



Statens haverikommission
Swedish Accident Investigation Board

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Report RL 2009:15

**Accident to aircraft SE-LTF on the E 45 road
north of Kungälv, Västra Götaland county,
on 7 February 2008**

Case L-01/08

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

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Report RL 2009:15

The Swedish Accident Investigation Board (Statens haverikommission, SHK) has investigated an aircraft accident that occurred on 7 February 2008 on the E45 road nrth of Kungälv, Västra Götalands county, involving an aircraft registered SE-LTF.

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

The Swedish Accident Investigation Board will be grateful to receive, by 19 of april 2010 at the latest, particulars of how the recommendations included in this report are being followed up.

Göran Rosvall

Sakari Havbrandt

Duplicate to The Swedish Transport Agency

Report RL 2009:15.....	4
1 FACTUAL INFORMATION	6
1.1 History of the accident	6
1.2 Injuries to persons	6
1.3 Damage to the aircraft	6
1.4 Other damage.....	6
1.5 Personnel information.....	7
1.5.1 Pilot	7
1.6 The aircraft.....	7
1.7 Meteorological information.....	7
1.8 Aids to navigation	7
1.9 Communications.....	8
1.10 Aerodrome information.....	8
1.11 Flight recorders and voice recorders.....	8
1.12 Accident site and aircraft wreckage	8
1.12.1 Accident site	8
1.12.2 Aircraft wreckage	8
1.13 Medical information	9
1.14 Fire	9
1.15 Survival aspects	9
1.16 Tests and research	9
1.16.1 Examination of the broken fuel pipe	9
1.17 Organisational and management information	10
1.18 Other aspects	10
1.18.1 Equal opportunities aspects	10
1.18.2 Other events with broken fuel pipes	11
1.18.3 Measures taken by the engine manufacturer	11
1.18.4 Measures taken by EASA	11
2 ANALYSIS.....	11
2.1 The engine stoppage	11
2.2 The emergency landing	12
2.3 Airworthiness assessment	12
3 CONCLUSIONS.....	12
3.1 Findings	12
3.2 Causes.....	13
4 RECOMMENDATIONS.....	13

Attachment 1

Statement from EASA

Attachment 2

Submission from The German Federal Bureau of Aircraft Accident Investigation (BFU - Bundesstelle für Flugunfalluntersuchung)

Report RL 2009:15

L-01/08

Report finalised 2009-10-20

Aircraft; registration and type	SE-LTF, DA 40D
Class, airworthiness	Normal/valid Certificate of Airworthiness
Registered owner/Operator	Siemens Financial Service AB/Svensk Pilotutbildning AB
Time of occurrence	7 February 2008, time 18:40 in darkness Note: All times are given in Swedish standard time (UTC + 1 hour)
Place	E45 road north of Kungälv, Västra Götaland county, (posn. 57° 54' N 012° 03' E)
Type of flight	Training flights
Weather	According to SMHI's analysis: Wind south to south-west 5-8 knots, visibility > 10 km, no cloud below 2000 feet, temperature/dew point +3/+1 °C, QNH 1028 hPa
Persons on board:	1
crew members	
Injuries to persons	None.
Damage to the aircraft	Substantially damaged
Other damage	Damage to two cars and two street lighting columns
The pilot:	
Sex, age, licence	Male, 22 years, PPL
Total flying time	79 hours, all on type
Flying hours previous 90 days	6 hours
Number of landings previous 90 days	16

The Swedish Accident Investigation Board (SHK) was notified on 7 February 2008 that an aircraft with registration SE-LTF had an accident at 18:40 hours on that day on the E45 road north of Kungälv, Västra Götaland county.

The accident was investigated by SHK represented by Göran Rosvall, Chairperson and Sakari Havbrandt, Investigator in Charge.

The investigation was followed by Niklas Svensson, Swedish Civil Aviation Authority.

Thomas Karge was the accredited representative for Germany.

Summary

The pilot took off from Gothenburg City Airport for a solo navigation exercise to gain a night-time endorsement to his pilot's licence. After about ten minutes of flight the engine stopped. The pilot carried out an emergency landing on the only available lit area, on the E45, which is a four-lane motorway. The right wing struck a lighting column before the aircraft landed on the ground. Immediately after touching down the aircraft collided with a private car. The aircraft then slid off the road and continued along the grass to the left of the road. Another private car was struck by gravel and wreckage parts as the aircraft finally stopped.

