aibn Accident Investigation Board Norway

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REPORT SL 2019/10

REPORT ON AIR ACCIDENT AT SVOLVÆR AIRPORT HELLE, NORWAY ON 11 FEBRUARY 2018 INVOLVING PIPER PA-28-161, LN-TOS

The Accident Investigation Board has compiled this report for the sole purpose of improving flight safety. The object of any investigation is to identify faults or discrepancies which may endanger flight safety, whether or not these are causal factors in the accident, and to make safety recommendations. It is not the Board'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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This report has been translated into English and published by the AIBN to facilitate access by international readers.
As accurate as the translation might be, the original Norwegian text takes precedence as the report of reference.

Photos: AIBN and Trond Isaksen/OSL

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AIR ACCIDENT REPORT

Aircraft:	Piper PA-28-161
Nationality and registration:	Norwegian, LN-TOS
Owner:	Tromsø Flyklubb, Tromsø
Operator:	Same as owner
Crew/commander:	1
Passengers:	1
Accident site:	In the ocean 360 metres north-east of the end of the runway at Svolvær Airport Helle, Norway (ENSH) (68° 14.884 N 014° 40.743 E)
Accident time:	Sunday, 11 February 2018 at 2033 hours

All times given in this report are local time (UTC + 1 hour) unless otherwise stated.

ACCIDENT NOTIFICATION

At 2043 hours, the on-call accident inspector at the Accident Investigation Board Norway (AIBN) was notified by the Police operations centre in Nordland County that a light aircraft had crashed into the ocean at Svolvær Airport Helle. Two accident inspectors were mobilised and arrived at the airport the next day.

In accordance with ICAO Annex 13, Aircraft Accident and Incident Investigation, the US National Transportation Safety Board (NTSB) was notified as a representative of the state of manufacture. They appointed an accredited representative to assist in the investigation, as needed.

SUMMARY

Earlier that day, two relatives had flown from Tromsø Airport Langnes to Svolvær Airport Helle via stopovers at Leknes and Røst. It was dark when they departed from Svolvær on a VFR-night flight towards Tromsø. A video recording shows the aircraft starting to turn to the right just after take-off to the north on runway 01. Over the next few seconds, the turn became increasingly tight, while the aircraft kept losing altitude. The changes in the aircraft's direction of movement were steady and there is nothing to indicate that it was exposed to turbulence, a sudden change in wind direction or that the aircraft stalled before it struck the sea.

The AIBN believes that multiple factors contributed to this accident. It was unusually dark on the evening in question and there were only few lights north of the airport to serve as visual references. The two pilots also exercised poor light discipline by using headlamps in the cockpit until the aircraft started taxiing out toward the runway. The ability to transition to night vision varies considerably, but generally declines with age. It is also known that older people cannot achieve as good light sensitivity as younger people. The commander was 79 years old, and the passenger, who was also a pilot, was 63 years old. It is therefore likely that the two people on board lost visual references after take-off, thus losing control of the aircraft.

The right to fly VFR at night[1] does not expire and thus does not need to be renewed. This raises the issue of an assessment as to whether older people with night VFR rights should be subject to a regular form of evaluation and expanded vision test to retain this right.

The AIBN has not found any technical faults in the aircraft that could explain the accident.

1. FACTUAL INFORMATION

1.1 History of the flight

1.1.1 The two deceased were uncle/nephew and private pilots. They were 79 and 63 years old, respectively, and had flown together multiple times before. On Friday, 9 February, they started planning a "Tour de Lofoten" flight the upcoming Sunday. Good weather had been forecast and they checked the opening hours of relevant airports. The youngest of the two had a cousin living in Svolvær and an agreement was made for the two of them to visit in the afternoon.

1.1.2 LN-TOS had been flown earlier on Saturday and was parked in the Tromsø Flying Club hangar at Tromsø Airport Langnes (ENTC). The youngest pilot arrived at the hangar in the evening to prepare for the flight the next day. The airport lacked a fuel facility for Avgas 100LL and the flying club thus had to purchase fuel from Flybunkringsservice AS at Torp. A new sealed drum was opened and approx. 90 litres were filled in the aircraft, so the two tanks together contained 180 litres. It was difficult to obtain Avgas 100LL to top off during the planned flight. Three 20-litre cans had therefore been borrowed from Tromsø Ultralight Aircraft Club, and were filled with fuel from the same drum and brought along in the aircraft's luggage compartment.

1.1.3 People who talked to the two pilots during the preparations on the Sunday before take-off did not notice anything out of the ordinary. The youngest of the two pilots signed for completed inspection of the aircraft at 1200 hours.

1.1.4 According to the aircraft's log book, LN-TOS took off from Tromsø Airport Langnes at 1220 hours. The youngest of the two signed as commander. The first stopover occurred at Leknes (ENLK) at 1405 hours. They stayed at Leknes for just over one hour before taking off toward Røst Airport (ENRS) at 1520 hours. The oldest of the two was listed as commander for the flight to Røst.

1.1.5 The landing at Røst occurred at 1600 hours. At Røst, they drank coffee and ate cakes before continuing toward Svolvær Airport Helle (ENSH) at 1700 hours. The youngest of the two was listed as commander for the flight to Svolvær. The youngest took a few photos along the route, which were posted on Facebook. The photos generally showed excellent weather; sunny and blue skies. However, one photo taken before arriving at Røst showed that there were some clouds in the area.

1.1.6 LN-TOS landed on runway 19 at Helle at 1745 hours. The youngest of the two was then operating the radio. The AFIS officer asked if they would be staying for long and they responded that they would be staying until at least eight o'clock, maybe longer. They parked the aircraft at the GA platform to the north and were let out of the airport through

[1] Flights that take place according to the rules for visual flight at night (VFR – Visual Flight Rules). Night is defined as when the sun is more than 6° below the horizon.

a gate operated by airport security. Outside the gate, they were picked up by the cousin and drove together to Svolvær.

1.1.7 The cousin has provided the AIBN with a description of the time spent with the two pilots. During the visit with the cousin, they e.g. discussed the flight. They both described a wonderful flight and expressed no concerns as regards the return to Tromsø, which would take place in the dark. The youngest of the two pilots submitted a flight plan for the return to Tromsø. Take-off from Helle was scheduled at 2030 hours, with a landing of Tromsø at 2155 hours. The oldest pilot was listed as commander. For this reason, the oldest pilot will hereinafter be referred to as the commander and the youngest pilot the passenger.

1.1.8 The cousin drove the two back to Helle at approx. 1950 hours, at which point they were admitted to the airport by airport security and approached the aircraft. It was completely dark when they arrived, but the GA platform was lit up.

