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## **Report RL 2000:43e**

**Incident involving aircraft SE-KFP  
in airspace between Sundsvall, Y county  
and Gävle, X county, Sweden,  
on 3 February 2000**

### **Case L-008/00**

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Translated by Tim Crosfield

From the original Swedish at the request of the Board of Accident Investigation.  
In case of discrepancies between the English and the Swedish texts, the Swedish text is to be considered the authoritative version.

2000-12-22

L-008/80

Swedish Civil Aviation Administration

601 79 NORRKÖPING

**Report RL 2000:43e**

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The Board of Accident Investigation has investigated an incident that occurred on 3 February 2000 in the airspace between Sundsvall, Y county and Gävle, X county, involving an aircraft with registration SE-KFP.

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.

Olle Lundström

Monica J Wismar

Henrik Elinder

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<i>Aircraft: registration, type Class/airworthiness</i>	<b>SE-KFP, Beech B200C</b> Normal, valid certificate of airworthiness
<i>Owner/Operator</i>	SOS Flygambulans AB, Säve flygplatsväg, SE-423 73 Säve
<i>Date and time</i>	03-02-2000, between 05.30h and 05.40h in darkness <i>Note:</i> All times in the report in Swedish normal time (SNT) = UTC + 1 hour
<i>Place of occurrence</i>	Airspace between Sundsvall, Y county, and Gävle, X county, at or below FL 190 approx. 5 800 m above sea level
<i>Type of flight</i>	Ambulance flight
<i>Weather</i>	According to SMHI analysis for Gävle/Sandviken airport 06.12 h: Wind 250°/05 kts, Visibility > 10 km, Clear sky, temp/dewpoint -9/-12 °C, QNH 1002 hPa.
<i>Persons on board: crew</i>	2/1
<i>passengers</i>	2
<i>Injuries to persons</i>	None
<i>Damage to aircraft</i>	No damage
<i>Other damage</i>	No damage
<i>Commander:</i>	
<i>age, certificate</i>	37 yrs, B with instrument rating
<i>total flying time</i>	2 716 h of which 2000 h on type
<i>flying hours previous 90 days</i>	160 h, all on type
<i>number of landings previous 90 days</i>	141
<i>Co-pilot</i>	
<i>age, certificate</i>	49 yrs, B with instrument rating
<i>total flying time</i>	6 244 h, of which 543 h on type
<i>flying hours previous 90 days</i>	170 h, all on type
<i>number of landings previous 90 days</i>	140
<i>Nurse</i>	Employed by the aircraft company since 1999

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The Board of Accident Investigation (SHK) was notified on 9 February 2000 that an incident involving an aircraft with registration SE-KFP occurred in the airspace between Sundsvall, Y county, and Gävle, X county, on 3 February 2000 between 05.30 h and 05.40 h.

The incident has been investigated by SHK represented by Olle Lundström, Chairman, Monica J Wismar, Chief Investigator flight operations and Henrik Elinder, Chief Technical Investigator, aviation.

The investigation was followed by Max Danielsson, Swedish Civil Aviation Administration.

## Summary

The aircraft took off from Kiruna at 04.23 h for an acute ambulance flight with a patient to Stockholm/Bromma airport. A doctor was also on board. The flight took place at flight level 190 (approximately 5 800 m altitude) where the outside air temperature was between  $-41$  and  $-37$  °C. When the aircraft had passed Sundsvall the pilots noted that the fuel flow to the left engine started to oscillate and that thrust from the engine was decreasing. Shortly thereafter the engine stopped. It was decided to continue the flight to Stockholm on the right engine alone.

Just north of Gävle the fuel flow to the right engine also started to oscillate and thrust from this engine to decrease. The crew then declared an emergency and requested clearance to land at Gävle/Sandviken airport. During the flight there it was possible to restart the left engine but only limited thrust was obtained. After touchdown the pilots obtained normal reverse thrust from both engines. The aircraft subsequently taxied to the airport building where the engines were shut down following normal routines. The landing took place at 06.17 h.

No technical fault has been found in the aircraft. Before the flight and following full refuelling the aircraft had been parked in a warm hangar for about 12 hours. Drainage had not thereafter been carried out according to current regulations.

The incident was probably caused by water in the fuel turning to ice or ice crystals during the flight in an area of low outside air temperature, temporarily causing a pressure drop or a blockage in the engine fuel system.

## Recommendations

None.