The pilot was unhurt and could exit the aircraft without assistance. Neither of the car drivers were injured.

The technical investigation revealed that the outlet pipe from the high pressure pump had broken due to fatigue. At the time of the accident the engine manufacturer and the certifying aviation authority EASA were aware of the risk of fuel pipe breakage as a previous event had happened due to the same problem.

The accident was caused by poor design of the broken fuel pipe.

Recommendations

It is recommended that EASA considers a fresh evaluation of its criteria in assessing airworthiness, so that aircraft with known serious design faults are not permitted to fly. *(RL 2009: 15 R1)*.

1 FACTUAL INFORMATION

1.1 History of the accident

The pilot took off from Gothenburg City Airport for a solo navigation exercise to gain a night-time endorsement to his pilot's licence. The climb out was via the outward reporting point BOHUS and thence northwards. After about ten minutes of flight, just north of Kungälv, the engine stopped at a height of 1500 feet. The pilot went through the check list, without any result. He transmitted an emergency message and carried out an emergency landing on the only available lit area, on the E45, which is a four-lane motorway. In order to avoid the lighting columns, the pilot decided at a late stage to land against the road traffic direction in the two left lanes. Despite this the right wing struck a lighting column before the aircraft landed on the ground. Immediately after touching down the aircraft collided with a private car. The tip of the right wing of the aircraft struck the car windscreen. The aircraft then slid off the road and continued along the grass to the left of the road up to a junction, where the right wing once again collided with a lighting column, which caused the aircraft to swing round to the left, whereupon it stopped. Another private car was struck by gravel and wreckage parts as the aircraft finally stopped.

The pilot was unhurt and could exit the aircraft without assistance. Neither of the car drivers were injured.

The accident took place at position 57° 54' N 012° 03' E.

1.2 Injuries to persons

	Crew mem- bers	Passengers	Others	Total
Fatal	–	–	–	–
Serious	–	–	–	–
Minor	–	–	–	–
None	1	–	–	1
Total	1	–	–	1

1.3 Damage to the aircraft

Substantially damaged.

1.4 Other damage

Damage to lighting columns and two private cars.

1.5 Personnel information

1.5.1 Pilot

The pilot, male, was 22 years old at the time and had a valid Private Pilot's Licence (PPL).

Flying hours			
	24 hours	90 days	Total
previous	0	6	79
All types	0	6	79
This type	0	6	79

Number of landings previous 90 days: 16.

1.6 The aircraft

The aircraft	
Manufacturer	Diamond
Type	DA 40 D
Serial number	D4. 007
Year of manufacture	2003
Gross mass	Max. authorised flying mass 1,150 kg, actual approx. 950 kg
Centre of mass	within permitted limits
Total flying time	2060 hours
Number of cycles	
Flying time since latest inspection	30 hours
Fuel loaded before event	Jet A1 full

Engine

Manufacture	Thielert
Engine model	TAE 125-02-99
Number of engines	1
Total operating time, hrs	46
Operating time since overhaul	40

Propeller

Propeller	MTV-6-A
Propeller running time since basic inspection	60 hours

The aircraft had a valid Certificate of Airworthiness.

1.7 Meteorological information

According to SMHI's analysis:

Wind south to south-west 5-8 knots, visibility > 10 km, no cloud below 2000 feet, temperature/dew point +3/+1 °C, QNH 1028 hPa

1.8 Aids to navigation

Not applicable.

1.9 Communications

Normal radio communications took place until the pilot transmitted an emergency message.

1.10 Aerodrome information

Not applicable.

