Statens haverikommission
Swedish Accident Investigation Authority

Interim Statement SRL 2022:01e

Accident at Örebro Airport, Örebro County, on the 8 July 2021 involving the aeroplane SE-KKD of the model DHC-2 Mk III, privately operated in connection with parachute operations.

File no. L-47/21

2022-01-27

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

ISSN 1400-5719

This document is a translation of the original Swedish report. In case of discrepancies between this translation and the Swedish original text, the Swedish text shall prevail in the interpretation of the report.

Cover photo no. 3 – © Anders Sjödén/Swedish Armed Forces.

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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.

Interim Statement

The results of the investigation will be published in a final report. Such a report shall be published, if possible, within twelve months after the accident. SHK has decided to publish an interim statement at an earlier date. The statement contains, in addition to a report of the sequence of events, information on the progress of the investigation and relevant parts of the factual material gathered.

Publication of the interim statement takes place during a phase where the investigation has not yet been completed, for which reason the content of the material now presented may come to be supplemented, amended or omitted in the final report.

The interim statement has not undergone the consultation process that precedes the publication of a final report. Hence, SHK cannot guarantee that everything presented in this interim statement will be part of or be identical to the content of the subsequently published final report.

The investigation

The Swedish Accident Investigation Authority was informed on the 8 July 2021 that an accident involving an aeroplane with the registration SE-KKD had occurred at Örebro Airport, Örebro County, that same day at 19:20 hrs.

The accident is being investigated by SHK as represented by Ms Jenny Ferm, Chairperson, Mr Mats Trense, Investigator in Charge, Mr Johan Nikolaou, Operational Investigator, Mr Sakari Havbrandt, Technical Investigator and Mr Tomas Ojala, Investigator specialising in Fire and Rescue Services.

Ms Nora Vallée from the Transportation Safety Board of Canada (TSB) participates as an accredited representative for Canada. She is assisted by advisor Mr Dennis Pollard from type certificate holder Viking Air Ltd and Mr Robert Duma as advisor from engine manufacturer Pratt & Whitney Canada Corp.

Mr Jason Aguilera from the National Transportation Safety Board (NTSB) is participating as an accredited representative from the USA. He is assisted by Mr Les Doud as an advisor to the propeller manufacturer Hartzell Propeller Inc.

SHK is assisted by Magnic AB as an expert in sound and image analysis, Ms Liselotte Yregård as an expert in aviation medicine and Mr Kristoffer Danèl as an aeronautical expert.

Mr Hender Mendes participates as an adviser on behalf of the European Union Aviation Safety Agensy (EASA).

Mr Magnus Axelsson participates as an adviser on the behalf of the Swedish Transport Agency.

The Swedish Transport Agency and the EASA are participating in advisory capacities and have been continuously kept informed of the investigation.

The following organizations have been notified: The International Civil Aviation Organization (ICAO), EASA, the European Commission and the Swedish Transport Agency.

Investigation material

Interviews have been conducted with e.g. the air traffic controller who was on duty, witnesses, the instructor who was responsible for the pilot's training and several of the pilot's proficiency checks, as well as pilots who have experience of flying the type of aircraft.

The accident site and the aircraft have been investigated. Technical investigations have been carried out on the relevant parts of the aircraft as well as equipment that was on board.

The engine and propeller have been disassembled and inspected.

Registrations from a GPS, radar registrations from LFV and the Swedish Armed Forces and sensor data from Flightradar24 have been analysed. Furthermore, sound recordings from the air traffic control and from a private film recording have been analysed.

Interim Statement SRL 2022:01e

Aircraft:	
Registration, type	SE-KKD, DHC-2
Model	De Havilland Canada DHC-2 Mk III
Class, airworthiness	Normal, Certificate of Airworthiness and valid Airworthiness Review Certificate (ARC)[1]
Serial number	1629 TB17
Owner/Holder	Kalle David Flyg AB/South Sweden Flight Academy AB
Time of the occurrence	8 July 2021, at 19:20 hrs in daylight. Note: all times are given in Swedish daylight-saving time (UTC[2] + 2 hrs)
Location	Örebro Airport, Örebro County, (position 69 13N, 015 02E, 58 metres above sea level)
Type of flight	Private/parachute lift
Weather	According to METAR[3]: Wind 230˚/4 knots, visibility >10 km, clouds few towering cumulus with base at 4,000 feet and scattered clouds at 8,500 feet, temperature/dewpoint +23/+14°C, QNH[4] 1021 hPa.
Persons on board:	9
Crew	1
Passengers	8
Injuries to persons	9 fatalities
Damage to the aircraft	Destroyed
Other damages	None
The Pilot	
Age, licence	62 years, PPL[5]
Total flight time	1,049 hours, of which 556 hours on type
Flight time last 90 days	22 hours, of which 20 hours on type
Landings last 90 days	61, of which 47 on type

[1] ARC – Airworthiness Review Certificate.
[2] UTC – Coordinated Universal Time.
[3] METAR – METeorological Aerodrome Report.
[4] QNH (Question Nil Height) – The atmospheric pressure adjusted to the mean sea level.
[5] PPL – Private Pilot License.

1. FACTUAL INFORMATION

1.1 History of the flight

1.1.1 Preconditions

The intention of the flight was to drop eight parachutists from an altitude of 1,500 metres. Earlier in the day, the pilot had performed six parachute lifts from Örebro Airport alternately with another pilot, who in turn performed five parachute lifts. The twelfth lift would be the last for the day. In the control tower at the airport, an air traffic controller was on duty.

1.1.2 Sequence of events

After take-off, the aircraft climbed to an altitude of between 400 and 500 feet above the ground before changing course by 180 degrees to the left and descending at a steep angle to the ground. According to witnesses, the aircraft turned around quickly and dived with a 45-degree nose down.

During the impact, the landing gear was broken off, after which the aircraft skidded on its belly 50 metres straight ahead and began to burn. The flight lasted 46 seconds.

All nine persons on board sustained fatal injuries.

The accident occurred at position 59°13N 015°02E, 58 metres above sea level.