1.1.9 A video camera belonging to the airport showed the flight preparations. The pilots e.g. topped off fuel from two red 20-litre plastic cans and recorded in the aircraft log book that the tanks held a total of 160 litres of fuel before take-off. The volume of motor oil was correspondingly listed as 6.5. The commander signed for completed pre-flight inspection at 2015 hours. A small satchel with a fastening strap that was hung around the propeller for a period of time was moving a bit in the wind, indicating that there was a weak stable easterly or north-easterly wind.

1.1.10 The video recordings showed the passenger sitting in the left seat and the commander sitting in the right seat[2]. A while after the engine was started, the aircraft was taxied at 2020 hours so that it was standing with its nose pointing to the south, nearly straight toward the video camera at the airport. The aircraft then remained in this position for seven minutes.

1.1.11 Both on board used headlamps. The passenger used the headlamp periodically until the aircraft started taxiing out toward the runway. The commander did not use the headlamp once the aircraft started taxiing. During the seven minutes the aircraft had its nose pointing toward the south, the commander took a lightly coloured document down from the glare shield. He then pulled the yoke toward himself, causing the elevator to lift up, and kept it there for a period of three minutes. Then the document was returned to the glare shield.

1.1.12 Playback of the communication between LN-TOS and AFIS shows that LN-TOS called up Helle Information at 2026 hours. All subsequent radio communication took place between the AFIS officer in the tower at Helle and the commander. LN-TOS stated that they were ready for take-off to Tromsø, night VFR according to the flight plan. The AFIS officer informed them that the runway in use was 01. When asked by the AFIS officer about the altitude at which they would fly, the commander responded 5,500 ft.

1.1.13 At the same time, at 2026 hours, the passenger published an update on Facebook, stating that they were ready for take-off from Svolvær to Tromsø.

1.1.14 LN-TOS entered the runway at 2028 hours. The AFIS officer has explained to the AIBN that it was highly unusual for anyone to fly night VFR. He therefore contacted Norway

[2] A commander should normally be sitting in the left seat.

control at Bodø, to clarify whether clearance was needed. Norway control cleared LN-TOS to fly at 5,500 ft, as desired, and this was communicated to LN-TOS at 2029 hours.

1.1.15 It was unusually dark outside and the AFIS officer was concerned for how the pilot was intending to undertake the departure toward the mountains to the north. At 2030 hours, while the aircraft was taxiing toward the south on the runway before take-off, he asked about this and received confirmation that the plan was to bank to the right after take-off. At 20:31:40, the commander stated that they were starting the take-off, to which the AFIS officer responded *Runway free* and listed the time of departure as 2032 hours.

1.1.16 A total of two video cameras at the airport covered LN-TOS' movements. They show that the aircraft took off approx. halfway down the runway. The landing lights were on at this time. At first, the camera that filmed the take-off and departure only captured the "strobe lights" from the aircraft (see Item 1.6.4.1). It climbed in a seemingly normal way to an altitude of just under 500 ft before starting a climbing turn to the right. During the turn, for a brief period of four seconds, no lights are seen before the strobe lights and then a bit later the recognition lights appear again. At this time, the aircraft was maintaining an easterly course and reduced its climb. During the nine seconds that passed once the lights were again visible, the banking increased to 60 – 70° and the altitude declined rapidly. The aircraft had completed a right turn of approx. 270° to the right when it impacted the ocean 55 seconds after taking off from the runway. Shortly before LN-TOS hit the ocean with a descent angle of approx. 45°, the reflection from the aircraft's lights could be seen in the ocean (see Figure 3). The entire visible part of the flight took place with smooth movements. The landing light was switched off during the last part of the flight.

1.1.17 The AFIS officer saw the aircraft disappear in the ocean and immediately sounded the alarm. The first car from the airport thus mobilised as little as 41 seconds after the aircraft hit the ocean. The airport's boat was launched and the two were found a brief time later deceased, floating in the sea.

1.1.18 One witness who lived north of the airport has explained to the AIBN that he saw the lights from the aircraft. He was sitting inside and saw the aircraft make a sharp turn to the right. Then he saw the lights go straight down into the ocean while simultaneously hearing an engine rev up. He therefore opened the veranda door and heard a bang echo in the mountains. Convinced that he had witnessed an accident, he walked over to a small hill closer to the airport. From there, he saw a boat with a searchlight in the area where the aircraft disappeared. It was so dark outside that it was difficult to walk and orient oneself in the terrain.

1.2 Injuries to persons

Table 1: Injuries to persons

Injuries	Crew	Passengers	Others
Deceased	1	1	
Severe			
Minor/none			

1.3 Damage to aircraft

The aircraft was a total loss. See Chapter 1.12 for a more detailed description.

1.4 Other damage

None

1.5 Personnel information

1.5.1 The commander

1.5.1.1 The commander, age 79, was an active pilot in both Tromsø Flying Club and Tromsø Ultralight Aircraft Club. He started flying ultralights in 1991 and progressed to completing a private pilot licence (PPL(A)) via Tromsø Flying Club in 1995. In 1996, he attained the privilege to fly night VFR, which never expires. The privilege to fly single-engine piston (SEP) aircraft was most recently renewed on 4 April 2016, and was valid until 30 April 2018.

1.5.1.2 According to the commander's flight time log, during the period from September 2012 until the accident, he had logged 14 hours and 50 minutes at night, distributed across 10 flights. The last flight logged in the night/dark[3] column was flown on 26 September 2017, then also with LN-TOS. The commander had not logged any night flights in a simulator. Multiple flights with LN-TOS had taken place with the nephew. They would normally rotate flying as the commander, e.g. to distribute expenses for aircraft rental.

1.5.1.3 The commander had logged a total of 8 hours and 15 minutes of instrument time.

1.5.1.4 The commander held an air sports licence/pilot licence issued by Norges Luftsportforbund, which was valid until 27 March 2019. This licence applied for three-axis ultralights with instructor privileges IR and examiner privileges IK1. The commander had a total of 840 flight hours in ultralights, 470 hours of which as an instructor. This instruction took place in the ultralight club's two aircraft, Aeroprakt A-22L and Flight Design CTSW. Both aircraft are side-by-side, meaning that the instructor sits on the right side of the cockpit during instruction. The flying clubs stated that the commander had flown as commander from the right side of the cockpit even in situations where instruction was not carried out.

1.5.1.5 The commander was considered a reliable and safety-focused pilot. He was thorough when planning flights and was deemed to maintain a high safety standard as an instructor.

