Norwegian Safety
Investigation Authority

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REPORT AVIATION 2025/08

Aviation accident at Reinsvoll Airfield in Innlandet county on 28 August 2023 with MLP Aviation LTD Christen Eagle II, LN-TBN

The Norwegian Safety Investigation Authority (NSIA) has compiled this report for the sole purpose of improving flight safety.

The purpose of the NSIA's investigations is to clarify the sequence of events and causal factors, elucidate matters deemed to be important to the prevention of accidents and serious incidents, and to make possible safety recommendations. It is not NSIA's task to apportion blame or liability.

Use of this report for any other purpose than for flight safety shall be avoided.

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Photo: Aviat Aircraft

This report has been translated into English and published by the NSIA to facilitate access by international readers. As accurate as the translation might be, the original Norwegian text takes precedence as the report of reference.

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Air accident report

Table 1: Data

Aircraft:	MLP Aviation LTD Christen Eagle II
Nationality and registration:	Norwegian, LN-TBN
Owner:	Private
Operator:	Owner
Pilot:	1
Passengers:	1
Site of incident/accident:	Reinsvoll airfield in Innlandet county, approx. 550 metres south of the threshold to runway 34
Time of incident/accident:	Sunday 28 August 2023, at 1852 hrs

All times given in this report are local times (UTC + 2 hours) unless otherwise stated.

Notification

On Monday 28 August 2023 at 1936 hrs, the Norwegian Safety Investigation Authority (NSIA) was notified by the police of an aircraft accident at Reinsvoll airfield. It soon became clear that the accident concerned a Christen Eagle II with registration LN-TBN. The aircraft had crashed in the forest south of the airfield, and both the pilot and passenger had died. The NSIA travelled to the site of the accident the following morning to begin its investigation.

Summary

On Monday 28 August 2023, the owner of LN-TBN, a Christen Eagle II aircraft, had planned a flight from Reinsvoll airfield with a passenger. The plan was to fly sightseeing over Toten before finishing off with some aerobatics over the airfield.

They took off at 1817 hrs, and after about 30 minutes of flying, they returned to Reinsvoll where they performed some basic aerobatic manoeuvres over the airfield. After the last manoeuvre, they continued south for 2–3 km before turning back towards the airfield. At this point, witnesses described hearing the engine sputter for two or three seconds before running normally again. Just south of the airfield, they turned westward in a wide left turn before approaching the airfield again from the south-west. On the way towards the airfield, witnesses have stated that the aircraft nose suddenly pitched down. Three witnesses believe they heard a bang just before the aircraft pitched down. The aircraft was located in the forest about 550 metres south of the threshold of runway 34 at Reinsvoll. Both the pilot and passenger had died.

The NSIA has carried out thorough investigations into technical, operational and human factors but has been unable to explain why, according to witnesses, the aircraft went from flying straight and level to the aircraft's nose suddenly pitching down.

Based on the position and altitude of the aircraft, the NSIA believes that the steep descent was not part of normal manoeuvring. The manoeuvre may have been unintentional or the result of problems with the aircraft. In case of total or partial loss of engine power a steep descend will be necessary to establish and maintain best glide airspeed. The investigation has not uncovered any technical faults with the engine, ignition or fuel system. However, the NSIA cannot rule out the possibility.

The bang some of the witnesses heard just before the aircraft pitched down may have been an indication of problems with the engine. Based on findings at the accident site the NSIA believes the propeller rotated and the engine was running at the time of the accident, although it cannot be determined whether the engine produced full power. If the engine stopped at the time the bang was heard, the pilot may have been able to restart it, but too late to avoid the trees. A situation like this would have demanded a lot of attention by the pilot. At the same time, with a passenger in the front seat, limited view of the instruments would have made it challenging to analyse a possible engine problem. Limited forward field of view may also have contributed to the pilot not noticing the trees ahead in time.

The NSIA does not propose any safety recommendations in connection with this investigation.

1. Factual information

1. Factual information

1.1 History of the flight

On 28 July 2023, the passenger's spouse contacted the pilot by email to find out whether it was possible to book a flight. She had found the pilot's contact details on the local flying club's website and wrote that she wanted to give her spouse a local flight as a gift. The pilot replied that he had a Christen Eagle II aircraft that could perform aerobatic manoeuvres (see Figure 1). The flight would last about 45 minutes. The passenger would have the opportunity to try to fly during a local tour around Toten, while the pilot could perform aerobatics over the airfield. The price of the flight was also agreed upon. Over the next few weeks, there was some communication to find a suitable time when the weather was good enough. On the morning of Monday 28 August, they agreed to meet the same day at 1800 hrs to carry out the flight.

Figure 1: LN-TBN. Photo: Private

The passenger arrived at Reinsvoll airfield with his closest family at approximately 1745 hrs. The pilot arrived about five minutes later, conducted a preflight of the aircraft and pulled it out of the hangar. The atmosphere was good, and the pilot explained a bit about the aircraft and the flight. Exactly what was said is not known, but among other things, they talked about the landing phase, which was slightly different. To be able to see ahead, the pilot explained that he had to approach at a slight sideways angle. This could be uncomfortable but was completely normal. They also talked about where they were going to fly and that the pilot could perform aerobatics over the airfield, but only if the passenger wanted to. They also joked about there being a fair number of cows on the airfield.

Photos and video show the pilot helping the passenger to fasten his seatbelt, and pointing out details in the cockpit and explaining. At 1808 hrs, they started the engine. After engine start, and again a few minutes later after taxiing forward, those watching have explained that there seemed to be some problems with the headphones they were using, and that the pilot and passenger eventually swapped headphones.

Before taxiing onto the runway for departure, an engine check was carried out. A review of a video taken while the engine was being checked indicates that the engine and propeller were functioning normally.

At 1817 hrs, the aircraft took off towards the south. Witness observations and photos suggest that they started the flight east of the airfield, in the area around Bøverbru, Kolbu, Lena and up towards Gjøvik. Uncertainty surrounding the timing of the various observations makes it difficult to determine the flight route with certainty. Figure 2 shows a possible flight route. This is based on a combination of videos and photos with relatively accurate timings, observations with uncertain timings and an assumed airspeed of 120–130 mph.

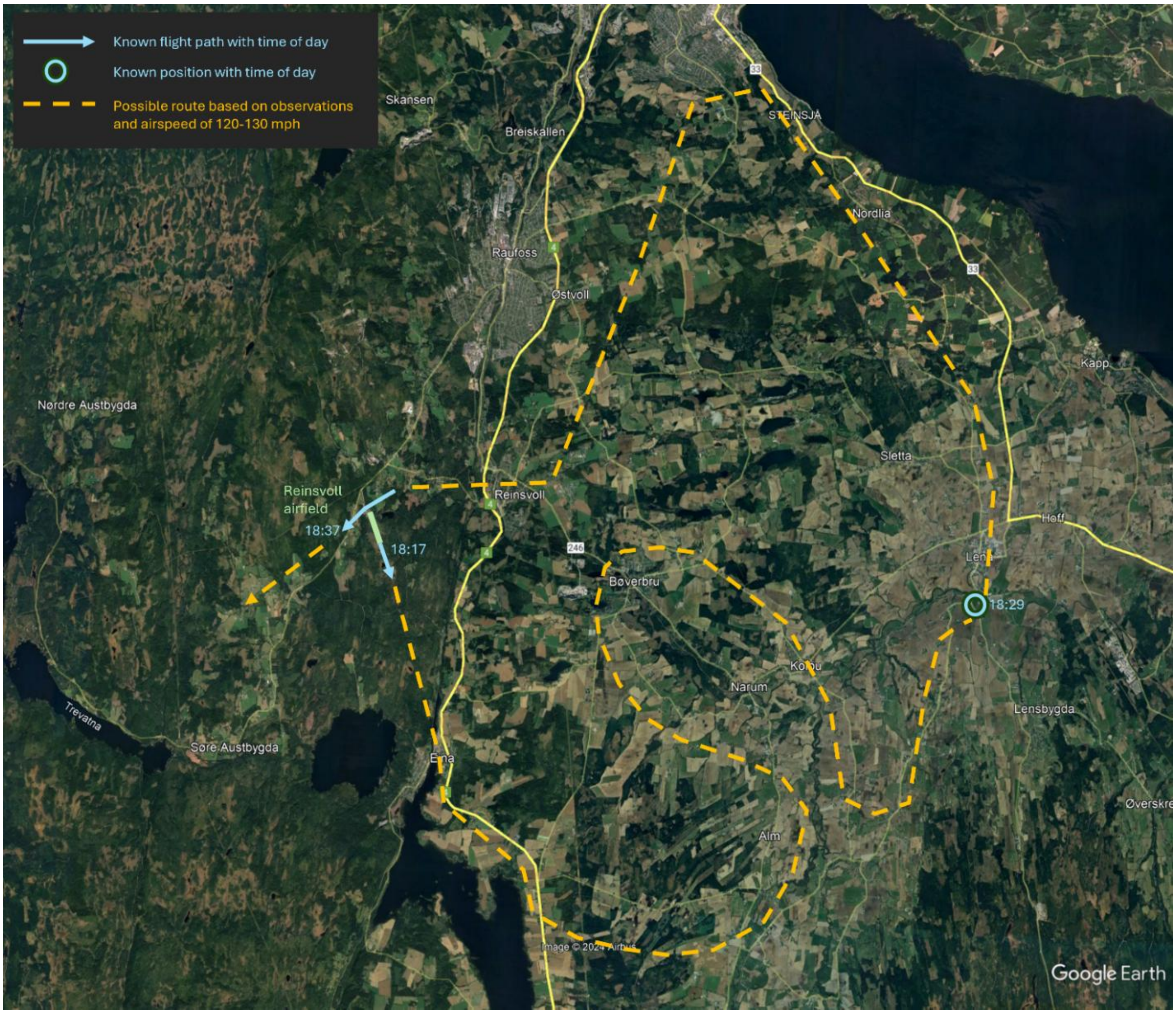

Figure 2: Illustration of a possible route during the first part of the flight, from departure at 1817 hrs until 1837 hrs. Photo: Google Earth. Illustration: NSIA.

After approximately 20 minutes of flying – at 1837 hrs – they returned to the airfield and crossed over the northern end of the runway towards the west. Few witness observations in the area west of the airfield make it impossible to say where they flew, but they returned to the area around the airfield at approximately 1845 hrs. For the next four minutes, they manoeuvred over the airfield. Photos and videos indicate that they flew three loops. During the last loop, they did a roll at the top before completing the loop and leaving the airfield heading south.

Several witnesses saw and/or heard the aircraft as it flew southwards. One of the witnesses has stated that he believed the aircraft was flying inverted during part of this stretch. The aircraft turned back towards the airfield shortly after it had crossed Vestbakkvegen[1], at around 1850 hrs, see Figure 3. Shortly afterwards, several witnesses reported what they perceived as two or three loud

[1] *Vestbakkvegen is the road running from east towards the west and crossing the assumed flight path in figure 3.*

bangs, or that the engine sputtered for two or three seconds before running smoothly again. There are slightly different opinions as to whether the engine stopped or whether it was running while this happened. After this, the aircraft continued north towards the airfield, and witnesses have stated that they thought it was coming in to land. Instead, the aircraft turned westwards. Witness observations suggest that it made a wide left turn before heading back towards the airfield from the south-west. Based on the distance between the witnesses and the aircraft and sight lines, the NSIA has estimated that the aircraft was at an altitude of around 1,000 ft at this time. Shortly afterwards, witnesses who had visual contact with the aircraft explained that the nose of the aircraft suddenly pitched ‘straight down’. Three of the witnesses have been convinced that they heard a bang just before the aircraft pitched down. Two of the others that saw the aircraft have not mentioned anything about a bang, and have had different opinions about whether the engine was running or not as the aircraft went down. One of the two witnesses believed he heard the engine running, while the other have stated that he thought he had not heard the engine. The witnesses have explained that they shortly afterwards heard noises that may have been the aircraft hitting trees or the ground. A couple of witnesses that was in the area but did not have direct eye contact with the aircraft have stated that they thought they had heard a louder engine noise and possibly a bang just before it fell silent. As they did not see the aircraft when they heard the sounds, it is unclear whether this happened before or after the aircraft nosed down.

Based on information from NORSAR[2], the time of the accident is assumed to be 18:51:53.

[2] NORSAR is an independent research foundation that, among other things, monitors seismic events. The time of the accident has been estimated by NORSAR based on a signal picked up at one of their monitoring stations.

