



**Statens haverikommission**  
Swedish Accident Investigation Board

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***Report RL 2009:17e***

**Accident to aircraft D-EBKB at Veberöd,  
Skåne County, on 6 June 2008**

Case L-11/08

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**Statens haverikommission**  
Swedish Accident Investigation Board

2009-11-18

L-11/08

The Swedish Transport Agency  
SE-601 73 NORRKÖPING, Sweden

### **Report RL 2009:17e**

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The Swedish Accident Investigation Board (Statens haverikommission, SHK) has investigated an aircraft accident that occurred on 6 June 2008 at Veberöd, Skåne county, involving an aircraft registered D-EBKB.

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

Göran Rosvall

Stefan Christensen

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## Report RL 2009:17e

L-11/08

Report finalised 2009-11-18

Aircraft; registration and type	D-EBKB, Mooney M20J
Class, airworthiness	Normal, valid Certificate of Airworthiness
Registered owner/Operator	Private ownership
Time of occurrence	6 June 2008, time 17:16 in daylight Note: All times are given in Swedish daylight saving time (UTC + 2 hours)
Place	Veberöd, Skåne county, (posn. 55° 38.1' N, 013° 33.8' E, 90 m above sea level)
Type of flight	Private
Weather	According to SMHI's analysis: Wind south-east 1015 knots, good visibility, no clouds, temperature/dew point 22/8 °C, QNH 1018 hPa.
Persons on board:	
pilot	1
Passengers	-
Injuries to persons	None
Damage to the aircraft	Substantially damaged
Other damage	-
The pilot:	
Sex, age, licence	Male, 47 years, German PPL
Total flying time	408 hours, of which 311 hours on type
Flying hours previous 90 days	6 hours, all on type
Number of landings previous 90 days	4

The Swedish Accident Investigation Board (SHK) was notified on 6 June 2008 that an aircraft with registration D-EBKB had an accident at 17:15 hours on that day at Veberöd, Skåne county.

The accident was investigated by SHK represented by Göran Rosvall, Chairman and Stefan Christensen, Investigator in Charge.

The investigation was followed by Gun Ström of the Swedish Transport Agency, Civil Aviation Department, until 1 June 2009, and thereafter Nicklas Svensson.

### Summary

The pilot had earlier that morning flown from Germany to Sjöbo, Sweden, and should after a short ground stop – after refuelling – fly to Rügen. About 3-4 minutes after take off the engine lost power and the pilot made an emergency landing in an open area with marshy surface conditions. The aircraft was substantially damaged, but the pilot, who was unhurt, was able to get out of the aircraft by himself after the emergency landing and then contacted the rescue centre.

At the investigation of the engine and fuel system nothing incorrect or abnormal was found. Analyses of fuel from the aircraft showed that more than one type of petrol had been used, and that the sample from the injector contained water. Investigation of the fuel caps – situated in a recess in the wing – showed that the O-rings at the right cap did not seal, so that water could leak through and into the tank. The manufacturer of the aircraft had issued directives regarding change or control of the O-rings.

At control of the tanks it was found that there were possibilities for small amounts of water to collect at the bottom of the tank, and that this –if the aircraft was leaning unfavourably – not fully could be drained out.

The accident was probably caused by deficient maintenance, resulting in an unsealed right wing tank filler cap, which meant that water could have leaked into the aircraft's wing tank.

### **Recommendations**

None.

# 1 FACTUAL INFORMATION

## 1.1 History of flight

Early that day the pilot had taken off from Jena in Germany for a private flight to Sjöbo, Sweden. After a brief period on the ground for refuelling, among other things, the aircraft, a Mooney M20J, again took off to fly to its destination Rügen in Germany. The pilot stated in an interview that after refuelling he had drained the aircraft fuel tanks. The take off and climb out took place as normal, but after 3-4 minutes of flight, when the aircraft had reached an altitude of about 1000 feet, the engine lost power and the pilot could no longer maintain altitude.

