Norwegian Safety Investigation Authority

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REPORT AVIATION 2024/08

Air accident at Trollnes in Arendal municipality on 25 June 2023, involving a Robinson R44, LN-OSS

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 issue safety recommendations if relevant. It is not the NSIA's task to apportion blame or liability under criminal or civil law.

This report should not be used for purposes other than preventive aviation safety work.

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Photo: The police / NSIA

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

Type of aircraft:	Robinson R44 Raven I
Nationality and registration:	Norwegian, LN-OSS
Owner:	Company LN-OSS AS[1]
Operator:	Private
Pilot in command:	Minor injuries
Passengers:	1, minor injuries
Accident site:	Trollnes, Arendal municipality
Accident time:	Sunday 25 June 2023, at 1320 hours

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

Notification

At 1402 hours on Sunday 25 June 2023, the Norwegian Safety Investigation Authority's (NSIA) accident investigator on duty received notification from the Joint Rescue Coordination Centre (JRCC) that there had been an accident involving a helicopter northeast of Arendal. There were two people on board, but neither of them were seriously injured. Two accident investigators responded and began their investigations on arrival at the accident site at approximately 1930 hours the same day.

The following bodies were notified of the accident in accordance with ICAO Annex 13 and the Aviation Act Section 12-6, cf. Regulation (EU) No 996/2010 Article 9(2):

- The US National Transportation Safety Board (NTSB)
- The European Union Aviation Safety Agency (EASA), which appointed a technical advisor
- The Civil Aviation Authority Norway (CAA)

[1] *After the accident, the company changed its name to Helisys AS.*

Summary

The pilot in command of LN-OSS was flying from Mandal to Jessheim with a scheduled stopover at Trollnes, northeast of Arendal, to pick up a passenger. During landing at Trollnes, he lost control of the helicopter, which hit the rocks on the shoreline and was completely destroyed. Both people on board escaped with minor injuries. The landing attempt was filmed by both a witness on the ground and a camera inside the helicopter. The footage has been very helpful to the investigation of the accident. The accident occurred when the pilot miscalculated the helicopter's position relative to the edge of the landing site. There was a steep slope at the rear of the landing site and the helicopter landed closer to the slope than intended. When he lowered the collective and the weight of the helicopter was shifted onto the skids, the helicopter tipped backwards and crashed.

The NSIA considers the landing site to be marginal suitable generally and for a pilot with limited experience especially.

Neither of the people on board were wearing a helmet or life jacket. No safety briefing had been given before the flight, and the passenger was not familiar with flying a helicopter. Several protective measures had therefore been dropped. The helicopter was flown over open water during the approach. After the accident it ended up in shallow water. The NSIA believes that the accident could easily have caused greater harm to those on board.

The helicopter was equipped with crash-resistant fuel tanks, and no fuel leaks or fire occurred.

Like most private helicopter pilots, the pilot was not part of any club community or flight operations environment. Such communities have been established for most other areas of aviation. The investigation has highlighted the advantages a private pilot may gain from being part of a flight operations environment to share experiences and thereby increase safety awareness and knowledge.

About the investigation

Purpose and method

The NSIA has classified the incident as an aviation accident.[2] The purpose of the NSIA's investigation has been to identify the factors that contributed to LN-OSS crashing immediately after its landing attempt at Trollnes. The NSIA has also considered what can be done to improve safety and prevent the recurrence of similar accidents in the future.

The accident and the circumstances surrounding it have been investigated and analysed in line with the NSIA's framework and analysis process for systematic safety investigations (the NSIA method[3]).

Focus and delimitation of the investigation

The investigation highlights the advantages a private pilot may gain from being part of a flight operations environment for, among other things, experience sharing between pilots.

Sources of information

The NSIA has obtained information from the following sources:

- Investigations at the site of the accident
- Interview with the pilot in command
- The pilot in command's report
- Interview with the passenger
- Aircraft documents
- Video footage of the incident
- Technical examinations of the helicopter
- Photos and witness information from the police

The investigation report

The first section of the report, 'Factual information', describes the sequence of events, associated data and information gathered in connection with the accident, and the NSIA's examinations and related findings.

The second section, 'Analysis', describes the NSIA's assessments and analyses of the sequence of events and contributing factors, on the basis of factual information and examinations carried out. Details and factors that are found to be less relevant in order to explain and understand the accident are not discussed in depth.

