

## *Final report RL 2021:05e*

**Accident at Visby Airport, Gotland County, on 19 June 2020 involving the aircraft SE-IMY of the model TB 10, operated by private individual.**

File no. L-48/20

19 May 2021

SHK investigates accidents and incidents from a safety perspective. Its investigations are aimed at preventing a similar event from occurring in the future, or limiting the effects of such an event. The investigations do not deal with issues of guilt, blame or liability for damages.

The report is also available on SHK's web site: [www.havkom.se](http://www.havkom.se)

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## General observations

The Swedish Accident Investigation Authority (Statens haverikommission – SHK) is a state authority with the task of investigating accidents and incidents with the aim of improving safety. SHK accident investigations are intended to clarify, as far as possible, the sequence of events and their causes, as well as damages and other consequences. The results of an investigation shall provide the basis for decisions aiming at preventing a similar event from occurring in the future, or limiting the effects of such an event. The investigation shall also provide a basis for assessment of the performance of rescue services and, when appropriate, for improvements to these rescue services.

SHK accident investigations thus aim at answering three questions: *What happened? Why did it happen? How can a similar event be avoided in the future?*

SHK does not have any supervisory role and its investigations do not deal with issues of guilt, blame or liability for damages. Therefore, accidents and incidents are neither investigated nor described in the report from any such perspective. These issues are, when appropriate, dealt with by judicial authorities or e.g. by insurance companies.

The task of SHK also does not include investigating how persons affected by an accident or incident have been cared for by hospital services, once an emergency operation has been concluded. Measures in support of such individuals by the social services, for example in the form of post crisis management, also are not the subject of the investigation.

Investigations of aviation incidents are governed mainly by Regulation (EU) No 996/2010 on the investigation and prevention of accidents and incidents in civil aviation and by the Accident Investigation Act (1990:712). The investigation is carried out in accordance with Annex 13 of the Chicago Convention.

## The investigation

SHK was informed on 19 June 2020 that an accident involving one aircraft with the registration SE-IMY had occurred at Visby Airport, Gotland County, on the same day at 12.35 hrs.

The accident has been investigated by SHK represented by Mr Mikael Karanikas, Chairperson until the 22<sup>nd</sup> of November 2020 and thereafter chaired by Mr Jonas Bäckstrand, Mr Tony Arvidsson, Investigator in Charge, and Mr Mats Trense, Operations Investigator.

Mr Regis Zimmermann has participated from France as accredited representative on behalf of BEA (Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile).

The accredited representative from France has been assisted by Ms Catherine Héreau as adviser from the type certificate holder Daher Aerospace.

Mr Deepak Joshi has participated from United States of America (USA) as accredited representative on behalf of the NTSB (National Transportation Safety Board).

The accredited representative from USA has been assisted by advisors from Parker Hannifin Corporation.

The investigation was followed by Magnus Axelsson and Nicklas Svensson of the Swedish Transport Agency.

The following organisations have been notified: European Aviation Safety Agency (EASA), EU-Commission, BEA, NTSB and the Swedish Transport Agency (Transportstyrelsen).

#### *Investigation material*

Interviews have been conducted with the pilot, the passenger and the air traffic controller who were in position at the accident. The accident site and the aircraft have been investigated. Reference assessment to measure the temperature in the brake disc during different braking has been performed as a special technical examination.

A meeting with the interested parties was held on 11 February 2021. At the meeting SHK presented the facts established during the investigation, available at the time.

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Aircraft:	
Registration, type	SE-IMY, TB Series
Model	TB-10
Class, Airworthiness	Normal, Certificate of Airworthiness and Valid Airworthiness Review Certificate (ARC) <sup>1</sup>
Serial Number	656
Owner	Gotland's Flying Club
Time of occurrence	19 June 2020, 12.35 hrs in daylight Note: All times are given in Swedish daylight saving time (UTC <sup>2</sup> + 2 hours)
Place	Visby Airport, Gotland County, (position 5938N 01819E, 44 metres above mean sea level)
Type of flight	Private
Weather	According to Metar: wind 060 degrees 11 knots, CAVOK <sup>3</sup> , temperature/dew-point +22/+16°C, QNH <sup>4</sup> 1013 hPa
Persons on board:	2
crew members including cabin crew	1
passengers	1
Injuries to persons	None
Damage to aircraft	Substantially damaged
Other damage	None
Pilot in command:	
Age, licence	25 years, CPL <sup>5</sup>
Total flying hours	184 hours, of which 4 hours on type
Flying hours previous 90 days	8 hours, of which 4 hours on type
Number of landings previous 90 days	25, of which 11 on type

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<sup>1</sup> ARC – Airworthiness Review Certificate.

<sup>2</sup> UTC – Coordinated Universal Time.

<sup>3</sup> CAVOK – Ceiling and Visibility OK.

<sup>4</sup> QNH – Barometric pressure at mean sea level.

<sup>5</sup> CPL – Commercial Pilot License.

## **SUMMARY**

The intention was to carry out a private flight with an acquaintance over Gotland.

After the landing, the pilot let the aircraft roll out with the intention of leaving the runway at runway end 03 to taxi back to Gotland's Flying Club via the taxiway system. Approximately 40 seconds after the landing, the pilot received clearance from the tower to turn around on the runway. He stopped temporarily at runway 10/28 and then taxied all the way to Gotland's Flying Club.

Just before parking, the pilot and the passenger got the first indication that there was a problem when they smelled a faint smoke odour. At parking, the pilot saw smoke and then flames that broke out in front of the wing. The pilot ordered the passenger to evacuate.

The pilot fought the fire at the left landing gear leg using a fire extinguisher. The municipality's fire and rescue service arrived at the accident site and extinguished the fire.

At the examination of the aircraft no technical faults were found that could have caused the fire. However, there were traces of an oil stain in the hangar at the place where the caliper was positioned when parking.

During the investigation, it has emerged that the brake hose that was installed has not been included in the maintenance program and that the hose probably exceeded its calendar time by a large margin.

SHK:s reference taxiing showed that with normal braking or with a light application of the brakes it was relatively easy to reach a temperature on the brake disc that could ignite the hydraulic oil.

SHK conclude that the probable cause of the fire is that atomized oil has sprayed onto the heated brake disc and ignited. The fire has after that spread to tires, wheel covers and other combustible materials around the landing gear.

The accident was probably caused by the condition of the brake hose causing an oil leak, which in combination with a hot brake disc caused the fire.

The fact that the hose's calendar time was not considered when establishing the new maintenance program can be seen as a shortcoming in the routines of the airworthiness organisation. This has resulted in that the maintenance tasks prescribed by the type certificate holder has not been evaluated by the airworthiness organisation.

## **Safety recommendations**

None.

## **1. FACTUAL INFORMATION**

### **1.1 History of the flight**

#### **1.1.1 *Preconditions***

The intention of the pilot was to carry out a private flight with an acquaintance over Gotland. The aircraft was parked in the hangar at Gotland's Flying Club before it was taken out for flight. The flight lasted 25 minutes and it was nice weather with light winds from the northeast. A landing was carried out with a planned touch and go. Thereafter a final landing at Visby Airport were performed, on runway 03.