1.5.1.6 Since vision is of material importance for flying in the dark, the AIBN had acquired information from the commander's aeromedical examiner and general practitioner. According to this information, the commander underwent operations for cataracts in January 2011 and March 2012. He then underwent laser treatment for visual axis opacification in both eyes in 2012 and supplemental treatment in the right eye in March 2013. Bilateral corneal dystrophy[4] (map-dot-fingerprint dystrophy) was proven as of 2015, corrected visual acuity is normal with this. The formal vision requirements were satisfied with the use of glasses (see also Item 1.13.4).

[3] In aviation, darkness is defined as the time between sunset and sunrise when, due to reduced daylight, a prominent non-illuminated object cannot be clearly seen from a distance of more than 8 km.

[4] Link to information about corneal dystrophy: https://emedicine.medscape.com/article/1193945-overview

1.5.1.7 The commander held a class 2 medical certificate valid until 27 March 2018. The certificate had a VML restriction "*correction for defective distant, intermediate and near vision*".

Table 2: Commander's flight hours (PPL(A))

Flight hours	All types	Relevant type
Last 24 hours	0:40	0:40
Last 3 days	0:40	0:40
Last 30 days	0:40	0:40
Last 90 days	0:40	0:40
Total	1,404	Unknown

1.5.2 The passenger

1.5.2.1 The passenger, age 63, was issued a private pilot licence (PPL(A)) in 2003 and had privileges to fly multi-engine piston (MEP) aircraft for the 2006 – 2012 period. He was active in multiple flying clubs and became a member of Tromsø Flying Club in the summer of 2015. In 2006, he attained the privilege to fly night VFR which never expires. The privilege to fly single-engine piston (SEP) aircraft was most recently renewed on 21 April 2017, and was valid until 30 April 2018.

1.5.2.2 The passenger had previously flown LN-TOS as commander at night, most recently on 4 February 2018 during a round trip from Tromsø Airport Langnes via Hasvik Airport (ENHK) and Sørkjosen Airport (ENSR). This flight was logged with a total of 2 hours and 50 minutes and nine landings. The passenger had not logged any night flights in a simulator. Multiple previous flights with LN-TOS had taken place along with the uncle.

1.5.2.3 Since vision is of material importance for flying in the dark, the AIBN had acquired information from the passenger's aeromedical examiner and general practitioner. From this information, it is evident that the passenger had satisfactory visual acuity at a distance without glasses. Due to diabetes, the passenger was examined by an ophthalmologist on 5 July 2017. No vision problems were found at this time. The formal vision requirements were satisfied with the use of glasses (see also Item 1.13.4).

1.5.2.4 The passenger had a class 2 medical certificate which was valid until 11 July 2018. This certificate had a VNL restriction "*correction for defective near vision*".

Table 3: Passenger's flight hours

Flight hours	All types	Relevant type
Last 24 hours	2:35	2:35
Last 3 days	2:35	2:35
Last 30 days	3:20	3:20
Last 90 days	5:35	5:35
Total	561	Unknown

1.6 Aircraft information

1.6.1 Introduction

This aircraft is a single-engine low-wing aircraft that seats four people. The wings, fuselage and all control surfaces are constructed in aluminium. The aircraft is equipped with flight controls on both sides.

1.6.2 Aircraft data

Manufacturer:	Piper Aircraft, Inc.
Type/model:	PA-28-161
Serial number:	2842248
Year of manufacture:	2005
Total flight time:	3,991:40 hours
Engine type:	Teledyne Continental O-320-D3G
Propellers:	Sensenich 74DM6-0-60
Maximum take-off mass:	1,107 kg
Fuel type:	AVGAS 100LL

1.6.3 LN-TOS

1.6.3.1 LN-TOS was purchased new by Tromsø Flying Club and was first registered in Norway's aircraft registry on 2 September 2005.

1.6.3.2 LN-TOS was equipped to fly night VFR. It was equipped with a standardised set-up with flight instruments on the left side, but only an altimeter on the right side. The centre of the instrument panel included e.g. a combined communication and navigational system of the type Garmin 430 (see Figure 1).

1.6.3.3 LN-TOS was involved in an air accident on 7 April 2010, when it flew into a cableway and had parts of its right wing and tail sheared off. The aircraft was then repaired and issued a new airworthiness certificate in 2011. This accident is described in the AIBN report SL RAP 2013/14.

1.6.4 Lights

1.6.4.1 Externally, LN-TOS was equipped with navigation lights, anti-collision lights on the wing tips (strobe lights), landing lights and front-facing lights on the outer wing tips (recognition lights). These lights could be operated by four white switches mounted in the central part of the instrument panel. The row of switches in the middle of the instrument panel was in the following order (from the left):

BATT MASTR - ALTR - FUEL PUMP - NAV LIGHT - STROB LIGHT - LDG LIGHT - RECOG LIGHT - PITOT HEAT

1.6.4.2 In the interior, the aircraft had instrument lights and lights in the cabin. The instrument lights were white and could be adjusted stepless continuously and individually in three different areas:

SWITCH - PANEL - AVIONICS

The switches were mounted below the yoke on the left side of the instrument panel. The cabin light was on the ceiling between the pilots. The brightness of the white light could be adjusted stepless.

1.6.4.3 The landing lights were in the middle of the air intake just under the propeller. The proximity to the propeller could result in a slight reflection on the propeller and it was common practice to switch off the landing light after take-off.

Figure 1: Instrument panel in LN-TOS. Six of the eight white switches in a row are visible in the centre of the image. Photo: Tromsø Flying Club

1.6.5 Maintenance

1.6.5.1 The plane's *Aircraft Journey Log Book* was found floating in the ocean. It had been filled in up to the columns relevant for preparations before take-off from Svolvær. The log stated that a cowling had been slightly damaged after opening during take-off on 2 January 2018. The aircraft maintenance technician assessed the damage to be insignificant for further flight and this note was included in the section for *Remaining notes.* No other *Remaining notes* were listed in the plane's *Aircraft Journey Log Book.*

1.6.5.2 According to the aircraft's *Technical aircraft logs,* the aircraft underwent a combined 100 hours inspection and an annual inspection on 29 January 2018. At this time, the aircraft had a total flight time of 3,979:50 hours and the engine flight time 1,628:20 hours since the overhaul (11:50 hours before the accident).

1.6.5.3 According to the technical documentation, the artificial horizon (Attitude Gyro) was replaced on 9 August 2017. Part number 23-501-06-9, serial number T29853J was installed.

1.6.5.4 When asked by the AIBN, members of Tromsø Flying Club stated that there were no known technical issues with the aircraft.