1.2 Injuries to persons

	Crew	Passengers	On board, total	Others
Fatal	1	8	9	-
Serious	-	-	0	-
Minor	-	-	0	Not applicable
None	-	-	0	Not applicable
Total	1	8	9	-

1.3 Damage to the aircraft

Destroyed.

1.4 Other damage

1.4.1 Environmental impact

Fuel and combustion residues on ground.

1.5 The crew

1.5.1 Pilot's qualifications

Pilot in command

Pilot in command, 62 years old and was holding a PPL with valid rating on type and a medical certificate.

Flying hours				
Last	24 hours	7 days	90 days	Total
All types	4	4	22	1049
Type in question	4	4	20	556

Number of landings actual type last 90 days: 47.
Skill test on type 8 May 2006.
Last PC[6] on the type DHC-2 SET carried out on 30 May 2020.
The rating was valid until 31 May 2022.

1.6 The Aircraft SE-KKD

The aircraft SE-KKD was of the model De Havilland Canada DHC-2 Mk III (see Figures 1 and 2). The model is a high-wing aircraft and is powered by a turboprop engine. It is 10 metres long and has a wing span of just over 14 metres. The wheel width on the main landing gear is 3.1 metres.

The aircraft was modified for parachuting, which i.e. means that there were no passenger seats in the cabin. There was room to accommodate nine parachutists and one pilot.

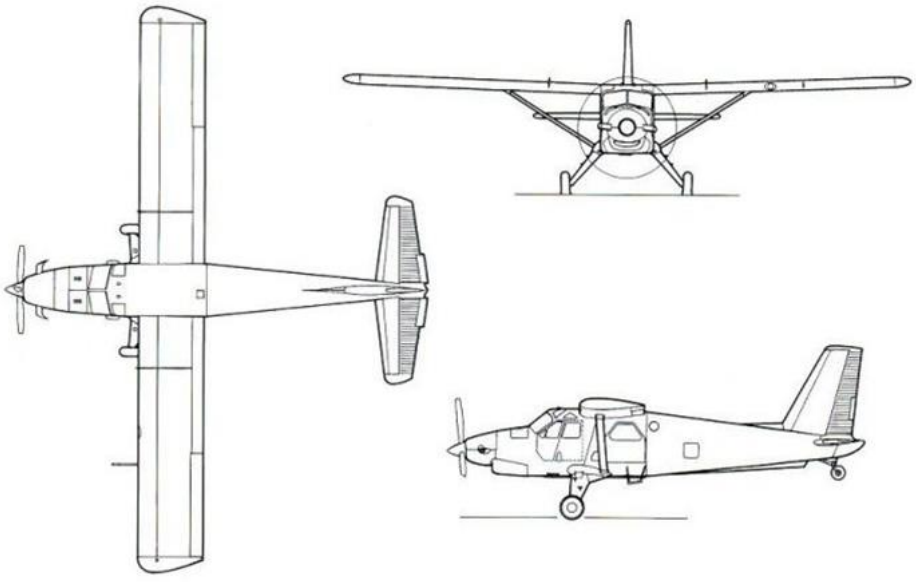


Figure 1. Three-plane sketch of the aircraft type DHC-2.

[6] PC – Proficiency Check.

Figure 2. The aircraft SE-KKD before the accident.

1.6.1 The aeroplane

Type certificate holder	Viking Air Limited
Model	DHC-2 Mk III
Serial number	1629 TB 17
Year of manufacturing	1966
Gross mass (kg)	Max. take-off 2 436, actual see section 1.16.6
Centre of gravity	See section 1.16.6
Total flight time, hours	14 538
Flight time since last inspection, hours	56
Total landings	25 605
Type of fuel uplifted before the accident	Jet A1

Engine	
TC-holder	Pratt & Whitney Canada Corp
Type	PWC PT6A-34

Propeller	
TC-holder	Hartzell Propeller Inc
Type	Hartzell HC-B3TN-3D/T10282N

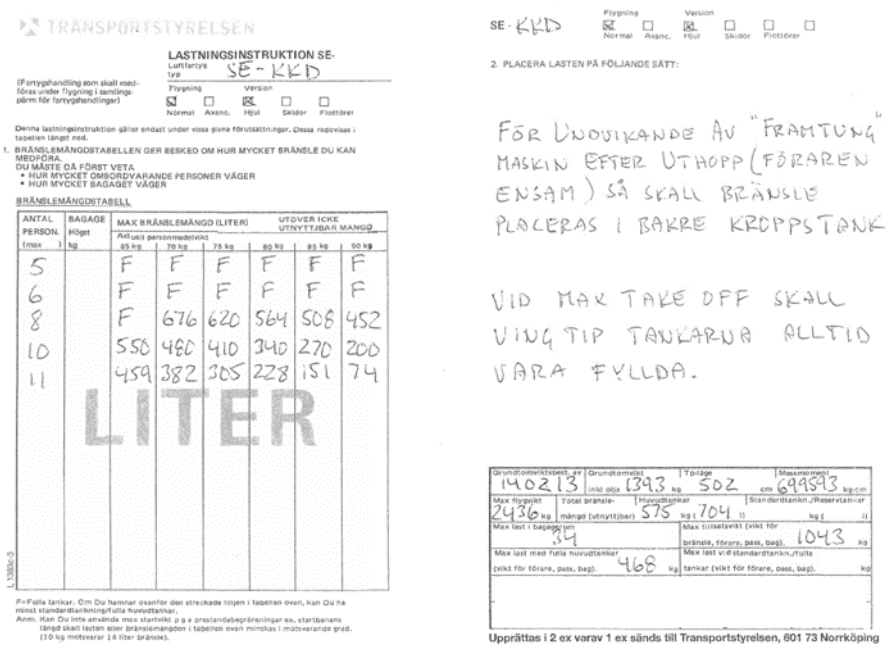
Hold items	None

The aircraft had a Certificate of Airworthiness and a valid ARC.

1.6.2 Loading instructions

Each aircraft shall have a system to enable the pilot to ensure that the mass and balance are within permissible limits.

The load instruction that was established for the aircraft only states restrictions on the location of the load when there is one pilot on board (see Figure 3).