The report ends with the NSIA's conclusions.

[2] *Cf. Regulation (EU) No 996/2010 Article 2(1)(b)*
[3] *See https://www.nsia.no/About-us/Methodology*

1. Factual information

1. Factual information

1.1 History of the flight

At 1300 hours on Sunday 25 June 2023, the pilot in command was scheduled to fly from a local landing site outside Mandal to Jessheim with the helicopter LN-OSS. He had one passenger on board. The investigation has revealed that the passenger did not receive any specific safety briefing before the flight. The passenger had no knowledge of flying in a helicopter from before, and this was his first time in a helicopter. The pilot had a scheduled stop at Trollnes, about 4 km northeast of Arendal, to pick up another passenger before continuing to Jessheim.

The helicopter took off from Mandal with full fuel tanks, and the flight from Mandal to Trollnes took place as expected under VMC.[4] Trollnes is a coastal residential area northeast of Arendal, and the scheduled landing site was normally used as a car park, see Figure 1. The pilot has explained to the NSIA that he had inspected the landing site from the ground, but that he had not landed a helicopter there before. He expressed that he did not see any major challenge with the landing site, as he had landed in tighter landing sites before.

Figure 1: The tarmacked area in the middle of the photo shows the landing site at Trollnes. The arrow marks the direction of approach. Source: Google Maps / annotation by NSIA

The pilot in command had mounted a camera on the inside of the helicopter's windscreen, and the NSIA has gained access to the recordings of the approach. The footage shows that there was a slight south-westerly wind at the time of the incident, which meant that the pilot had to make the approach with a slight crosswind from the left.

The helicopter flew almost horizontally towards the landing site. The pilot flew the helicopter at low speed the last few metres above the rocky shore and hovered on the spot a couple of times before bringing the helicopter down at the edge of the tarmacked area. The moment after the helicopter

[4] *Visual meteorological conditions (VMC): Flight conducted in accordance with visual flight rules.*

skids came into contact with the tarmac, the footage shows the helicopter tipping backwards. The pilot in command has explained that he attempted to remedy the situation by lifting the helicopter back into the air, but this had failed. The helicopter rotated to the left before hitting the ground and ended up on the rocks on the shoreline with the tail boom pointing out into the water, see Figures 2 and 3. The pilot in command has explained to the NSIA that, just before landing, he received a warning about low rotor rpm and that the engine misfired. He has also explained that it felt as if a magnet was pulling the helicopter the moment it tipped backwards. The NSIA has reviewed the video with sound and images, more about this in 1.16 and in the analysis.

Figure 2: The photo was taken approximately one hour before the full ebb-tide. The two orange cones at the edge of the tarmacked area represent points where the mid-section of the helicopter's skids was in contact with the ground. The two vehicles were not at the site at the time of landing. The witness who filmed the crash was standing on the veranda seen at the top of the photo. Photo: The police / NSIA

Both the pilot in command and the passenger were conscious after the accident. The pilot managed to make his way out of the wreckage without assistance, while the passenger needed help from a person who came running down to the wreckage after the accident.

A witness standing on the veranda filmed the approach and the crash, the NSIA has gained access to this footage.

Witnesses immediately called the medical emergency phone line 113 to report the accident. Ambulance personnel arrived shortly after and took the pilot and passenger in to the ambulance for a medical examination.

1.2 Injuries

Table 2: Injuries

Injuries	Crew	Passengers	Other
Fatal			
Serious			
Minor/none	1	1	

1.3 Damage to aircraft

The aircraft suffered major structural damage; see 1.12.2 for a detailed description.

1.4 Other damage

A small amount of oil leaked into the sea. Arendal fire and rescue service put out booms to limit the oil spill.

1.5 Personnel information

The pilot in command underwent flight training for a Private Pilot Licence Helicopter (PPL-H) in Denmark and Norway. The theoretical part and some of the flying lessons were carried out in Denmark, while the remaining flights and final flight test took place at Kjevik. He completed his training and passed the final test in March 2015. All flights after this have been conducted either alone or with friends and relatives as passengers. The annual renewal of the right to fly an R44 (Proficiency check – PC) was carried out with an examiner at Kjevik. The most recent renewal was valid until 30 June 2024.