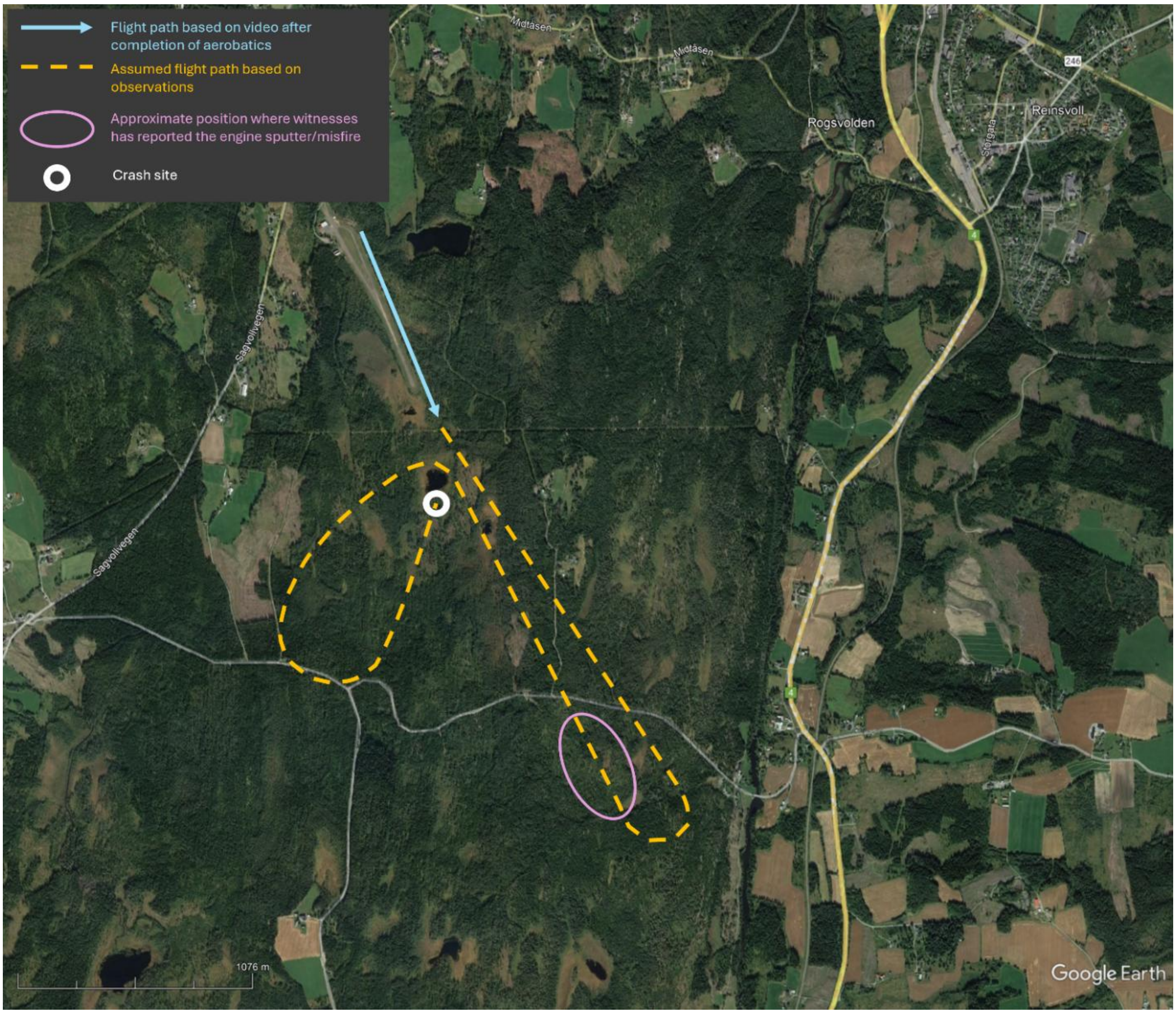

Figure 3: Assumed flight path for the last part of the flight (after performing aerobatics and up until the accident). Photo: Google Earth. Illustration: NSIA.

1.2 Injuries

Table 2: Personal injuries

Injuries	Crew	Passengers
Fatal	1	1
Serious		
Minor/none		

1.3 Damage to aircraft

The aircraft was completely destroyed, and all parts were found within a small area (see Figure 4). For a more detailed description, see Sections 1.12 and 1.16.

Figure 4: Overview of the accident site the day after the accident. The bodies of the deceased have been removed, and some parts of the wings have been repositioned. Photo: NSIA

1.4 Other damage

There was damage to some of the trees closest to the site of the accident (see Section 1.12 for details). Fuel and oil had leaked out from under the wreckage.

1.5 Personnel information

The pilot was in his 50s and had been interested in flying since childhood. He started flying light aircraft in the mid-1990s and was issued a private pilot licence (PPL(A)) in 1996. In 2008, he completed aerobatics training and qualification through Nedre Romerike Flyklubb, and he held valid privileges for aerobatics.

The pilot had a total flying time of 727 flight hours on aircraft he owned himself or had access to through flying clubs. After purchasing LN-TBN in 2020, he had primarily flown this aircraft. In total, he had just under 93 flying hours in the aircraft, of which 43 hours were logged as aerobatics. He had also participated in the Norwegian Aerobatic Championships several times.

The pilot held a valid PPL(A) with privileges to fly single engine piston (SEP) aircraft until 30 September 2023. He had a class 2 medical certificate that was valid until 29 October 2023.

Table 3: Flying experience, pilot

Flying experience	All types	Type in question
Last 24 hours	0:45	0:45
Last 3 days	0:45	0:45
Last 30 days	6:25	6:25
Last 90 days	15:15	15:15
Total	727:55	92:50

1.6 Aircraft information

1.6.1 GENERAL INFORMATION

LN-TBN was a Christen Eagle II with serial number S308. Christen Eagle was developed in the late 1970s. It is a single-engine biplane with tail wheel, designed for unlimited aerobatics. The aircraft was intended for the homebuild market and was delivered in the form of 26 kits with detailed and illustrated step-by-step construction manuals. The idea was that anyone with reasonable technical knowledge would be able to build the aircraft without any previous experience in building aircraft and without using special tools. Around 1,000 aircraft are said to have been built. The aircraft is still available as a kit, in addition to being available assembled from the factory.

Christen Eagle II is the two-seater version of Christen Eagle I. The two seats are in tandem. Both the front and rear seat positions are equipped with a stick for elevator and aileron inputs, pedals for controlling the rudder and brakes, and a throttle. Elevator trim, propeller and mixture controls, and all switches – including those necessary for starting the engine – are only available in the rear cockpit. The aircraft is therefore primarily flown from the rear seat.

A canopy of clear acrylic glass covers the cockpit. The canopy is right-hinged and opens by tilting it up and to the right. A canopy crossmember is mounted on the canopy frame and remains across the cockpit just behind the back of the front seat when the canopy is closed. The aircraft also has a jettison system for the canopy.

The aircraft has a truss type fuselage comprising welded steel tubes. The wings have symmetrical airfoils and a 0° angle of incidence, and are constructed with wooden ribs and spars. The front part of the fuselage is skinned in aluminium, while the wings and rear part of the aircraft, including the tail, are covered with fabric.

A selection of Christen Eagle II specifications is presented in Table 4.

Table 4: Specifications for Christen Eagle II. Data: 924 Airplane Flight Manual

Engine:	AVCO Lycoming AEIO-360-A1D, 200 hp
Propeller:	Hartzell HC-CZYK-4/C7666A-2, constant speed
Fuel capacity:	25 US gal (94.6 litres) (24 US gal usable)
Fuel type:	AVGAS 100 (green), AVGAS 100LL (blue)
Max weight:	
Normal category:	1,600 lb (725.7 kg)
Aerobatics category:	1,520 lb (689.5 kg)
Length:	18 ft 6 in (5.64 m)
Wing span:	19 ft 11 in (6.07 m)
Height:	6 ft 6 in (1.98 m)
Wing area:	125 ft^2 (11.61 m^2)
Structural limits at acrobatic weight:	+7g, -5g
Speeds:	
Stall speed, V_S	58 mph
Recommended engine-out glide speed	90 mph
Manoeuvring speed, V_A	155 mph
Never exceed speed V_{NE}	210 mph

1.6.2 HISTORY LN-TBN

LN-TBN was delivered as a kit from Christen Industries Inc. and was mainly built in Italy. In accordance with the Approval for the Issue of a Permit to Fly[3], the Italian authorities (RAI – Registro Aeronautico Italiano) carried out an inspection of the aircraft before the fabric covering was installed, and found it to be satisfactory. The aircraft was never registered in Italy but was sold on to England where it was completed and registered as G-EGEL. The UK Civil Aviation Authority issued a Permit To Fly on 15 December 1991. In 1998, the aircraft was sold to German owners and operated primarily in Germany and France until 2018. The aircraft continued to fly under British registration until 2000. From 2000 to 2003, the aircraft was registered in the USA as N388AG and operated under a special airworthiness certificate issued by the Federal Aviation Administration (FAA). In 2003, the aircraft was again registered in England. In 2018, the aircraft was sold to a Czech owner, registered as OK-EGL and granted a Czech special certificate of airworthiness in 2019. The aircraft was sold on to the Norwegian owner in 2020.

The aircraft was registered in Norway as LN-TBN in 2021, and the Norwegian Civil Aviation Authority (CAA) issued a special certificate of airworthiness (SLB) on 29 June 2021. The decision to issue the SLB was made after an inspection by the CAA and was based on the provisions of the

[3] *According to the 'Approval for the Issue of a Permit to Fly' issued by the Civil Aviation Authority in the UK on 15 October 1991 (Airworthiness Approval Note No: 22761P).*

Aviation Act and Regulations No 721 of 26 June 2007 on amateur built aircraft, (BSL B 3-1).[4] The CAA made an assessment of the need to stipulate special restrictions or conditions for the aircraft, but found that this was not necessary beyond what already followed from the Aviation Act, regulations and the aircraft's flight manual.

On 10 May 2022, the CAA issued a new SLB together with a national airworthiness review certificate (N-ARC), in accordance with new regulations. The two certificates document the continued airworthiness of the aircraft. N-ARC is issued with a one-year validity based on a maintenance report. The most recent maintenance report and N-ARC were completed on 30 May 2023, with an expiry date of 31 May 2024. Copies of the documents were sent to the CAA by email on 6 June 2023.

1.6.3 PERFORMANCE CHARACTERISTICS AND LIMITS RELATED TO MANOEUVRING

The Christen Eagle II flight manual describes the aircraft as very stable and controllable. At the same time, it responds to small control inputs in all axes, and little force is needed to move the control surfaces. These characteristics make the aircraft easy to manoeuvre and well-suited to aerobatics, but also require the pilot to be aware of the risk of overcontrol. The flight manual emphasises the importance of the pilot having adequate qualifications and being accustomed to handling aircraft with similar characteristics (cf. Eagle II Aircraft Construction Manual 924 Flight Kit, pages 1-6):

> *The Eagle II aircraft is very stable and controllable, but control forces are extremely light, and the aircraft is highly responsive to small control inputs.*
>
> *<u>WARNING</u>*
>
> *The Christen Eagle II is a high-performance aircraft intended for aerobatic competition. Because of design optimization for this type of flight (such as a high power to weight ratio and extremely responsive controls), pilots must be properly qualified before attempting flight.*

The flight manual further explains about manoeuvring with the centre of gravity (CG) close to the aft limit of the aircraft (see Eagle II Aircraft Construction Manual 924 Flight Kit, page 2-2):

> *The pitch maneuvering ability of an aerobatic aircraft is optimized when the aircraft flight CG is set relatively near the aft limit, but still within the allowable safe CG range. The Christen Eagle II was designed so that the flight CG of the aircraft falls near the aft limit. However, this characteristic places a stringent requirement on all owners and pilots: The aircraft CG must be accurately determined, and aircraft loading must be planned so that a safe CG location will always be maintained.*

The flight manual mentions the following limitation several places:

> *Never attempt aerobatics without at least 6 gallons of fuel.*

[4] *Two days after the decision was made, several new regulations entered into force: "Forskrift 15. februar 2021 nr. 524 om luftfartsoperasjoner med nasjonalt sertifiserte luftfartøy" (regulation on aviation operations with nationally certified aircraft), "forskrift 25. juni 2021 nr. 2246 om nasjonal sertifisering av luftfartøy" (regulations on national certification of aircraft), and "forskrift 25. juni 2021 nr. 2247 om kontinuerlig luftdyktighet for nasjonalt sertifiserte luftfartøy" (regulations on continuous airworthiness for nationally certified aircraft).*

1.6.4 ENGINE AND PROPELLER

LN-TBN was equipped with a Lycoming AEIO-360-A1D engine and a two-blade Hartzell HC-C2YK-4CF constant-speed propeller. The Lycoming AEIO-360 is a 4-cylinder, air-cooled, fuel injected engine rated at 200 hp. As installed on LN-TBN the exhaust pipes from the engine did not have mufflers, and the exhaust pipes from the cylinders on each side were combined (2 into 1).

The lubrication system was of a pressure wet sump type with an oil pump mounted on the accessory housing and an external oil cooler. The system included an inverted oil system designed to ensure normal oil supply with minimal loss of oil during negative-g manoeuvring.

1.6.5 FUEL SYSTEM

The aircraft's 25 US gal (94.6 litre) fuel tank was located between the engine compartment (directly behind the firewall) and the forward cockpit. A flexible flop tube with a weighted end was installed in the fuel tank. The tube's flexibility and weight are intended to ensure that the end of the tube remains immersed in the fuel regardless of the aircraft's attitude.

On the rear side of the tank, visible from the cockpit, was a transparent plastic tube that served as a fuel sight-gauge. The flight manual includes a note that the fuel gauge is not intended for use on the ground, or during flight with more than 10–12 US gal. (approx. 37–45 litres) of fuel on board. A quick drain was fitted to the underside of the tank to drain any water that had collected at the bottom. The tank had a vent mounted near the tank cap, with a vent line running down to the underside of the aircraft.

From the fuel tank, fuel lines ran along the left-hand side of the fuselage back to a fuel pump assembly mounted on the floor in the rear cockpit. The pump assembly included a fuel selector, a filter and a quick drain. The pump had a lever to manually pump fuel from the tank to the engine at start-up or if the engine driven fuel pump failed.

From the fuel pump assembly, fuel was directed forward along the left-hand side of the fuselage, through the firewall and to an engine driven fuel pump. The diaphragm-type pump was driven by the engine camshaft.