The pilot carried out the prescribed measures in accordance with the procedure for engine misfiring or stoppage, involving among other things switching over from the right fuel tank to the left tank, and then began to prepare for an emergency landing. According to the interview with the pilot, the engine never stopped completely, but gradually ran slower and slower – thereby losing power - despite the pilot increasing the throttle setting.

Due to the low altitude, the pilot did not have much time to select a suitable field in which to land. He saw an open area ahead with what looked like grass on it. According to the pilot, the emergency landing was controlled, with the engine idling. The landing took place in a relatively low arable area near to Veberöd. After touching down, the aircraft went through a barbed wire fence and broke a fence post. Due to the long grass and marshy ground, the roll out was very short and the aircraft came to a halt with the wheels partly sunk into the ground.

The pilot, who was unhurt, was able to get out of the aircraft by himself after the emergency landing and then contacted the ARCC<sup>1</sup>. The local rescue services arrived at the accident site at 17:58, and the first police patrol arrived at 18:02.

The accident occurred at 17:16 at position 55°38.1'N, 013°33.8E; 90 m above sea level, in daylight.

## 1.2 Injuries to persons

	Crew members	Passengers	Others	Total
Fatal	–	–	–	–
Serious	–	–	–	–
Minor	–	–	–	–
None	1	–	–	1
Total	1	–	–	1

## 1.3 Damage to the aircraft

Considerable

## 1.4 Other damage

A barbed wire fence suffered minor damage during the emergency landing.

<sup>1</sup> ARCC: Aeronautical Rescue Co-ordination Centre

## 1.5 Personnel information

### 1.5.1 Pilot

The pilot, male, was 47 years old at the time and had a valid German Private Pilot's Licence (PPL).

Flying hours			
	24 hours	90 days	Total
previous	2	6	408
All types	2	6	311
This type	2	6	

Number of landings this type previous 90 days: 4.

Flight training on type carried out on 6 July 1998.

Latest PC (Proficiency Check) carried out on 8 January 2008 on a Mooney M20J.

## 1.6 The aircraft

### 1.6.1 General

The aircraft	
Manufacturer	Mooney
Type	M20J
Serial number	24-0500
Year of manufacture	1978
Gross mass	Max. authorised flying mass 1,243 kg.
Centre of mass	Within permitted limits
Total flying time	2594 hours
Number of cycles	2775
Flying time since latest periodic inspection (100 hours)	29 hours
Fuel loaded before event	203 litres of 91-96 UL
<i>Engine</i>	
Manufacture	Lycoming
Engine model	IO-360A1B6D
Number of engines	1
Engine	
<i>Total operating time, hrs</i>	2594
Operating time since overhaul	29
Cycles since overhaul	28
<i>Propeller</i>	
Manufacturer	Muhlbauer
Model	MTV-12-B/180-17
Propeller running time since basic inspection	83 hours

The aircraft had a valid Certificate of Airworthiness.

## 1.6.3 Fuel system

General

The fuel system in the Mooney M20J is of a conventional type, with two wing tanks. The tank selector at the pilot's seat has three positions, Left tank, Right tank and Closed.