TRANSPORTSTYRELSEN

LASTNINGSINSTRUKTION SE-

Luftfartyg typ SE-KKD

Flygning: ☒ Normal ☐ Avanc. Version: ☒ Hjul ☐ Skidor ☐ Flottörer

Denna lastningsinstruktion gäller endast under vissa givna förutsättningar. Dessa redovisas i tabellen längst ned.

1. BRÄNSLEMÄNGDSTABELLEN GER BESKED OM HUR MYCKET BRÄNSLE DU KAN MEDFÖRA.
DU MÅSTE DÅ FÖRST VETA
• HUR MYCKET OMBORDVARANDE PERSONER VÄGER
• HUR MYCKET BAGAGET VÄGER

BRÄNSLEMÄNGDSTABELL

ANTAL PERSON. (max)	BAGAGE Högst kg	MAX BRÄNSLEMÄNGD (LITER) Aktuell personmedelvikt 65 kg	70 kg	75 kg	80 kg	85 kg	90 kg	UTÖVER ICKE UTNYTTJBAR MÄNGD
5		F	F	F	F	F	F	
6		F	F	F	F	F	F	
8		F	676	620	564	508	452	
10		550	480	410	340	270	200	
11		459	382	305	228	151	74	

LITER

F=Fulla tankar. Om Du hamnar ovanför den streckade linjen i tabellen ovan, kan Du ha minst standardtankning/fulla huvudtankar.
Anm. Kan Du inte använda max startvikt p g a prestandabegränsningar ex. startbanans längd skall lasten eller bränslemängden i tabellen ovan minskas i motsvarande grad. (10 kg motsvarar 14 liter bränsle).

SE-KKD Flygning ☒ Normal ☐ Avanc. Version ☒ Hjul ☐ Skidor ☐ Flottörer ☐

2. PLACERA LASTEN PÅ FÖLJANDE SÄTT:

FÖR UNDVIKANDE AV "FRAMTUNG" MASKIN EFTER UTHOPP (FÖRAREN ENSAM) SÅ SKALL BRÄNSLE PLACERAS I BAKRE KROPPSTANK.

VID MAX TAKE OFF SKALL VINGTIP TANKARNA ALLTID VARA FYLLDA.

Grundtomviktsbest. av	Grundtomvikt inkl olja	Tyngdpunktläge	Massmoment
140213	1393 kg	502 cm	699593 kg cm

Max flygvikt	Total bränslemängd (utnyttjbar)	Huvudtankar	Standardtankar./Reservtankar
2436 kg	575 kg (704 l)		kg (l)

Max last i bagagerum	Max tillsatsvikt (vikt för bränsle, förare, pass, bag).
54	1043 kg

Max last med fulla huvudtankar (vikt för förare, pass, bag).	Max last vid standardtankn./fulla tankar (vikt för förare, pass, bag).
468 kg	kg

Upprättas i 2 ex varav 1 ex sänds till Transportstyrelsen, 601 73 Norrköping

Figure 3. The picture shows the load instruction that applied to the aircraft SE-KKD.

Skånes parachute club, which was the club that usually used the aircraft in its operations, also had an Excel spreadsheet for mass and balance calculation. Calculations in the spreadsheet assumed that the right pilot seat was removed and that there was room for parachutists there. However, the information in the spreadsheet was unknown to the pilots who flew the aircraft in Örebro on the day of the accident.

At the time of the accident, the right pilot seat was installed, which meant that the parachutists sat further back than normally compare to when two parachutists are sitting to the right of the pilot (see Figure 4).

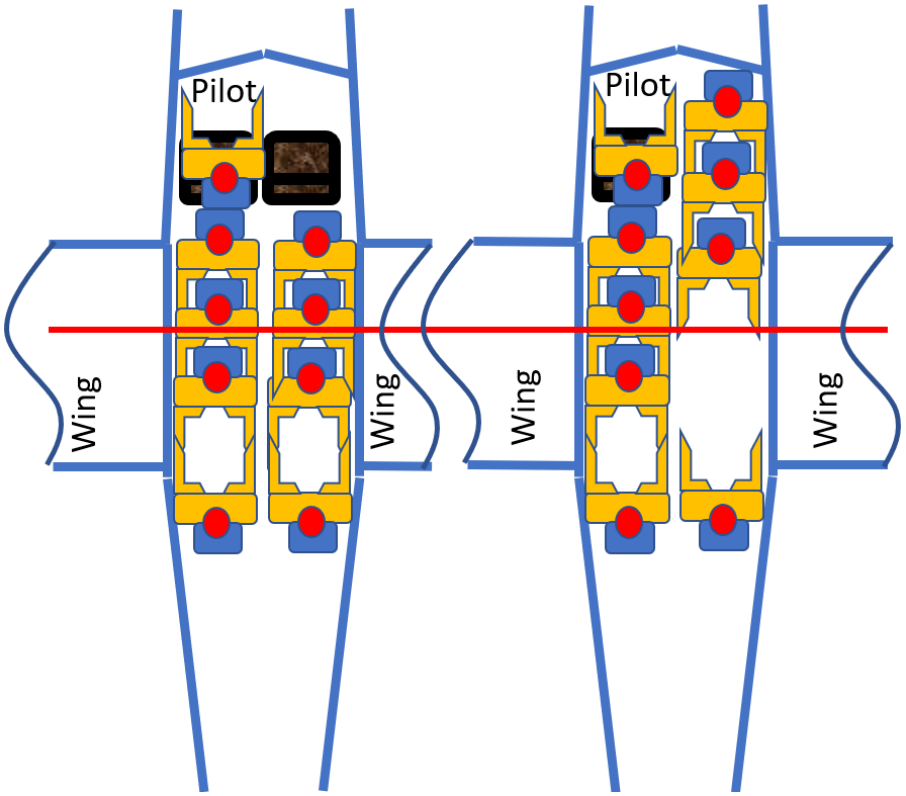


Figure 4. The left picture shows how those on board were seated during the accident flight. The right picture shows how the parachutists normally would be seated when the right pilot seat was removed. The red line shows the rear limit of the permissible centre of gravity.