Before the flight, the passenger was instructed by the pilot, not to touch the rudder pedals or the control wheel.

#### **1.1.2 *Sequence of events***

The aircraft landed approximately 200 metres into the runway. After landing, the pilot intended to leave the runway at the end of the runway. He therefore let the aircraft slowly roll out and continued to taxi. After a while, the pilot received a clearance from the tower to backtrack on runway, and via the taxiway K continue to Gotland's Flying Club. The pilot slowed down and turned around about 1 340 metres onto the runway.

When taxiing south, the pilot experienced that the aircraft turned to the left and he had to constantly correct with the right pedal to steer the aircraft in the direction of the runway. The pilot has explained the behaviour of the aircraft, that the wind was blowing obliquely from behind on the left side of the aircraft's vertical fin, which caused the aircraft to turn to the left.

As the aircraft approached runway 10/28, which they needed to cross, the pilot was not sure if he had a clearance to do that. He therefore stopped temporarily at the holding point runway 10/28 and received clearance to cross the runway, to taxi all the way to Gotland's Flying Club.

Just before parking, the pilot and the passenger got the first indication that there was a problem when they smelled a faint smoke odour. At parking, the pilot saw smoke and then flames that broke out in front of the wing. He turned off the engine and the electrical main switch, but did not apply the parking brake. The pilot then ordered the passenger to evacuate through the right door, to avoid the fire on the left side, and the pilot followed with the aircraft's fire extinguisher. During the evacuation, the pilot called SOS Alarm.

When the pilot and the passenger came around the aircraft, there was a heavy fire around the left landing gear and the pilot immediately tried to fight the fire.

The municipality's fire and rescue service arrived at the accident site and extinguished the fire.

The accident occurred at position 5938N, 01819E, 44 metres above mean sea level.

## 1.2 Injuries to persons

	Crew members	Passengers	Total on-board	Others
Fatal	-	-	0	-
Serious	-	-	0	-
Minor	-	-	0	Not applicable
None	1	1	2	Not applicable
Total	1	1	2	-

## 1.3 Damage to aircraft

Substantially damaged.

## 1.4 Other damage

None.

## 1.5 Personnel information

### 1.5.1 Qualifications and duty time of the pilot

#### *Pilot in command*

The pilot in command, was 25 years old and had a current CPL(A) with valid class qualifications and medical certificate.

Flying hours				
	24 hours	7 days	90 days	Total
Latest	24 hours	7 days	90 days	Total
All types	0.5	0	7.6	184.4
Actual type	0.5	0	3.6	3.6

Number of landings actual type previous 90 days: 25.

Familiarisation on type concluded on 4 June 2020.

Latest PC<sup>6</sup> conducted on 5 March 2020 on Cessna 172R.

## 1.6 Aircraft information

The aircraft of the model TB 10 is a four-seater, low-wing single-engine aircraft. It is almost 8 metres long and has a span of just under 10 metres. Wheel fairings were installed on the aircraft (see Figure 1).

<sup>6</sup> PC – Proficiency Check.

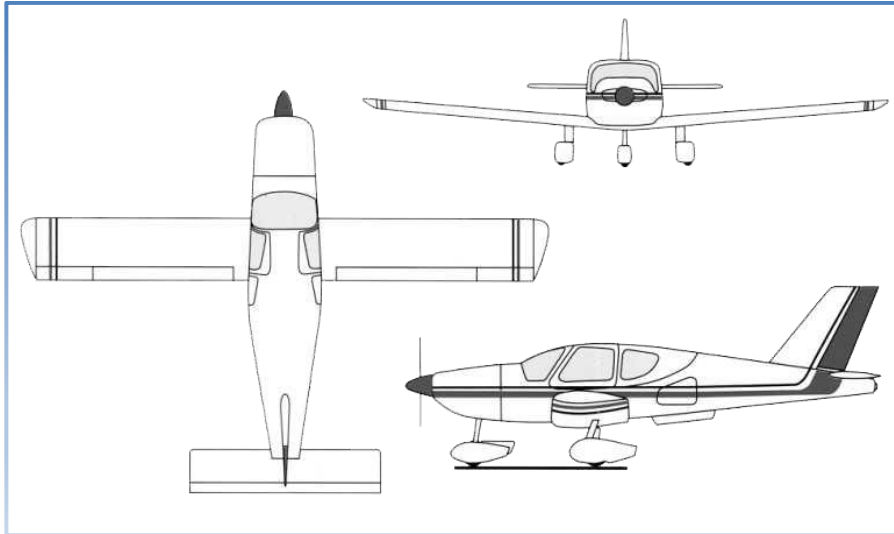


Figure 1. Three-view drawing of the aeroplane model.

**1.6.1 Airplane**

TC-holder	Daher Aerospace
Model	TB-10
Serial number	656
Year of manufacture	1987
Gross mass, kg	Max start/landing mass 1 150/1 092 current 1 040
Centre of gravity	Within limits
Total flying time, hours	4815
Flying time since latest inspection	12
Number of cycles	6876
Type of fuel uplifted before the occurrence	Avgas 100LL
<hr/>	
Engine	
TC-holder	LYCOMING ENGINES
Type	O-360-A1AD
Number of engines	1
<hr/>	
Propeller	
TC-holder	HARTZELL PROPELLER INC
Type	HC-C2YK-1BF/F7666A-2
Deferred remarks	None
<hr/>	

The aircraft had a Certificate of Airworthiness and a valid ARC. The last annual review was performed 23 September 2019.

The recent 100-hour inspection was performed on 11 June 2020 at the aircraft’s total operating time of 4 802 hours.

### **1.6.2 Brake System**

Braking is performed using hydraulic disc brakes which are operated by means of brake pedals. Both the left and right pilot positions are equipped with brake pedals (see Figure 2).

Differential braking helps to manoeuvre the aircraft during taxiing. The left pedal activates the left brake and the right pedal activates the right brake.

The parking brake consists of a knob located on the lower part of the instrument panel that operates a valve. To activate the parking brake, the pilot depresses the pedals and turns the knob to the right. To release the parking brake, the pilot depresses the pedals and turns the knob to the left back to the vertical position. An indicator light on the warning panel shows the position of the parking knob.

The Pilot's Information manual states that the parking brake must not be used when the brakes overheat.

### **1.6.3 The hydraulic oil**

The hydraulic oil in the brake system and in the landing gear shock absorber was of the type Aeroshell Fluid 41 which meets the specification MIL-PRF-5606H. According to the manufacturer's safety data sheet, the flash point is set to at least 82°C and the thermal ignition point to at least 320°C.

The flash point is the temperature at which the substance emits sufficient combustible gas to ignite by a flame or a spark. The thermal ignition point is the temperature when the substance is so hot that the combustible gas ignites in contact with oxygen without another ignition source.

The thermal ignition point can generally drop by 100°C if the hydraulic oil is atomized, which means that the thermal ignition point could be 220°C.

Ignition against a hot surface is a complex process affected by a large number of factors such as surface temperature, geometry and ambient temperature and air flow. It is difficult to give an exact limit for when ignition against hot surfaces occurs.