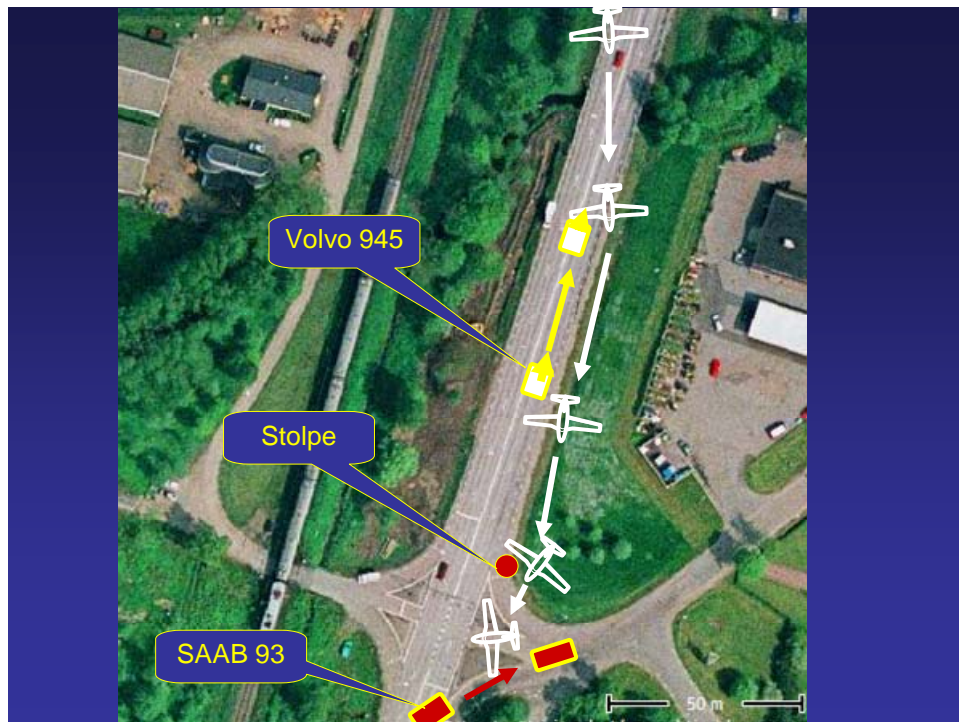
1.11 Flight recorders and voice recorders

None. Not required.

1.12 Accident site and aircraft wreckage

1.12.1 Accident site

The accident took place on Europe road 45, which is a motorway with four lanes.



A schematic illustration of the accident site and the sequence of events

1.12.2 Aircraft wreckage

The day after the accident SHK carried out a technical investigation of the aircraft.

The right wing was broken off a few metres away from the wing root. The right landing gear and nose wheel were broken. The propeller was damaged. The left wing and the fuselage were more or less intact.

During the examination it was noted that the left wing tank, which is the main tank, and had been in use during the flight, only contained about five litres of fuel. The tank was removed, found to be complete, and there was no fuel in the wing outside the tank.

The memory unit inside the aircraft's FADEC (Full Authority Digital Engine Control) could be read and showed that the pressure in the fuel pipe after the high pressure pump (Common Rail) had suddenly reduced to more or less zero at the time the engine stopped.

When pressure was applied to the fuel system from the pipe leading from the left tank, strong leakage occurred at the outlet pipe from the high pressure pump. The pipe was dismantled and found to be broken at the connection flange. A visual examination with the aid of a magnifying glass revealed that the broken surface showed signs of fatigue. The pipe was sent to Bodycote Materials Testing for further examination. See section 1.16.1

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

There was no fire.

1.15 Survival aspects

The risk of a collision with serious consequences is considered to be high when landing on a road carrying road traffic. In this particular case there were collisions with both fixed objects and a private car. The collisions were however so minor that personal injury was not caused.

1.16 Tests and research

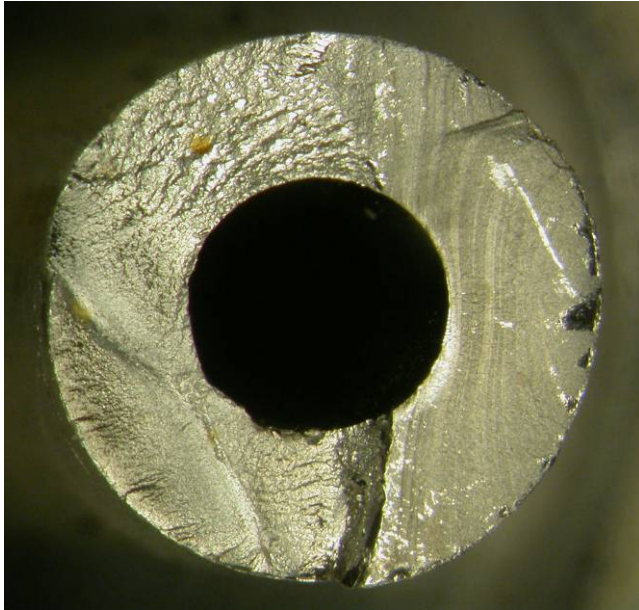
1.16.1 Examination of the broken fuel pipe

The fuel pipe was examined by Bodycote Materials Testing AB in respect of the break at the connection flange.