Pressurised fuel was routed to a fuel injection servo via a filter. The servo adjusted the mixture of fuel and air based on the position of the throttle and the mixture control lever. From the servo fuel was led via a distributor valve to fuel nozzles on each cylinder. The distributor valve distributed the fuel equally to the four cylinders and shut off the fuel supply when the engine was stopped and the fuel pressure fell below a set value.

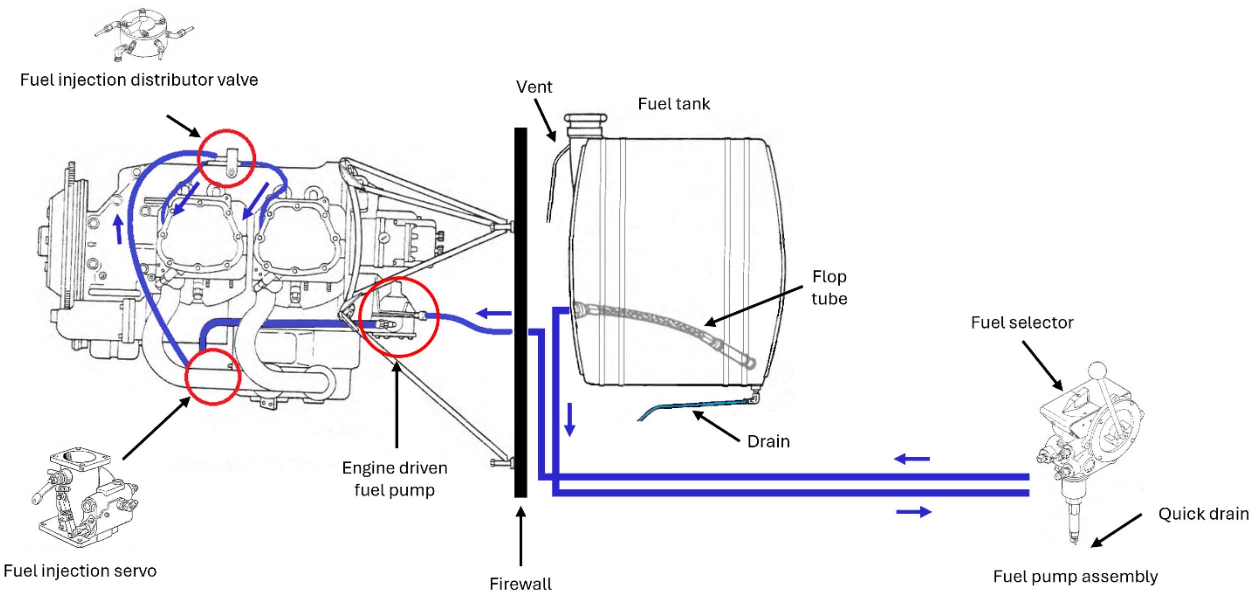

Figure 5: Simplified schematic of the fuel system in LN-TBN. Illustration: NSIA

Two service bulletins (SB) have been issued that deal with the flop tube assembly. SB370 Fuel Quantity Site Tube & Flop Tube Assembly, released in 1993, recommended all owners of a Christen Eagle II older than four years to inspect the overall condition of the flop tube assembly, and replace it if the hose was stiff. The service bulletin also stressed the importance of including hose inspection as part of the aircraft's maintenance programme. In 2008, a new service bulletin (no. 376) was published about flop tubes manufactured by Stratoflex. The SB warned of a potential safety issue where a stiff tube could lead to fuel starvation during inverted flight, and owners were requested to replace the hose. According to LN-TBN's maintenance documentation, the flop tube was replaced in 2008 and has been checked several times during subsequent maintenance inspections.

1.6.6 INSTRUMENTATION

All aircraft and engine instruments were located on the instrument panel in the forward cockpit (see Figure 6). To gain a better understanding of the pilot's ability to observe the instruments with a passenger in the front seat, the NSIA got access to another Christen Eagle. The investigations showed that with a man of medium height and build in the front seat, the pilot was unable to see the instruments in a normal sitting position (see Figure 7). The airspeed indicator, altitude indicator and parts of the vertical speed indicator could be seen by leaning to the left. By leaning to the right, oil pressure, manifold pressure, fuel flow, RPM and parts of the EGT indicator could be observed. With a larger person in the front seat (or someone leaning to the side), the overview of the instruments would be further restricted.

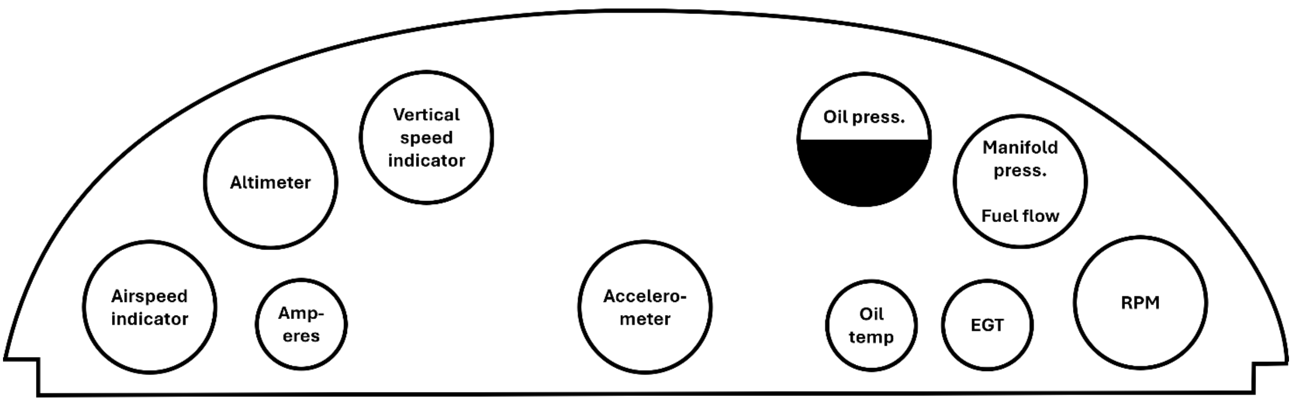

Figure 6: The instrument panel in LN-TBN. Illustration: NSIA

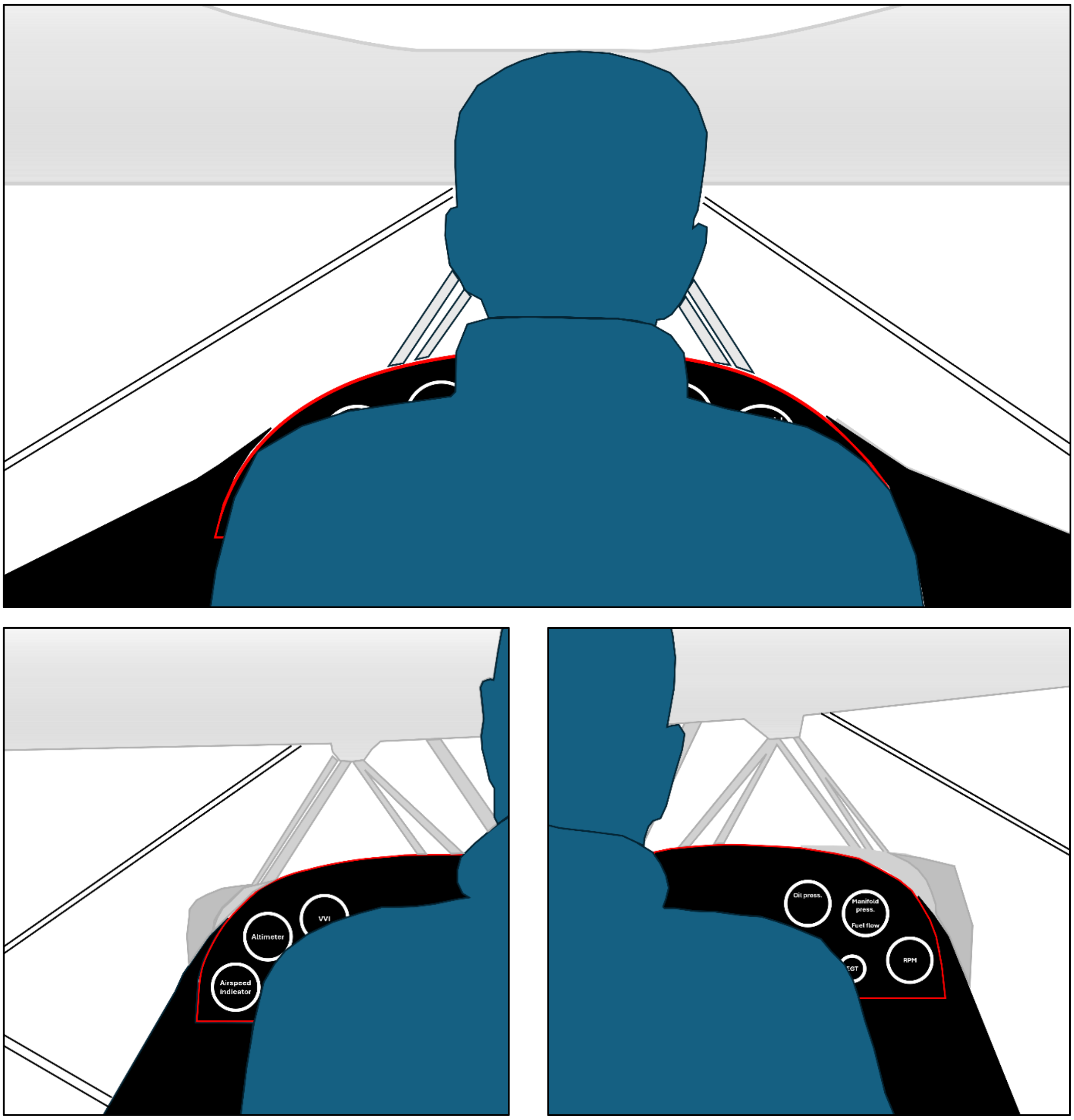

Figure 7: Illustration of the pilot's view of the instrument panel with a passenger in the front seat, viewed directly from behind and with the pilot leaning to the left and right. Illustration: NSIA

1.6.7 FUEL, WEIGHT AND BALANCE

The NSIA has not found any documents showing the amount of fuel at the beginning of the flight or weight and balance calculations for the flight. The flight manual includes a generic example of weight and balance based on a pilot and passenger weight of 190 lb (approx. 86 kg) each. This example (see line labelled 'example' in Figure 8) shows the aircraft's centre of gravity (CG) within the limits for aerobatics. Based on the available information, the NSIA has made the following calculations for the flight in question:

Fuel consumption at different engine settings according to the flight manual:

- Full power 2,700 RPM/28.6 in Hg): 15.8 US gal/h (approx. 60 l/h)
- 75% (2,450 RPM/25.0 in Hg): 12 US gal/h (approx. 45 l/h)
- 65% (2,350 RPM/23.5 in Hg): 10.5 US gal/h (approx. 40 l/h)
- 50% (2,000 RPM/22.7 in Hg): 8.1 US gal/h (approx. 31 l/h)

Fuel estimate:

- On 24 August 2023, LN-TBN carried out 10-minutes of aerobatics. According to the aircraft's log book, the fuel level was 50 litres before the flight. The NSIA has estimated fuel consumption during the flight at between 7.5 and 10 litres.
- Estimated fuel level at start-up on 28 August 2023: 40-42.5 l.
- Estimated consumption during flight:
    - From start-up to aerobatics (28 min @ 50%): 14.5 l
    - Manoeuvring/aerobatics (4 min @ 75%): 3 l
    - From aerobatics to accident (3 min @ 50 %): 1.5 l
- Estimated fuel level at the time of the accident: 21–23.5 l

The estimate is based on the assumption that the pilot flew with a relatively low power setting (50% during cruise). If the pilot actually flew at 65% engine power during cruise, consumption would have been approximately 4.5 litres higher. Information received by the NSIA indicates that a normal engine setting for cruise was 2,200 RPM with a manifold pressure of 22 in Hg, which would give a consumption between what the flight manual indicates for 50% and 65%.

Table 5 shows the weight and balance calculations at start-up and the time of the accident, based on a fuel level of 42.5 litres at start-up and 23.5 litres at the time of the accident. 3 lb (approx. 1.4 kg) has been added to the weight of both the pilot and the passenger for clothing. Figure 8 shows the weight and balance calculations in the aircraft's CG diagram.

Table 5: Weight and balance calculations. Data: NSIA.