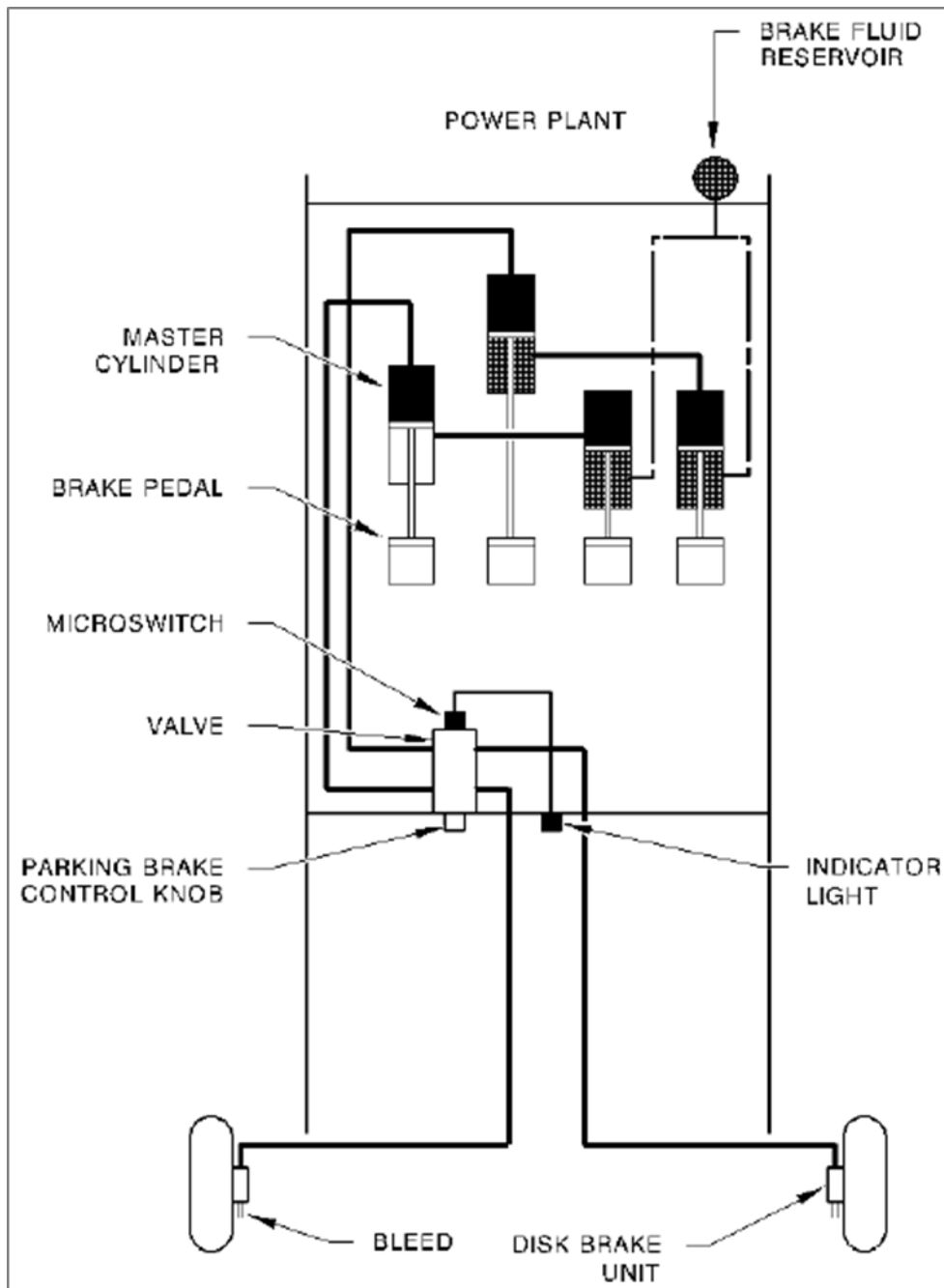


Figure 2. Schematic of the brake System. The aircraft had also been modified and equipped with brakes on the right-hand side. Picture: Socata TB-10 Pilot's Information Manual.

#### 1.6.4 Steering

On the ground, the aircraft is controlled by nose wheel steering by means of rudder pedals being connected with push rods to the nose wheel. The lower part of the pedals is connected to the nose wheel and the rudder. The upper part of the pedals is connected to the brakes.

When a rudder pedal is fully depressed, the nose wheel turns approximately 22 degrees to the left and 18 degrees to the right, respectively. By applying either the left or right brake, the turning radius can be increased. The smallest turning radius of the aircraft is obtained by means of differential braking.

### 1.6.5 *Pilot's Information Manual*

The flight manual states the following about the steering.

*“Steering the airplane with the rudder pedals only is generally sufficient. The combined use of the rudder pedals and the brakes permits, if necessary, tight turns.”*

### 1.6.6 *Brake caliper*

The caliper with part number 30-63J which was installed on the left landing gear was made of sand cast AZ81A-T4 magnesium alloy and certified according to FAA TSO C26. The certification means that the brake is required to endure 100 stops from 70 mph, with a deceleration rate of 10 ft/s<sup>2</sup>. Proper cooling is required between stops in order to accomplish the requirement. The O-ring that is installed on the piston inside the brake caliper has an operating range between -40°C and +121°C. The magnesium alloy from which the brake caliper is made of has a melting point of at least 421°C.

The latest replacement of brake pads on the left side was made on 15 October 2019 at 4 702 hours total time. There is no information when the O-ring for the piston was replaced.

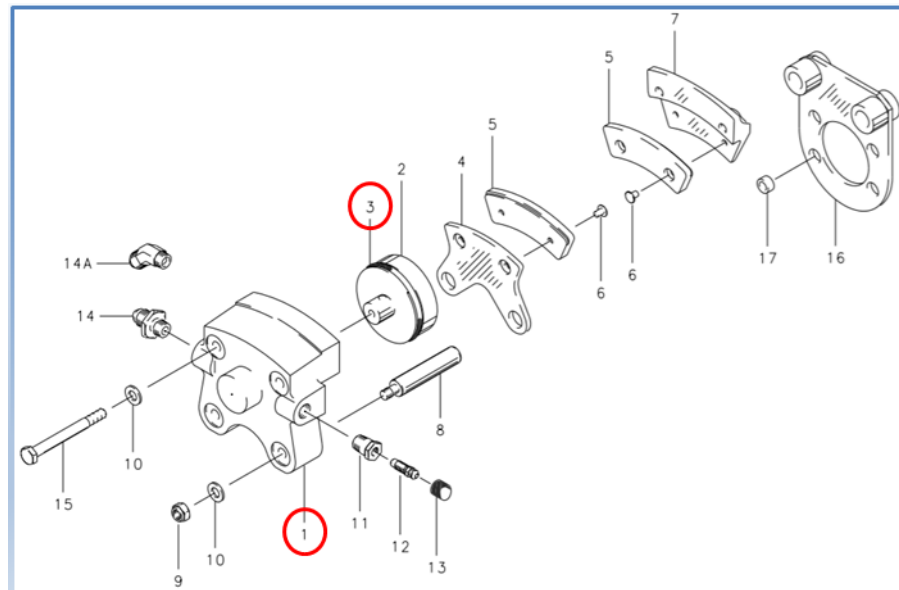


Figure 3. Exploded view of the brake caliper and its parts. Number 1 in the view is the brake caliper and number 3 is the O-ring installed on the piston. Image: Parker Hannifin Corporation, Illustrated Parts List, Catalog AWBPC0001-25/USA.