The fuel pipe is about 40 cm long and only secured by collar nuts at each end.

Inspection under an optical microscope showed that the break was caused by metal fatigue that began at two points approximately opposite to each other. The fatigued surfaces met at the centre of the cross-section and there was a very small amount of residual breakage.



*At the right side of the break can be seen about 60 beach marks
On the left side of the break no beach marks can be seen.*

Conclusions drawn by Bodycote

The fuel pipe broke due to metal fatigue.

The stresses that caused the metal fatigue were forward and backward bending loads.

On the surface of the break could be seen about 60 beach marks. If each beach mark represents an engine start the crack was present for an estimated 100 engine starts.

The large proportion of fatigue in relation to the remainder of the break shows that the stresses that caused the fatigue were relatively low.

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 Other events with broken fuel pipes

SHK has found three other events in which fuel pipes have broken in the same place on the same type of engine. In all the following four events have been noted:

- JY-EEE, DA 40 D, 29 October 2007
- SE-LTF, DA40 D, 7 February 2008
- N1735L, Cessna 172, 21 February 2008
- 9M-HMI, DA40 D, 4 March 2008

1.18.3 Measures taken by the engine manufacturer

The engine manufacturer issued a technical message, TM TAE 125-1005 P1, on 8 February 2008. The message said that an extra securing bracket for the pipe in question should be installed within 30 flying hours.

On 11 February there was a revised message, TM TAE 125-1005 P1 rev 1. The time allowance for implementation was reduced so that the modification should take place within 10 flying hours, or within 30 hours of total running time for engines with less than 20 hours total.

On 2 March the message was revised once more, TM TAE 125-1005 P1 rev 2, which meant that the time allowed for the implementation was reduced to within 2 flying hours for a ferry flight to the next maintenance station, limited to VFR flying conditions.

1.18.4 Measures taken by EASA

On 13 February 2008 EASA issued an Emergency Airworthiness Directive, EAD No.: 2008-0027-E, with the same content as the manufacturer's message, TM TAE 125-1005 P1 rev 1.

On 11 March 2008 EASA issued a revised Emergency Airworthiness Directive, EAD No.: 2008-0056R1-E, with the same content as the manufacturer's message TM TAE 125-1005 P1 rev 2.

EASA has issued a statement with comments concerning its measures, see Appendix 1.

2 ANALYSIS

2.1 The engine stoppage

The engine stoppage was caused by the outlet fuel pipe from the high pressure pump breaking, so that the engine no longer received fuel. The fatigue failure showed about 60 beach marks, which could coincide with the approximate number of engine starts that were performed during 46 flying hours. Leakage from the pipe had probably taken place before the final complete break. After the complete break, a large amount of fuel emptied out into the engine compartment during the period that the propeller was windmilling and thereby driving the fuel pump.

The relatively long fuel pipe, that was only supported by union nuts at each end, was subjected to vibration that led to the metal fatigue. With four such

breaks occurring at the same place, it is considered obvious that there was a design deficiency.

2.2 The emergency landing

An emergency landing is always a risky event. If as in this case it takes place in darkness and at a relatively low starting height it is even more risky. From a height of 1500 feet the pilot had less than two minutes before reaching the ground. During this short time the emergency check list for engine restart and the selection of a place to land had to be done.

In the situation encountered by the pilot the choice of a motorway was reasonable, since it was the only lit area where it was possible to land without personal injury. The decision to land in the opposite direction to road traffic may seem to have been unsuitable. However this decision came at a late stage due to the presence of obstacles in the form of lighting columns, so it must be seen as understandable, as a collision with a lighting column is something that should be avoided.

2.3 Airworthiness assessment

At the time of the accident the engine manufacturer and the certifying aviation authority EASA were aware of the risk of fuel pipe breakage as a previous event had happened due to the same problem. A service bulletin, which permitted a further 30 running hours, was issued by the manufacturer the day after the accident. This bulletin had probably been prepared some time before the accident, and was not a direct consequence of this particular accident. A few days later EASA issued an airworthiness directive that limited continued flying without taking corrective measures to 10 running hours.

Within the next month there were a further two events with the same cause. After these events the airworthiness directive was stiffened so that only one two hour flight to a maintenance station, in VFR, was permitted.

SHK finds it doubtful that this type of engine could still be considered airworthy after four events with broken fuel pipes have occurred. In addition, SHK finds that it is worth investigating whether at least one or more of the events could have been avoided with a more purposeful follow-up of the airworthiness of this type of engine after the first event.