## 1 FACTUAL INFORMATION

### 1.1 History of the flight

The aircraft landed on 2 February 2000 at 13.07 h at Umeå airport. Before being placed in a heated hangar for the night it was filled with 450 litres JET A1, Statoil, in the wing tanks. To allow space for the cold fuel to expand in the tanks as the aircraft became warm in the hangar, the tanks were not entirely filled, termed “hangar fuelling”. The aircraft then stood parked in the hangar, which was heated to about +5°C, until 01.15 h next morning when it was taken out for a flight to Kiruna. During the flight to Kiruna the outside air temperature was between –41 and –37°C. The aircraft landed in Kiruna at 02.34 h and the wing tanks were filled with 492 litres JET A1, Shell.

The aircraft then took off from Kiruna at 04.23 h for an acute ambulance flight with a patient to Stockholm/Bromma airport. On board were also a doctor and a nurse. The flight took place at flight level (FL) 190 (approx. 5 800 m altitude). When the aircraft had passed Sundsvall the pilots noted that the fuel flow to the left engine was starting to oscillate and that thrust from the engine was decreasing. Shortly after this the engine stopped. Since the weather was favourable and in view of the patient’s acute medical status, the crew decided to continue the flight on the right engine alone to Stockholm, which then had the nearest open airport. Steps were taken according to the emergency checklist to restart the left engine but to no avail. At the same time altitude decreased to FL 150 (approx. 4 550 m) where the temperature was –33 to –29°C.

Just north of Gävle the fuel flow to the right engine also started to oscillate and the thrust from that engine decreased. The crew then notified flight control that there was an emergency situation and requested clearance to proceed to the nearest airport for landing, which was Gävle/Sandviken airport. During the flight there it was possible to restart the left engine but only limited thrust was obtained. The crew then had the airfield in sight and managed largely with height loss alone to reach the field and land on runway 18. After touchdown on the runway the pilots obtained normal reverse thrust from both engines. The aircraft was then taxied in to the airport building where the engines were shut down according to normal routines. Landing was at 06.17 h.

The staff at Gävle/Sandviken airport air-traffic control were informed of the situation by Arlanda flight control at 06.09 h. They acted according to the current emergency lists for “Crash Danger” and the airport fire and rescue organisation was alerted before the aircraft landed. An alarm was also sent to the Emergency Rescue Services.

After landing the patient, the nurse and the doctor were transported to Huddinge hospital in Stockholm in a road ambulance.

### 1.2 Injuries to persons

	<i>Crew</i>	<i>Passengers</i>	<i>Others</i>	<i>Total</i>
Fatal	–	–	–	–
Serious	–	–	–	–
Minor	–	–	–	–
None	3	2		5
Total	3	2	–	5

**1.3 Damage to aircraft**

No damage.

**1.4 Other damage**

No damage.

**1.5 Personnel information****1.5.1 Commander**

The commander was 37 years old at the time and had a valid B Licence with instrument rating.

*Flying hours*

<i>previous</i>	<i>24 hours</i>	<i>90 days</i>	<i>Total</i>
All types	3:20	160	2 716
This type	3:20	160	2 000

Number of landings this type previous 90 days: 141.

Flight training on type concluded 31 May 1996.

Latest periodic flight training (PFT) carried out 18-01-2000 on Beech 200.

**1.5.2 Co-pilot**

The co-pilot was 49 years old at the time and had a valid B Licence with instrument rating.

*Flying hours*

<i>previous</i>	<i>24 hours</i>	<i>90 days</i>	<i>Total</i>
All types	3:20	170	6 244
This type	3:20	170	543

Number of landings this type previous 90 days: 140.

Flight training on type concluded on 30 March 1999.

Latest periodic flight training (PFT) carried out 27-09-1999 on Beech 200.

**1.5.3 Other crew members**

The crew included a nurse. She was appointed by the company in 1999 and underwent emergency training during November 1999.