Item	Weight (lb)	Station (in)
Empty weight	1,039.00	89.65
Pilot (aft seat)	183.00	143.37
Passenger (fwd seat)	223.00	111.32
Fuel	67.32	86.25
Parachute	15.20	143.37
At engine start:	1,527.52	99.63
Fuel used:	30.10	86.25
At time of accident:	1,497.42	99.90

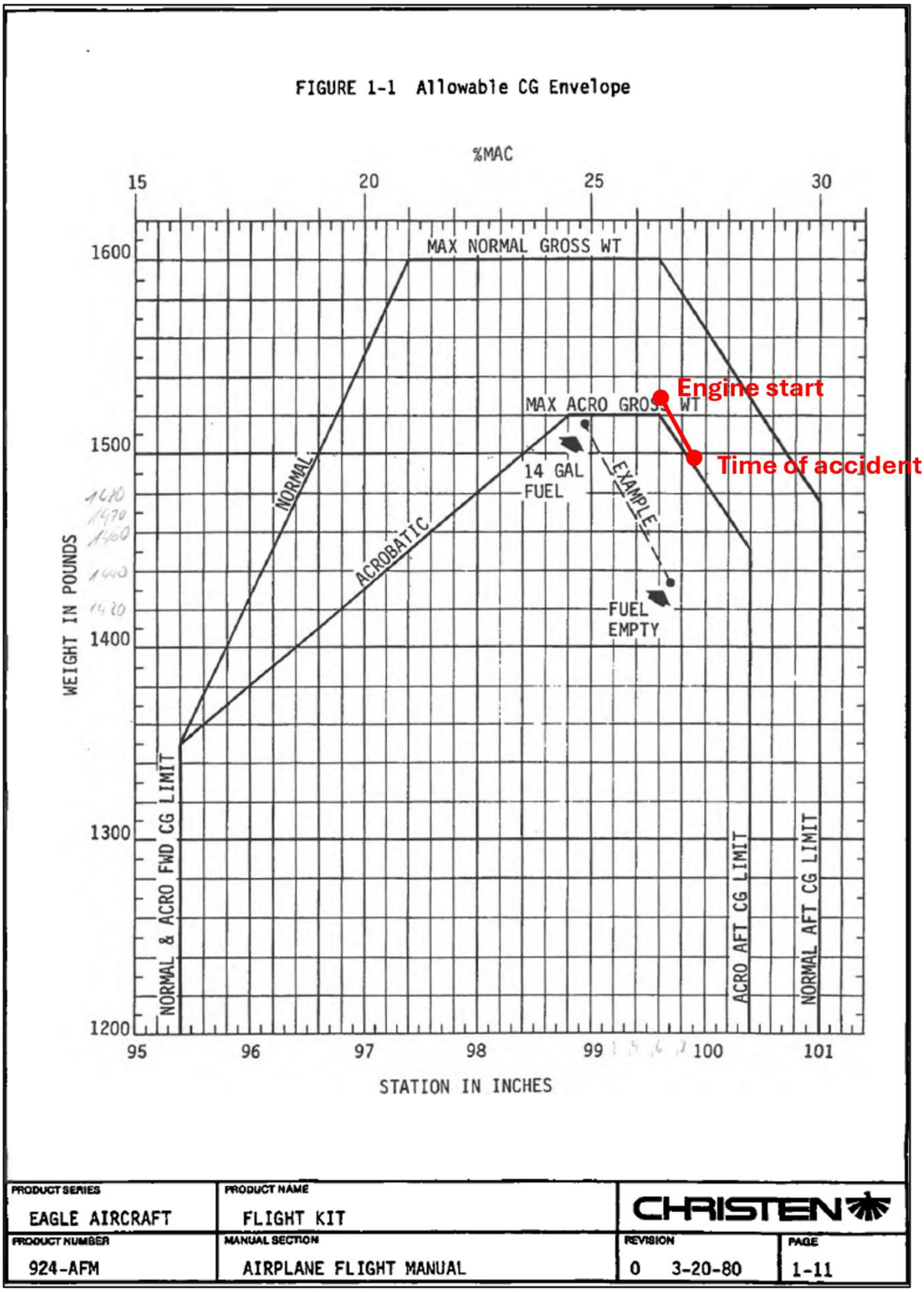

Figure 8: CG during the flight. Data: 924 Airplane Flight Manual / NSIA

1.6.8 SEAT BELTS

The original seat belts in the aircraft had been replaced with new seat belts from Hooker Custom Harness, Inc. The new seat belts were 5-point harnesses with a double lap belt, and were manufactured in February 2019 according to the labelling on the belts. The NSIA has not been able to confirm whether the belts were replaced while the aircraft was in Czech or Norwegian ownership.

According to the aircraft maintenance procedures, the condition of the seat belts should be checked in connection with the 100-hour, or annual, inspection:

> *92. Inspect seat belt and harness webbing, stitching, and attachment for wear, damage, and deterioration.*
>
> *93. Check seat belt buckling and adjusting mechanism.*

1.7 Meteorological information

Weather observations and forecasts in the form of METAR and TAF are not issued for Reinsvoll airfield. A weather report prepared by the Norwegian Meteorological Institute describes the weather in the area for the time period covering the flight as characterised by Towering Cumulus (TCU) and Cumulonimbus (CB) and medium-high clouds. The ground temperature was between 15 and 17 degrees C, with a dew point between 11 and 14 degrees C. The surface wind was generally 5–10 knots from the southwest with gusts between 10 and 15 knots. However, the wind conditions could differ in connection with showers. The report states the following:

> *In connection with showers in the area, the wind conditions would be completely different, as both strong updrafts and downdrafts can occur inside the shower clouds, and relatively strong winds can occur on the ground. This is especially true of the most intense CB clouds and in connection with squall lines.*

A radar animation shows a squall line passing over Reinsvoll around the time of the accident (see Figure 9).

A few lightning strikes were recorded near Oslo and north-east of Lillehammer around the time of the accident, but none near the airfield at Reinsvoll. Based on satellite imagery, the lightning strikes were recorded in the areas with the most convective and severe cumuliform clouds.

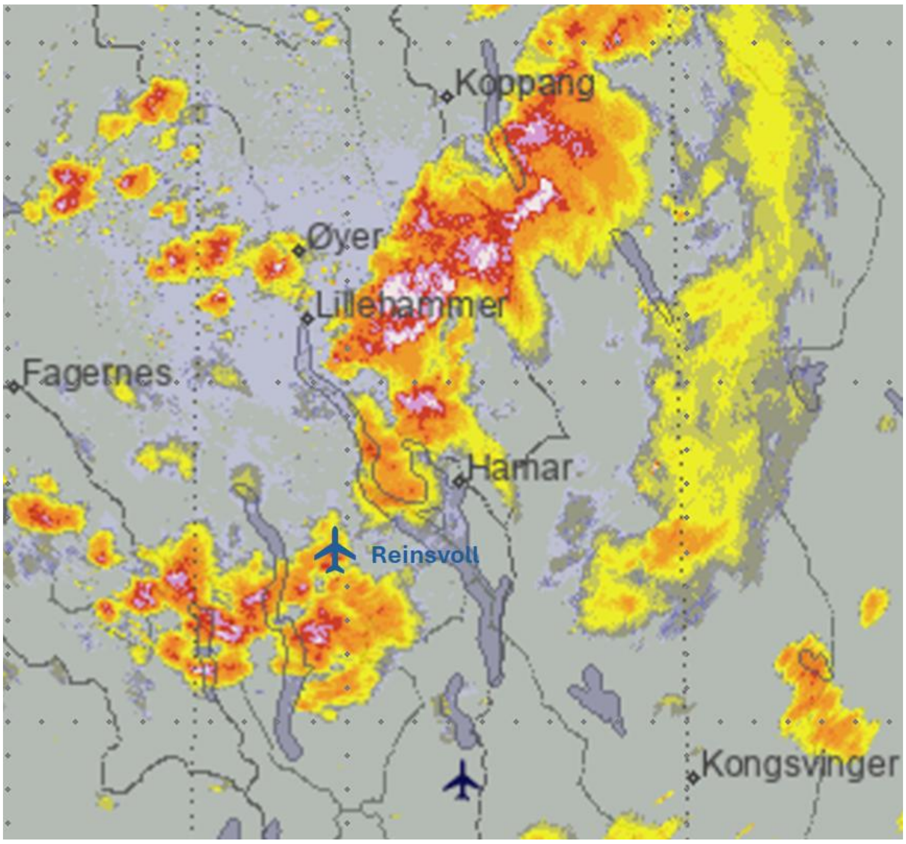

Figure 9: Radar image from Hafjell weather radar at 18:50. Data: Norwegian Meteorological Institute

Video footage from the start-up, departure and aerobatics shows that the weather was cloudy, but the movement in the trees does not indicate that there was much wind around the airfield. The witnesses were not asked about the weather around the time of the accident, and none of them mentioned it as a factor.

1.8 Aids to navigation

Not applicable.

1.9 Communications

The aircraft was equipped with a VHF radio and transponder with mode S. The flight took place in uncontrolled airspace and the NSIA has no information to indicate that there has been communication between LN-TBN and air traffic control, or between LN-TBN and other aircraft. In accordance with local procedures at Reinsvoll, blind transmissions must be sent at all reporting points and routine position reports during the landing circuit (cf. Gjøvik and Toten flying club operations manual, section 4.5).

1.10 Aerodrome information

Reinsvoll airfield (ENRV) is located on the western side of Rv 4, approximately 6 km south-southwest of Raufoss. The airfield is privately owned and operated by Gjøvik and Toten flying club under a licence granted by the CAA. The airfield is primarily used for pilot training, wildfire patrols and private flights in aircraft with a maximum permitted total weight of 5,700 kg.

The airfield is located 1,380 ft (421 m) above sea level. The direction of the runway is 16-34 and it measures 630 x 20 metres with a gravel surface. The airfield is only approved for VFR flights during daylight hours. The airspace around the airfield is uncontrolled up to 4,500 ft, where the Oslo TMA starts.

According to Jeppesen information and information in the airfield operations manual (available on Gjøvik and Toten flying club's website), terrain on the north-eastern side of the airfield area affects the approach to runway 16 and the climbout from runway 34. In connection with westerly winds, wind shear may occur during the final part of the approach to runway 16.

On the day of the accident, cows were observed in the southern part of the airfield (to the west of the runway) before LN-TBN’s departure and after the accident. At 20:47, video from the police helicopter shows 19 cows just west of the runway, roughly where the old runway/taxiway meets the new runway.

1.11 Flight recorders

LN-TBN was not equipped with a flight recorder, nor is this mandatory for this type of aircraft.

1.12 The accident site and wreckage information

1.12.1 ACCIDENT SITE

LN-TBN crashed approximately 50 metres south of Seterputten pond, which is approximately 500 metres south of the threshold of Reinsvoll’s runway 34 (N 60°39'52'' E 010°34'17''). The accident site was in the boundary between a marshy area and a copse (see Figure 10). Trees of varying sizes surrounded the accident site. However, it was relatively open to the west–south-west, which is the direction the aircraft is believed to have approached from. Three trees closest to the accident site were damaged by the aircraft (see Figure 11). The surrounding area was surveyed by a drone and no damage to other trees was observed.

Figure 10: Area view of the accident site, towards the north-east. Photo: NSIA

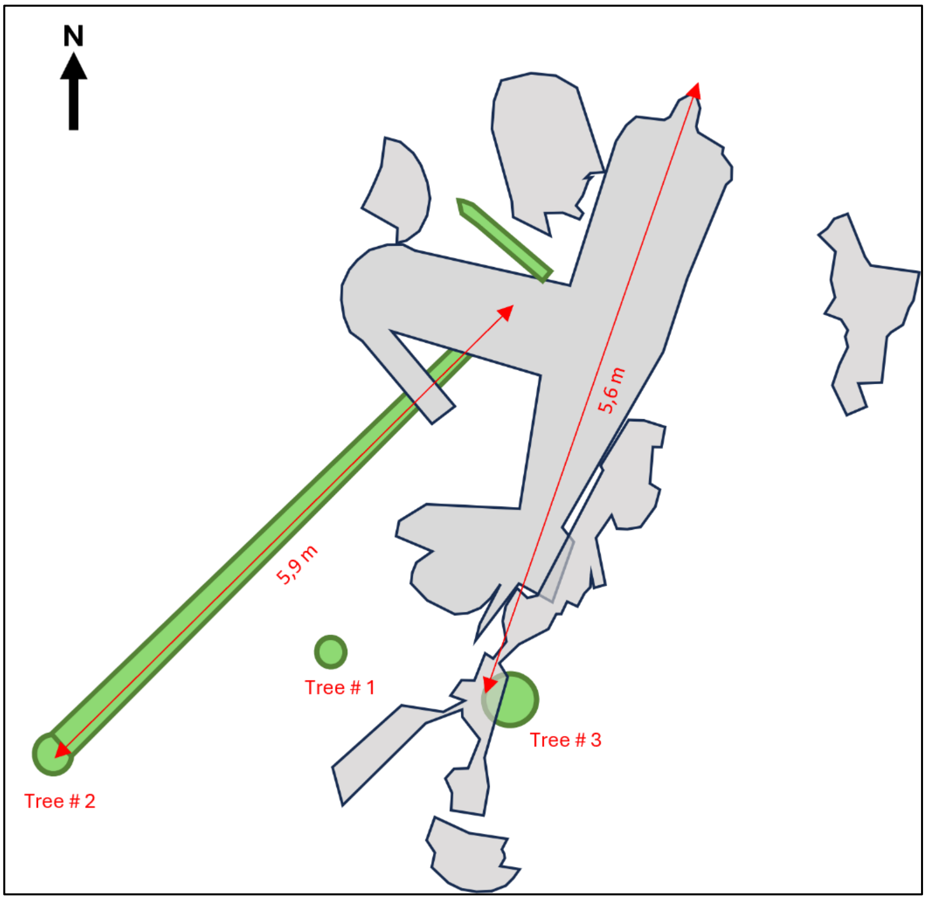

Figure 11: Illustration of the aircraft and trees at the accident site. Illustration: NSIA

The aircraft cut through two smaller trees and left scratches and cuts in the bark of a larger tree. Tree number 1 was the smallest tree and was cut off just under two metres above the ground (see Figure 12). Tree number 2 was broken close to the root and cut into four pieces. The bottom section was 5.9 metres long and was lying across the ground from where the tree had been standing, pointing towards the left-hand side of the aircraft. The second-lowest section was approximately 0.8 metres long and was lying to the left of the aircraft. The second-highest section was approximately 1.3 metres long and was lying about 7–8 metres in front of the aircraft. The treetop had snapped backwards and was lying behind the aircraft. The total length of the tree was just under 13 metres. The centre cut through the tree appeared to run from the bottom upwards, seen from the aircraft's assumed direction of travel. The other two cuts through the tree were at an angle, with the lowest point on the tree's right-hand side (seen from the aircraft's assumed direction of travel).

