The aircraft had a valid Certificate of Airworthiness.
c) The aircraft had been maintained in accordance with the relevant instructions.
d) Part of a plug to piston-pin no. 4 had broken away and caused secondary damage.
e) The oil filter was clogged with aluminium fragments.
f) All connecting rod bearings had seized.
g) Connecting rod no. 2 had failed.
h) The oil supply channel in the crankshaft to connecting rod no. 2 had been incorrectly formed during manufacture.
i) The oil pressure was low.
j) The engine manufacturer has taken measures to eliminate the technical inadequacies which resulted in the primary material damage.

3.2 Causes of the accident

The accident was caused by the inadequate design of the piston-pins and the piston-pin plugs in this type of engine. A contributory factor may have been a defect in the crankshaft as manufactured and low oil pressure.

4 RECOMMENDATIONS

None.