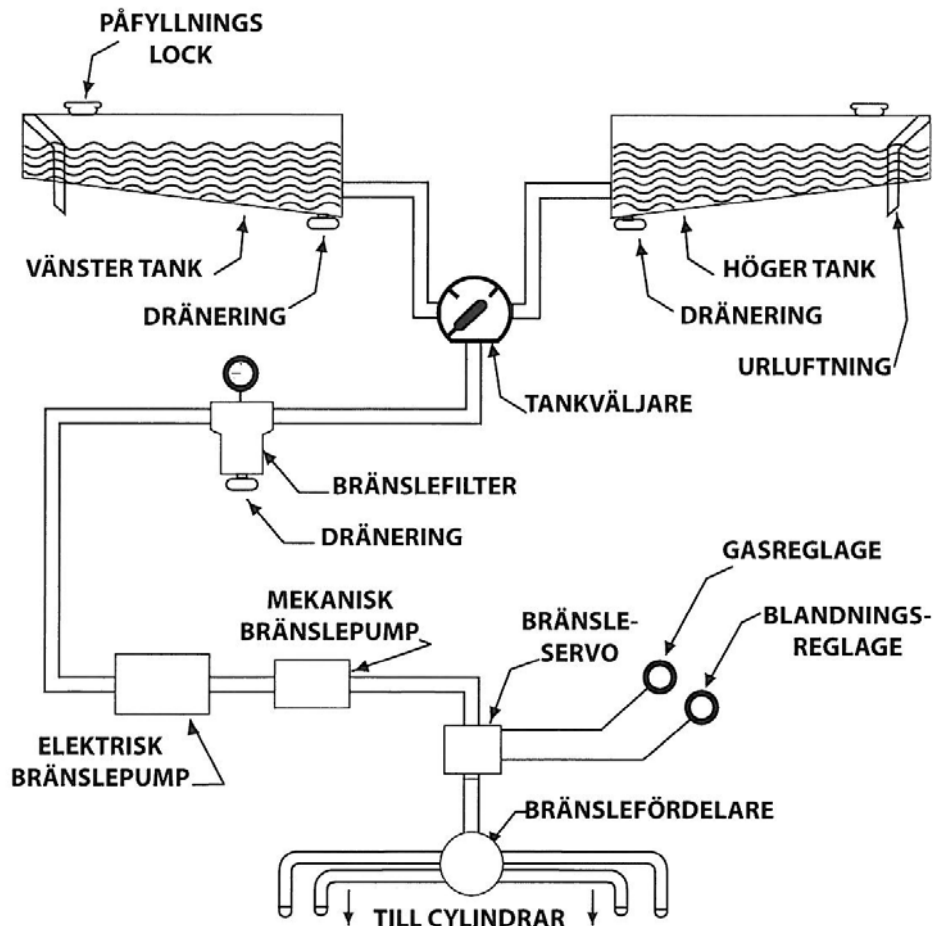


Fig.3. Mooney M20J fuel system.

Illustration notations (top to bottom, left to right):

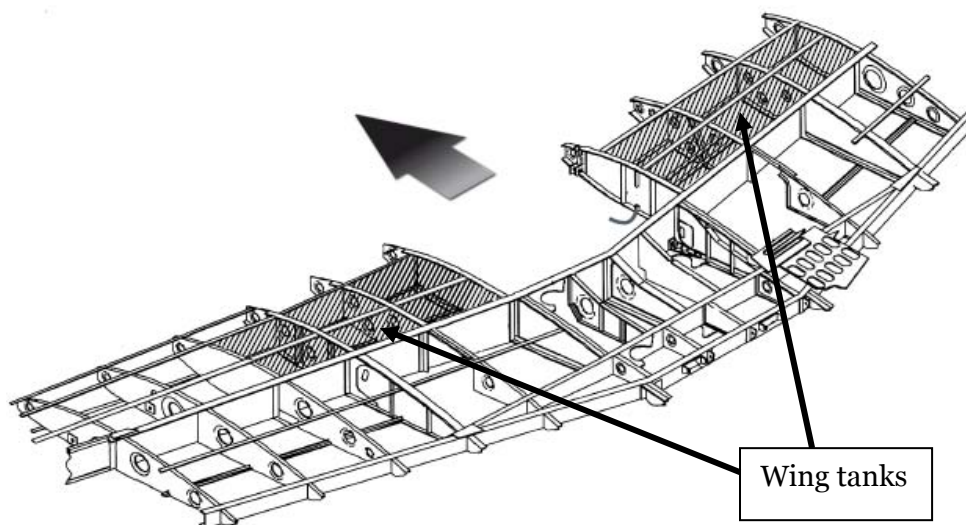
Filler cap  
 Left tank  
 Right tank  
 Drain  
 Vent  
 Tank selector  
 Fuel filter  
 Drain  
 Throttle control  
 Mechanical fuel pump  
 Fuel servo  
 Mixture control  
 Electric fuel pump  
 Fuel manifold  
 To cylinders

The fuel filter has a drain valve that is opened by a control on the floor at the pilot's seat. The electric fuel pump, that is normally switched on during take-

off and landing, is controlled by a switch on the instrument panel. The mechanical fuel pump is driven by the engine. The fuel is then fed to the fuel servo, which, depending on the throttle control and mixture control positions, regulates the fuel flow to the engine. From the servo the fuel passes to the fuel manifold that divides the fuel to the four injection valves.