**1.5.4 Pilots' working hours**

During the week prior to the event the pilots had had the following schedules:

	Commander	Co-pilot	Number of flights
28-01-2000	08.15–16.55	Off duty	5
29-01-2000	Off duty	Off duty	
30-01-2000	Off duty	Off duty	
31-01-2000	13.00–21.50	13.00–21.50	4
01-02-2000	09.30–12.35	09.30–12.35	2
02-02-2000	09.00–13.40	09.00–13.40	3
03-02-2000	00.30–02.34	00.30–02.34	2

## 1.6 Aircraft information

### 1.6.1 General

#### AIRCRAFT:

<i>Manufacturer:</i>	Beech Aircraft Corp.
<i>Type:</i>	B200C
<i>Serial number:</i>	BL 132
<i>Year of manufacture:</i>	1988
<i>Gross weight:</i>	Max authorised 5 670 kg, actual on landing 5 126 kg (11 300 lbs.)
<i>Centre of gravity:</i>	Within permitted limits
<i>Total flying time:</i>	7 691 h
<i>Number of cycles:</i>	9 486
<i>Flying time since latest inspection:</i>	202 h
<i>Fuel loaded before event:</i>	JET A1

#### ENGINE:

<i>Manufacture:</i>	Pratt & Whitney, Canada
<i>Model:</i>	PT6A-42
<i>Number of engines:</i>	2

ENGINE:	<i>No 1</i>	<i>No 2</i>
<i>Total operating time, hrs</i>	7 566	7 510
<i>Operating time since overhaul</i>	2 667	2 792
<i>Cycles after overhaul</i>	3 195	3 355

#### PROPELLER

<i>Manufacture:</i>	Hartzell HC-B3TN-3N
<i>Operating time since latest overhaul</i>	
<i>Propeller 1:</i>	1 430 hrs
<i>Propeller 2:</i>	1 430 hrs

The aircraft had a valid Certificate of Airworthiness.

### 1.6.2 Fuel system

The aircraft type has two fuel tanks in each wing (Main tank and Auxiliary tank) and a tank in each nacelle. It is possible to transfer fuel from the system of one side to that of the other (cross-feed). Fuel is pumped from the tanks to each engine's fuel system by an engine-driven boost pump in each wing. Each fuel system contains three separate fuel filters:

#### 1. Firewall fuel filter

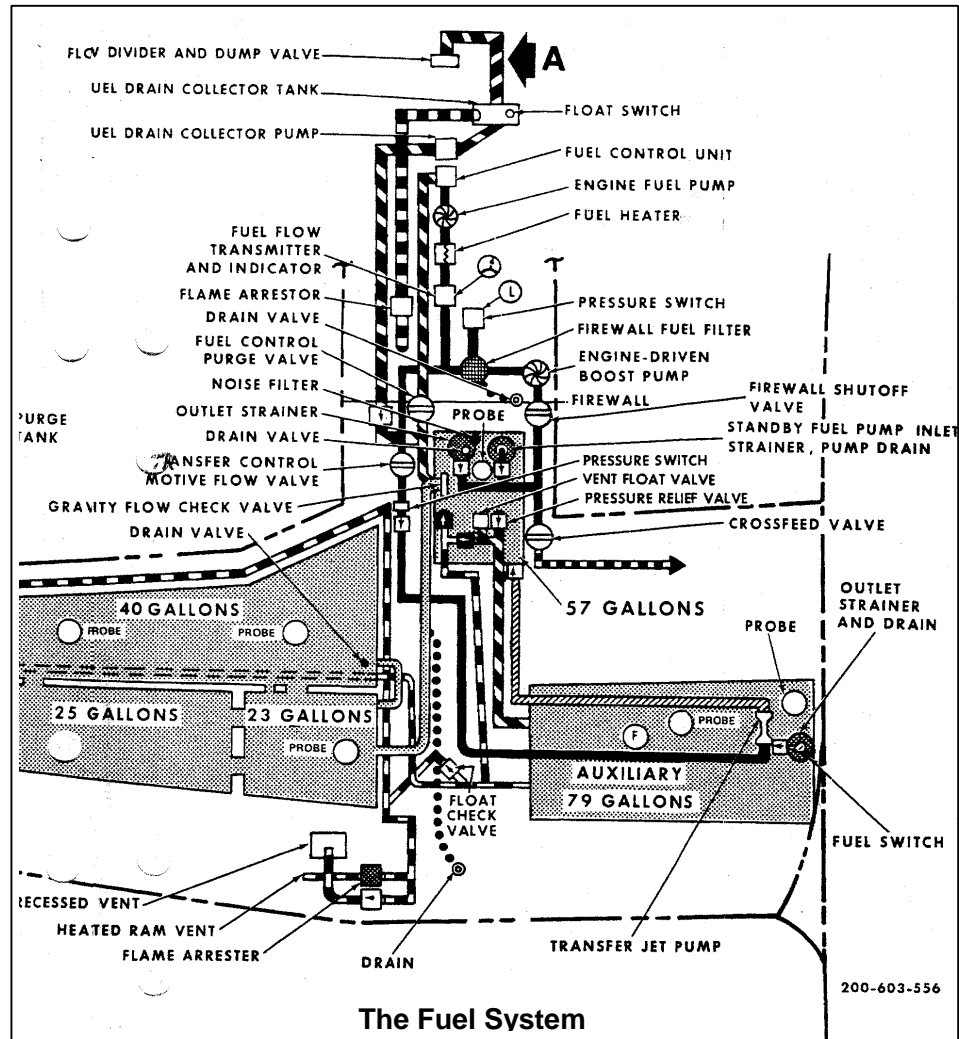
Metal mesh filter placed on the engine gondola firewall after the engine-driven boost pump. Replacement interval 200 flying hours.