The pilot in command had a medical certificate class 2, which was valid until 12 May 2024 with the limitation VML (Valid only with correction for defective distant, intermediate and near vision). This means that the pilot had to wear glasses or contact lenses when flying.

In an interview with the NSIA, the pilot stated that he felt rested and fit to fly on the day in question.

He has also explained that he did not take part in any flight operations environment or any other form of exchange of safety information with other pilots.

Table 1: Flying experience, pilot in command

Flying experience	All types	On type
Last 24 hours	0:20	0:20
Last 3 days	0:20	0:20
Last 30 days	7:00	7:00
Last 90 days	7:00	7:00
Total	321:10	321:10

1.6 Aircraft information

1.6.1 GENERAL INFORMATION

The Robinson R44 Raven I is a lightweight single-engine helicopter equipped with a Lycoming IO-540-AE1A5 air-cooled six-cylinder carbureted engine. It can carry one pilot and three passengers. The cabin of the R44 is mainly composed of aluminium and fibreglass. The helicopter is equipped with sound and light signals that are triggered if the rotor rpm falls below 97%. The helicopter is only approved for flying during daytime in accordance with visual flight rules (VFR day).

Nationality/registration:	LN-OSS
Manufactured:	2008
Serial number:	1617
Type certificate:	EASA.IM.R.121
Maximum permitted take-off mass:	1,089 kg
Main rotor diameter:	10.06 m
Approved fuel grades:	Avgas 100LL or Avgas 100/130
Total flight hours LN-OSS:	2,430.5 hours

The Robinson R44 has a collective pitch control that allows the pilot to change the pitch angle of both main rotor blades collectively. Via the collective, the pilot can also manually regulate the engine power. This is normally not necessary other than during start-up, shutdown, during autorotation training or in emergency situations. During normal flight, at an engine rpm of over 80%, the rpm is automatically controlled by a governor.

The helicopter was equipped with an Emergency Locator Transmitter (ELT). This was automatically triggered when the helicopter crashed and was manually switched off at approximately 1400 hours, 40 minutes after the accident. There were no life jackets on board, and neither the pilot in command nor the passenger was wearing a helmet. The helicopter had crash-resistant fuel tanks.

1.6.2 MASS AND BALANCE

The NSIA has estimated that the helicopter had the following mass at take-off from Mandal:

Table 4: Mass calculations

	Mass
Empty weight	683 kg
Fuel	137 kg
Pilot and passenger (standard weights)	168 kg
Baggage	40 kg
Total	**1,028 kg**

According to the NSIA's calculations, the helicopter's mass and centre of gravity were within permissible limits at the time of the accident.

1.6.3 MAINTENANCE

The NSIA has only reviewed the helicopter's maintenance documentation to a limited extent. No irregularities relating to the helicopter's maintenance were found that could have had an impact on the sequence of events.

1.7 Meteorological information

1.7.1 METEOROLOGICAL AERODROME REPORT (METAR) FOR KRISTIANSAND AIRPORT KJEVIK (ENCN)

ENCN 25/06/2023 10:50->METAR ENCN 251050Z 19012KT 9999 FEW025 21/15 Q1019

1.7.2 AERODROME FORECAST (TAF) FOR KRISTIANSAND AIRPORT KJEVIK (ENCN)

ENCN 251100Z 2512/2521 19010KT CAVOK PROB30 2518/2521 BKN010 BECMG 2519/2521 VRB03KT=

1.7.3 WEATHER OBSERVATIONS FROM VIDEO

The two video recordings that the NSIA has gained access to show that it was partly cloudy, fair weather at the accident site. The footage also indicates that there was a slight south-westerly wind at the time of the incident.

1.8 Aids to navigation

Not applicable.

1.9 Communications

The pilot in command was in contact with Kjevik Approach on the frequency 119,950 MHz when he passed Kjevik's airspace, and reported the frequency to Arendal Airport, Gullknapp (ENGK), transmitting blind on 129,900 MHz before landing at Trollnes.

1.10 Aerodrome information

A helicopter pilot must, on an independent basis, assess whether a landing site is suitable and can be used. A condition is that permission has been obtained from the landowner in advance, and such permission had been obtained in this case.

1.11 Flight recorders

Not installed nor required.