### The tanks

The wing tanks on this type of aircraft are integral (“wet wing”), meaning that the wing skins are sealed at the joints and rivets, and provide space for the fuel. Each tank is equipped with a drain valve at its rear lower area. The tanks have separate vents and sunken filler caps. The tank outlets are located at the rear and are equipped with finger strainers.



Each tank is traversed by two ribs which, in addition to the design of the pierced framework, also has interconnection holes drilled in the bottom edges to facilitate fuel flow between the pockets and to prevent any water present from becoming trapped. The side walls of the tanks are made with sealed ribs and the rear edge of the tanks are the wing spars. The suction part from the tank, i.e. the fuel pipes to the engine, are located at the rear of each tank, with the suction pipes about 10 mm above the skinning forming the bottom of the tank. The suction pipes are made in the form of downward bent pipes.

The drain points are located in the same areas as the suction pipes and the top of each drain valve is located at the same height as the suction pipes, about 10 mm above the skinning forming the bottom of the tank. The places in the tanks where these valves are located are at the lowest point while the aircraft is level. A small amount of water can collect at the bottom of each tank in the layer below the tops of the drain valves.

### Tank filler caps

Each wing tank is equipped with its own filler and a separate filler cap. The filler caps are sunken into a recess in the wing sheet metal structure in order to reduce aerodynamic drag. Sealing is by means of an outer and an inner O-ring, and the filler caps are closed and sealed by an eccentric handle on top of each filler cap.

On 12 February 1986 FAA<sup>2</sup> issued an AD<sup>3</sup> number 85-24-03 with a warning that water could enter the tanks if the filler caps fitted badly and/or the O-rings were worn. This Directive required obligatory inspection and checking of the filler cap sealing function every 100 flying hours, or annually.

### **1.7 Meteorological information**

According to the SMHI (Swedish Meteorological and Hydrological Institute) analysis:

Wind south-east 10 knots, good visibility, no clouds, temperature/dew point 22/8 °C, QNH 1018 hPa.

According to the pilot, the previous flight that same day had taken place in good weather conditions, with largely no clouds and no precipitation.

### **1.8 Aids to navigation**

Not applicable.

### **1.9 Communications**

The radio communications associated with the take off was normal.

As the aircraft was at such a low altitude when the engine malfunction occurred, the pilot did not have time to transmit an emergency message by radio. However he did contact the ARCC by telephone after the emergency landing.

### **1.10 Aerodrome information**

Sjöbo airfield status was in accordance with the KSAB manual Svenska Flygfält (Swedish Airfields). All the surfaces at the airfield – runway, taxiways and aircraft stands – are of grass with varying degrees of evenness and quality.

### **1.11 Flight recorders and voice recorders**

None. Not required.

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<sup>2</sup> Federal Aviation Authority