### 1.6.7 *Brake hose*

According to the type certificate holder's illustrated parts catalog (IPC), the brake hose that is to be installed at the brake caliper on the main landing gear can have three different part numbers, see Figures 4 and 5.

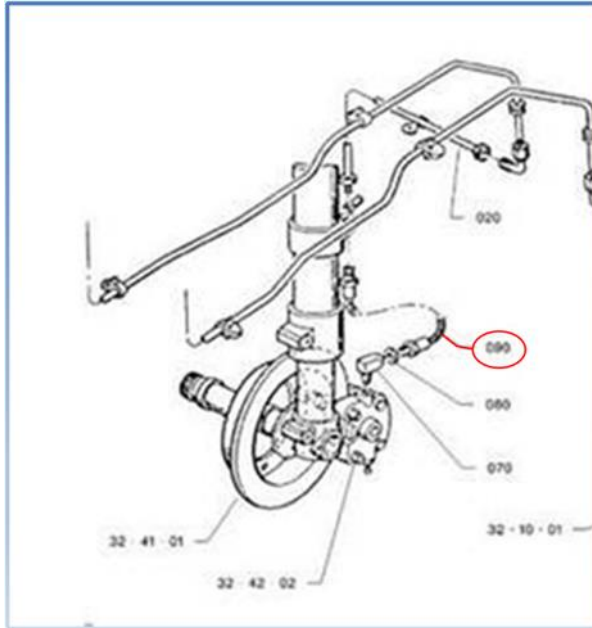


Figure 4. Image from the type certificate holders illustrated parts catalogue (IPC). The brake hose has item number 090 on the image.

90	7850091700	.HOSE		2	NP
		CANCELLED SEE SB 10-31-32			
- 90A	TB10 45017000	.HOSE		2	
		ORDER IMPERATIVELY 2 X			
		7850091701			
		RPLD BY 7850091701			
- 90B	7850091701	.HOSE	VF0877	2	
		RPLS TB10 45017000			

Figure 5. Extraction from the illustrated parts catalogue with the three different part numbers on the brake hose.

According to the service bulletin (SB10-31-32-Rev02) published in October 1992, the type certificate holder recommends replacing brake hoses with part number 7850091700 to part number 7850091701, during inspection or at the latest at the next annual inspection. The service bulletin is not mandatory to follow, but the type certificate holder does not provide new brake hoses with part number 7850091700.

According to the spare parts catalog, it appears that part number TB1045017000 is also no longer provided, but has been replaced by part number 7850091701, which is the only part number provided by the type certificate holder.

The brake hose that was installed to the brake caliper on the left main landing gear was completely destroyed by the fire and it has not been possible to determine its part number. The hose that was mounted on the right landing gear does not have a clear marking with a part number. Photos taken on the right brake hose and a hose from the type certificate holder's store have been compared and show that it is most likely part number 7850091701 that was installed on the right side, according to the type certificate holder.

### 1.6.8 *Maintenance Manual, MM*

In the maintenance manual chapter 05-10-00, there is a table for hoses in part number order and a short description of where in the aircraft the hoses are located as well as the service life for each hose, so-called calendar time. The storage time of the hose must also be considered when determining the hose’s calendar time.

The table contains three different part numbers for the brake hose that can be installed for the brake caliper on the main landing gear, according to the type certificate holder’s illustrated spare parts catalog. One of the part numbers can be found on page one of the table and the other two part numbers on page four. All part numbers for the effective brake hose have different calendar times, from five years to unlimited, see Figures 6 and 7.

TB10 45017000	32	Brake on landing gear leg Master cylinder brake at R.H. and L.H. stations	Teflon	Unlimited
TB10 45052000	32	Brake on landing gear leg	Teflon TITEFLEX	Unlimited

Figure 6. Extraction from MM 05-10-00 page 6. Page 1 of 4 in the table.

Z00.N7850091700	32	Master cylinder brakes at R.H. and L.H. stations Brake on landing gear leg	SATMO K2 F1 1700	10 years
Z00.N7850091701	32	Master cylinder brakes at R.H. and L.H. stations Brake on landing gear leg	SATMO F1 K2 1700 P	5 years

Figure 7. Extraction from MM 05-10-00 page 9. Page 4 of 4 in the table.

### 1.6.9 *Maintenance*

Gotland’s Flying Club, which was the owner of SE-IMY, had signed an agreement on the performance of and responsibility for certain tasks related to the aircraft’s Continuing Airworthiness Management Organisation, (CAMO<sup>7</sup>). In the maintenance program established in 2017, for SE-IMY, there was no documentation regarding the calendar time for brake hose with part number according to the type certificate holder’s illustrated parts catalogue.

The airworthiness organisation has stated that when the maintenance program was drawn up, the technical documentation was in poor order as the aircraft had not been airworthy for about six years. The technical documentation and the old maintenance program did not contain any information on part numbers or calendar times on brake hoses.

When establishing the new maintenance program, the table for hoses with calendar times was examined in the maintenance manual, chapter 05-10-00. During the review, they found a brake hose with part number TB1045017000 on the first page that had unlimited calendar time and assumed that it applied to the brake hoses.

<sup>7</sup> CAMO – Continuing Airworthiness Management Organisation.

At the 100-hour inspection on SE-IMY, 11 June 2020, a general visual inspection of the landing gear was carried out. A visual inspection was also carried out to inspect the condition of the brake system on the landing gear, its attachment, brake pads and disc wear. No remark in the brake system or brake hoses was noted.

### **1.7 Meteorological information**

According to Metar: Wind 060 degrees 11 knots, CAVOK, temperature/dewpoint +22/+16°C, QNH 1013 hPa.

The accident happened during daylight.

### **1.8 Aids to navigation**

Not relevant.

### **1.9 Communications**

Communication was established with the Visby Tower. Relevant parts of the communication are presented in 1.11.2.

### **1.10 Aerodrome information**

Visby Airport had status according to AIP<sup>8</sup> Sweden, with two runways 03/21 (2000 x 45m) and 10/28 (1100 x 40m). The pilot used runway 03 for take-off and landing. The runway and taxiways were dry.

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<sup>8</sup> AIP – Aeronautical Information Publication.