1.7 Meteorological information

According to METAR: Wind 230 degrees, 4 knots, visibility > 10 km, few towering cumulus with a base of 4,000 feet and scattered clouds with a base of 8,500 feet, temperature/dew point +23/+14°C, QNH 1021 hPa.

In the altitude layers up to 600 feet, the winds were around southwest (230 degrees), 4 to 10 knots.

The accident happened in daylight.

1.8 Aids to navigation

Not applicable.

1.9 Radio communications

The radio communication was normal until the air traffic controller, after take-off, called the aircraft without receiving a response.

1.10 Aerodrome information

The airport is an approved instrument airport according to AIP[7] Sweden. The airport has a paved runway with the designations 10/19. At the time, runway 19 was used, which is 3,270 metres long and 45 metres wide. The runway was dry at the time.

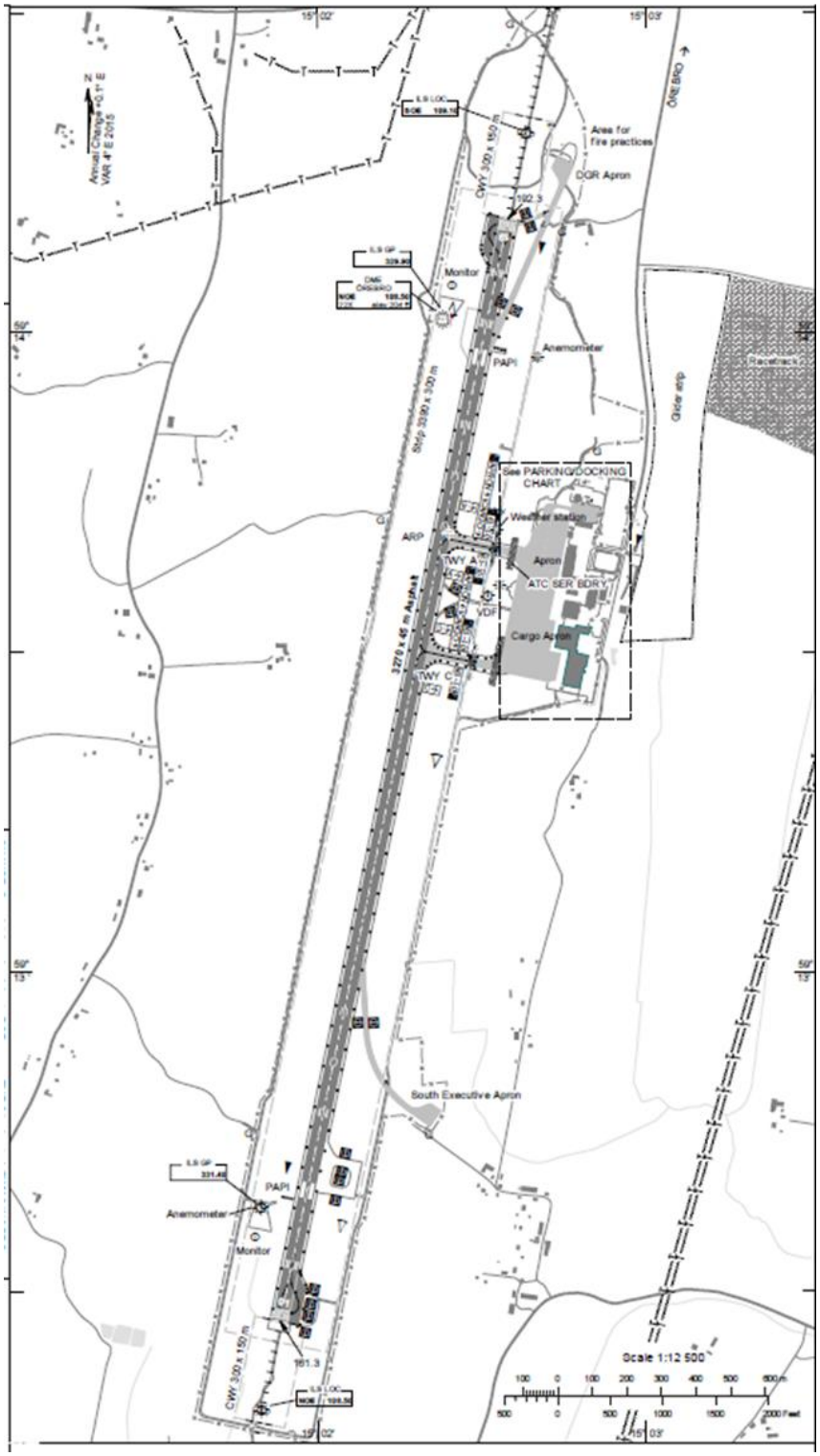


Figure 5. Overview of Örebro Airport. Image: AIP Sweden.

[7] AIP – Aeronautical Information Publication.

1.11 Flight recorders

There was no permanently installed flight or voice recorder in the aircraft and such equipment was not required for this type of aircraft.

SHK has obtained, read out, or attempted to read out, information from other sources or entities, which is presented below. The information is not processed by SHK in any other way than that it has been marked out on the images below. SHK has initiated analysis of the probable flight path based on available information.

1.11.1 Recorded radar data from LFV – Air Navigation Services of Sweden

The aircraft's transponder provided the radar system with an identification signal and an altitude indication. The lateral position was calculated by the radar equipment based on the transponder's identification signal, while the altitude information was obtained directly from the aircraft's transponder. Figure 6 shows the aircraft's position recordings from Askersund's radar.

Figure 6. The aircraft's position registrations from Askersund's radar. Specified altitudes are adjusted for atmospheric pressure reduced to mean sea level (QNH) Image: Google Earth with markings inserted by SHK.

1.11.2 ADS-B registrations from Flightradar24

The aircraft's transponder, equipped with an ADS-B[8] function, calculated and recorded data from a built-in GPS receiver and a pressure sensor connected to the aircraft's static system. The data included lateral position indications, altitude information, speed, track, vertical climb or descent speed and time indications for each registration. The transponder sent the data to two ground stations near Örebro Airport, which forwarded the information to Flightradar24. Figure 7 shows the aircraft's position recordings from the ADS-B function.