<sup>3</sup> AD: Airworthiness Directive

## 1.12 Accident site and aircraft wreckage

### 1.12.1 Accident site

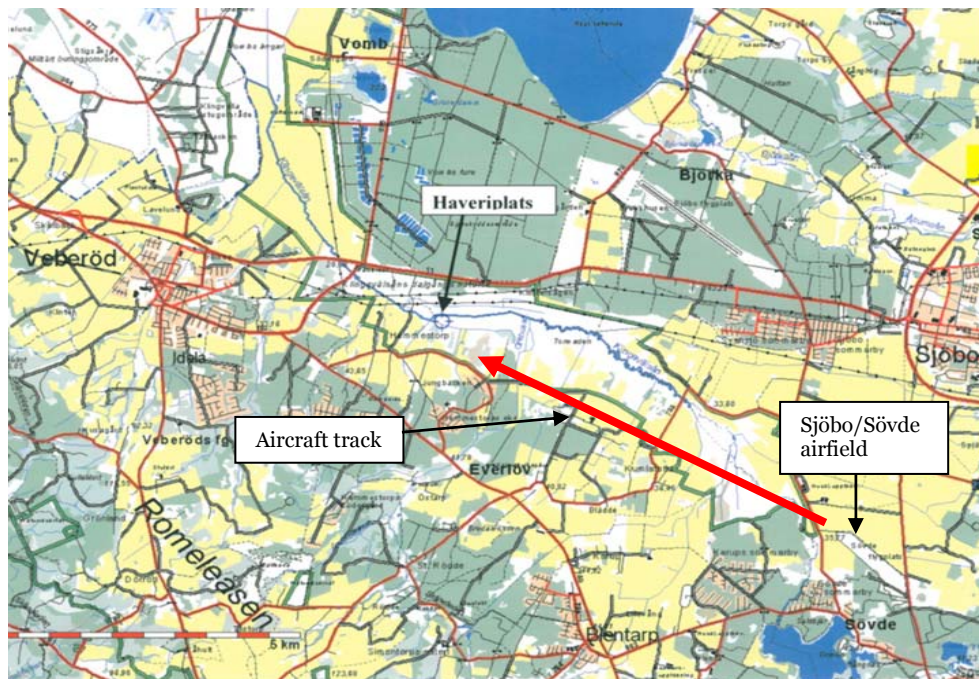


Fig. 1. Accident site

### 1.12.2 The aircraft



Fig.2. The aircraft after the emergency landing.

The aircraft suffered the following damage in the emergency landing:

- Skin damage to the left wing
- Skin damage to the right tailplane
- Damaged landing gear doors
- Tips of propellers broken off
- Structural damage to the fuselage

### **1.13 Medical information**

Nothing indicates that the mental and physical condition of the pilot was impaired before or during the flight.

### **1.14 Fire**

Not applicable

### **1.15 Survival aspects**

#### *1.15.1 General*

According to the pilot the emergency landing was controlled. The surrounding terrain around Sjöbo and on the approach to the area of the emergency landing mainly consists of open ground of various kinds. Due to the low altitude when the engine started to malfunction, the pilot had no other choice than to select the open area that was in front of him. The location of this area, with marshy grassland meant that the last part of the retardation was very strong as the aircraft wheels sank into the surface.

The risk of fire can in the case of this emergency landing be assessed as negligible, considering the type of ground and the absence of material that could generate sparks. The ground was firm enough for the aircraft wheels to roll to some extent, which prevented digging in and possible overturning as a result.

The Emergency Locator Transmitter (ELT) of type Pointer 3000 was not activated in the accident.

#### *1.15.2 Actions by the rescue services*

The local rescue services arrived at the accident site about 42 minutes after the accident occurred. The personnel could see that the pilot had left the aircraft without assistance and was unhurt. The rescue services then secured the aircraft wreckage, taking into account the possibility of fuel leakage.

### **1.16 Tests and research**

#### *1.16.1 Examination of the engine*

The engine was removed from the aircraft wreckage and sent under SHK supervision to an authorised engine workshop for examination. An earlier inspection had shown that the engine had no externally visible damage or suffered any other effects from the accident. For the examination, the engine was installed on a test bench for checking and test running, with the following results:

- After starting, the engine would only run at 1200-1400 rpm. When the throttle was advanced vibration occurred and the rotation speed reduced.
- After 5-10 minutes at 1200-1400 rpm a further attempt was made to push the throttle forward to increase the power. The engine responded very slowly, but gradually increased speed to 2200 rpm after some time. After reaching 2200 rpm an attempt was made to increase the

speed further, which was found to be impossible, without vibration and a reduction of the rpm. At this point the testing finished for the day.

- The next day the engine was started and renewed attempts were made. The engine now ran normally and a complete engine test could be performed without difficulty. The test produced normal values.