Tree number 3 stood directly behind where the aircraft tail was lying. The lower 5.5 meters of the tree had multiple scratches and cuts in the bark (see Figure 13).

Figure 12: Tree number 1. Photo: NSIA

Figure 13: Tree number 3. Photo: NSIA

1.12.2 THE WRECKAGE

All parts of LN-TBN remained within a relatively small area at the accident site (see Figure 4 and Figure 14). The aircraft had come to rest against a small rise in the terrain. The lower part of the propeller spinner was in the ground resting against a rock on the right-hand side. One of the propeller blades was pointing straight up and looked relatively undamaged, with the exception of two small deformations on the front of the blade near the blade root. The second propeller blade was bent backwards beneath the aircraft. The nose of the aircraft was bent down slightly and pressed inwards, and the fuselage was slightly bent to the left. The acrylic glass in the canopy was shattered, while the canopy frame was in the locked position.


Figure 14: From the accident site. Photo: NSIA

The fuel tank was empty when the NSIA arrived at the accident site. However, personnel who arrived at the site immediately after the accident have explained that they could smell fuel.

All the wings were broken off. The upper centre wing was still attached to the fuselage. The lower right wing had broken off at the wing root and was lying along the right-hand side of the fuselage. The ailerons of both wings on the right were still connected, but was detached from the wing and were lying behind the aircraft (from tree number 3 and further back). The NSIA was informed that one of the wings had been lying across the cockpit and had been moved to get to the bodies of the deceased. This was most likely the upper left-hand wing. Both of the left-hand wings were broken off and found lying to the left of the aircraft.

The vertical stabiliser and rudder were attached to the tail section of the aircraft and was relatively undamaged. The outboard 1/3 of the left elevator was broken off. The remaining part of the left elevator was still attached to the horizontal stabiliser. The stabiliser had surface damage, but otherwise looked structurally intact. The left elevator trim was in a nose down position. On the right side of the tail section, both the horizontal stabiliser and elevator had been knocked backwards and destroyed.

In the cockpit, the glass on the accelerometer and oil pressure indicator was broken, and the manifold pressure/fuel flow indicator had been pushed in. The accelerometer read -1.6 and +11.2 g (the indicator scale went from -4 to +12 g). The hour meter on the tachometer showed 1,635.2 hours. Beyond this, none of the instruments provided relevant information.

All the switches in the rear cockpit (magnetos, battery, instruments, radio and generator) were in the off position when the NSIA arrived at the accident site. The NSIA has not been able to confirm who turned off the switches. Other controls in the cockpit were found in the following positions:

- Throttle – Full open.
- Propeller – High RPM (approx. 1 cm from full effect).
- Mixture – Rich (full effect).
- Elevator trim – Full nose down.
- Canopy – Locked.

After an initial examination of the accident site, the wreckage was transported to the NSIA's hangar in Lillestrøm for further examination. Details of the examinations are given in Section 1.16.

1.13 Medical and pathological information

Both the pilot and passenger underwent autopsies at Oslo University Hospital. The autopsy reports describe extensive injuries to the head and chest of both of the deceased, as well as fractures to the legs. The head and chest injuries are believed to be the cause of death. There was no evidence that the pilot suffered any sudden illness or incapacity before the accident. No traces of alcohol, medication or narcotic substances were found in the forensic toxicology tests of blood and urine samples.

1.14 Fire

No fire occurred in connection with the accident.

1.15 Survival aspects

A witness who was less than 700 metres from the crash site saw the aircraft disappear behind the trees and heard a bang. The witness immediately called the Emergency Medical Communication Centre (AMK) and reported the observation and the assumption that the aircraft had gone down just south of Reinsvoll airfield. Triple notification of the incident was made to all emergency services at 1855 hrs, and the Joint Rescue Coordination Centre (JRCC) was notified to take on overall management and coordination of air resources. The fire service, ambulance and police arrived at Reinsvoll airfield at around 1915 hrs. At the same time, a helicopter from the Norwegian Air Ambulance Foundation (NLA) arrived and began searching for the aircraft. The aircraft was quickly located. The helicopter landed in an open area about 200 metres from the accident site, after which a doctor and rescueman made their way to the accident site on foot. The pilot and passenger were found in the aircraft and both were confirmed dead.

1.16 Tests and research

1.16.1 EXAMINATION OF THE AIRCRAFT

1.16.1.1 General examination of the wreckage

The NSIA has conducted a thorough examination of the aircraft wreckage. The following was observed:

- The wreckage had damage that was consistent with it having hit the ground with both forward and downward velocity. For example, the landing gear strut had been forced upwards and backwards and had been detached from the fuselage structure.
- The fuselage structure had been deformed several places along the aircraft. The damage was particularly severe in the area around the landing gear attachment and on the underside of the fuselage behind the cockpit. At the front, the fuselage structure had been pushed in, particularly the lower part. The cabane struts supporting the upper wing were virtually undamaged. Similarly, there was little damage to the tail wheel and tail wheel attachment. In the tail section, the lower right longeron had been snapped, and the area showed signs of having been pushed in.
- The frame underneath both seats had collapsed, and the floorboards in the cockpit were cracked and partially deformed. The centre of the front instrument panel was bent forward. Similarly, the instruments and switch panel in the rear cockpit had shifted slightly forward.

- The canopy frame was closed and locked, while the canopy glass had shattered.
- The wing spar in each of the wings had broken off. An approximately 50 cm long section of the lower left wing remained attached to the fuselage. The leading edge of the wing was reinforced with a thin metal plate, and the metal was deformed at the fracture surface. The angle and shape of the deformation appeared to be the result of a collision with a tree, where the aircraft has been in a slight left turn with the nose about 20 degrees below the horizon. Two other loose metal reinforcements from the leading edge of the wings were found among the wreckage. These appear to have been deformed as a result of the collision with trees. All fractures in the wing attachments, rods, fittings and bracing wires were consistent with overloading in connection with the crash.
- The NSIA has not found any remains of birds on the wreckage.

1.16.1.2 Control surfaces and flight controls

The control surfaces and associated flight controls were examined with the aim of determining whether they were intact before the accident. The following was observed:

- The sticks in the front and rear cockpit were connected and could be moved. There was continuity between the sticks and the elevator, and the elevator moved with stick input. Damage to the right elevator and a bend in the elevator pushrod behind the cockpit prevented full control surface deflection.
- There was continuity between the pedals in the front and rear cockpit and the rudder.
- The aileron pushrods that ran through the lower wings were cut, severing the connection between the sticks and the control surfaces. When either stick was moved all parts of the aileron control mechanism up to the fracture point moved with it. The damage was consistent with having occurred during the accident.
- There was continuity between the elevator trim lever and the trim tab on the left elevator, and the trim tab moved with the lever. On the right-hand side, the horizontal stabiliser had been knocked backwards and the trim tab and linkage connecting it to the horizontal stabiliser had been broken off.

1.16.1.3 Engine

The following was observed when examining the engine:

- A small amount of engine oil was seeping from the quick drain. The quick drain was pressed in and was in the open position, and the drain tube was bent backwards. Only a few drops of engine oil were found in the oil sump.
- The engine oil filter was dismantled and inspected. The inspection of the filter element did not reveal any metal chips or other abnormalities.
- The valve covers were removed. The visible part of the valves and the valve mechanism were found to be normal. All valves moved normally when the engine was rotated.
- The upper spark plugs were removed and a leak check was carried out on a cold engine. The cylinder leakage was measured against a reference pressure of 80 psi. This gave the following results:

  Cylinder no. 1: 73 psi

  Cylinder no. 2: 72 psi

  Cylinder no. 3: 77 psi

  Cylinder no. 4: 76 psi

- The cylinders were dismantled and inspected. Nothing noteworthy was found on the cylinders, piston heads, piston rings or valves.
- The spark plugs had a normal appearance.
- A check of the ignition timing showed that the left magneto fired 19.8° before top dead centre. Similarly, the right magneto fired 19.5° before top dead centre.
- The magnetos and associated wires were tested with a multimeter and no faults were detected.
- Both magnetos, associated wires and spark plugs were taken to the Norrønafly workshop at Rakkestad for further examination. NSIA personnel were also present. No faults were detected.
- The air filter was somewhat compressed and the front was partially covered with pine needles, moss and soil. There was no indication that the filter had been clogged or that the air intake was restricted before the accident.
- The linkage from the throttle to the fuel injection servo was damaged but continuous.
- The linkage from the mixture control lever to the fuel injection servo was damaged but continuous.

1.16.1.4 Propeller and propellor governor

The propeller type Hartzell HC-C2YK-4F/FC7666A-2 with serial number AU14714B and governor F-6-56 with serial number D4659-TJ were taken to Norrønafly Propeller & NDT for further examination. NSIA personnel were also present. The following relevant findings were made during disassembly of the propeller:

- The outer half of blade no. 1 was bent slightly forwards. With the exception of a couple of minor deformations on the front of the blade close to the blade root, there were no obvious signs of external damage.
- Blade no. 2 was bent sharply backwards and had two deep cuts in the leading edge of the blade, as well as a number of cuts and scratches both along and across the blade.
- The pitch change knobs were broken off on both blades.
- The hub flange was slightly bent.
- The counterweight of the no. 1 propeller blade was butted against the propeller hub cylinder. The counterweight of blade no. 2 had punctured the cylinder.
- The piston in the propeller hub was in the low pitch position when cylinder had been punctured by the counterweight of blade no. 2.
- The propeller was assessed to have been in good condition before the accident, both externally and internally. The damage that was identified was considered to have been the result of the accident.

Figure 15: Propeller blade no. 1 from LN-TBN (marked with green tape) placed next to a propeller blade of the same type shows that the outermost part of the blade is bent forwards. Photo: NSIA

Figure 16: Propeller blade no. 2 from LN-TBN. Red arrows indicate two significant cuts in the leading edge of the blade. Photo: NSIA

Relevant findings when examining the propeller governor:

- No abnormalities found on external inspection of the propeller governor.
- The governor was tested in a bench and was within specifications with one minor discrepancy. Low rpm setting was slightly lower than the specification. According to the test report this is common and not a concern.

As the governor functioned satisfactorily during the bench test, it was not considered necessary to dismantle the unit.

1.16.1.5 Fuel system

Examinations of the fuel tank revealed that it had been punctured and the tank was empty. The tank was deformed in several places. A loose O-ring was found in the tank, and it is assumed it should have been attached to the end of the tank's flop tube. When the flop tube was removed about a week and a half after the accident, it was stiff and its flexibility was significantly reduced.

Based on a known problem with flop tubes losing their flexibility over time, it was decided to leave the flop tube in fuel overnight to see whether it regained some of its flexibility. The flop tube's flexibility was then assessed by holding it horizontally and measuring the height from where the flop tube was attached to the tank wall and to the end of the flop tube (inlet). The measurement showed that the tube flexed downwards about 25 cm from the attachment point. When rotated 180° (to an "upside down" attitude) the flop tube flexed the same amount.

A test was also carried out to see if the tube would dry out and become stiffer if it was not continuously immersed in fuel during a flight. The tube was removed from the fuel and its flexibility was assessed repeatedly over a period of 55 minutes without significant changes being observed. Since it was assumed that the aircraft had been parked with a minimum of 40 litres of fuel, and this was well above the level that would adequately cover the flop tube, it was not considered relevant to conduct any further tests of the tube.

In addition to inspecting the fuel tank and testing the flop tube, the following observations were made when examining the fuel system:

- The vent in the fuel tank was open.
- The filter in the fuel pump assembly was clean and undamaged. The quick drain at the bottom of the filter housing had been knocked off and the filter housing was empty. The fuel selector was tested with compressed air and functioned normally. A functional test of the fuel pump assembly was carried out with water. The pump functioned normally.
- Just under 1 dl of fuel was found in the hoses between the fuel tank, the fuel pump assembly and the connection at the firewall.
- A few drops of fuel were found in the hose between the firewall and the engine driven fuel pump.
- The engine driven fuel pump was dismantled and inspected. A few millilitres of fuel were found inside the pump, but otherwise it was clean. The diaphragms and valves were undamaged and functioned as intended. The pump was mechanically sound and undamaged. When the engine was rotated, the plunger that operates the fuel pump went in and out in sync with the engine's rotation. The plunger slid effortlessly in the sleeve.
- Some fuel was found in the hose between the engine driven fuel pump and fuel injection servo, but the hose was not full.
- The fuel filter on the fuel injection servo was removed and checked. The filter was clean, but only a few millilitres of fuel flowed out of the unit when the filter was removed.
- No fuel was found in the hose between the fuel injection servo and the fuel injection distributor valve.
- A few drops of fuel were found at the poppet valve in the fuel injection distributor valve. The diaphragm in the distributor valve was intact.