Figure 7. The position recordings from ADS-B. Specified altitudes are adjusted for atmospheric pressure reduced to mean sea level (QNH) Image: Google Earth with markings inserted by SHK.

1.11.3 Registrations from a GPS receiver

An independent Garmin GPSmap was mounted on the dashboard in front of the pilot. The unit was damaged by fire and has been sent to the French aviation accident investigation board (Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile, BEA) which has assisted SHK in reading out information from the unit. The memory component has been extracted from the unit and a decoding process has been performed with special software from BEA.

[8] ADS-B – Automatic Dependent Surveillance-Broadcast.

Figure 8. Garmin GPS map.

Registrations from all flights during July 8 could be retrieved from the memory component. The information consisted of lateral positions, GPS altitude information and time for each registration. All registrations are calculated based on information from the GPS system. Figure 9 shows the aircraft's position and altitude recordings.

Figure 9. Aircraft position and altitude recordings from GPS. Image: Google Earth with markings inserted by SHK.

Figure 10 presents the vertical climb profile for all flights during 8 July. The profile in purple illustrates the accident flight.

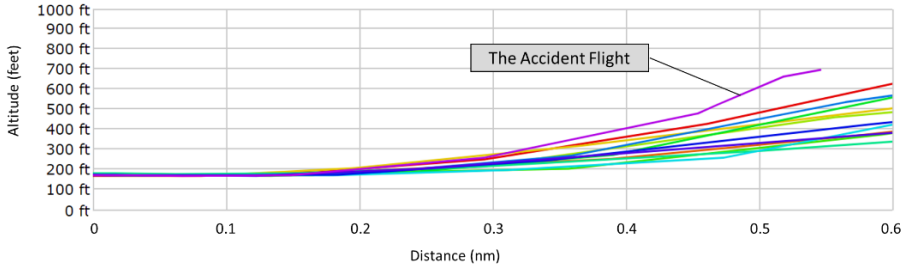


Figure 10. Vertical climb profile from all flights (one nautical mile equals 1 852 km).

1.11.4 Registrations from the aircraft transponder

The aircraft's transponder had the possibility to record flight data on a memory card. However, no memory card was mounted in the device, which meant that no data was recorded.

1.11.5 Sound recordings from the flight

Recordings from the propeller sound have been obtained from two separate sources (see Figure 11).

A private person who filmed another object at the same time as the accident occurred. The person was 1,370 metres south of the crash site. Propeller sound from SE-KKD was recorded for 26 seconds during the last part of the flight.

There was a recording equipment with a microphone in the tower, that recorded all sounds in the tower. Propeller sound from SE-KKD was recorded for 23 seconds during the take-off and for 9 seconds during the last part of the flight.

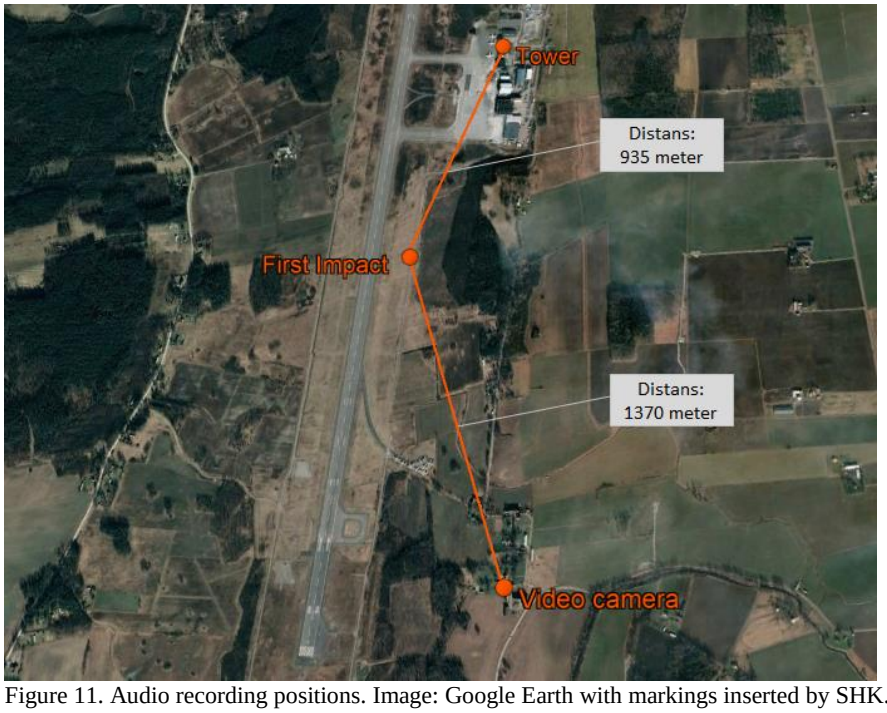


Figure 11. Audio recording positions. Image: Google Earth with markings inserted by SHK.

The sound registrations have been analysed by Magnic AB. Figure 12 presents a spectrogram in which the frequency of the propeller sound can be read. Using the frequency, the propeller speed can be calculated.

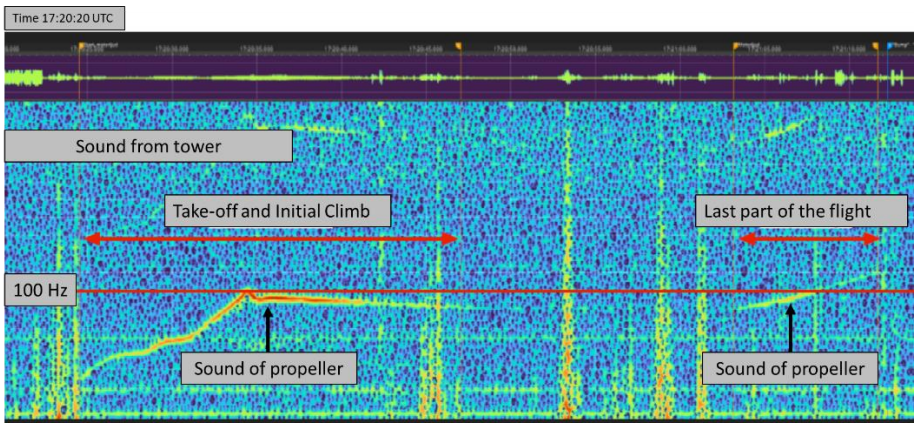


Figure 12. Spectrogram from the recording in the tower. Image: Magnic AB with markings inserted by SHK.