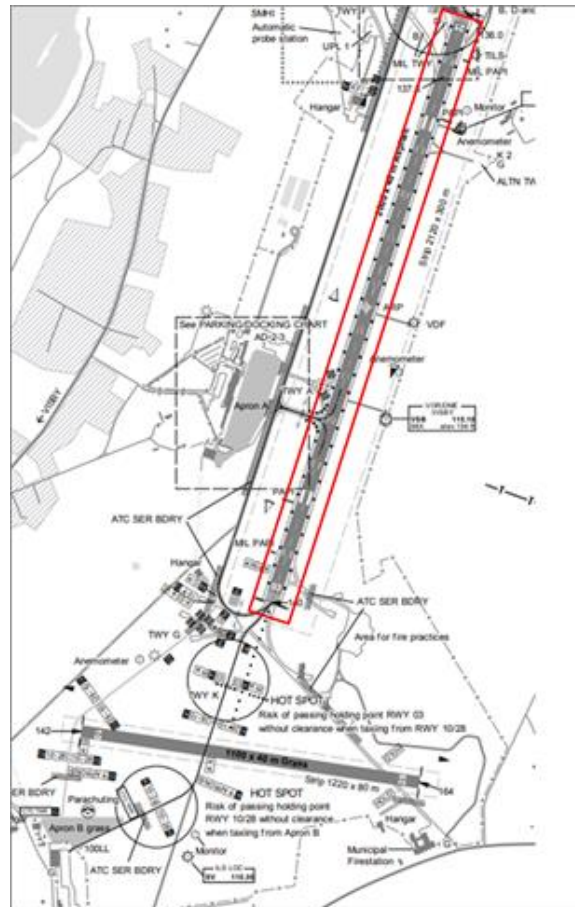


Figure 8. Visby Airport. Runway 03/21 marked in red.  
Picture: AIP Sweden.

## 1.11 Flight recorders

The aircraft was not equipped with and also had no requirement for recording equipment.

### 1.11.1 Flightradar24

The flight was recorded using ADS-B<sup>9</sup> data obtained by Flightradar24 and presented on their website. SHK has obtained data from Flightradar24 and illustrates the landing and taxiing after the turn around on the runway (see Figure 9 and 10).

<sup>9</sup> ADS-B – Automatic Dependent Surveillance-Broadcast.



Figure 9. The Landing. Each point represents the average speed (ground speed) calculated from the previous point. Route and text inserted by SHK. Picture: Google Earth.

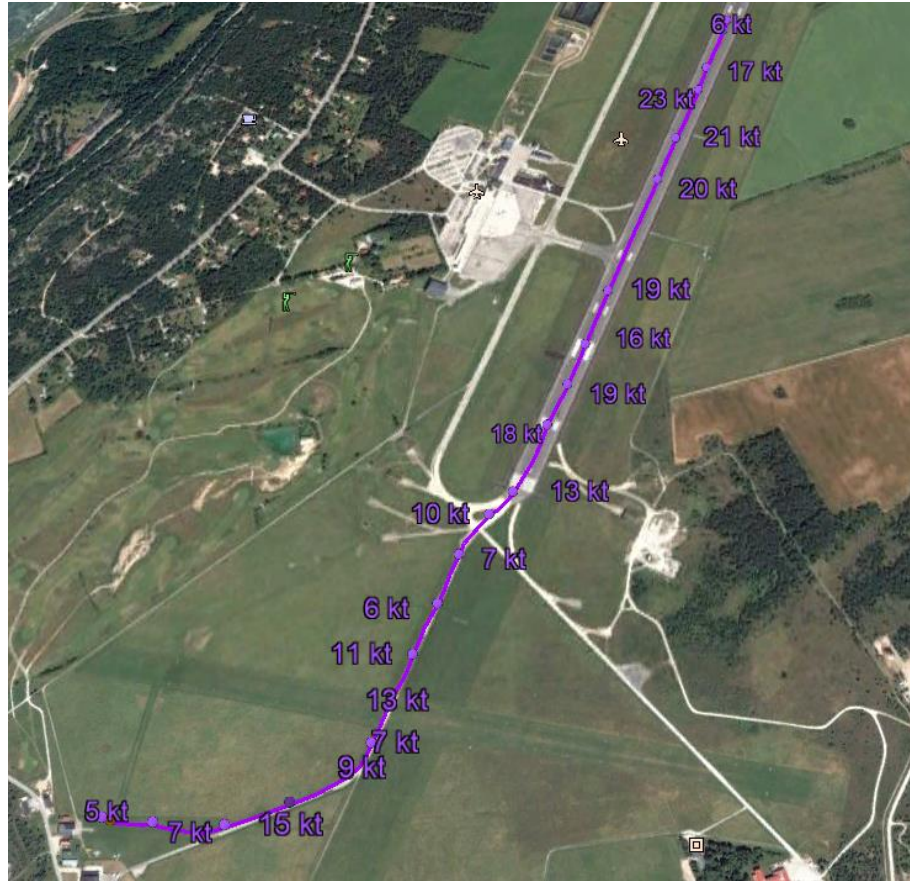


Figure 10. The aircraft's taxi route on ground after the turn around on the runway. Each point represents the average speed (ground speed) calculated from the previous point. Some points have been removed to enhance presentation. Route and text inserted by SHK. Picture: Google Earth.

### 1.11.2 Data from Swedish Air Navigation Services Provider (LFV)

Data from Ricochet have been collected and analysed. Ricochet is a recording and playback system used by LFV to document audio and video presented to air traffic controllers.

Time	Visby Tower	The Pilot	Radar Data
0.518438	Clear to land		
12:28:04			Aircraft's landing
12:28:37			The aircraft's transponder was switched off
12:28:46	Clearance to backtrack on the runway and taxi to Visby Flying Club		
12:41:20	The Tower was observing smoke at Visby Flying Club		
12:42:50		The Pilot called the Tower	

Table 1. Significant events obtained from recorded radio communications and radar data presented to air traffic controllers.

### 1.11.3 *Recording with sound from mobile phone*

The passenger, who was sitting in the right seat, filmed a sequence with sound during the landing. The film begins just before the landing and ends a bit into the rollout. The sequence is filmed straight ahead in the direction of travel. The film shows the right side of the instrument panel and the runway through the windscreen. The film has been analysed by SHK.

The film shows that the landing was normal and the engine speed was gradually reduced during the roll-out to 300–400 revolutions above idle. The film also shows that no specific braking occurs after landing and during the roll out and at the end of the film a slight increase in power was observed.

## 1.12 **Accident site and aircraft wreckage**

### 1.12.1 *Accident site*

The accident occurred on a grassy area outside the hangar at Gotland's Flying Club. The taxi was performed on asphalt except for the last stretch which was on grass.



Figure 11. Left picture: Overview of the grass surface where the aircraft stopped. The arrow shows the direction of travel the last part before stopping. Red ring marks final position and marks in the grass after the fire. Right picture: Fire place and dark track in the grass after taxiing in and the arrow shows the direction of travel. Traces from the fire place on this side has been created after the fire was extinguished and the aircraft was moved.



Figure 12. Final position of the aircraft after the fire. Left picture from behind. Right picture from the front. Photo: Swedavia.

### **1.12.2 Aircraft wreckage**

The left main wheel, brake caliper, landing gear and the lower skin and ribs on the left wing were damaged by fire and affected by high temperatures. Most of the brake caliper was melted into a lump and did not remain on the aircraft. The wheel fairing had burned out and only a few metal parts and fiberglass remained.

No aircraft parts were found elsewhere at the airport. In the grass there was a black track from the left landing gear after taxiing to the parking (see Figure 11 and 12).