The fuel injection servo (part number 2524054-11, serial number 77088), fuel injection distributor valve (part number 2524232-2, serial number 932J) and four fuel nozzles (part number 2524864-2) were sent to Precision Airmotive LLC in Washington, USA for further examination. The US National Transportation Safety Board (NTSB) was present during the examinations. Some minor external damages were found, but all components passed the facility's Acceptance Test Procedures (ATP) without remarks. Precision Airmotive stated that the fuel injection servo had left the factory in 2007, and they have not registered any overhaul since then. According to Service Bulletin PRS-97, second revision, published by Precision Airmotive, the overhaul interval for the servo is 12 years. The aircraft's technical records indicate that the servo was installed in the aircraft in 2008, and the

NSIA has not found any documentation indicating that the servo has been overhauled since installation.

1.16.2 FUEL SAMPLES

After the accident, a fuel sample was taken from the fuel facility at Reinsvoll Airfield. The sample was sent to Petrotest AS for analysis of appearance (water and larger particles), water content, vapour pressure and distillation profile. The results were compared with the requirement for AVGAS 100LL in ASTM D910 Standard specification for Aviation Gasolines. According to the analysis, the sample had no visible particles or free water and it satisfied the requirements of AVGAS 100LL.

1.16.3 SEATS AND SAFETY BELT ATTACHMENT

Investigations showed that both seats had been forced down towards the floor and the steel frame holding the seats was bent downwards. The frame under the front seat also had several fractures.

In the rear cockpit, the crossmember to which the shoulder harness was attached was bent forwards. The crossmember had also torn off near its attachment points to the upper longerons on both sides (see Figure 17).

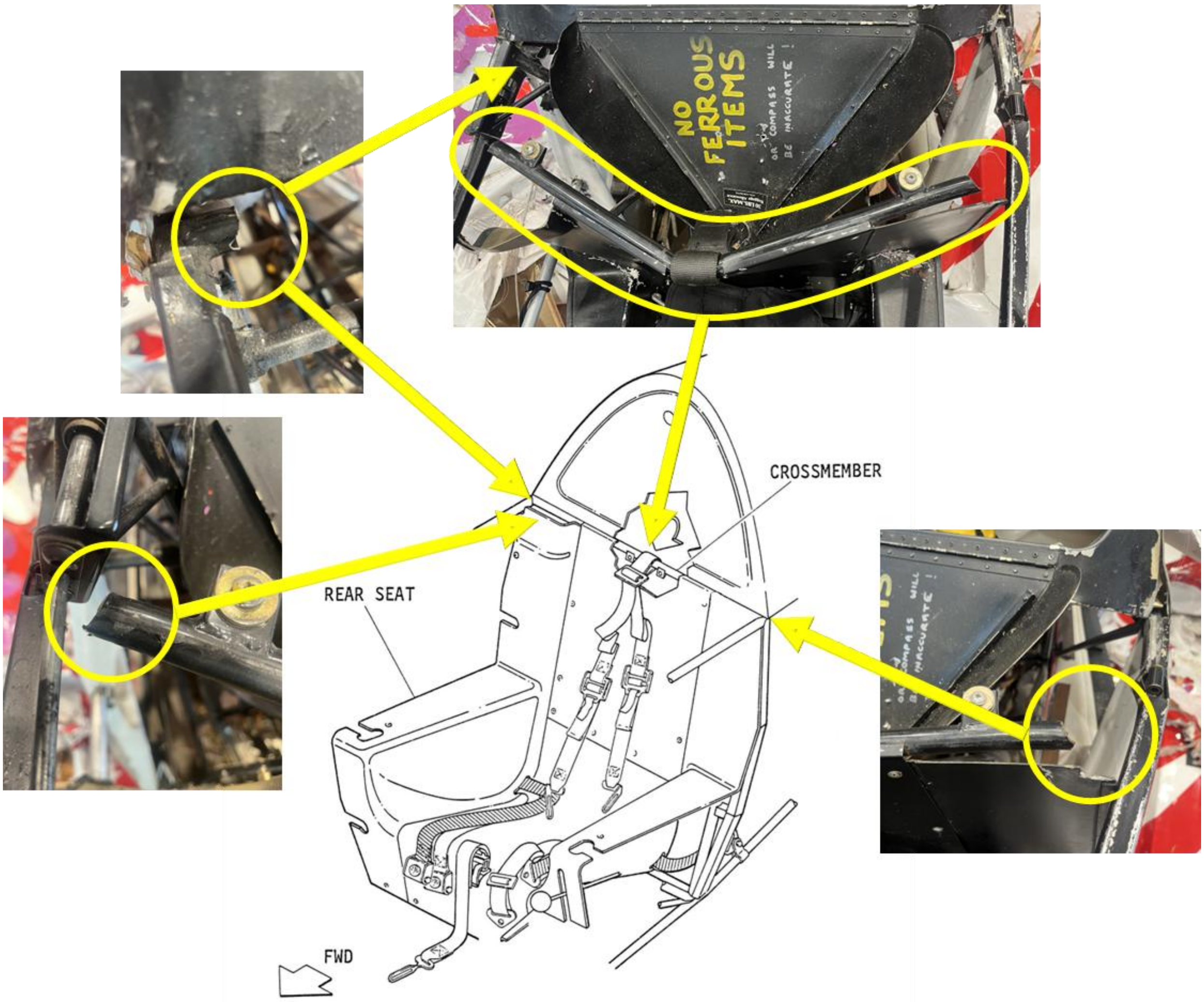

Figure 17: Fracture in the attachment and bending of the crossmember for fastening the shoulder harness in the rear cockpit. Illustration: Christen Eagle. Photo: NSIA

In the front cockpit, the shoulder harness was found to be loose, and there was no bending or damage to the crossmember to which the harness should have been attached. Above the crossmember was a bracket that concealed the crossmember itself. This had an oblong hole through which the harness should have been threaded (see Figure 18). The harness had no visible damage. Approximately 14 cm from the end of the harness there was a three-bar slide adjuster. The webbing should have been threaded back through the slide adjuster to lock the harness to the crossmember (see Figure 20).

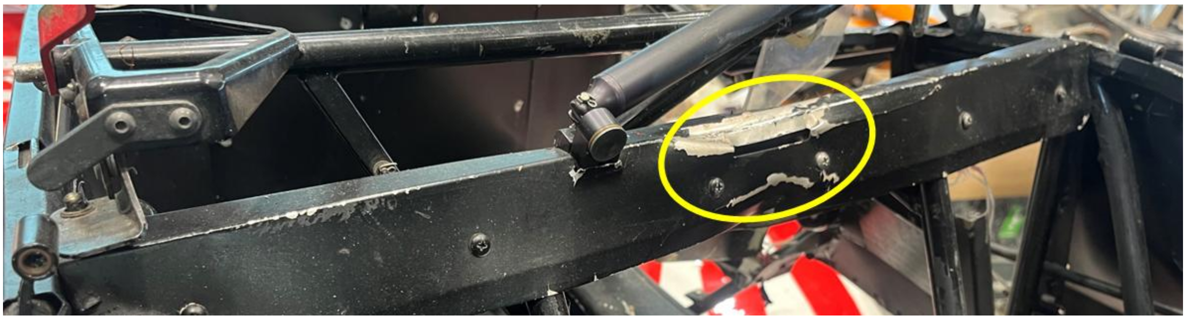

Figure 18: Crossmember with overhead bracket, which the shoulder harness in the front seat should have been fastened through and around. Photo: NSIA

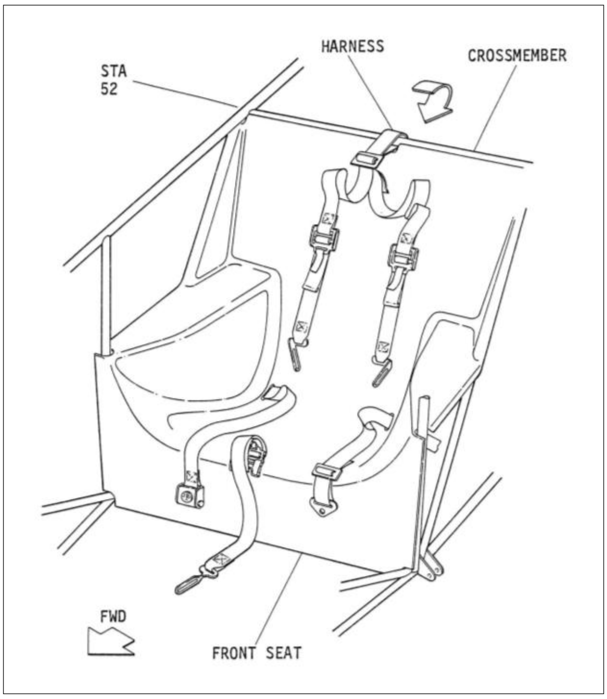

Figure 19: Installation of shoulder harness in the front seat. Illustration: Christen Eagle/NSIA

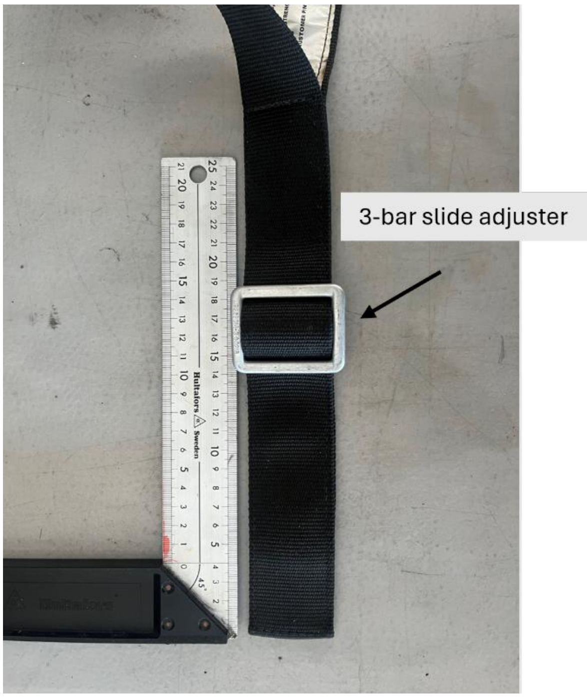

Figure 20: Slide adjuster for attaching the shoulder harness in the front seat. Photo: NSIA

Pre-departure photos show that the passenger was using the shoulder harness, and it appeared to be tightly positioned down along the passenger's back.

1.17 Organisational and management

1.17.1 GENERAL INFORMATION

LN-TBN was a privately owned aircraft, and was flown by its owner during the accident flight. Although the pilot's contact details were found on the local flying club's website, the flight had not been organised by the flying club.

1.17.2 FLIGHTS WITH PASSENGERS

Regulations No. 524 of 15 February 2021 on aviation operations with nationally certified aircraft require the pilot to inform any passengers about matters relating to the certification and technical standards for the aircraft:

> ***Section 5. Providing information to passengers***
> *The pilot shall inform the passengers of the main differences between the planned flight and commercial flights, including that the aircraft does not fulfil international technical standard requirements. The pilot shall inform passengers of their rights under Section 6.*
>
> *The information must provide a suitable basis for passengers to assess whether they wish to take the flight.*

The CAA has a website providing information for passengers of small aircraft[5]. The CAA has also created a three-minute video that gives a general overview of the risks associated with flying small aircraft. A poster with information and a link to the video has been sent to all flying clubs in Norway (see Appendix A). A separate website[6] provides more specific information about the risks of flying private small aircraft compared to commercial flights. These include factors such as the pilot's training and experience, simpler equipment in the aircraft and certification requirements.

1.18 Additional information

1.18.1 ADVISORY CIRCULAR (AC) 21-34 SHOULDER HARNESS – SAFETY BELT INSTALLATIONS

In 1993, the Federal Aviation Administration (FAA) issued an Advisory Circular dealing with safety belts (AC 21-34 Shoulder Harness – Safety Belt Installations). The AC provides information and guidelines on how safety belts and shoulder harnesses can be installed in aircraft to ensure compliance with other regulations (‘acceptable means’). AC 21-34 is still applicable in the US and available on the FAA website.

1.19 Useful or effective investigation techniques

No investigation methods warranting special mention have been used.

[5] Skal du være passasjer i småfly? (Are you going to be a passenger in a small aircraft? – in Norwegian only) (luftfartstilsynet.no)
[6] Passasjer i småfly? (Passengers in small aircraft – in Norwegian only) (luftfartstilsynet.no)

2. Analysis

2. Analysis

2.1 Introduction

The NSIA's understanding of the course of events is based on witness statements and some photo and video material, as well as examinations of the accident site and the aircraft wreckage. The NSIA does not have any stored electronic information from the flight. Many of the witnesses have heard but not seen the aircraft, and there has been great uncertainty about the timing of the observations. The analysis therefore begins with an account of how the NSIA assesses the observations that appear most relevant to the course of events. In this connection, we also discuss the possible reason why, according to witness observations, the engine sputtered about 1.5 minutes before the accident occurred, and the extent to which this may have had an impact on the subsequent course of events.

Since there is little evidence that can explain the accident, the NSIA has chosen to base its further analysis on factors that are the most common causes of accidents involving small and experimental aircraft, and has further assessed the extent to which these correspond with the findings of the investigations. This is followed by an assessment of the survival aspects of the accident, before the analysis concludes with other findings that are not considered directly relevant to the accident.

2.2 Sequence of events

Several witnesses explained that the engine was running rough and sputtered during the flight. Some of these witnesses most likely heard the aircraft during the first part of the flight (during the sightseeing to the east of Reinsvoll). The sound of the engine, as installed on the Christen Eagle II, is slightly different to what is common on other small aircraft. The engine sound is rougher and this may have caused many of the witnesses to react. However, the NSIA finds it unlikely that the pilot would have continued the flight, including aerobatics, if he had perceived that the engine was sputtering or running abnormally. In addition, videos from the engine test before take-off, and from take-off, overflight and aerobatics give no indication that there was anything wrong with the engine. The NSIA considers it likely that the aircraft functioned normally, at least up until they had completed the aerobatics.