1.12 The accident site and wreckage information

1.12.1 ACCIDENT SITE

The accident occurred in a tarmacked parking area next to a private residence at Trollnes, about 4 km northeast of Arendal. The distance from the parking area to the sea was approximately 21 metres, see Figure 4. It was surrounded by trees to the right and left and a house with a veranda in front towards the parking area. There were no obstacles along the chosen direction of approach. The minimum distance to the veranda from the edge of the tarmacked area where the helicopter landed was about 10 metres. There was a 4.6-metre clearance between the main rotor and the veranda from where the helicopter touched down. The parking area was about 8.5 metres above sea level.

The high tide at the accident site on that day was at 1202 hours and the accident occurred at 1320 hours.

Figure 3: The edge of the tarmacked area where the helicopter landed. See Figure 2 for the location of the cones. Photo: NSIA

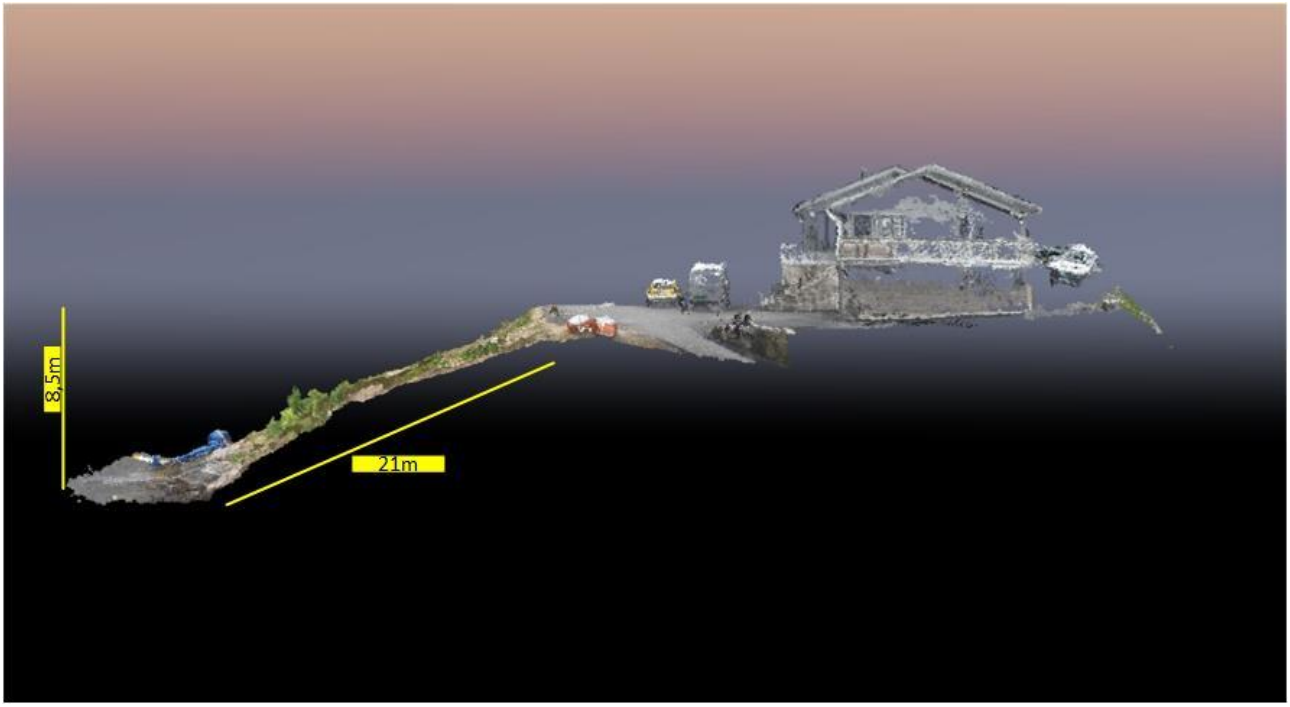

Figure 4: The illustration shows details of the slope where the accident took place. Illustration: NSIA

1.12.2 HELICOPTER WRECKAGE

The helicopter remained in one piece on the rocks with its tail broken. The cabin suffered moderate damage and came to rest with its left side down. The tail boom was partly broken off with part of it lying in the sea with the tail rotor under water. The main rotor was still attached to the helicopter, but the blades were bent with some marks from the impact. The engine and drive train between the engine and the main rotor appeared undamaged. The battery mounted on the left side of the engine compartment came loose, see Figure 5. The right skid on the landing gear was broken off, and the aft cross tube had detached from the fuselage.