1.6.6 Mass and balance

The aircraft's mass and balance has subsequently been calculated based on the following:

- Report from the last weighing of LN-TOS on 21 January 2011
- The weight of the two on board is based on the autopsy reports + 5 kg for each
- Emergency equipment and personal belongings totalling 10 kg positioned with an arm equivalent to the aircraft's back seat.
- 160 litres of fuel in the tanks
- A full 20-litre fuel can was placed in the luggage compartment

	Mass (kg)	Arm (in)	Momentum (kg x in)
Aircraft's mass	705.4	86.5	61,031.2
Fuel[5]	114.0	95.0	10,792.0
Commander and passenger	230.0	80.5	18,515.0
Presumed luggage in back seats	15.0	118.1	1,771.0
Fuel can placed in luggage compartment	7.1	142.8	1,428.0
Total	1,071.5	87.3	93,537.2

The maximum allowed take-off mass is 1,107 kg (2,440 lb).

The centre of gravity (arm) must be between 87 – 93 in.

1.7 Meteorological information

1.7.1 The weather in the Tromsø – Lofoten area was generally good, with south-easterly winds, good visibility and few clouds.

1.7.2 Routine weather observations (METAR) or terminal aerodrome forecasts (TAF) for Leknes, Røst and Svolvær were not available on the morning of 11 February.

1.7.3 The following METAR for Tromsø was published at 0950 hours:

[5] This includes fuel filled from two 20-litres plastic cans at Svolvær.

METAR 110850Z 19009KT CAVOK M01/M07 Q1003 NOSIG RMK WIND 2600FT 18021KT

1.7.4 The following TAF for Tromsø was in effect as of 0600 hours:

TAF 110500Z 1106/1206 20009KT 9999 FEW0400

1.7.5 Before take-off from Svolvær, the following TAF was in effect as of 1800 hours:

ENSH 111700Z 1118/1121 13009KT CAVOK=

1.7.6 The following METAR were published during the period before and after take-off from Svolvær:

ENSH 111750Z 11006KT CAVOK 01/M07 Q1002 RMK WIND 150FT 07009KT

ENSH 111850Z 06010KT CAVOK 01/M06 Q1002 RMK WIND 150FT 07011KT

1.7.7 The AFIS officer provided LN-TOS with the following information just before take-off:

Wind 060 degrees 10 kt, temperature 1, QNH: 1002

1.7.8 Sunset in Svolvær occurred at 1550 hours. Multiple witnesses have described the light and weather conditions at Svolvær Airport Helle during the period around the accident. They emphasised that this night was unusually dark, without a visible moon or aurora borealis. They also expressed that it was difficult to distinguish the dark mountains from the dark sky.

1.7.9 According to the Time and Date website, the moon at Svolvær was in its last quarter on 7 February. The new moon was 15 February. On 11 February, the moon set at 1029 hours and was not above the horizon at the time of the accident.

1.8 Aids to navigation

Svolvær Airport was equipped with a localizer (LOC), distance measuring equipment (DME), two non-directional beacons (NDB) and a VHF direction finder.

1.9 Communications

A review of recorded communication shows that the communication between LN-TOS and the AFIS unit was on frequency 120.200 MHz and of good quality.

1.10 Aerodrome information

1.10.1.1 Svolvær Airport Helle (ENSH) is located at the outer edge of Austnesfjorden in Lofoten (position 68°14'36"N 014°40'09"E). The site is surrounded by mountainous terrain in the west-north-east sector. The airport is located 29 ft above sea level (MSL). The runway direction is 01/19. The airport has instrument approach for landing towards the north (RWY 01). The take-off run available (TORA) for RWY 01 take-off is 876 m.

Figure 2: Photo taken from tower at the airport. The arrow points to the location where the wreckage was found. Photo: AIBN

1.11 Flight recorders

Not mandatory and not installed.

1.12 Wreckage and impact information

1.12.1 Crash site

LN-TOS crashed in the sea and came to rest at a depth of 77 metres approx. 360 metres north-east of the end of the runway at Helle, position 68° 14.884 N 014° 40.743 E. The seabed was sloping, rocky and partially covered by fine sand.