3 CONCLUSIONS

3.1 Findings

- a) The pilot was qualified to perform the flight.
- b) The aircraft had a valid Certificate of Airworthiness.
- c) The fuel pipe had a deficient design that led to fatigue failure.
- d) The fuel pipe problem was known about at the time of the accident.
- e) The engine type was still considered to be airworthy after four identical cases of pipe failure.

3.2 Causes

The accident was caused by poor design of the broken fuel pipe.

4 RECOMMENDATIONS

It is recommended that EASA considers a fresh evaluation of its criteria in assessing airworthiness, so that aircraft with known serious design faults are not permitted to fly. (*RL 2009: 15 R1*).

Attachment 1

EASA has issued the following statement with comments concerning its measures:

In January 2007 the TAE 125-02-99 engine entered into service. By October 2007 508 engines were in service and did accumulate a fleet time of around 11,000 flight hours. The fleet leader engine in the field had accumulated more than 350 flight hours at this time.

On 29 October 2007 the JY-EEE DA40D event did happen. The engine stopped during a climb in a trainings flight (touch and go). The student pilot landed the aircraft successfully. The engine time since new (TSN) was 163 h.

On 5 November 2007 ACG forwarded the DAI Occurrence report about this incident to EASA. EASA forwarded it to TAE.

On 9 November 2007 EASA was informed that TAE identified a cracked fuel line based on pics from the operator, and that the operator was requested to send the failed part to TAE.

Pics were forwarded to EASA on 12 November 2007.

On 22 November 2007 EASA requested an update about the investigation status. TAE informed about a hair crack of the fuel line caused by fatigue due to vibration, based on analysis of the defective part, and that the design of an additional support has started (for reducing the vibration level on the fuel line).

On 11 December 2007 the CAW meeting between DAI/TAE/ACG/EASA took place in Wiener Neustadt. TAE informed about the issue and planned solution.

On 6 February 2008 TAE sent the draft SB to EASA, the publication was planned for 8 February 2008. The proposed compliance time of 100 h was based on the first single event after 163 h with some safety margin. TAE did need some time for designing the change, testing and ordering of parts. Parts were expected to be available from 8 Febr. 2008 onwards.

On 6 February 2008 EASA sent the draft AD to TAE for review

On 7 February 2008 the SE-LTF DA40 event happened.

On 8 February 2008 (Friday) TAE informed EASA about the reason for emergency landing DA40 SE-LTF: broken HP fuel line after 45 h and published the TM TAE 125-1005P1 (compl. time 30 h) published. EASA requested a reduced compliance time for avoiding additional events.

On 11 February 2008 (Monday) TAE published SB TM TAE 125-1005P1, Rev. 1 (compl. time 10 h; 30 h for engines with less than 20 hours total).

On 13 February 2008 (Wednesday) EASA published EAD 2008-0056-E (compl. time 10 h).

On 21 February 2008 the N1735L C172 event happened (IFSD after 3 flight hours).

On 27 February 2008 TAE informed EASA about a possible fuel line crack (unconfirmed because parts not yet at TAE) on the N1735L.

On 4 March 2008 the 9M-HMI DA40 event happened (after 23 h).

On 6 March 2008 (Thursday) TAE informed EASA about a fuel line crack after 23 h in Malaysia (9M-HMI), the SB has not been carried out. TAE reduced the compliance time to 2 h (only ferry flight allowed) and issued TM TAE 125-1005P1, Rev. 2.

On Monday 10/11 March 2008 (Monday/Tuesday) EASA published EAD 2008-0056R1-E.

No further incidents have happened so far.

The TAE couldn't find material or manufacturing problems of the fuel line in their investigation.

Based on the chronology stated above and the information provided by TAE, it can be stated that the incidents in February/March couldn't be avoided. A grounding of the fleet after the first incident was considered being inappropriate based on the service experience (around 500 engines and 11,000 flight hours without problem).

Attachment 2

The German Federal Bureau of Aircraft Accident Investigation (BFU - Bundesstelle für Flugunfalluntersuchung) has submitted the following comment to the report:

The flight was performed under Night VMC conditions. During operation of a single engine aircraft an engine shut down or engine failure has to be considered as a probable event. The ability of an emergency landing on a suitable site is a compensating measure to prevent an accident in case of an engine shut down. Under the circumstance of Night VMC the limited number of suitable landing sites led to increased risk on this flight.