A preliminary analysis of the sound recordings shows the propeller rpm in Figure 13. The propeller rpm is the mean value corrected for the Doppler[9] effect based on the position indications from Flightradar24 (section 1.11.2) and Garmin GPS (section 1.11.3).

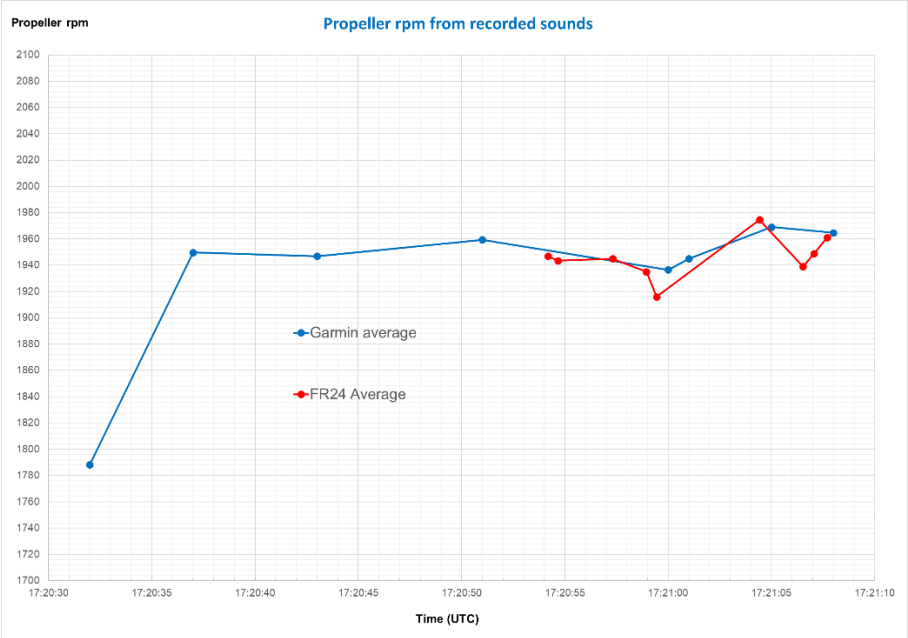


Figure 13. Mean value of propeller rpm corrected for the Doppler effect. Image Magnic AB.

The sound recordings will be further analysed.

[9] Doppler – Physical phenomenon, which means that the frequency of a signal, such as sound waves, is perceived differently depending on whether the source is approaching or moving away in relation to the observer.

1.11.6 Examination of the parachutist's registration equipment

The altimeters and acoustic altimeters that were found on board have been analysed. No information was available on any of the devices.

The parachute packages contained automatic triggers (cypresses) for the reserve parachutes. The activation altitude for these devices was not reached and due to that there was no information on the devices.

1.11.7 Examination of mobile phones

During the examination of the accident site, no mobile phones were found. The police authority later handed over the pilot's mobile phone to SHK. The telephone has been analysed, but no information relevant to the investigation has been found.

1.11.8 Examination of the Pilot watch

The pilot wore a Garmin D2 AIR watch. The watch is subject to further investigation.

1.11.9 Examination of GoPro cameras

Two cameras were found at the accident site. One was in good condition, but contained no information. The other was damaged in the fire and sent to BEA for an attempt to read out information. No information related to the accident was found, but seven other films from previous jumps could be retrieved.

1.11.10 Summary of registrations

All registrations are presented in Figure 14.

Figure 14. Blue markings show radar data, green markings show ADS-B data and grey markings with a star show GPS data. Image: Google Earth with markings inserted by SHK.

1.12 Accident site and aircraft wreckage

1.12.1 Accident site

The final position was to the east of the runway, 142 metres from the runway centre line and 1,540 metres from the end of runway 19, next to a road within the airport area.

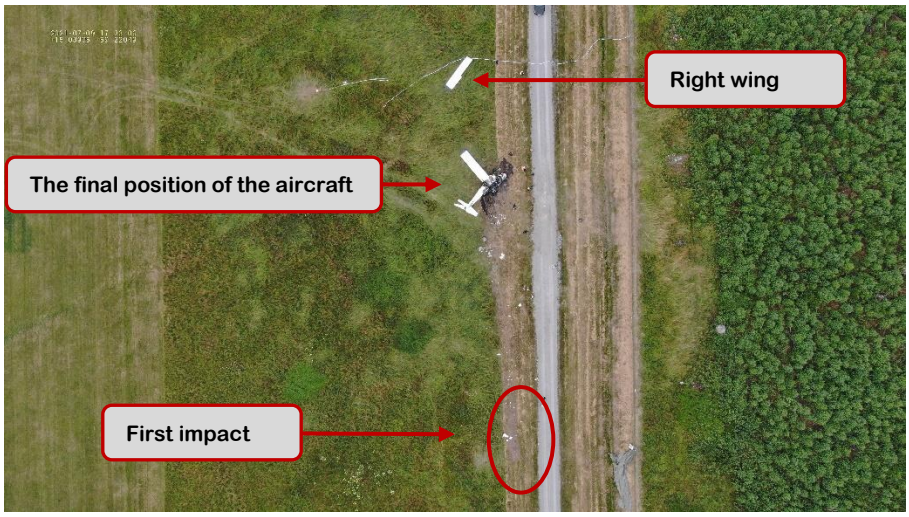


Figure 15. The accident site and the aircraft's position next to a road east of the runway.

1.12.2 Aircraft wreckage

During the impact, parts of the aircraft separated, such as the propeller, right wing and left main landing gear along the 50 metres that the aircraft skidded.

Figure 16. The aircraft at the accident site.

The right wing detached from the aircraft in connection with the impact and ended up 20 metres in front of the aircraft. Two propeller blades broke away from the hub and the hub separated from the engine gearbox.