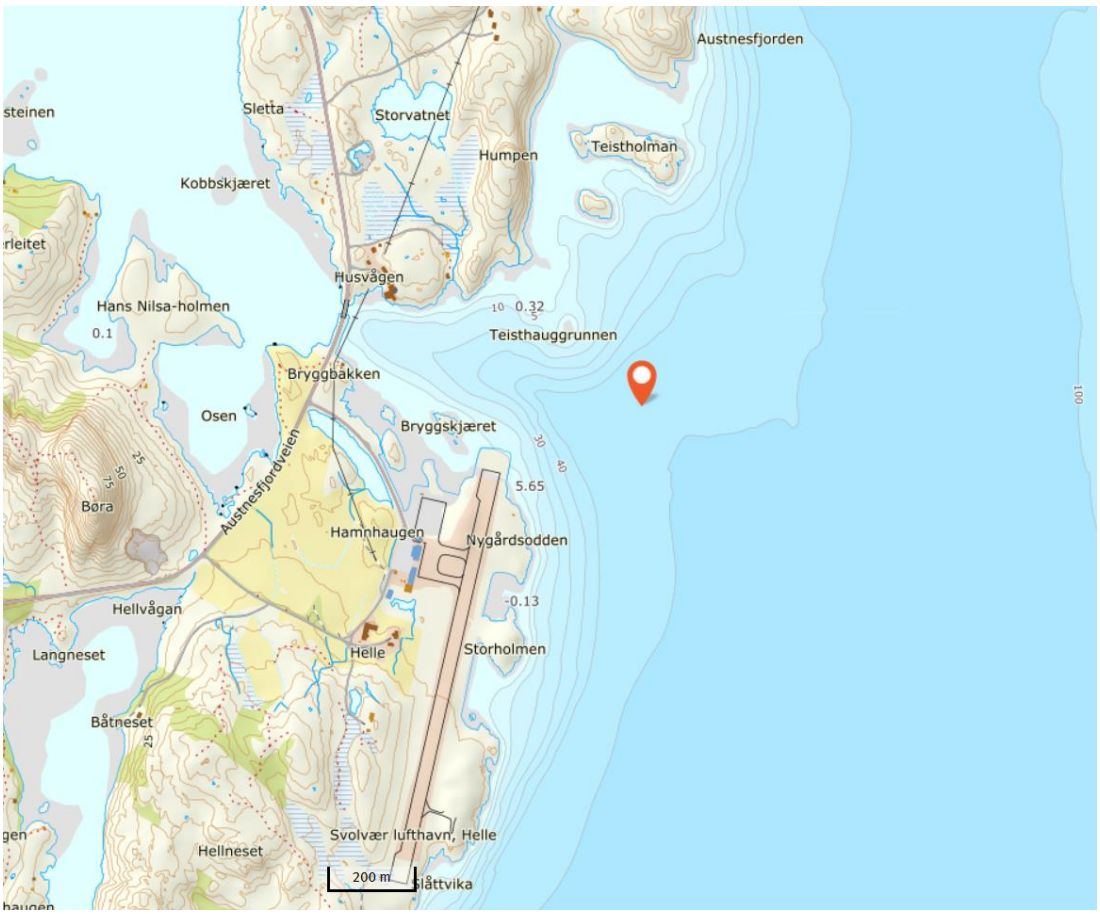

Figure 3: Map of the airport and crash site. Map: © Norwegian Mapping Authority

1.12.2 Wreckage

1.12.2.1 *General information*

Immediately after the accident occurred, a number of items were found floating in the ocean. Some items were also later found along the shoreline. This included the private belongings of the two pilots, the plane's *Aircraft Journey Log Book*, floor mats, pieces of insulation, a petrol funnel, one litre of motor oil, various emergency equipment, the content of the aircraft's first aid kit, the cabin's fire extinguisher and the propeller spinner (see Figure 5).

The wreckage was located and raised one week after the accident occurred. A number of small wreckage parts were found on the seabed across an area of approx. 40 x 40 metres. The major wreckage, and the right wing that was torn off, were located approx. 20 metres apart. The majority of the aircraft was raised along with the main wreckage and right wing. The propeller was missing, and after a fruitless search in an area of approx. 70 x 100 metres, the search was ended.

Figure 4: Main wreckage after being raised from the ocean. Photo: AIBN

Figure 5: Spinner, complete with attachment bolts and backplate. Photo: AIBN

1.12.2.2 *Fuselage*

The fuselage had sustained substantial damage from the front and all the way back to the seat back in the back seat. Behind the luggage compartment, the fuselage was bent sharply to the right. At the transition to the tail fin, the tail was bent to the left correspondingly.

The engine and nosewheel had been knocked loose and were only connected to the fuselage by hoses, cables and wires. The firewall between the engine and cabin was connected to the instrument panel and parts of the flight controls. Engine cowlings, windows, the door and most of the cabin structure were missing.

All the damage revealed in investigations of the flight controls and tailplanes were consistent with damage occurring in a powerful impact with the ocean. The damage pattern on the control yokes provided no indication as to who had been controlling the aircraft. The flaps handle was found in the centre position, i.e. the take-off position. The fuel selector was found in the position for the left tank.

A red undamaged 20-litre plastic can containing about 10 litres aviation fuel was found in the back of the aircraft's tail.

1.12.2.3 *Instrument panel*

The instrument panel was found to be relatively complete (see Figure 6). The following is noted:

- The artificial horizon was still in the instrument panel and was relatively undamaged. It indicated that the aircraft's right wing was pointing 45° down (roll to right) and that the aircraft's nose was pointing approx. 5° up. Faults and damage found during disassembly of the instrument are all compatible with damage that may have occurred in a powerful impact with the ocean and subsequent damage following the incursion of saltwater. Saltwater damage to bearings made it impossible to test the instrument.

- The airspeed gauge showed 0.

- The altimeter was found set to 1001 hPa (29.55 inHg).

- The vertical speed indicator showed the maximum negative reading, i.e. -20,000 ft/min.

- The turn and bank indicator indicated that the wings were horizontal.

- The engine's RPM indicator was broken and had come loose from the instrument panel. An examination of the instrument face with a view of finding impact marks from the indicator needle, was fruitless.

- The magnetic switch was found in the OFF position without the key. Using the aircraft's spare key, it has been possible to verify that, from a mechanical perspective, the switch functioned normally. Due to saltwater damage, it was not possible to verify the electric function of the switch as it had been before being damaged by saltwater.

- The three switches for instrument lighting exhibited varying levels of damage. The switch for SWITCH was partially broken. The switch for PANEL was found with panel lighting turned up approx. 1/3. The switch for AVIONICS was knocked completely out of the panel and missing.

- The switches for exterior lights were knocked loose from the instrument panel and were partially destroyed. These switch positions were deemed not to provide reliable information.

- The handles for throttle and mixture had been pushed out of position and were deemed not to provide reliable information.

Figure 6: The instrument panel and flight controls after being raised from the seabed and placed on the recovery barge deck. Photo: AIBN

1.12.2.4 *Engine*

The engine including accessories was relatively unharmed. The following is noted:

- The engine rotated freely without internal mechanical damage.
- All valves moved normally when the crankshaft was rotated.
- The spark plugs were found to be in good condition. Soot and some contamination were found on a few plugs. In our experience, such observations are made in engines that are flash-cooled and filled with saltwater.
- The operation of magnetos, the fuel pump and vacuum pump functioned as normal when the crankshaft was rotated.
- The left ignition magneto rotated along with the crankshaft. The right magneto had been knocked loose, but could be rotated by hand.
- The carburettor had been crushed and parts of it were missing.
- The fuel pump was disassembled and correct function was verified.
- The vacuum pump was disassembled and correct function was verified (see Figure 7).
- The propeller flange was bent into an S shape. Two of the bushings (nuts) for the propeller's bolts were missing. Three bushings had been partially pushed in and one

bushing was in the right position. Parts of the propeller bolts were found in the four remaining bushings (see Figure 8).

Figure 7: The vacuum pump after being opened up. Photo: AIBN

Figure 8: The propeller flange on the engine. Photo: AIBN

1.12.2.5 *Wings*

The left wing was attached to the main wreckage. It had sustained a relatively small amount of damage, with the exception of the outermost about two metres, which had sustained considerable damage and were bent down. This also included the entire aileron, which was bent and torn off from the outer rudder hinge. The flaps was relatively intact and was found in the upper position. The fuel tank was virtually unharmed. Faults revealed in investigations of the aileron function were compatible with damage that occurred in a powerful impact with the ocean.

The right wing had been torn off from the main wreckage. The middle of the wing was bent sharply backward. The outer part of the wing had been pushed in and bent back into an angle of approx. 45°. The right undercarriage leg had been torn off, so the wheel was only attached by the brake line. The aileron was damaged, but was still attached to the wing at the rudder hinges. The flaps was bent, but was still attached to the wing by the hinges. It was most likely in the upper position. The fuel tank had been ruptured. Faults revealed in investigations of the aileron function were compatible with damage that occurred in a powerful impact with the ocean.