#### 2. Inlet screen

Metal mesh filter, placed on the engine before the engine fuel pump. Replacement interval 400 flying hours.

#### 3. Outlet filter

Paper filter placed on the engine after the engine fuel pump. Replacement interval 400 flying hours (Some time before the event the aircraft manufacturer had prolonged the replacement interval for the outlet filter from 200 flying hours to 400).



## 1.7 Meteorological information

At the time of the incident a cold front was moving in a southerly direction over Götaland. In Upper Norrland the weather was cold and in most places clear.

According to SMHI analysis:

Umeå 01.30 h wind 310°/09 kts, visibility >10 km, clear sky, temp./dewpoint -12/-19 °C, QNH 992 hPa

Kiruna 02.30 h wind 310°/02 kts, visibility >10 km, clear sky, temp./dewpoint -11/-17 °C, QNH 988 hPa

Kiruna 04.20 h wind 310°/05 kts, visibility >10 km, clear sky, temp./dewpoint -10/-16 °C, QNH 989 hPa

Gävle 06.12 h wind 250°/05 kts, visibility >10 km, clear sky, temp./dewpoint -9/-12 °C, QNH 1002 hPa.

Outside air temperatures on the Kiruna–Gävle leg were:

FL 190 -41 (in the north) to -29°C

FL 150 -33 (in the north) to -37°C

### 1.8 Aids to navigation

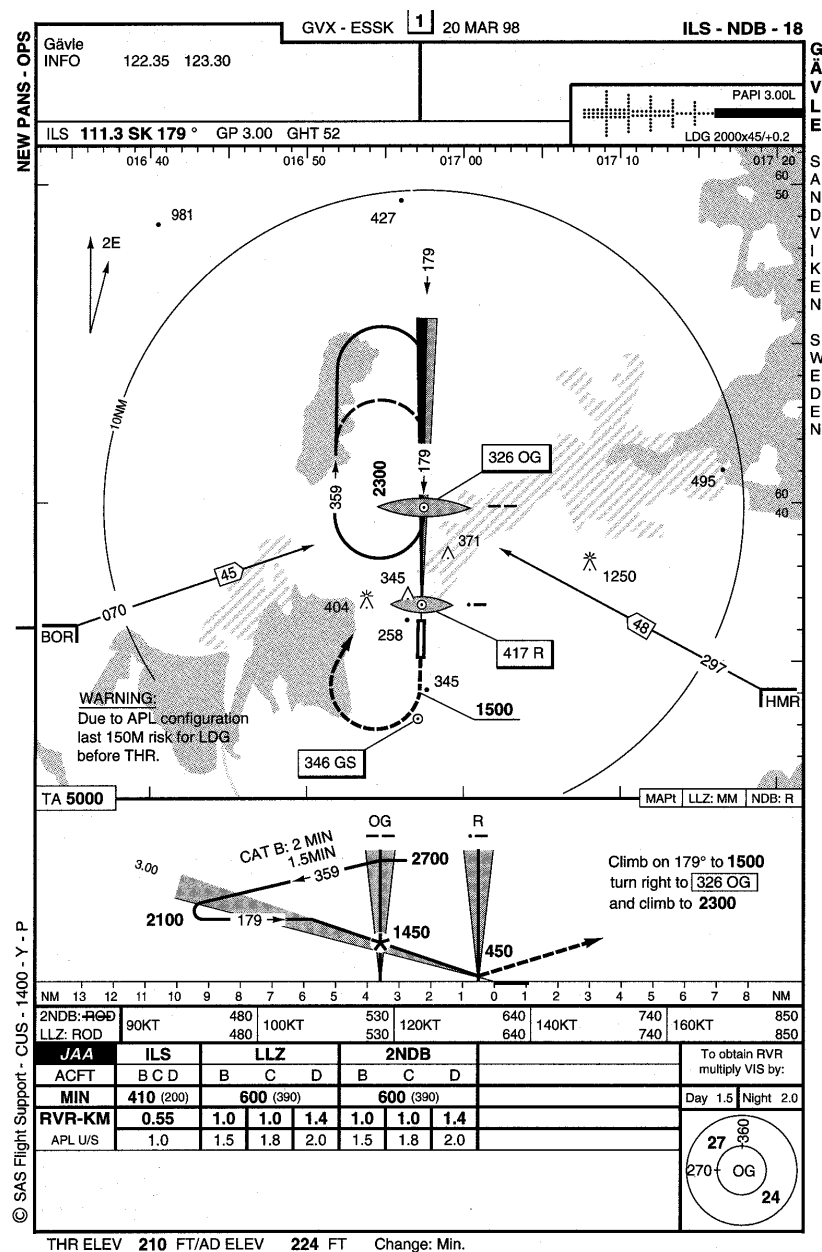
Gävle/Sandviken airport runway 18 is equipped with an instrument landing system (ILS). The approach and landing were conducted visually.