The cabin area was exposed to fire.

1.13 Medical and pathological information

Nothing has been found to indicate that the mental and physical condition of the pilot was impaired before or during the flight.

1.14 Fire

A fire broke out during the impact. The fire was extinguished by the rescue service.

1.15 Survival aspects

1.15.1 The rescue operation

The rescue operation will be addressed in the final report.

1.15.2 Location and use of belts on board

The pilot was seated in the left pilot seat and used a four-point belt.

The parachutists were seated in the cabin behind the pilot which was not equipped with seat belts or other restraining devices.

1.16 Special investigations

1.16.1 Flight Control System

The flight control system has been examined. No evidence suggesting any malfunctions has been detected.

Elevator trim system

In order to fly stable in different flight conditions such as different mass centre positions, flap positions or air speed, the pilot must keep the elevator in a position specific to meet the current condition. To reduce or eliminate the required control force, there is a trim device.

There is a trim panel in the ceiling between the pilot seats. The mechanism in the ceiling contains a gear that transmits the movement from the trim wheels to a cable system on to a cable drum that affects the elevator trim tab on the trailering edge of each elevator. The elevator trim emits a force on the rear elevator trailering edge, up or down depending on the set angle.

During parachute operations, there will be a major change in the aircraft's mass and centre of gravity position after the parachutists have left the aircraft. This causes a large change in the position of the elevator, which in turn requires a trim change to maintain a stable flight without large control forces.

The trim settings on the trim panel in Figure 17 show an elevator trim setting which, according to other pilots who have flown the aircraft in parachute operations, is normal for landing with a pilot and without parachutists onboard.

Figure 17. The picture on the left shows the trim panel from the wreckage and the picture on the right shows an intact panel with the same setting. The red boxes show the elevator trim.

The trim setting corresponds to the position in the figure 18.

Figure 18. The left image shows the position of the elevator trim after the accident and the right image is taken from a surveillance camera when the aircraft is taxying out to the runway.

The left image on figure 19 shows an elevator trim setting which, according to other pilots, is normal for take-off with a pilot and eight parachutists on board. The right image in the same figure shows the position before one of the other flights during the day. The trim position on the panel in the figure corresponds with the trim tab position in the figure.

Figure 19. The left part of the picture shows a trim setting which, according to other pilots, is normal for take-off with a pilot and eight parachutists on board. The red box shows the elevator trim. The right part shows the position of the rudder before one of the previous flights during the day.

1.16.2 Engine examination

The engine has been examined with assistance from the type certificate holder. Nothing has emerged from the examination that indicates a malfunction.

1.16.3 Analysis of fuel

It was not possible to take fuel samples from the aircraft's fuel tanks. A fuel sample was therefore taken from the refuelling facility that was used when SE-KKD was refuelled at Örebro Airport. SHK has commissioned Element Materials Technology AB to carry out an analysis of the fuel, which was of the type Jet A1.

Results of the analysis showed that measured values were within the limits required except the test "Solid Contaminants" that observed visible particles. The properties "Water Content" and "Water Tolerance" showed no signs of contamination and were normal.

1.16.4 Propeller examination

The propeller has been examined with the assistance of the type certificate holder.

The examination showed nothing abnormal and that the engine produced high power with positive thrust on the propeller at impact.

1.16.5 Examination of warning lights

SHK has examined seven of the aircraft's warning lights.

Stall warning light

The warning light is located on the instrument panel and illuminates when the angle of attack[10] approaches stall[11].

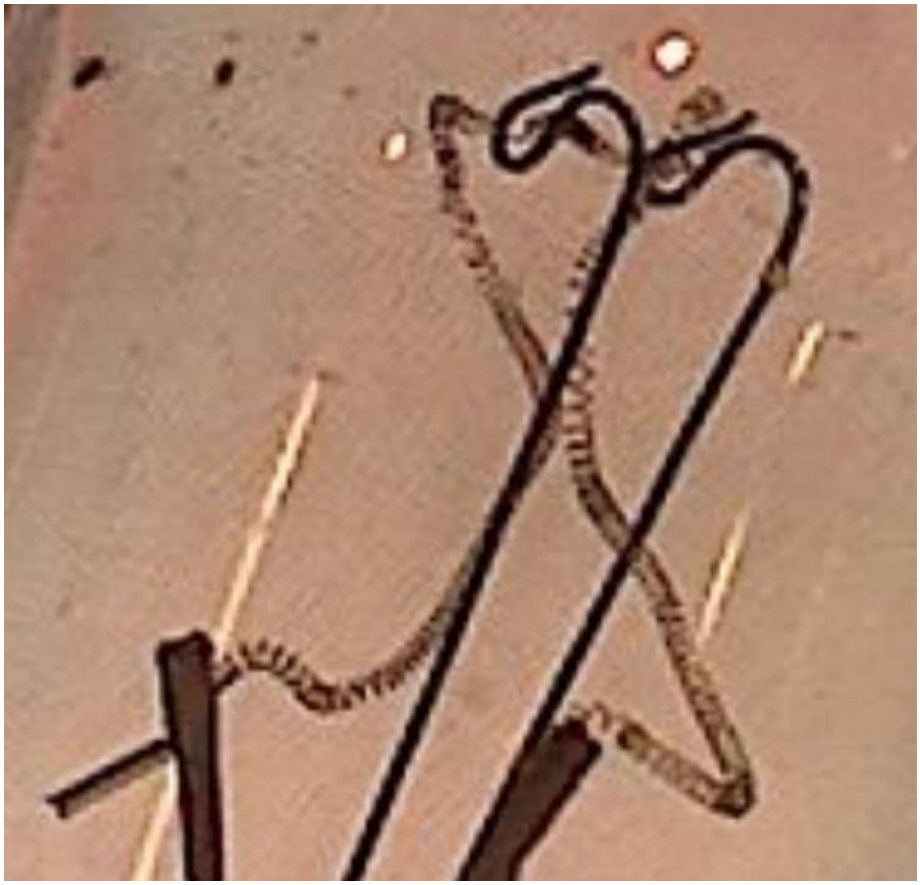


Figure 20. Enlargement of an image on the stall warning light bulb. The picture shows the deformed filament.