1.12.2.6 *Tailplanes*

The left tailplane was relatively intact. The right tailplane had sustained considerable damage, and had been bent backward and up. The elevator trim was still attached to the tailplane, but had sustained equivalent damage on the right side.

1.13 Medical and pathological information

1.13.1 The two decedents were autopsied at the University Hospital of Northern Norway. Both had sustained extensive injuries and it was concluded that they died instantly from the injuries that occurred in the impact with the ocean. The autopsy has not contributed in determining who was controlling the aircraft when it impacted the ocean.

1.13.2 The two decedents showed no signs of consumption of alcohol, narcotic substances or medication.

1.13.3 A study undertaken by Jackson et al (1999), *Aging and dark adoption*, shows that the ability to adapt to night vision varies considerably, but generally declines with age. The result of tests with 94 people aged 20 – 80 can be found in Figure 9. The figure shows that, on average, an 80-year-old person takes 16.69 minutes to achieve "Rod-cone break"[6]. The corresponding figure for a 20-year-old is 13.56 minutes. The figure also shows that older people never achieve the same sensitivity to light as younger people (third component).

[6] The transition where the rods' (without colour vision) ability to perceive light exceeds the cones' (with colour vision) ability to perceive light (photosensitivity).

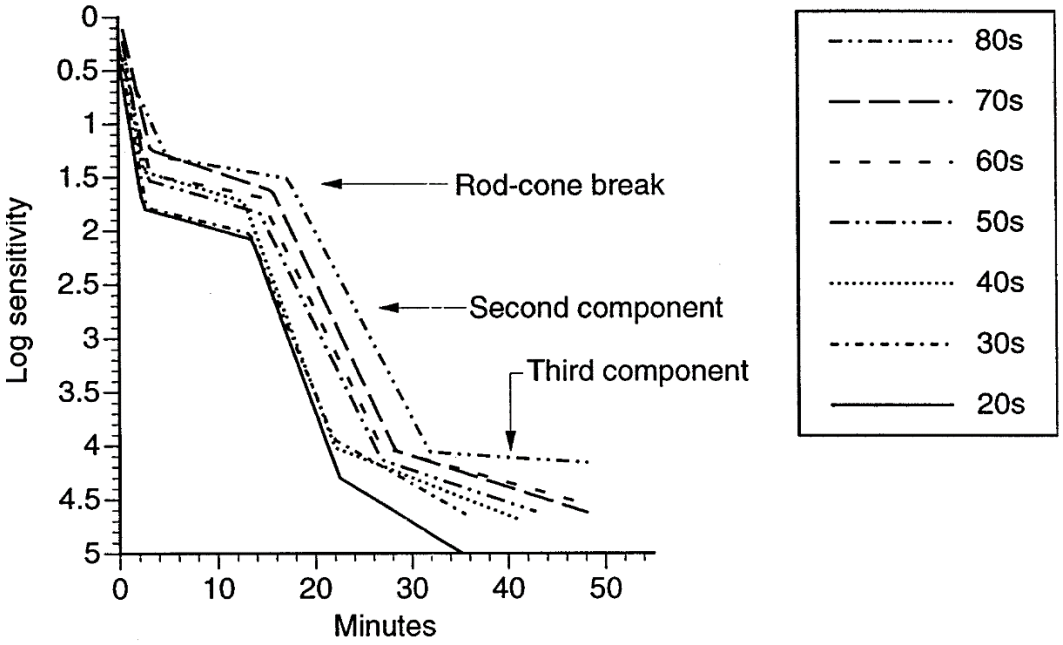

Figure 9: The ability to transition to night vision as a function of age. Please note that the scale for photosensitivity is logarithmic. Source: Vision Research 39 (1999) 3975-3982

1.13.4 Night vision can be measured using the Goldmann-Weekers dark adaptometer. However, this test is time-consuming to carry out and the equipment is only available at a few hospitals. There is therefore currently no practically feasible method for assessing a person's night vision.

1.13.5 The two people on board were required to use glasses when they flew. Multiple photos taken during previous flights show that they normally used glasses on board. Glasses were not found on the deceased during the autopsy. At the crash site, only one pair of glasses were found in a case.

1.14 Fire

No fire occurred.

1.15 Survival aspects

1.15.1 The fuselage had sustained substantial damage from the front and all the way back to the seat back in the back seat. The seat belts in the front seats had been partially ripped from the fuselage.

1.15.2 No signals were received from the Emergency Locator Transmitter (ELT) in connection with the accident. The ELT cannot transmit emergency signals under water.

1.15.3 The AFIS officer in the tower at Helle witnessed the accident and immediately sounded the alarm. Personnel from the fire and rescue service mobilised immediately. The first vehicle left the garage as little as 41 seconds after the aircraft hit the ocean. It immediately became clear that it was necessary to use the airport's boat. A 6.6-metre long RIB of the brand Polarcirkel was launched few minutes later and set course for the presumed crash site. The two descended were located quickly using the searchlights on the boat reflecting on high-visibility strips on the life jackets. The life jackets need to be activated manually and neither of the life jackets were inflated.

1.15.4 A number of resources arrived at the site quickly, including the rescue vessel Sundt Flyer from Svolvær and the Armed Forces' search and rescue helicopter.

1.16 Tests and research

None

1.17 Organisational and management information

1.1.1 The flight in question is defined as a private flight, which means that the commander is personally responsible for complying with relevant statutes and regulations. The flight also took place under the auspices of Tromsø Flying Club which is associated with the powered aircraft section of Norges Luftsportforbund (NLF). This means that, in order to lease the club's aircraft, the commander had to comply with the club's internal provisions. This e.g. applies for the club's own check-out program for the aircraft type.

1.18 Other information

1.18.1 Requirements for flying night VFR

1.18.1.1 Flying according to the rules for visual flying at night (night VFR) is allowed pursuant to the *Standardised European Rules of the Air*, SERA.5005(c). These rules set equivalent general requirements for ceiling, visibility and distance to clouds that apply for VFR flights in daylight[7]. The only additional requirement is that the ceiling must be at least 1,500 ft.

1.18.1.2 The privilege to fly night VFR is issued by the Civil Aviation Authority. This privilege does not expire and thus need not be renewed. Item 1.18.1.7 below lays out the requirements set for bringing along passengers.