When the aircraft headed south after the aerobatics, a witness explained that he thought the aircraft may have flown inverted for a while before it rolled back up-right and turned north towards the airfield. The witness was so convinced that he phoned a pilot he knew to ask whether this was even possible. The witness lost sight of the aircraft for part of the time he thought it may have been flying inverted. Based on the statement, the NSIA has estimated that the aircraft was out of sight for just over 20 seconds. Although the aircraft can technically fly inverted for 20 seconds, the NSIA considers it unusual to fly inverted for that long. If it is correct that the aircraft was inverted, it is perhaps more likely that they performed one or more rolls.

Several independent witnesses have testified that they heard the aircraft engine sputter at a point in time that coincides with the position indicated in Figure 3, shortly after the aircraft turned back towards the airfield. This sputtering was described as 2–3 loud bangs, or misfiring. The coinciding description and time of the observations leads the NSIA to believe that the engine may have sputtered or run rough at this point in time. According to the witnesses, the engine ran normally after this.

The aircraft continued towards the airfield before making a wide left turn, approaching the airfield again from the south-west. Several witnesses who saw the aircraft at this time explained that the nose of the plane suddenly pitched down. Based on where the aircraft was and its altitude, the NSIA believes that the steep descent was not part of normal manoeuvring. The manoeuvre may have been unintentional or the result of problems with the aircraft. Three of the witnesses have been convinced that they heard a bang just before the aircraft pitched down. Witness statements differ with regard to what they heard after the nose of the aircraft dropped, and it is difficult to form a clear picture of whether the engine was running or not based on the statements. If there was a problem with the engine – either the engine stopping or power being reduced – this may have forced the pilot to push the nose down to maintain airspeed while attempting to restart the engine or handling the problem. A cut through a tree found close to the accident site suggests that the propeller was rotating just before it hit the ground. The cut ran upwards and the cut surface was relatively smooth. It is hard to imagine anything other than the propeller making this cut. Damage and marks on the propeller blade that was bent back beneath the aircraft, also indicate that the propeller was rotating and that it must have stopped abruptly after the aircraft hit the ground (approximately ¼ rotation). NSIA believe the propeller would not have rotated at a sufficient rpm to cut through the tree unless the engine had been running. However, it is not possible to determine whether the engine was producing full power.

Marks on the leading edge of the lower left wing indicate that the aircraft struck the trees at the accident site with the nose pointing about 20 degrees below the horizon in a gentle left turn. The damage to the aircraft, in terms of the nose being bent slightly down and inwards, may indicate that it hit the ground with approximately the same attitude. The wings were broken off in the collision with the trees about 7 metres above the ground. Given the distance from the trees to where the aircraft came to rest, it must then have fallen at a relatively steep angle (approximately 40 degrees) to the ground and stopped abruptly against a small rise in the terrain.

The fact that the aircraft hit the trees with its nose about 20 degrees below the horizon after witnesses described seeing the aircraft's nose pitching abruptly downwards almost vertically may indicate that the pilot made an attempt to right the aircraft. The NSIA has no indications that the aircraft has spun.

2.3 Possible causal factors

2.3.1 INTRODUCTION

Various factors that may have contributed to the loss of control and thus to the accident, either individually or in combination, are discussed below. The factors listed below are not exhaustive, but are typical factors that contribute to accidents involving small and experimental aircraft.

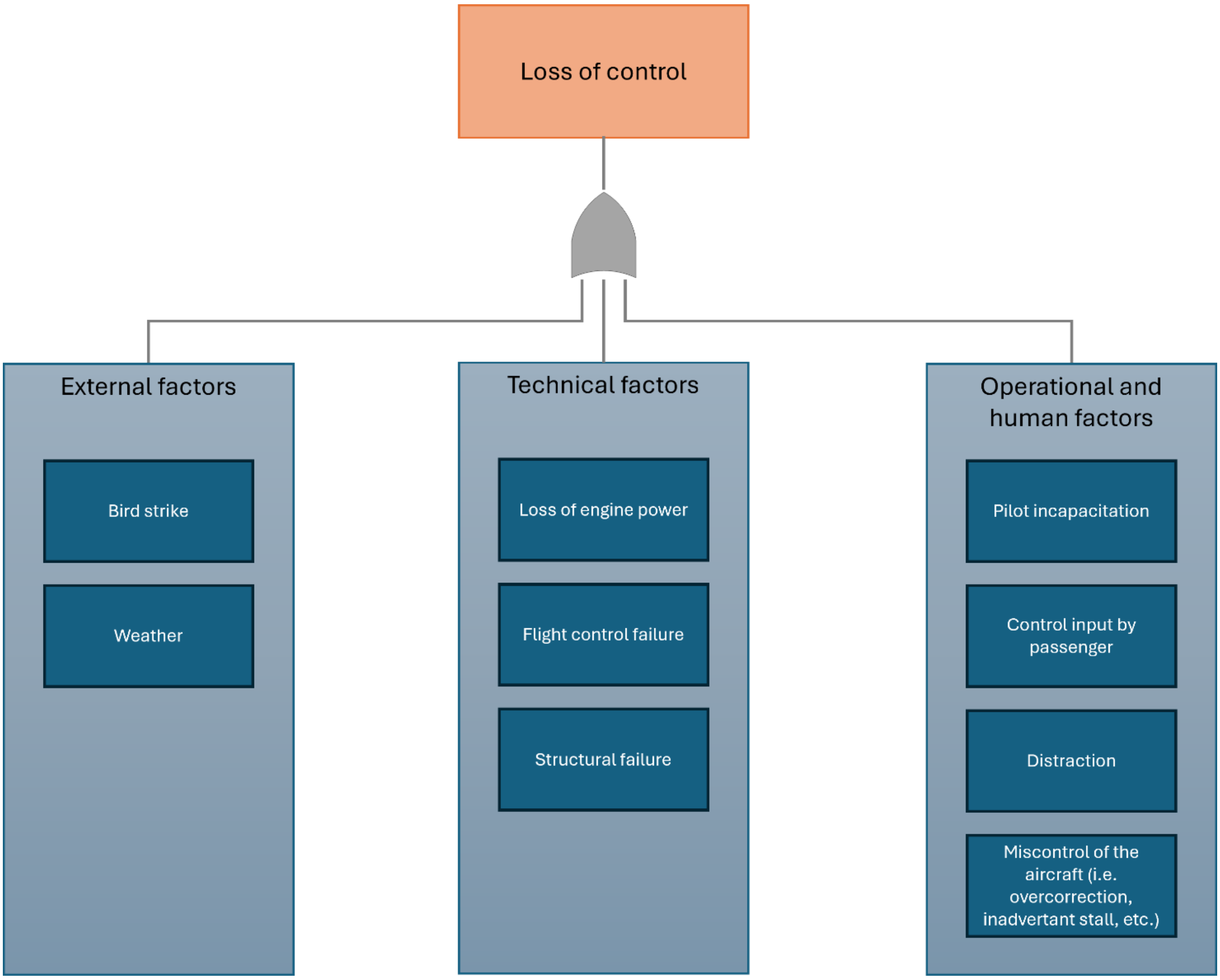

Figure 21: Simplified fault tree analysis. Possible scenarios that can lead to loss of control. Illustration: NSIA

2.3.2 EXTERNAL FACTORS

The NSIA has assessed whether the weather may have been a factor in the accident. Airfield information on local weather conditions indicates that there can be wind shear on the final part of the approach to runway 16 with westerly winds. The position of LN-TBN was not such that this is considered relevant.

The weather report from the Norwegian Meteorological Institute indicates that there was a possibility of gusty winds from the strongest CB clouds and in connection with the squall lines. Lightning strikes were also recorded in the areas with the most convective and powerful shower clouds. Radar animation shows a squall line passing over Reinsvoll at around the time of the accident (see Figure 9) with some smaller but powerful shower clouds passing south of the airfield. However, the strongest showers appear to be in the area east of Lillehammer. Lightning strikes were also registered here. No lightning strikes were recorded near Reinsvoll. None of the witnesses the NSIA has spoken to have mentioned any particular weather or wind conditions at the time of the accident. Given that Christen Eagle is a relatively light aircraft with a lot of engine power and that it was cruising at approximately 1,000 ft above the ground, the NSIA does not find it likely that the reported weather conditions would have forced the aircraft down. The NSIA therefore finds it unlikely that the weather was a factor in the accident.

A witness has explained that he observed cranes in the area south of the airfield earlier that day. The NSIA has not made any findings consistent with the LN-TBN having a bird strike and this causing the accident.

2.3.3 TECHNICAL FACTORS

2.3.3.1 Loss of engine power due to mechanical failure of engine or propeller

The NSIA has dismantled the engine and propeller to look for indications of failures that may have caused full or partial loss of engine power. All the damage found is consistent with a collision with the ground. In general, the engine and propeller appear to have been in good condition.

2.3.3.2 Loss of engine power due to air supply or ignition failure

The entire ignition system has been inspected. Magnetos, spark plugs and connecting high-voltage wiring have been tested at Norrønafly workshop in Rakkestad, without any faults being detected. Nor were any faults found in the ignition switch or associated wiring. The investigation has not revealed any indications of a fault related to the engine air supply either.

2.3.3.3 Loss of engine power due to fuel supply failure

A number of factors can lead to the engine not receiving an adequate supply of fuel. The most common causes include contaminated fuel, a faulty fuel pump, running out of fuel or the fuel selector being in the wrong position. On aircraft with a flop tube in the tank, the flexibility of the tube can also affect the fuel supply in connection with manoeuvring.

LN-TBN only had one fuel tank, and the fuel selector could only be set to the ON or OFF position. The selector was in the ON position when the aircraft was inspected by the NSIA. The technical investigations revealed no faults with the engine driven fuel pump, the fuel pump assembly or the fuel injection servo.

The fuel tank was punctured during the accident and all remaining fuel had leaked out. It was therefore not possible to take samples of the fuel on board LN-TBN. Instead, samples were taken from the fuel facility at Reinsvoll, where LN-TBN had refuelled a few days earlier. The samples from the fuel facility were within the requirements set for AVGAS 100LL, and no visible particles or water were found in the sample. During the examination of the aircraft, all filters in the fuel system were checked and found to be clean. A photo taken before the flight also suggests that the pilot took a fuel sample from the fuel pump assembly in connection with the preflight. The NSIA has been informed that it was routine to take a sample from both the pump and the tank. The NSIA finds it unlikely that the pilot would have chosen to fly if he had seen signs of water or other contamination in the fuel.

The hole in the fuel tank has made it impossible to determine how much fuel was left at the time of the accident. The smell of fuel at the accident site is an indication that they did not run out of fuel. At the same time, according to the flight manual, just under 4 litres of the fuel on board is unusable, and this may have been enough fuel to cause the smell at the accident site. Estimations of the fuel level (see 1.6.7) indicate that the aircraft had not run out of fuel, but this is dependent on the estimated consumption and fuel level they started with being relatively correct. When comparing the estimated consumption at 65% engine power during cruise in 1.6.7 with the consumption shown in the aircraft's log book from previous flights, the estimated consumption of 24 litres is somewhat higher than the historical data for similar flights. If an extra margin is nonetheless added and the calculation is based on an average of 75% engine power throughout the flight, the consumption would be 26 litres. To run out of fuel in this case would mean that the fuel level at take-off must have been approximately 30 litres, including unusable fuel. Based on calculations using information in the aircraft's log book, the NSIA finds it unlikely that they would have started the flight with such a low fuel level and thus run out.

A number of witnesses have stated that the engine sputtered when the aircraft was south of the airfield after the aerobatics. This may indicate a temporary problem with the fuel supply. Given that a witness believes they were flying inverted or rolled shortly before the engine sputtered, and that they had a limited amount of fuel on board, it is reasonable to link this to the flop tube in the tank. According to the Christen Eagle flight manual, a limit of a minimum of 6 US gallons of fuel for aerobatics (approx. 22.7 litres) applies. It is the NSIA's understanding that this limit is related to the extent to which the fuel tank's flop tube reaches the fuel during inverted flight. It is a known problem that flop tubes can lose their flexibility over time. Previously released SB 376 from Aviat Aircraft Inc. highlights that this can pose a potential flight safety risk in connection with inverted flight. The NSIA has tested the flop tube installed in LN-TBN and found that it had sufficient flexibility to not make the tube's flexibility a factor within the limits given in the flight manual. Information from other Christen Eagle pilots suggests that there may nonetheless be problems with the fuel supply where the engine can sputter during rolls, especially slow rolls. During this form of manoeuvring, both the fuel and the flop tube will rotate in the tank. This can lead to temporary problems with the fuel supply, but it is normally corrected by flying straight and level.

Based on the NSIA's fuel calculations, the fuel level was approximately 6 US gal (approx. 22.7 litres) when they had finished the aerobatics over the airfield. This assumes that they started the flight with 40 litres (approx. 10.5 US gal) of fuel and flew the sightseeing part of the flight with approximately 50% engine power. They may have flown with a slightly higher engine setting and had a slightly higher fuel consumption, but it is also likely that they started the flight with somewhat more fuel. The NSIA therefore considers it unlikely that the fuel level was significantly lower than 6 US gal. Video footage from the aerobatics indicates that the engine was running normally during this part of the flight. Given that they were primarily flying loops, where there is normally a positive G-load on the aircraft throughout the manoeuvre, it is unlikely that a fuel level below 6 US gal would have had a negative effect on the fuel supply during this manoeuvre. If, on the other hand, they flew inverted or performed rolls, as a witness believes they did after heading south following the aerobatics, this could explain why the engine sputtered shortly afterwards. Witness statements nevertheless indicate that the engine was running normally after this, and the NSIA believes that any manoeuvring that may have contributed to the engine sputtering would not have led to further engine problems at the time of the accident, approximately 1.5 minutes later.