The filament in the light bulb had been deformed without breaking, which indicates that it was hot and illuminated at impact.

[10] Angle of attack – The angle between the wing and the flight path of the aircraft.
[11] Stall – Loss of lift due to that the angle of attack is so great that the air flow separates from the wing.

Other lights

Other examined warning lights were not illuminated. The survey has included the following lights:

"Beta fail" – illuminate if there is a fault in the propeller reverse system.

"Pitch position" – illuminate for certain faults in the propeller control system.

"Chip detect" – illuminate if there are metal chips in the oil system.

"Generator warning" – illuminate if the generator does not supply power.

"Low fuel pressure left and right" – low fuel pressure warning.

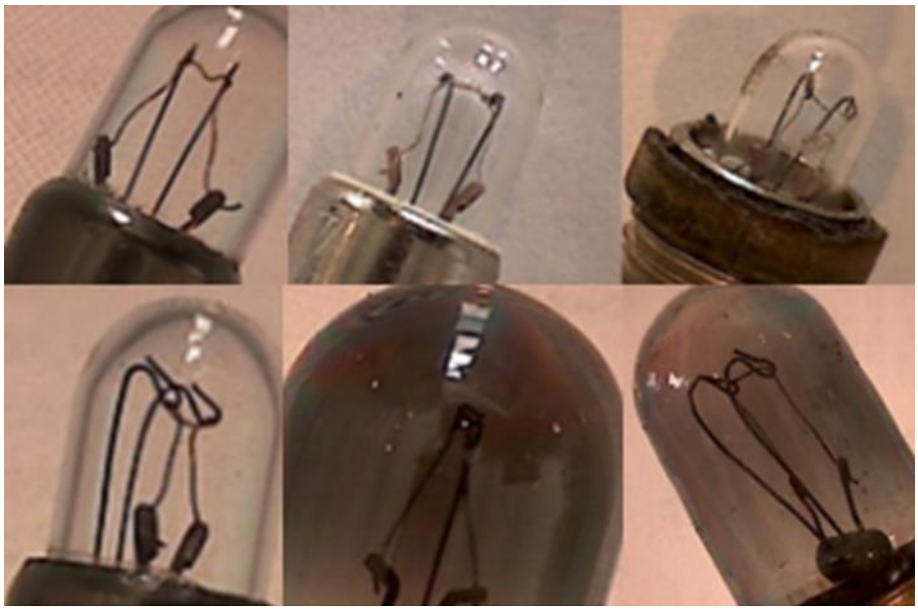


Figure 21. The filaments of these light bulbs were intact, indicating that they were not illuminated. From the top left row: Beta fail, Pitch position and Chip detect. Bottom row: Generator warning, Left low fuel pressure and Right low fuel pressure.

1.16.6 Mass and balance calculations

It is crucial that the mass and balance of an aircraft are within permissible values to ensure a safe flight. However, this does not mean that it is impossible to fly the aircraft if you end up slightly outside the permitted area. If the centre of gravity is behind the permitted limit the aircraft becomes less stable and more demanding to control. It also becomes more sensitive to other disturbances such as turbulence or incorrect trim settings.

SHK has carried out mass and balance calculations with several different assumptions regarding the position of the parachutists in the cabin.

In order to more thoroughly determine where each individual parachutists mass centre was, a model of the passenger cabin was built. A weighing exercise with eight parachutists sitting in the model was performed and resulted in the determination of the mass centre position for each row, to be used for further calculations. There are currently several uncertainties in the calculations. For example, it is not established in what order and exactly where the parachutists were seated. All calculations made so far shows that the mass and balance position was within the red rectangle near the aft upper corner of the envelope (see Figure 22).

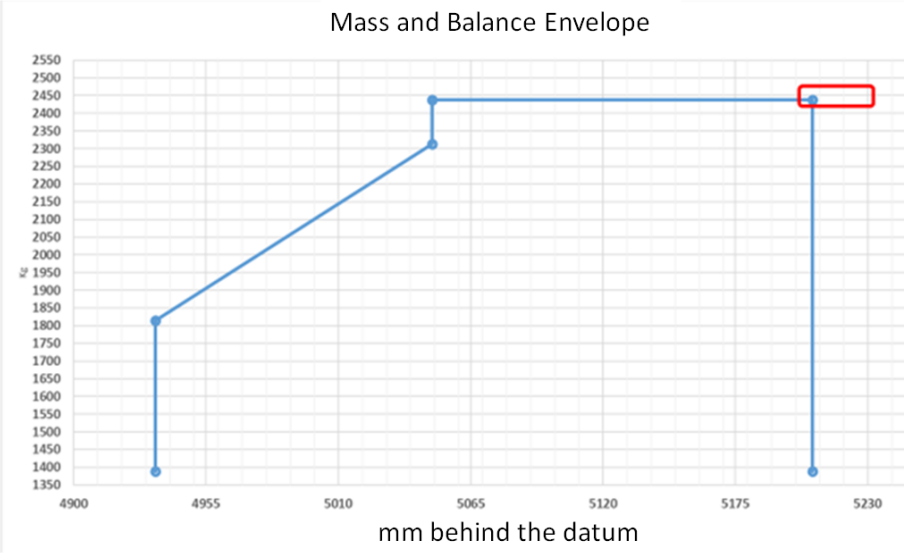


Figure 22. Mass and balance envelope. The vertical axis shows the mass of the aircraft and the horizontal axis shows the mass centre position of the aircraft. The blue lines show the permissible range.

SHK has interviewed pilots who flew the aircraft. They were all of the opinion that there was no risk to end up behind the permitted mass centre area.

1.17 Organisational and management information

1.17.1 The operator

The operation is performed within EASA's private aviation regulation PART-NCO, hence the operation does not require any further approval. This means that the commander is the operator.

1.17.2 Mass and balance determination before flight

SHK has not found any documented mass and balance calculations performed before the flight.

1.18 Additional information

1.18.1 The continued investigation

SHK's work continues with collection of facts and analysis.

On behalf of the Swedish Accident Investigation Authority

Jenny Ferm Mats Trense