1.18.1.3 In order to operate at night, the aircraft must be equipped according to the joint European rules for *Non-Commercial Air Operations with Other-Than-Complex Motor-Powered Aircraft* PART-NCO. As regards lighting equipment, NCO.IDE.A.115[8] *Operating light* applies:

> *Aeroplanes operated at night shall be equipped with:*
>
> *(a) an anti-collision light system;*
>
> *(b) navigation/position lights;*
>
> *(c) a landing light;*
>
> *(d) lighting supplied from the aeroplane's electrical system to provide adequate illumination for all instruments and equipment essential to the safe operation of the aeroplane;*
>
> *(e) lighting supplied from the aeroplane's electrical system to provide illumination in all passenger compartments;*
>
> *(f) an independent portable light for each crew member station; and*

[7] Minimum requirement stipulated in Section 2-37 of Regulation relating to air traffic rules (BSL F 1-1)
[8] Instruments, data and equipment – IDE

(g) lights to conform with the International Regulations for Preventing Collisions at Sea if the aeroplane is operated as a seaplane.

1.18.1.4 General requirements related to access to instruments and equipment are laid out in NCO.IDE.A.100 *Instruments and equipment – General.*

(d) Instruments and equipment shall be readily operable or accessible from the station where the flight crew member that needs to use it is seated.

1.18.1.5 The following applies as regards instrumentation: NCO.IDE.A.120 *Operations under VFR-flight and navigational instruments and associated equipment.*

(a) Aeroplanes operated under VFR by day shall be equipped with a means of measuring and displaying the following:

(1) magnetic heading;

(2) time, in hours, minutes and seconds;

(3) pressure altitude;

(4) indicated airspeed; and

(5) Mach number, whenever speed limitations are expressed in terms of Mach number.

(b) Aeroplanes operated under visual meteorological conditions (VMC) at night, or in conditions where the aeroplane cannot be maintained in a desired flight path without reference to one or more additional instruments, shall be, in addition to (a), equipped with:

(1) a means of measuring and displaying the following:

(i) turn and slip;

(ii) attitude;

(iii) vertical speed; and

(iv) stabilised heading;

and

(2) a means of indicating when the supply of power to the gyroscopic instruments is not adequate.

1.18.1.6 Requirements for initial application and maintenance of privileges to fly night VFR can be found in the joint European rules for *Flight Crew Licencing* PART FCL. The requirements for acquisition are laid out in FCL.810 *Night rating.*

1.18.1.7 The requirements as regards maintaining the rating are laid out in FCL.060 *Recent experience*:

(b)Aeroplanes, helicopters, powered-lift, airships and sailplanes. A pilot shall not operate an aircraft in commercial air transport or carrying passengers:

(1) as PIC or co-pilot unless he/she has carried out, in the preceding 90 days, at least 3 takeoffs, approaches and landings in an aircraft of the same type or class or an FFS representing that type or class. The 3 take-offs and landings

shall be performed in either multi-pilot or single-pilot operations, depending on the privileges held by the pilot; and

(2) as PIC at night unless he/she:

(i) has carried out in the preceding 90 days at least 1 take-off, approach and landing at night as a pilot flying in an aircraft of the same type or class or an FFS representing that type or class; or

(ii) holds an IR;

1.18.2 Crew requirements

As regards the crew on board the aircraft in question, NCO.GEN.105 *Pilot-in-command responsibilities and authority* applies.

(b) The pilot-in-command shall ensure that during critical phases of flight or whenever deemed necessary in the interest of safety, all crew members are seated at their assigned stations and do not perform any activities other than those required for the safe operation of the aircraft.

1.18.3 Occurrence of night VFR in 2018

The AIBN has obtained information from Avinor (AIS/NOTAM) concerning civilian night VFR flights in Norway in 2018 (excluding Svalbard). In excess of 20 VFR night flight plans were submitted. Four of these flight plans involved LN-TOS. According to the youngest pilot's log book, he was registered as commander for these flights.

1.19 Useful or effective investigation methods

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

2. ANALYSIS

2.1 Introduction

Investigations of the wreckage, information from multiple witnesses and video recordings of the actual course of events have made it possible to piece together a relatively good understanding of how the accident occurred. The AIBN has not found any technical faults in the aircraft that may have contributed to the accident occurring. Below follows an analysis of operational conditions in particular, including a discussion of factors concerning VFR flights at night and the challenges these entail.

2.2 The course of events

2.2.1 The course of events is well-documented. The take-off was seemingly normal and the aircraft started a steadily rising turn to the right. The lights from the aircraft disappeared for four seconds. Since there were no clouds in the area, this can only be understood as the switch marked STROB LIGHT being briefly switched off in error (see Item 1.6.4.1). This factor is analysed in more detail in Chapter 2.7.

2.2.2 Once the lights re-appeared, the aircraft had an easterly course while still turning steadily to the right. Over the next few seconds, the turn became increasingly tight, while it kept

losing altitude. The changes in the aircraft's direction of movement were steady and there is nothing to indicate that it was exposed to turbulence, a sudden change in wind direction or that the aircraft stalled before it struck the sea. Based on the video and damage to the aircraft, the AIBN is of the assessment that the aircraft hit the ocean at an angle of approx. 45° (nose down) and a roll of 60 – 70° to the right.

2.3 Technical investigations

2.3.1 The damage to the aircraft shows that it impacted the ocean with substantial force with the front and right wing first. Damage to the outer right wing indicates that the wing hit the water at an angle of approx. 45°. The fact that the wing was ripped off the fuselage and that the main wheel leg was torn off indicates that the speed, and thus the force, was significant in the impact with the ocean.

2.3.2 All faults and damage in the aircraft's flight controls can be explained by the strains that occurred then the aircraft hit the ocean. All vital parts of the wings, tailplanes and control surfaces were also found. It is therefore unlikely that the two on board lost control of the aircraft due to faults in the flight controls.

2.3.3 The engine was investigated to the extent possible, considering the damage. The faults found were all compatible with the aircraft impacting the ocean with significant force. It has not been possible to verify the ignition system and carburettor, but the appearance of the spark plugs indicated that the engine had correct combustion during the time before the crash.

2.3.4 The propeller flange showed clear signs of the propeller being driven by the engine when it separated. The overloading of all six propeller bolts and the fact that only one of the propeller bolt bushings (nuts) was still in the right position confirm that an excessive torque was transmitted before the propeller disappeared. The fact that the propeller was not found in the search area could indicate that it was spinning at a high RPM and that it was flung far away once it separated. The conclusion is that the AIBN finds no basis to believe a lack of engine power may have been a cause of the accident. The statement from the witness who heard an engine revving up supports this conclusion.