The investigations have not revealed any defects in the fuel system that would indicate that the engine could not produce full power.

2.3.3.4 Faults in flight controls

Examination of the flight controls showed continuity between the sticks and pedals in the front and rear cockpits and on to the elevators and rudder. There was also continuity between the sticks and pushrods leading to the ailerons at the wing roots. Although the connection to the control surfaces was broken, the examinations indicate that all the damage to the flight controls was the result of the crash. The NSIA has not found any indications of faults with the flight controls before the accident.

When the aircraft was examined at the accident site, the elevator trim was found in the full nose down position. It is most likely that the weight of the elevator trim lever was sufficient for it to be knocked into the full nose down position when the aircraft hit the ground. The NSIA also believes that the pilot would normally be able to overpower the trim using stick input even if the elevator was inadvertently trimmed fully nose down.

2.3.3.5 Structural defects

All parts of the aircraft were found within a few metres of the accident site, and all the damage is consistent with the aircraft hitting the trees in the immediate vicinity of the accident site and then hitting the ground. The NSIA has not found any signs of structural failures that have arisen prior to this.

2.3.4 OPERATIONAL AND HUMAN FACTORS

Operational and human factors cover a wide range of topics. In connection with this accident, the NSIA has primarily assessed whether physiological factors such as loss of consciousness or acute illness in the pilot, unintentional control input from the passenger, inattention or distraction may have contributed.

Based on the autopsy report, there is nothing to suggest that the pilot suffered sudden illness or similar that would have rendered him unable to handle the aircraft.

When the flight was arranged, the pilot had explained that the passenger could try flying himself during the flight. One possible scenario is that the pilot let the passenger fly and the passenger made a too large or abrupt stick input. The Christen Eagle aircraft is highly manoeuvrable, light on the controls and therefore easy to over-control. At the same time, it must be assumed that if the pilot had allowed the passenger to fly, he would also have paid attention and taken back control if necessary.

Another possibility is that the passenger inadvertently pushed the stick forward, and that this took the pilot by surprise. Based on the fact that the aircraft was at around 1,000 ft before suddenly losing altitude, the pilot would most likely have been able to regain control of the aircraft in such a scenario. Limited forward visibility and overview of the instruments may nevertheless have contributed to reducing the pilot's situational awareness.

The engine sputtering when they were south of the airfield may have led to stress for one or both of them. A limited view of the engine instruments and the fuel level indicator on the tank may have made it difficult for the pilot to analyse what may have caused the engine to run rough or sputter. On the other hand, if the pilot was unsure of the reason for the engine sputtering and whether it could indicate more serious engine problems, it is difficult to understand why he made a wide left turn instead of continuing in for landing. Cows in the runway area may, however, have contributed to a decision not to continue the approach, and exacerbating the situation by demanding attention. Irrespective of whether or not cows in the airfield area have been a contributing factor, the NSIA finds it problematic that it is apparently accepted that cows are present on the airfield during flight operations.

Most accidents involving small and experimental aircraft that cannot be related to technical causes involve loss of control in connection with manoeuvring or landing. In this accident, according to witness statements, LN-TBN was flying straight and level at an altitude of approximately 1,000 feet when the nose suddenly dropped. The NSIA finds it unlikely that the sudden descent was part of a planned manoeuvre where misjudgement or incorrect control input caused the pilot to subsequently lose control of the aircraft. The aircraft was not in the landing phase, where low altitude and speed result in slimmer margins.

Independent of the reason for the aircraft suddenly pitching down, the cockpit layout makes it challenging for a pilot if something unforeseen happens while flying with a passenger in the front seat. Limited view of the airspeed indicator and engine indicators may have contributed to the pilot loosing situational awareness. Limited forward visibility may also have contributed to the pilot too late becoming aware of the obstacles, in the form of trees, ahead of the aircraft, making any attempt at an emergency landing difficult.

2.4 Survival aspects

According to the autopsy report, both the pilot and the passenger died from head and chest injuries. Weaknesses in the attachment of the safety belts appear to be a contributing factor to the injuries identified.

The passenger's shoulder harness was found loose in the aircraft after the accident. Pre-departure photos show that the passenger was wearing a shoulder harness. The harness sat relatively tightly along the passenger's back, indicating that it must somehow have been fastened. The NSIA nevertheless believes that the harness would not have come loose if it had been installed correctly. The harness should have been threaded through a three-bar slide adjuster, around a crossmember behind the seat and back to the slide adjuster (see Figure 19). In a photo given to the NSIA, the three-bar slide adjuster appears to be placed so far up the passenger's back that the remaining part of the harness, which was measured at 14 cm (see Figure 20), may not have been long enough to reach around the crossmember and back to the slide adjuster to lock the harness. The NSIA cannot say whether the harness was installed incorrectly when the belts were replaced, or whether the harness has been adjusted at a later date. Normally, there will be no need to adjust the slider after installation, as individual adjustment of the length of the shoulder harnesses is done with the adjustment mechanism in front of the chest. There are no marks or depressions on the harness indicating that the slide adjuster has been moved. The harness must have been sufficiently secure for the discrepancy not to have been discovered in connection with the annual inspection of the aircraft, previous flights where the front seat was in use, or when the passenger fastened the harness prior to the accident flight. The inspection described in the maintenance procedures covers the general condition of the harness and signs of wear, damage and deterioration. The inspection does not specifically mention the harness attachment points. The cover over the crossmember where the front seat harness should have been attached may make it difficult to discover that the harness is installed incorrectly unless you specifically check for the harness being routed back through the slide adjuster. The deceleration forces during the crash were sufficient to cause the shoulder harness to loosen, resulting in the passenger being thrown forward, hitting his head on the instrument panel.

The pilot's shoulder harness was attached to a crossmember behind the seat as described in the Christen Eagle construction procedures. The deceleration forces during the accident caused the crossmember to be bent forward at the point where the shoulder harness was attached. In addition, the crossmember had been torn off close to where it was welded to the right and left longerons. As a result of the failure of the structure which the shoulder harness was attached to, the pilot was thrown forwards and hit his head on the canopy crossbar which was located across the cockpit just behind the front seat. The pilot had also partially slided under the hip belt (submarining). A short seat back with the shoulder harness attached lower than the pilot's shoulders may have contributed to this in that the hip belt had been lifted when the upper body was thrown forward.

NSIA have inspected the structure around the crossmember where the front seat shoulder harness should have been attached, and compared it to the equivalent structure in the aft cockpit. The load bearing structure is similar in the front and the back. The cover over the crossmember in the front does not significantly strengthen the structure. If the shoulder harness in the front seat had been correctly installed and not become detached during the crash, the NSIA believes the crossmember in the front would have failed in the same way the crossmember behind the back seat failed. As a result, even if the front seat shoulder harness had been correctly installed this might not have prevented the passenger from hitting his head on the instrument panel. The accident shows that the structure was not designed to withstand the load that occurred in the accident, given how the shoulder harnesses were installed. By attaching the shoulder harness to the centre of a crossmember, the deceleration forces were concentrated in one point. With a different attachment structure, the forces could have been distributed in a way that would have made a structural failure less likely. These are issues that the amateur-built and experimental aircraft communities in particular should be aware of. AC 21-34 *Shoulder Harness – Safety Belt Installations* published by the FAA provides a lot of information that can be useful in this context.

2.5 Findings not directly relevant to the accident

2.5.1 WEIGHT AND BALANCE

Based on the NSIA's calculations, the aircraft's weight and balance was outside the limits for aerobatics (see Figure 8). The NSIA has not found information to indicate that the pilot had made weight and balance calculations for the flight in question based on actual weights. It is possible that he considered this unnecessary, given that the flight manual gives an example of a flight with a passenger where the aircraft is well within the limits for aerobatics. However, the example differs from the actual situation in that the weight of the pilot and passenger was too low. While the example used a weight of 190 lb (approx. 86 kg) for each person on board, the actual weight was just under 200 lb (approx. 91 kg) for the pilot (including parachute) and just over 220 lb (approx. 100 kg) for the passenger. The NSIA's calculations indicate that the aircraft's centre of gravity was behind the recommended limit for aerobatics, but within it for normal flight. Variations in fuel quantity do not affect this result, but if the weight of the two people on board is lower, this shifts the line for the centre of gravity calculation (see Figure 8) to the left. If the combined weight of the pilot and passenger was 4 lb (approx. 2 kg) lower than what NSIA has based its calculations on, the centre of gravity calculation will be shifted so that it is at the aft limit for aerobatics.

Based on witness statements about the flight just before the accident, the NSIA believes that the pilot manoeuvred within the category for normal flight, and that the aircraft's centre of gravity at this time was within the limits specified in the aircraft's manual. The NSIA nevertheless wishes to emphasise the importance of performing weight and balance calculations based on actual weights before each flight, and of manoeuvring within the limits specified for the aircraft. On many small aircraft, what are perceived as relatively marginal changes in weight can have a major impact on the aircraft's centre of gravity.

2.5.2 THE PILOT'S DUTY TO PROVIDE INFORMATION TO THE PASSENGER

According to the Regulations on aviation operations with nationally certified aircraft, the pilot has a clear obligation to inform passengers about the difference between commercial flights and the planned flight. The Regulations also state that the information must provide a suitable basis for passengers to assess whether they wish to take the flight. The flight with LN-TBN was a gift, and the flight was agreed between the pilot and the passenger's spouse. The communication between the two contains some information about the plane being an aerobatic aircraft, but nothing more about the risks associated with this type of experimental aircraft. The NSIA does not know whether the pilot explained more about this to the passenger just before the flight.

The NSIA believes that the requirement to provide passengers with information about the risks associated with the flight in a way that enables them to understand what risk they are accepting is important. This information must be communicated at an early enough stage to give passengers time to reflect and an actual opportunity to opt out of taking the flight. At the same time, the NSIA recognises that it can be difficult for a pilot to describe the risk objectively and in a way that is easy to understand. Very few pilots would probably fly if they perceived the risk to be high, and they will normally have confidence in both the aircraft and their own skills. The Norwegian CAA has posted information on its website about the risks associated with flying small aircraft, and the NSIA believes that pilots planning to take passengers on flights would benefit from referring passengers to this information. Given the circumstances, the NSIA doubts that the passenger on LN-TBN would have opted out of the flight even if he had read the information.

3. Conclusion

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3.1 Main conclusion

The NSIA has carried out thorough investigations into technical, operational and human factors but has been unable to explain why, according to witnesses, the aircraft went from flying straight and level to the aircraft's nose suddenly pitching down. Based on the position and altitude of the aircraft, the NSIA believes that the steep descent was not part of normal manoeuvring. The manoeuvre may have been unintentional or the result of problems with the aircraft. In case of total or partial loss of engine power a steep descend will be necessary to establish and maintain best glide airspeed. The investigation has not uncovered any technical faults with the engine, ignition or fuel system. However, the NSIA cannot rule out the possibility.

Some of the witnesses have stated that they heard a bang just before the aircraft pitched down. The bang may have been an indication of problems with the engine, and the pilot may have pushed the nose down to maintain airspeed. Based on findings at the accident site the NSIA believes the propeller rotated and the engine was running at the time of the accident, although it cannot be determined whether the engine produced full power. If the engine stopped at the time the bang was heard, the pilot may have been able to restart it, but too late to avoid the trees. A situation like this would have demanded a lot of attention by the pilot. At the same time, with a passenger in the front seat limited view of the instruments would have made it challenging to analyse a possible engine problem. Limited forward field of view may also have contributed to the pilot not noticing the trees ahead in time.

3.2 Investigation results

- The pilot had a valid pilot licence with privileges for aerobatic flying, as well as a valid medical certificate.
- The autopsy revealed no signs that the pilot had suffered any sudden illness that could have affected his ability to control the aircraft.
- The aircraft was registered in accordance with the applicable regulations and held a valid airworthiness certificate.
- Weight and balance were within the limits for normal flight during the flight, but outside the limits for aerobatic flying. There are no indications that this contributed to the accident.
- No technical faults have been found with the engine, propeller, fuel supply or flight controls.
- There are no signs of structural defects or damage that occurred prior to the accident.
- The fuel tank was punctured in connection with the accident and all remaining fuel had leaked out. The smell of petrol at the accident site, as well as calculations of fuel consumption, indicate that there was usable fuel in the tank before the accident.
- No impurities have been detected in the fuel sample from the fuel facility at Reinsvoll.
- Weather conditions have not been identified as a causal factor.
- Cows were observed in the airfield area both before and after the flight.
- Both the pilot and the passenger died from head and chest injuries.
- The passenger's shoulder harness was not correctly attached to the crossmember behind the seat and came loose in connection with the accident.
- The crossmember to which the pilot's shoulder harness was fastened was bent forward and torn off due to the deceleration forces when the aircraft hit the ground.

4. Safety recommendations

4. Safety recommendations

The Norwegian Safety Investigation Authority does not propose any safety recommendations.

Norwegian Safety Investigation Authority
Lillestrøm, 1 July 2025

Appendix

Appendix A Poster with safety information for passengers in small aircraft