The conclusions arrived at by the engine workshop were that either some foreign substance or dirt had entered the fuel system, or else the fuel was polluted or contained water. No other fault or abnormality could be found during examination of the engine.

#### 1.16.2 Fuel analyses

At the request of SHK samples of the fuel were taken from the aircraft after the accident. Altogether five samples were taken, from the following locations:

- Gascolator (fuel filter) (1)
- Servo valve (flow controller) (2)
- Left wing tank (at the drain point) (3)
- Right wing tank (at the drain point) (4)
- Injector (fuel distributor) (5)

#### Remarks

The figures in parentheses relate to the numbers of the sample bottles in accordance with Figure 3.



Fig.3. Fuel samples.

While collecting the fuel samples, according to the technician at the site, a fluid layer could be discerned in the sample taken from the injector. The method of taking this sample was to disconnect the fuel line from the servo to the injector and then start the electric pump. The sample contained a clearly visible amount of fluid with a higher density than could be seen at the bottom of the sample bottle.

Samples were also taken from the fuel in the storage tank at Sjöbo airfield, where the aircraft had been refuelled before the accident (6). The fuel in the storage tank was of Hjälmco Oil Avgas 91-96 UL type. All the samples were then sent to Bodycote at Linköping for examination and analysis.

Due to the variations in the amounts of fuel, the samples were analysed to different extents. Samples 2 and 5 were of a different colour to the other samples, which were all colourless. The analysis of sample 2 (light blue colour) showed that it included leaded petrol, probably 100LL. Sample 3 (blue-green colour) also probably included leaded petrol but the amount of the sample was too small for the lead content to permit analysis.

The analyses showed no abnormal contaminants in any of the samples. Examination of the chemical structure (by means of Gas Chromatography) indicated however some heavier fractions, which could imply a mixture of about 10% road vehicle petrol. The water amounts in all the fuel samples were normal (<50 mg/kg), apart from the sample taken from the injector, where the amount of water was 70 mg/kg.

Taken together, the results of the examination showed that the fuel in the accident aircraft probably consisted of a mixture of three different types of petrol, 91-96 UL, 100 LL and road vehicle petrol.

### 1.16.3 The engine manufacturer

After contacting the NTSB<sup>4</sup> SHK made contact with the engine manufacturer, Lycoming, in the USA. The company was provided with the facts of the circumstances surrounding the accident and information concerning the fuel analyses that had been performed. SHK asked the opinion of the manufacturer, primarily concerning the following questions:

- Would the mixtures of fuels that were found be able to cause engine malfunction of the type that happened during the accident?

*"The first two fuels, 100 LL and 91-96 UL, should operate the engine normally. 10 % of car fuel may or may not be good. If it's low octane, 87 or 89, even at 10 % it shouldn't be noticeable".*

- How was water able to enter the engine via the servo and the fuel distributor?

*"The inlet finger screen in the fuel servo injector is designed not to pass the specific gravity of water. However, if there is enough water in the system it could activate the by-pass spring in the fuel servo injector inlet finger screen and allow the water-contaminated fuel to get inside the servo."*

- If water has entered via the servo, how has this affected the performance and function of the engine?

*"When water gets here it screws up the diaphragms and they don't know how to meter this mixture and the engine will lose power."*

Put simply, the above means that according to the manufacturer the fuel mixture was not important, but if the fuel contained a large proportion of water the bypass function of the servo could be activated and the fuel/water mixture enters the servo and causes loss of power.

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<sup>4</sup> NTSB: National Transport and Safety Board. The equivalent of SHK in the USA.

#### 1.16.4 Examination of the fuel system

At the request of SHK the fuel system was completely dismantled and examined in an authorised aircraft workshop. Nothing incorrect or abnormal could be found during the examination. Apart from wear and a normal amount of contaminants, nothing was found that could be considered to have affected the supply of fuel to the engine.

The fuel filter and the electric fuel pump were also examined and found to be in normal condition.