The wreckage was taken to the NSIA's premises in Lillestrøm for further examination.

Figure 5: The illustration shows the left side of the cabin that was under water. The battery is the white box in the lower right-hand corner of the photo. Photo: NSIA

1.13 Medical and pathological information

The police carried out an alcohol and drug test on the pilot in command. None of the tests were positive.

1.14 Fire

No fire occurred in connection with the crash.

1.15 Survival aspects

Both the pilot in command and the passenger were strapped into their seats with a four-point seatbelt. Neither wore a helmet nor a life jacket during the flight. Life jackets were not available in the helicopter.

The helicopter had crash-resistant fuel tanks, and no fuel leaked from the tanks during the accident.

Some unsecured items in the cabin were thrown around during the accident. Two full 20-litre plastic fuel cans were located unsecured underneath the rear seats.

1.16 Tests and research

1.16.1 EXAMINATION OF WARNINGSYSTEM LOW ROTOR RPM

The helicopter type has a warning for low rotor speed with both light and sound. The NSIA has tested the system and has not uncovered any malfunction.

1.16.2 ANALYSIS OF ENGINE

The technical examination of the engine showed that it functioned normally until the time of the accident.

Analyses and spectrograms were conducted of the two video recordings containing the helicopter's engine and gearbox frequencies. The examinations have focused in particular on determining whether the engine provided normal power output until the time of the accident. The analyses have also identified when in the sequence of events a warning signal occurred for low rotor rpm.

1.16.3 FUEL SAMPLES

The NSIA took fuel samples from the helicopter's fuel tank. Similar samples were taken by Avinor, on behalf of the NSIA, from Kristiansand Airport Kjevik's fuel base and from their fuel truck. The samples were analysed by the chemicals and materials section of the Norwegian Armed Forces' laboratories (FLO/VEDL/FOLAT) at Kjeller. The analyses showed no signs of contamination or abnormal amounts of water in the fuel.

1.17 Organisational and management information

The helicopter was owned by the company Helikopter LN-OSS AS but was regularly leased to members of Oslo helicopter club. The pilot in command was a member of the club, and he had leased the helicopter for the flight in question at an agreed hourly rate.

The flight in question is defined as a private flight, which means that the pilot in command was required to comply with applicable laws and regulations.

1.17.1 OSLO HELIKOPTERKLUBB

The helicopter is operated by Oslo helicopter club (*Oslo Helikopterklubb*), based in Jessheim. The club had two helicopters at its disposal at the time of the accident, and 11 active members. Members of the club could lease helicopters and use them freely during the agreed lease period subject to the limitations stated in the contract. The contract was of a purely financial nature and contained no operational requirements or limitations.

The Continuing Airworthiness Management Organisation (CAMO) for the helicopter was Avitech AS, located at Kjeller Airport.

The club's helicopters were flown between 200 and 300 hours per year with normal club operations.

1.17.2 THE CIVIL AVIATION AUTHORITY NORWAY (CAA NORWAY)

The NSIA has looked at CAA Norway's proactive aviation safety work aimed at private helicopter activity. CAA Norway has an informative website containing a wealth of useful information aimed at the private pilot segment. Interested parties can also subscribe to safety letters published at

regular intervals. The training card is also an easily accessible means of assessing one's own suitability to fly an aircraft.

CAA Norway has also created an online course aimed at pilots with valid privileges who have not flown for a while and may need to refresh their knowledge before flying again.

1.17.3 THE EASA FRAMEWORK

Reference is made to EU Regulation 965/2012[5] Annex VII, Subpart D Section 2, which emphasises the following:

> *NCO.IDE.H.175 Flight over water*
>
> *Helicopters shall be equipped with a life-jacket for each person on board, or equivalent individual flotation device for each person on board younger than 24 months, that shall be worn or stowed in a position that is readily accessible from the seat or berth of the person for whose use it is provided, when:*
>
> *(1) flying over water beyond autorotational distance from land; or*
>
> *(2) taking off or landing at an aerodrome/operating site where the take-off or approach path is over water.*
>
> *(d) The pilot-in-command of a helicopter shall determine the risks to survival of the occupants of the helicopter in the event of a ditching, when deciding if the life-jackets required in (a) shall be worn by all occupants.*