### **1.12.3 Examination of the aircraft**

SHK conducted an examination of the aircraft on the 24<sup>th</sup> of June 2020 and another one on the 14<sup>th</sup> of July 2020 in the hangar associated to the flying club, where the aircraft had been moved after the incident. According to information from the flight club's mechanic, the parking brake was not activated. Before the aircraft was towed into the hangar, 60 litres of fuel were recovered from the left tank.

The tire and rim on the left landing gear had been ravaged by fire and parts of the rim had melted, the brake caliper cylinder had mostly melted. The fairing of the landing gear had partially melted and the brake hose for the brake caliper had burned up, only the metal nipples remained. The sheet metal skin on the underside of the left-hand wing and the ribs were affected by high temperatures.

During the technical examination of the aircraft, the brake pads and brake disc on the left side were checked, which showed that they were in good condition before the incident. The sliding pins for the brake caliper had been ravaged by fire but were intact.

The braking system in the aircraft was inspected and tested without remark. The hydraulic oil that remained in the brake system was visually inspected and found to be in good condition.

The nose wheel fairing and right landing gear fairing were inspected. No traces of grass or other contaminations of importance could be found.



Figure 13. Pictures on the underside of the wing that had been ravaged by fire.



Figure 14. Pictures on the left landing gear, rim, tire and brake that had been ravaged by fire.

#### **1.12.4 The hangar**

The aircraft was normally parked in the flight club's hangar when not in use. After the last inspection of the aircraft, it has been parked on the left side of the hangar, seen from the front.

After the accident, a stain was found in the parking lot on the hangar floor where the left landing gear had been positioned. The fluid had to some extent been absorbed by the concrete floor, but based on the fluids colour, smell and appearance it was judged that it resembled hydraulic oil. The texture of the fluid was sticky with a greasy surface.

No one has observed the stain before the accident. During interviews, it has emerged that the floor was not often washed. According to information received, no other leaks has been documented on the flight club's other aircrafts that were parked in the hangar.

The position of the stain is marked in Figure 15 and the appearance of the stain is shown in Figure 16.



Figure 15. The parking in the hangar illustrated with another aircraft of the same model. At the left landing gear, the stain is marked with a red circle.



Figure 16. Stain on the hangar floor. Picture: The Pilot.

### 1.13 Medical and pathological information

Nothing has indicated that the pilot's mental or physical condition was impaired before or during the flight.

### 1.14 Fire

A fire broke out at the left wheel. The fire spread to the wheel fairings and left wing around the landing gear leg and part of the flap was damaged by fire.

### 1.15 Rescue operation

At the time of the accident, the airport's fire and rescue service was not active, which meant that only the municipal rescue service was available.

The rescue operation was initiated by the pilot when he called SOS Alarm at the time 12.36. About a minute later, the municipal rescue service was alerted to the scene. The fact that the pilot called SOS Alarm directly was due to the pilot and the passenger were evacuating the aircraft. The pilot was unable to call on the VHF-radio and did not have the telephone number to the tower at that time.

Before the municipal rescue service arrived at the scene, the pilot first tried to extinguish the fire with a fire extinguisher from the aircraft. After this, the pilot retrieved two fire extinguishers from the hangar and extinguished the fire to embers, but shortly afterwards the fire started again.



Figure 17. The pilot fighting the fire. Photo: Swedavia.

The municipal rescue service arrived at the site outside the airport's fenced protection area. The pilot opened a personnel gate so that the rescue service had access to the aircraft. The fire was quickly extinguished with water and the rescue service ended at time 12.59.

When the air traffic control perceived smoke from SE-IMY a rescue operation was initiated despite that the airport rescue service were not active. The fire truck arrived at the scene after the fire was extinguished.

#### **1.15.1 Evacuation**

Both the pilot and the passenger evacuated the aircraft via the right side after the fire arose and the aircraft had come to a stop.

### **1.16 Tests and research**

#### **1.16.1 Reference taxiing**

SHK has carried out a reference taxiing with an aircraft of the same type.

The purpose of the reference taxiing was to understand how braking under different conditions affects the braking temperature. The reference assessment was performed at Visby Airport with an outside temperature of 18°C. At the time of the accident the outside temperature was 22°C. To measure the temperature, an infrared thermal thermometer was used, which was aimed at the brake disc before and after each step performed.

The first reference taxi simulated the accident aircraft's route and handling after landing on runway 03 by accelerating to landing speed and then reduce the engine to idle, rolling out and then turning around on the runway and taxiing back to Gotland's Flying Club. The temperature of the brake disc at the beginning of the test was 21.6°C and 44°C at the end of the test, a difference of 22.4°C. Both the time and average speed of the reference taxi corresponded with data from Flihtadar24.

Thereafter, a reference taxiing was performed from the start of the runway 03 to the end of runway 03 where the course of the aircraft was corrected by using the brakes. The temperature of the brake disc was 30°C at the beginning of the test and 60°C at the end of the test, a difference of 30°C.

To understand the temperature increase with a light continuous brake application during taxiing, a shorter test was performed. The temperature of the brake disc was 60°C at the beginning of the test and 75°C at the end of the test, a difference of 15°C at a distance of 210 metres.

Finally, a taxiing was performed on taxiway K where a braking to a stop was performed at the runway 10/28 and then continued the taxiing to finally stop after a total distance of 450 metres. Course corrections were made using the brakes. The temperature of the brake disc was 49°C at

the beginning of the test and 79.8°C at the end of the test, a difference of 30.8°C with a distance of 450 metres, and an average speed of 9.7 knots.

During the reference taxi, the wind conditions were similar to those in the accident flight with wind obliquely from behind. There were tendencies that the aircraft wanted to change direction and minor pedal adjustments were necessary to maintain the course.

**1.16.2 Speed at landing and taxi**

Upon landing, the speed was according to Flightradar24 approximately 65 knots and the aircraft slowed down slowly to a speed of 40 knots when a greater negative acceleration could be observed. When the aircraft turned around and taxied in the opposite direction, the speed were between 15 and 20 knots on the runway and then slowed down to between 5 and 10 knots on taxiway K.

The average speed for the entire distance back to the flying club, after the turn around on the runway, was 13 knots and the taxiing took just over 6 minutes.

**1.16.3 Joined Data**

SHK has below compiled data from Flightradar24 and Ricochet in a joint image.