#### 1.16.5 Examination of the fuel tanks and filler caps

The right side fuel tank showed clear evidence that the filler cap had previously been opened and that leaks in the sheet metal joints had been repaired by applying sealing compound. This compound was not of the correct quality and had therefore flaked and come loose. The underside of the wing also showed clear signs of fuel leakage, with stains from the fuel dye. Both fuel tanks had free passage between the baffles and the ribs.



Fig. 4. Right tank filler cap O-ring.

The fit and sealing capability of the filler caps were tested. The left filler cap fit well and water placed in the recess around the cap did not pass through the seal. The right filler cap did not fit so well in its opening and water placed in the recess around the cap made its way quite quickly through the seal and down into the fuel tank.

On checking the condition of the O-ring it was found that it had large drying out cracks and wear. According to the inspection report from the technical maintenance organisation that was responsible for the aircraft, the O-rings had been checked in accordance with AD 85-24-03.

### 1.16.6 Storage tank installation



Fig.5. Storage tank installation at Sjöbo/Sövde airfield.

The local flying club at Sjöbo/Sövde airfield is responsible for the operation and maintenance of the storage tank installation at the airfield. The tank is drained once per week and the fuel filter is drained before the first refuelling each day. When fuel is sold, it is the pilot concerned who manages the refuelling him/herself and decides how much fuel to take. It is clearly stated on the installation that the fuel type is 91-96 UL.

The tank is installed sloping down towards the bottom drain, which is located at the lowest point at the rear of the tank. Extraction of fuel - i.e. when aircraft are being refuelled - takes place through a float inside the tank.

From the flying club refuelling and draining diary for that particular day it can be read that the filter had been drained that morning and that other aircraft had refuelled before and after the accident aircraft was refuelled.

### 1.17 Organisational and management information

Not applicable.

### 1.18 Other aspects

#### 1.18.1 Equal opportunities aspects

This event has also been examined from the point of view of equal opportunities, i.e. against the background that there are circumstances to indicate that the actual event or its effects were caused by or influenced by the women and men concerned not having the same possibilities, rights or obligations in various respects. Such circumstances were however not found.

#### 1.18.2 Environmental aspects

The area where the emergency landing took place is a protected water area. The rescue services therefore guarded the accident site so as to prevent damage to the environment in the form of fluid release. Most of the contents of the aircraft fuel tanks were also emptied, to prevent possible leakage. No disturbance to the environment could however be noted.

## **2 ANALYSIS**

### **2.1 The flight**

#### *2.1.1 General*

The pilot was very familiar with his aircraft. He had owned it for several years and must therefore be considered as having a good knowledge of the aircraft characteristics and technical systems. During flights before the accident flight no notifications or abnormal observations arose in respect of the operation of either the aircraft or the engine.

The take-off and climb out were carried out in accordance with normal procedures, and when the engine lost power the pilot, by his own account, took measures in accordance with the aircraft emergency check list, after which a controlled emergency landing was performed. This type of engine problem, with a gradual reduction of power, can, according to SHK, indicate problems with the supply of fuel to the engine. There were absolutely no indications of other possible causes of the engine problem (ignition system, knocking, mechanical faults, etc.).

#### *2.1.2 Examination of the engine*

The technical examination of the engine showed no sign of damage or any other abnormality that could have affected its operation. The test runs that were carried out indicated that the engine problem was caused by the fuel.

The statement by the engine workshop was clear that the fuel had somehow been contaminated – by contaminants or water – and thereby caused the loss of power. The continuation of the SHK investigation was therefore concentrated on the fuel and its supply.

The examination of the fuel system that was subsequently carried out provided no indication of any fault or abnormality that could have affected the delivery of fuel to the engine.

### **2.2 The fuel**

#### *2.2.1 Storage tank installation*

During its time on the ground the aircraft was refuelled by the pilot. According to the interviews, the pilot stated that after refuelling he had drained (some fuel out of– Translator's addition) the aircraft fuel tanks. The samples that were taken from the storage tank did not show any contaminants or water in the fuel, so it is unlikely that the fuel that was added during refuelling could have caused the engine to lose power. This was supported by the fact that other aircraft were refuelled before and after the accident aircraft and no problems were subsequently reported.