From the same annex, the following applies under Subpart B:

> *NCO.OP.130 Passenger briefing*
>
> *The pilot-in-command shall ensure that before or, where appropriate, during the flight, passengers are given a briefing on emergency equipment and procedures.*

1.18 Additional information

Many flying clubs in Norway are affiliated to the Norwegian Air Sports Federation (NLF). The NLF has two sections, the motor-powered aircraft section (*motorflyseksjonen*) and the sport aircraft section, formerly referred to as microlight aircraft (*sportsflyseksjonen*). Membership of the motor aircraft section is voluntary, while membership of the sport aircraft section is a prerequisite for being able to fly sport aircraft. Both sections actively conduct flight safety work for members of affiliated clubs.

Based on several accidents relating to the sport aircraft community, this section conducted a risk assessment under the auspices of the operations and training committee (*Operasjons- og Utdanningsutvalget*). The risk assessment revealed a need to strengthen quality assurance in flight training activities. The assessment resulted in several risk mitigation measures to improve the regulations governing the practical training programme for and maintenance of instructor qualifications. This included preparing a completely new edition of the microlight manual *Mikroflyhåndboken*.

No helicopter clubs are members of NLF.

[5] *Applies as Norwegian law pursuant to Section 1 of Regulations No 956 of 7 August 2013 relating to air operations.*

1.19 Useful or effective investigation techniques

No methods warranting special mention have been used in this investigation.

2. Analysis

2. Analysis

2.1 Introduction

Through investigations at the accident site at Trollnes, interviews and video footage of the accident, the NSIA has mapped the sequence of events. The NSIA's technical examinations of the helicopter along with reviewing videos have shown that the engine and drive train functioned as normal until the time the helicopter crashed. The helicopter sustained extensive material damage from rolling down the slope. Furthermore, the main rotor's contact with the ground caused the engine to stop.

The focus of this analysis has been to map the sequence of events, assess the suitability of the landing site, look at the operational conditions and, finally, to review survival aspects.

2.2 Sequence of events

The NSIA's analysis of the sequence of events confirms the pilot's explanation that the approach was normal with an appropriate sink rate and speed. The video clearly shows that the helicopter landed with its centre of gravity too far aft and outside the tarmacked area. When the collective was lowered and the lift from the main rotor was reduced, the helicopter tipped backwards (see 6 and 7). The pilot attempted to remedy the situation by raising the collective, but this failed. The helicopter therefore hit the slope, tumbled downwards and ended up on the rocks on the shoreline.

A spectrogram of the audio recording on the videos shows that the engine and rotor speed were normal right up until the collective was lowered. There is therefore nothing to indicate that engine failure was a contributory cause. The analyses also show that the warning signal for low rotor rpm sounded after the pilot lost control of the helicopter. In addition, the technical examination shows no faults with the light and sound warning system.

Figure 6: Stills from the video footage showing that when the helicopter landed, a large section of the skids was outside the edge of the tarmacked area. Photo: Private video / NSIA

Figure 7: Stills from the video footage showing the helicopter about to tip down onto the slope. The red arrows indicate that the helicopter had an almost flat pitch (minimal lift from the rotor blades). The line shows virtually no coning of the main rotor. Photo: Private video, annotation by NSIA

2.3 Landing site suitability

The NSIA believes that the pilot in command gave himself small safety margins when choosing the landing site, and that the site was marginally suitable for landing with an R44 helicopter, particularly in light of the pilot's limited experience.

The minimum distance from the edge of the tarmacked area to the veranda was about 10 metres, which would mean a distance of about 4 metres from the tip of the rotor to the veranda if the helicopter had landed inside the area. The slope just beyond the tarmacked area also made the landing area particularly challenging.

An assessment of the suitability of landing sites is also discussed in the NSIA's report SL 2019/09, which states that the aviation safety forum for inland helicopters (*Flysikkerhetsforum*) recommends that the landing site at least should be twice the helicopter's largest dimension including the rotor blades. For a Robinson R44, this would mean that the landing site should be a minimum of 23x23 metres.