### 1.9 Communications

The pilots informed the controller at Sundsvall air traffic control area of the engine failure on the left engine and the decision to continue the flight to Stockholm. When thrust on the right engine decreased the aircraft was in the Stockholm air traffic control area. The pilots reported the situation to the air traffic controller and announced that it was an emergency.

### 1.10 Aerodrome information

Gävle/Sandviken airport had status according to AIP-Sverige/Sweden.



**1.11 Flight recorders**

None. Not required.

**1.12 Incident site and aircraft***1.12.1 Incident site*

The incident occurred in the airspace between Sundsvall and Gävle at or below FL 190.

*1.12.2 The aircraft*

The aircraft was not damaged.

**1.13 Medical information**

Nothing indicates that the mental or physical condition of the crew had been impaired before or during the flight. Earlier that evening they had had some hours sleep in Umeå.

**1.14 Fire**

There was no fire.

**1.15 Survival aspects**

The nurse and the physician together prepared the cabin for an emergency landing.

**1.16 Tests and researches***1.16.1 Technical investigation*

SHK was not informed of the incident until six days later. The introductory technical investigation of the aircraft on site in Gävle thus took place without the SHK's presence.

*1.16.2 The engine fuel system*

All fuel filters in the fuel system were checked for impurities and the presence of free water. In addition, fuel tests were taken from all filter housings and analysed on site for water content using water indicator ampoules. No fuel samples were taken for supplementary laboratory analysis. The results are tabled below:

<i>Filter</i>	<i>Left engine</i>	<i>Right engine</i>
Firewall fuel filter (Metal filter)	Normal degree of impurity No free water Water in fuel	Normal degree of impurity No free water No water in fuel
Inlet screen (Metal filter)	Normal degree of impurity No free water Water in fuel	Normal degree of impurity No free water No water in fuel
Outlet filter (Paper filter)	Normal degree of impurity No free water Water in fuel	Normal degree of impurity No free water No water in fuel

When the nacelle tanks were drained a fairly small quantity of water was observed. After cleaning and replacement of fuel filters approximately 40 l of fuel were removed from each fuel system. Thereafter the engines were

test-run on the ground for approximately 20 minutes without any fault or faulty function being discovered.

#### 1.16.3 *Inspection*

Following the checks and measures as above the aircraft was flown empty to Göteborg/Säve airport, where a 200-hour inspection and extra tank cleaning were carried out. The work was followed up by a representative of the Swedish Civil Aviation Inspectorate. No fault or abnormal operation could be found.

#### 1.16.4 *Fuel quality*

When SHK was informed of the incident fuel samples were taken from the fuel storage installation used in Umeå and Kiruna and sent to SGS Sweden AB for analysis. The samples met all applicable quality demands for Jet A1. According to the technical documents, the storage installations in question had been drained according to the regulations in force.

#### 1.16.5 *Routines prior to the flight*

According to the airline company's instructions, all drainage valves (12) must be drained during the daily inspection. This was not done before the takeoff from Umeå and, moreover, appears not to have been the practice among all the pilots.

### 1.17 **Organisational and management information**

#### 1.17.1 *General*

SOS Flygambulans AB has its headquarters in Göteborg and carries out some 3 500 national and international sick transports and ambulance flights annually. The aircraft fleet consists of five specially equipped, twin-engined Beech Super King Air 200. The crew consists normally of two pilots and a nurse. Through an agreement with Norrland University Hospital a physician with special competence and a nurse are normally included for intensive transports.