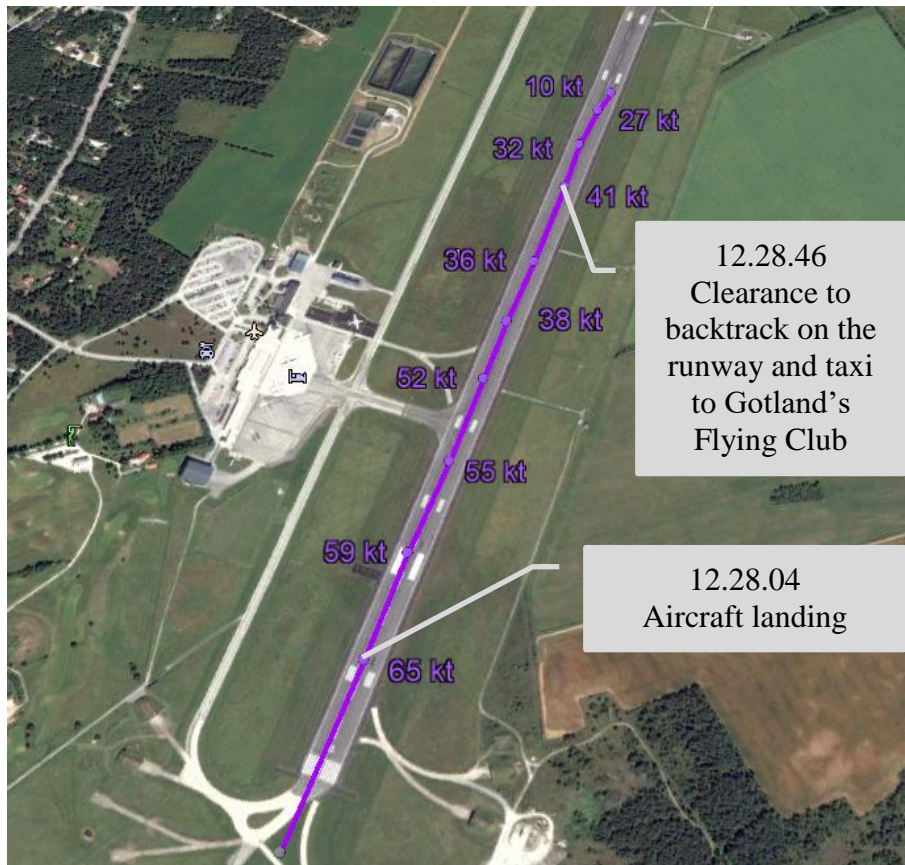


Figure 18. Joined Data from Flightradar24 and Ricochet. Route and text inserted by SHK. Picture: Google Earth.

## 1.17 Organisational and management information

The operating manual valid at the time of the incident at Gotland's Flying Club describes the handling of brakes during taxiing as follows.

*“4.8.2 Handling the aircraft's brakes*

*Experience shows that the brake discs on the club's TB9 and TB10 are sensitive to high temperatures. Do not steer the aircraft with the brakes when you taxi and let the aircraft roll out when you land, if the runway length allows this, it saves brakes and costs nothing.”*

## 1.18 Additional information

### 1.18.1 Similar events

SHK is aware of at least two similar incidents with the same type of aircraft. Two similar events are described below, the latter is under investigation at the time of the publication of this report.

*“In one incident, an Aerospatiale Tobago (TB10) was being taxied to check an instrument repair. When the pilot depressed the left brake pedal, it went to the floor, and the brake failed. Using rudder and the right brake, the pilot was able to taxi back to the ramp. A bystander was the first to notice that the left main wheel was on fire. What happened? The compression fitting that attached the brake line to the brake failed, and when the pilot stepped on the brake pedal, it squirted brake fluid onto the hot brake disk. It took seven 20-pound fire extinguishers to put out the fire. The pilot evacuated the aircraft quickly and wasn't injured.”<sup>10</sup>*

*“On Tuesday, January 12, 2021, at 13:50 LT, the SOCATA TB-10 aircraft with registration EC-FTJ suffered a fire during the taxiing phase at Matacan Airport (SLM/LESA), Salamanca. The aircraft, operated by a student pilot, was returning to the airport after conducting a training flight. Once the landing was made, while the aircraft was taxiing towards the platform, a fire broke out in the brake of the left leg of the aircraft's main landing gear, which spread causing significant damage to the gear leg and innerside of the plane. The fire was extinguished by airport firefighters. The pilot exited the aircraft and was unharmed.”*

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<sup>10</sup> AOPA – Reference: aopa.org.

## 2. ANALYSIS

### 2.1 Initial starting points

The data from the flight have been analysed together with the information from interviews with the pilot, among others, the sequence of events has largely been determined. The question that SHK primarily has to answer is why the fire has occurred.

#### 2.1.1 *Sequence of events*

After the landing, the pilot let the aircraft roll out with the intention of leaving the runway at runway end 03 to taxi back to Gotland's Flight club via the taxiway system. The landing took place early on the runway, which meant that there was a long taxi distance on the runway to reach the end of the runway. It would have been possible to leave the runway via taxiway A, which was an intermediate taxiway, but it would have required harder braking by the pilot. The flight club's operational manual states that the pilot should allow the aircraft to roll out on the runway to save the brakes, which the pilot was aware of. The first part of the landing and roll-out was filmed by the passenger. From the film it appears that the engine speed is slightly higher than idle and increases slightly at the end of the film.

The fact that the rollout was carried out with engine speed above idle and that the pilot's intention was to switch to taxiing to the end of the runway and that no other decelerations could be observed during the film sequence, explains the long rollout with lower deceleration speed than normal.

Approximately 40 seconds after the landing, the pilot received clearance from the tower to turn around on the runway to taxi back to the flight club. At this time, the deceleration increased and the speed decreased from 40 knots to just a few knots, as shown in the merged data presented in section 1.16.3.

After the pilot turned around on the runway and taxied south, he felt that the plane wanted to turn left. In order to steer the aircraft in the direction of the runway, the pilot had to compensate for this with the right rudder pedal. Which would mean that it is more likely that the right brake should have been used than the left. Similar tendencies could be experienced by SHK during the reference taxiing when the wind blew obliquely from behind.

Data obtained from Flightradar24 show that the speed during the taxiing varied slightly. Based on these data, it is not possible to determine with certainty the speed at each individual occasion. This is because the speed for each section is given as the average speed from the previous measuring point. The fact that the speed varies can be due to several factors such as changes in wind speed, runway inclination, changed engine speed, use of brakes or any combination of these factors. The factors that affect the speed changes presented in section 1.11.1 cannot

be determined with certainty. However, it is likely that the brakes were used for some reduction in speed in connection with the aircraft turning around on the runway, when the aircraft left the runway to enter taxiway K and when it stopped temporarily before crossing runway 10/28.

## **2.2 Technical examination**

At the technical examination carried out on the aircraft, it could be established that the left landing gear had been ravaged by fire. The damage caused to the inside of the tire and rim, as well as the fact that the brake caliper had mostly melted, indicate that it was in this area that the fire first started. The fact that the brake caliper melted indicates that it has been exposed to high temperatures for a long time, because the magnesium alloy has a melting point of at least 421°C.

Furthermore, it could be stated that the brake pads and brake disc on the left side, had been within approved tolerances before the event. The hydraulic oil remaining in the brake system was in good condition and was of the type Aeroshell Fluid 41.

The nose wheel fairing and the right landing gear fairing had no traces of grass or other contamination of importance, which may indicate that it was the same for the left landing gear cover before the fire.

After the accident, a spot was found in the aircraft's parking space in the hangar where the left landing gear had been positioned. From the colour, odour, appearance, consistency and position of the fluid, SHK assesses that it was most likely residues from a mineral oil of the same type used in the brake system or in the shock absorber of the landing gear leg.

During the examination, no other technical faults were found on the aircraft that could have caused the fire.