An assessment of the suitability of landing sites is also discussed in SL 2020/05. The following is quoted from this report:

> *The NSIA has observed that it is not uncommon to use helicopters for recreational purposes, and it may appear that the assessments regarding the choice of suitable landing sites are not always given sufficient weight. Landing sites should always be chosen with such good margins so as to avoid compromising safety should something unforeseen occur. The NSIA encourages relevant parties to use the report as an example for training purposes.*

The NSIA believes that the same factors also apply to the present aviation accident.

2.4 Operational factors

A private helicopter pilot is largely free to operate without being part of a flight operations environment. However, the NSIA believes that participation in such an environment offers several advantages that promote safety. Examples include the sharing of experience, discussions about risk and safety, feedback from others about own safety attitudes and performance, training activities and the establishment of common standards. A high percentage of the private pilot community are affiliated to aviation clubs where members are given an opportunity to participate in an operations environment. There is no such community for private helicopter pilots in Norway. The NSIA is aware that several unsuccessful attempts have been made over the years to establish such an environment (including by the NLF in 2019).

The private helicopter pilot community has one representative on the aviation safety forum for inland helicopters under the auspices of CAA Norway. The NSIA is under the impression that there is no active dialogue or sharing of information by the representative in this forum with the helicopter community.

During the last 10–15 years, the commercial segment of inland helicopter operations in Norway has seen a significant reduction in undesirable incidents. This was confirmed, among other things, in the safety study for inland helicopter operations Sikkerhetsstudie for innlandshelikoptre II (in Norwegian only), published in January 2022. The study concludes that the accident frequency for commercial and passenger flights has decreased by 56%.

The study does not highlight any specific reason for this positive development, but active safety work, exchange of experience and focus on the pilots' attitudes to risk have contributed positively.

In an interview with the pilot of LN-OSS, the NSIA was told that he did not take part in any flight operations environments or any other form of organised exchange of safety information with other pilots. This is not unique and may appear normal in this segment of the helicopter community. Neither common European nor national regulations require a private helicopter pilot to take part in safety work or other forms of exchange or transfer of experience. It is therefore up to the individual pilot and, potentially, a flight operations environment to determine whether it is possible to exchange experience on a par with other segments of aviation.

As stated in section 1.17.2 of this report, CAA Norway is making active efforts to increase the focus on its website on safety-promoting and risk reduction measures for the private pilot community. The NSIA considers this to be positive.

Statistics for private helicopter flights for the period 2012–2023 show that, on average, one aviation accident occurs per year. Several of these have been fatal accidents. CAA Norway has estimated that this segment of aviation as a whole only represents about 4,000 flight hours per year, which gives a relatively high accident rate compared with other segments of aviation.

Safety study for inland helicopter nr. I, which was published in February 2012, assessed the relationship between the pilots' age and experience against incidents and accidents. Chapter 5.2.7 states the following:

> *Based on our data, it may appear that the most recent pilots, i.e. those with 1,000 flying hours or less, are the ones who crash to the greatest extent. And within this group, it is pilots who are 50 years of age or older who have the most accidents associated with them.*

This correlation was not as clear in the latest safety study.

Assessing the experience level of a pilot is not an exact science. There will always be a compilation of the number of flight hours, content of the flight, training, interaction with other pilots,

continuity, reflection on one's own good and bad decisions, etc. Considering the complexity it can be to fly a small helicopter safely in Norway, the NSIA considers that a pilot with 321 hours spread over 8 years and the absence of a formalized operational environment, is a pilot with a low level of experience.

2.5 Survival aspects

The fact that the pilot and passenger were secured with seat belts and that the cabin remained almost intact were crucial to the fact that they only suffered minor injuries. Neither of them was wearing a helmet. The NSIA has on several occasions discussed the use of helmets and the importance of wearing one. Only coincidence prevented head injuries in this accident. The passenger was knocked almost unconscious.

The unsecured objects located in the cabin and the two 20-litre fuel cans located under the rear seats did not cause additional injury to the persons on board or problems during evacuation. Despite this, the NSIA considers it unfortunate that internal cargo is not secured, and this has been highlighted in several accident reports. The report concerning the accident involving an Airbus H125 (LN-OBP) in Verdal in 2022 mentions the significance of unsecured cargo; see SL 2023/09.

The wreckage of LN-OSS remained at the water's edge, mainly on land. The fuel type Avgas 100LL is highly flammable and it is not uncommon for such incidents to cause leaks from the fuel tanks.