#### 1.17.2 *Measures taken*

Certain criticisms have been directed by those involved towards the company regarding shortcomings in the routines for events of this nature. After the incident an analysis group in the company decided on the following measures, among others:

##### *With immediate effect:*

- fuel checks to be made daily before the first flight,
- the replacement interval for outlet filter to be shortened from 400 flying hours to 200,
- Anti-frost agent ("Prist") to be added to the fuel before night parking if there is a risk of ice crystal formation,
- When refuelling prior to night parking the inner tanks to be filled with at least 30–50 l fuel.

##### *To be done soonest in similar events:*

- carry out debriefing with the crew at their home base,
- call out extra personnel for planning,
- inform personnel via telephone chain,
- give written and oral information to predetermined persons within the organisation,
- send out press release with correct information,

- hold extra staff meeting regarding the safety issues arising.

*Note. When the pilots, after the incident, have begun to drain the fuel tanks according to the company's instructions free water in the fuel has been observed on more than one occasion.*

## **2 ANALYSIS**

### **2.1 Engine malfunctions**

Apart from a small amount of water in the aircraft's fuel system, no technical fault was found in the aircraft that could explain the failure of the left engine and the loss of thrust on the right engine. The fuel filters were soiled to the normal extent and after cleaning/replacing the filters and flushing the fuel systems both engines functioned without remark.

The engine problems arose after the aircraft during almost 3 hours had been flying at altitudes where the outside air temperature was between  $-30$  and  $-40^{\circ}\text{C}$ . In connection with the engine malfunctions the pilots noted that the fuel flow to the engines decreased. Everything therefore indicates that the engine malfunctions were caused by a fairly small amount of water in the fuel formed ice or ice crystals when the fuel was chilled at the low temperature. The ice then caused a pressure loss or a blockage in the fuel systems.

When the aircraft reduced altitude and was approaching Gävle where the ground temperature was substantially higher the water was probably re-absorbed in the fuel, which can explain why normal function was obtained on both engines after touchdown.

Contributing to the presence of water may have been that before the flight from Umeå the aircraft was refuelled with cold fuel and was then parked in a heated hangar for about 12 hours before being brought out for the flight. Water may have condensed in the tanks during that period and been absorbed in the fuel.

Moreover, it cannot be excluded that the aircraft on an earlier occasion may have been refuelled from an installation that had not been correctly maintained, and had thus taken on fuel with an excessive water content.

### **2.2 The flight**

Normal procedure for the failure of one engine on a multi-engined aircraft is to land as soon as is practically possible. SHK understands the pilots' choice to continue the flight despite the engine failure on the left engine. The nearest open airport was in Stockholm, and the other conditions for the flight were favourable. There was also an acute medical need to transport the patient rapidly to Stockholm/Bromma. The pilots probably judged the risk of suffering engine failure on the other engine as well to be minimal.

### **2.3 Operational routines**

As mentioned, the fuel system was not drained during the daily inspection before the flight from Umeå, which was a departure from the company's instructions. Since this appears to have been common among the company's pilots, a certain amount of water may have collected in the fuel system even before arrival at Umeå, without being detected. Whether draining would have revealed the presence of any water, thus preventing the incident is, however, uncertain.

The fact that it was not practice among all the pilots to follow the airline company's instructions on this aspect can be interpreted as a lack in the company's operational management. As mentioned in 1.17.2 the company's has, however, already taken measures to improve the situation.

### **3 CONCLUSIONS**

#### **3.1 Findings**

- a) The pilots were qualified to perform the flight.
- b) The aircraft had a valid Certificate of Airworthiness.
- c) After refuelling the aircraft stood parked for about 12 hours in a heated hangar.
- d) The aircraft was not drained before the flight, which was a departure from current regulations.
- e) Before the engine disturbances the aircraft flew for almost 3 hours in an area where the outside air temperature was between  $-30$  and  $-40^{\circ}\text{C}$ .
- e) No technical fault was found on the aircraft.
- f) A fairly small amount of water was found in the fuel system.
- g) Fuel samples taken from the two most recently used tank installations met the relevant specification.

#### **3.2 Causes of the incident**

The incident was probably caused by water in the fuel turning to ice or ice crystals during the flight in an area of low outside air temperature, temporarily causing a loss of pressure or a blockage in the engine fuel system.

### **4 RECOMMENDATIONS**

None.