## **2.3 Maintenance**

In the maintenance program established in the year 2017 for SE-IMY, there was no documentation regarding calendar time for brake hoses with part numbers according to the type certificate holder's illustrated spare parts catalog. The Airworthiness Organisation (CAMO) has stated that when the maintenance program was drawn up, the technical documentation was in poor order because the aircraft had not been airworthy for the past six years. In the technical documentation and in the old maintenance program there was no information about part numbers or calendar times for brake hoses.

According to the type certificate holder's illustrated spare parts catalog, the brake hoses that should be installed on the brake caliper at the main landing gears can have three different part numbers. During the investigation, it has emerged that only one part number is provided by the type certificate holder, which is 7850091701 and that brake hose has a calendar time of five years.

A comparison was made between the brake hose that was installed on the right landing gear and a brake hose from the type certificate holder's stock. The comparison showed that a brake hose with part number 7850091701 was installed on the right side, according to the type certificate holder. The brake hose that was installed on the left main gear was completely destroyed by the fire and no part number has been identified. Even though it was not possible to determine which brake hose that was installed on the left side, it is still most likely that it was the same as on the right side, namely 7850091701.

The airworthiness organisation did not discover that there were three different part numbers for the brake hoses, that shall be installed on the brake caliper on the main landing gear. In the maintenance manual, chapter 05-10-00, there was a table for hoses with specified calendar times established in part number order. On the first page there was a brake hose with part number TB1045017000 which had unlimited calendar time. The airworthiness organisation assumed that only this part number existed and that the hose had unlimited calendar time. The two other part numbers on page four in the table were never discovered.

The fact that the airworthiness organisation did not discover that the brake hose in question could have three different part numbers and calendar times when drawing up the new maintenance program may have been due to several factors. On one hand, there were shortcomings in the documentation for the aircraft as it had not been airworthy for six years, on the other hand, the airworthiness organisation may have relied too much on the old maintenance program.

The fact that the table is drawn up in part number order and that the part numbers were on different pages may have contributed to not understanding that there could be several part numbers for the brake hose in question.

Overall, this indicates that there were some shortcomings in the routines in the airworthiness organisation and that the documents provided by the type certificate holder were not examined thoroughly when establishing the new maintenance program. This led to that the brake hoses probably exceeded the calendar time by a large margin.

## **2.4 Reference Taxiing**

The purpose of the reference rating was to understand how the temperature of the brake disc was affected with different braking scenarios. SHK chose to carry out the tests only for short controlled distances in order to maintain an acceptable level of safety.

The reference taxiing on taxiway K was carried out without constant brake application, but with course corrections which were carried out partly with the help of the brakes application and included a stop. The total distance was 450 metres and the result was a temperature increase of 30.8°C.

In a test with very small application of the brakes during 210 metres, the temperature of the brake disc increased by 15°C. If the same temperature increase as in the reference taxi is applied for the entire taxi phase, 2 400 metres, the temperature of the brake disc would be just over 170°C. If the same condition was applied for the entire landing phase and the taxi phase, the temperature could have increased to just over 250°C.

Based on the results of the reference taxiing, it can be concluded that only a small application of the brakes is required to achieve a temperature on the brake disc that can ignite the hydraulic oil.

## **2.5 The rescue operation**

The pilot alerted the rescue service during the evacuation of the aircraft which meant that the rescue operation began without delay. The pilot's firefighting actions reduced the fire to embers and probably reduced the consequences of the fire. The measures taken by the municipal rescue service seem to have been appropriate to the needs that arose in connection with the accident.

SHK has found no reason to examine the rescue operation in more detail.

## **2.6 Summary of the analysis**

In order for a fire to occur, oxygen, heat and fuel are needed, also in the right proportion to each other. In this case, there is mainly reason to analyse issues of heat and fuel.

Frictional heat is generated in the brake disc when kinetic energy from the aircraft is converted to heat by friction between the brake disc and the brake pads during brake application. That the brake could be applied in other ways than normal use could have several reasons, both operational and technical. An example of this could be that the brake is applied through a continuous brake application by the pilot "riding the brakes" which can be both conscious and unconscious. Technical circumstances may include jamming of the brake caliper, brake oil leakage, contamination or corrosion on the sliding pins. The fact that the aircraft was equipped with wheel fairings also contributes to contain the heat and impairs the cooling of the brake disc.

The fact that the left landing gear had been ravaged by fire, the brake hose to the brake caliper had burned up and that most of the brake caliper had melted means that SHK has not been able to determine, with certainty a direct cause why the fire occurred.

As shown in section 2.1.1, nothing has come to light that indicates that the pilot has ridden the brakes, but this cannot be ruled out.

There were traces of an oil stain in the hangar at the place where the caliper was positioned when parking. If a caliper or a brake hose has a minor leakage, dust and other contamination can accumulate, which can cause a mechanical induced brake application that remains after the brakes are released. There is therefore a possibility that there may have been a brake application, without the pilot's influence.

During the investigation, it has emerged that the brake hose that were installed has not been included in the maintenance program and that the hose probably exceeded its calendar time by a large margin. It is therefore probable that the age of the brake hose has been a factor that caused a leak in the brake hose to the brake caliper for the left wheel.

The reference taxiing showed that with normal braking or with a light application of the brakes it was relatively easy to reach a temperature on the brake disc that could ignite the hydraulic oil.

Ignition against a hot surface is a complex process and specifying in detail how ignition can occur is difficult. However, SHK conclude that the probable cause of the fire has been that atomized oil has sprayed onto the heated brake disc and ignited. The fire has after that spread to tires, wheel covers and other combustible materials around the landing gear.

### **3. CONCLUSIONS**

#### **3.1 Findings**

- a) The pilot was qualified to perform the flight.
- b) The aircraft had a Certificate of Airworthiness and valid ARC.
- c) Steering was mostly performed with the nose wheel steering.
- d) A deceleration took place from about 40 knots before the aircraft turned around, about 1 340 metres into the runway.
- e) When backtracking on runway 03, the tailwind was oblique from the left.
- f) The taxi distance was just over 2 400 metres and lasted just over 6 minutes.
- g) The average speed of the taxiing back towards the flying club, after turning on the runway, was 13 knots.
- h) After the accident, at the parking spot for SE-IMY, an oil stain was found on the hangar floor where the left landing gear was positioned.
- i) The brake disc and brake pads on the left side were within approved tolerances before the event.
- j) The aircraft maintenance program did not contain any documentation regarding the calendar time of the brake hoses.
- k) The calendar time for the brake hoses had been exceeded.
- l) The fire caused significant damage to the aircraft.

#### **3.2 Causes/Contributing Factors**

The accident was probably caused by the condition of the brake hose causing an oil leak, which in combination with a hot brake disc caused the fire.

The fact that the hose's calendar time was not considered when establishing the new maintenance program can be seen as a shortcoming in the routines of the airworthiness organisation. This has resulted in that the maintenance tasks prescribed by the type certificate holder has not been evaluated by the airworthiness organisation.

### **4. SAFETY RECOMMENDATIONS**

None.

On behalf of the Swedish Accident Investigation Authority,

Jonas Bäckstrand

Tony Arvidsson