The manufacturer (Robinson Helicopter Company SB 78B) introduced a requirement in 2012 for all Robinson R44 helicopters to be equipped with crash-resistant fuel tanks. The requirement also has a retroactive effect on helicopters manufactured before the requirement was introduced. LN-OSS had such crash-resistant fuel tanks.

In the NSIA's opinion, the crash resistance helped prevent fuel leakage and fire hazard after the accident. Had there been a fire, the situation for those on board and their evacuation could have become critical or even fatal. It is not unlikely that the damage that occurred could have led to fuel leakage and a potential fire had the tanks not been equipped with this additional barrier, see Figure 8. In previous investigations, the NSIA has pointed out the danger of the battery becoming detached in accidents and that this can affect the risk of fire. The accident helicopter was equipped with the latest version of attachment, which should be an improved and more secure version.

Figure 8: Damage to the left fuel tank. Photo: NSIA

2.5.1 OPEN-WATER FLIGHTS WITH SINGLE-ENGINE HELICOPTERS

Flying a single-engine helicopter over water entails more elements of risk than flying over land, due to the risk of drowning. More factors therefore need to be assessed.

Figure 9: The helicopter in its final position on the rocks. Photo: The police/NSIA

The approach to Trollnes took place at low altitude over open water. No measures were taken to mitigate the risks associated with this. The passenger was knocked almost unconscious from the crash. The passenger was sitting in the front left-hand seat, i.e., in the part of the helicopter that ended up in the lowest lying position, see Figure 9. If the helicopter had landed further out, the risk that the passenger had been totally underwater would have been greater.

All single-engine helicopters will to a greater or lesser extent be in a critical phase when taking off and landing over water. There will be parts of the flight where neither the altitude nor the speed is sufficient to make a safe emergency landing. To be able to nonetheless carry out take-off and landing over water, a risk assessment must be carried out and safety barriers established that reduces the risk to an acceptable level. Examples of such barriers could be that all on board are wearing life jackets, that the helicopter is equipped with emergency floats, that a lifeboat is at the ready on the water or through the use of survival suits etc. None of these barriers were established for LN-OSS.

In an interview with the NSIA, the pilot in command said that he did not like flying at low altitudes over water and that he always used flight paths that provided safe emergency landing opportunities on land. Prior to this specific flight, the pilot of LN-OSS had not considered the use of life jackets relevant.

Based on video documentation and inspections of the accident site, the NSIA considers the approach route in question to be a flight over water without access to a safe emergency landing site on land. The requirement to have life jackets available to everyone on board is therefore considered relevant for the flight, see section 1.17.3.

The NSIA believes that the pilot's decision to fly without having life jackets available was a misjudgement and not in accordance with the applicable regulations. The NSIA also recommends

that life jackets be worn by those on board during this kind of flight in order to increase their chances of survival.

The NSIA believes that the pilot was aware that the approach would take place partly over water, and that the exercise of good airmanship would have led to both of them wearing a life jacket.

2.5.2 PASSENGER SAFETY BRIEFING

Based on interviews with the pilot and passenger, it is the NSIA's understanding that no safety briefing was given before the flight in question. The regulations, ref. 1.17.3, require the pilot in command to give passengers a safety briefing on emergency equipment and what to do in the event of an emergency. Awareness of what scenarios may occur and what to do should something serious occur may significantly reduce the overall risk.

3. Conclusion

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3.1 Main conclusion

The pilot miscalculated the landing, which caused the helicopter's centre of gravity to fall outside the edge of the tarmacked area at the landing site and the helicopter to tip backwards and fall down a slope.

The NSIA considers that the conditions at and the size of the landing site, in combination with the pilot's limited experience, were decisive factors to the accident occurring.

Risk-reducing safety equipment such as helmets and life jackets were not used.

3.2 Investigation results

A. The pilot held valid privileges to fly the helicopter.

B. The pilot had relatively limited flying experience overall, and was therefore considered inexperienced.

C. The NSIA's investigation has not found any faults or irregularities in the helicopter that may have had an impact on the sequence of events.

D. No security briefing was given before departure.

E. No measures were in place to mitigate the risk of flying at low altitude over water, including the availability of life jackets.

F. The NSIA believes that the landing site was initially marginal and too demanding for the pilot's level of experience.

4. Safety recommendations

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

Norwegian Safety Investigation Authority
Lillestrøm, 4 September 2024