The analysis of the fuel sample from the storage tank showed completely normal values, so according to SHK this can be ruled out as contributing to the accident.

#### *2.2.2 The fuel in the aircraft*

The analyses of the aircraft fuel that were carried out showed that there was a mixture of different types of petrol in the fuel tanks. However, the three types

of petrol that could be identified, according to the engine manufacturer could not have caused the engine to lose power, so that this mixture can also be eliminated as the cause of the accident.

The fuel sample from the line to the injector, located immediately upstream of the cylinders, did however contain water. The amount of water found in the analysis was not a significant volume, but could however have decreased due to the relatively long time between taking the sample and analysing it. According to the technician who took the samples from the aircraft, the amount of water at the time of taking the sample was clearly visible as a layer in the bottle. SHK therefore finds it very probable that at the time of the loss of power there was a significant amount of water present.

### 2.2.3 *The aircraft fuel tanks*

On examination of the aircraft fuel tanks it was found that the filler cap of the right wing tank did not provide sufficient sealing. Water that was placed in the recess made its way in a relatively short time through the seal and down into the tank. Considering the condition of the O-ring, SHK believes that it is unlikely that the measures prescribed by AD 85-24-03 were actually carried out.

The design of the tank, with the top of the drain valve about 10 mm above the inner bottom of the tank, allowed a certain amount of water to collect at the bottom of the tank. In the normal flight attitude – or when taxiing on a smooth surface – this has no effect on the fuel supply to the engine since the top of the suction pipe lies at about the same level in the tank.

It can however be said that it is completely possible to drain the tanks without getting all the water out. Normally this does not matter, since no fuel is taken from a level lower than 10 mm in the tank.

## 2.3 **Loss of power**

### 2.3.1 *General*

The weather on the day in question was fine and without precipitation, both during the earlier flight and in the area surrounding Sjöbo. It is therefore probable that any water in the tank was already there before refuelling. Taking into account the inadequate sealing of the right side filler cap, water could have leaked continuously down into the tank over a long period, in connection with precipitation. After refuelling the draining that was performed probably did not take away completely any water that could have been present in the bottom of the tank.

The drain point is located at the rear edge of the tank, which is the lowest part when the aircraft is level. The parking area beside the storage tank consists however of an uneven grassed area. It is therefore entirely possible that the aircraft – and thereby the drain – was parked tilted forward, meaning that the drain point was no longer the lowest point and therefore no water was drained out.

### 2.3.2 *Taxying out and take-off*

According to the pilot, taxiing out and take-off took place with the right tank selected. When taxiing out and taking off on the partially uneven grassed surface, an amount of remaining water from the right tank could enter the fuel suction pipe. The time period for such a volume of water to reach the vital

parts of the fuel system can be estimated as the approximately 3-4 minutes during which the engine ran faultlessly.

If a sufficient amount of water gets into the fuel servo, according to the manufacturer a by-pass function is activated. This probably happened in the case of the accident, and the water/fuel mixture could then continue into the engine via the manifold, with power loss as a result.

### **3 CONCLUSIONS**

#### **3.1 Findings**

- a)* The pilot was qualified to perform the flight.
- b)* The aircraft had a valid Certificate of Airworthiness.
- c)* No faults could be found in the engine.
- d)* No faults could be found in the fuel system.
- e)* The fuel consisted of a mixture of three different types of petrol, including road vehicle petrol.
- f)* Analysis showed that the fuel at the injector contained water.
- g)* Water could collect in the bottom of the wing fuel tanks.
- h)* The filler cap for the right wing tanks did not seal sufficiently.

#### **3.2 Causes of the accident**

The accident was probably caused by deficient maintenance, resulting in an unsealed right wing tank filler cap, which meant that water could have leaked into the aircraft's wing tank.

### **4 RECOMMENDATIONS**

None.