2.3.5 The airspeed gauge, the altimeter, the rate of climb and descent indicator, and particularly the artificial horizon, are important aids when flying at night. All instruments were damaged by saltwater, water pressure and as a result of the impact with the ocean, so it has thus not been possible to function-test the instruments. The AIBN believes that the indications shown when the instruments were raised are highly unreliable. However, the artificial horizon showed that the right wing was pointing 45° down (45° roll to right), which is generally compatible with the damage sustained by the aircraft. Faults and damage found during disassembly of the artificial horizon are all congruent with damage that may have occurred in a powerful impact with the ocean and subsequent damage due to the incursion of saltwater. The conclusion is that the artificial horizon was functional during the flight.

2.3.6 The aircraft's vacuum pump was found to be functional. The artificial horizon cannot function without it. This, along with the discoveries mentioned above, makes it highly likely that the artificial horizon was functioning as intended during the flight.

2.3.7 The conclusion is that the AIBN has not identified any faults or irregularities in its investigation of the aircraft that may have had an impact on the course of events.

2.4 Weather conditions

2.4.1 There was good visibility and little wind at the airport in connection with the take-off. Multiple local witnesses have explained that it was unusually dark on the evening in question. The sun had long since set, the moon was below the horizon and there was no visible aurora borealis.

2.4.2 With the aid of video recordings and conversations with witnesses, the AIBN has been able to piece together a good overview of the weather conditions at the airport at the time surrounding the take-off. There is nothing to indicate that wind conditions or poor visibility were contributing factors in the accident.

2.4.3 Before take-off, the AFIS officer stated that the runway in use was 01. This corresponded to the wind being stated as 10 kt from direction 060°. Even though the commander is free to choose to use a different runway direction than stated, a take-off from runway 19 would have resulted in a tailwind component of 7 kt. Based on the weather conditions in isolation, the AIBN finds it natural that the commander chose to take off on runway 01.

2.5 Who operated the aircraft

2.5.1 The two pilots on board both had valid privileges to operate the aircraft under VFR-night conditions. However, only the passenger (youngest pilot) had valid privileges for bringing passengers. The oldest pilot was listed as the commander in the flight plan submitted to air traffic control before take-off and the oldest pilot signed the aircraft's logbook. The oldest person was thus the formal commander.

2.5.2 Numerous factors also indicate that it was the commander who actually operated the aircraft. It was the commander who used what was most likely the checklist in connection with taxiing and the engine test. Furthermore, the commander switched off the headlamp during taxiing, which indicates that he wanted to increase his vision outside the aircraft. During the same period, the passenger had the headlamp switched on and e.g. published a post on Facebook. An additional confirmation that the formal commander actually operated the aircraft is that he was the one who communicated with the AFIS officer in connection with the take-off. Seen in isolation, with marginal visual references, it would also be natural for the person in the right-hand seat to operate the aircraft in a right turn. The pattern of them switching between flying every other flight also supports the conclusion that the formal commander operated the aircraft.

2.5.3 The video recording clearly shows that the commander sat down in the right-hand seat. He thus had his own flight controls, but, with the exception of an altimeter, had to use the instruments on the left side of the instrument panel. This would have a limited negative impact during a normal visual flight, but would make the transition difficult if it would become necessary to use the instruments to support the flight in the dark. The AIBN believes this was a significant contributing factor in the two people on board losing control over the aircraft.

2.5.4 The fact that the commander had no objections to flying from the right side could be related to him having experience as an instructor on ultralight aircraft, and that he therefore had experience sitting on the right and flying. People in the ultralight community have also said that the commander often flew ultralights from the right seat even when he was not instructing. However, he did not have privileges as an instructor

for normal class aircraft and should therefore have been sitting in the seat *"that was designated for him in the cockpit"* (see Chapter 1.18.2).

2.5.5 The AIBN cannot rule out that the passenger operated the aircraft during take-off. If the passenger took over the controls in connection with take-off, it could indicate that they realised the risk of taking off towards an area with few visual references and that they realised that the first turn had to be executed using the aircraft's instruments. In that case, the outcome demonstrates how challenging it can be to transition to flying by instruments.

2.6 Visual references

2.6.1 The take-off was towards the north. After the end of the runway was passed, there were very few visual references in the area. Some lights from the buildings at Husvågan and red obstruction lights on elevated terrain directly north of the site (see Figure 3) could provide references at the beginning, but during the climb-out it is probable that these lights were blocked by the engine and left wing. Once the aircraft started turning to the right, there were no lights to serve as a reference. Consequently, the two people on board had no natural horizon to us as reference. The AIBN's investigation shows that the conditions during this take-off were so demanding that they severely challenged the preconditions for being able to fly VFR at night. A precondition must be sufficient visual references.

2.6.2 Only after the aircraft turned right into a southern heading would the lights at Skrova, and later Svolvær, become visible. The AIBN believes there are few airports in Norway with such marginal visual references as a take-off in a northern direction from Svolvær Airport Helle.

2.6.3 A take-off into darkness with few or no visual reference points is very challenging, particularly if starting a turn. Immediately after leaving the end of the runway it would therefore be necessary to transit to instrument flying. Experience from investigations of other accidents has shown that even instrument rated pilots can lose control in a dynamic situation if they have to unexpectedly switch from visual flying to instrument flying. Instrument flying can be challenging, particularly with lack of training and recent relevant experience. None of the pilots had privileges to fly according to the instrument flight rules (IFR) although the commander in total had logged in excess of 8 hours of instrument time. There is reason to assume that they had little training in instrument flight. On the part of the commander, it would be especially challenging to switch to instrument flight because the instruments were difficult to read far out on the left side of the instrument panel.

2.6.4 A southward take-off along runway 19 would have provided significantly better visual references. The lights from both Svolvær and Skrova would have been very visible in the dark during the initial climb phase. The terrain south of the airport is also lower with fewer obstacles, so it would not have been necessary to turn shortly after take-off to achieve a safe altitude above the terrain. A southward take-off would have yielded a tailwind component of 7 kt. The aircraft manual only lists performance values for tailwinds up to 5 kt, and it is understandable that they wanted to avoid a take-off with 10 kt winds at an angle from the back left.

2.7 Potential influential factors

2.7.1 The light on the GA platform and the subsequent use of headlamps inside the aircraft prevented the eyes from adjusting to night vision. Only after the aircraft started taxiing out towards the runway did the cockpit go dark. Furthermore, the landing light was used during take-off. Taking off with the landing lights switched on is virtually standard, particularly at night. A take-off without using landing lights could make it more difficult to maintain course along the runway and increase the risk of hitting foreign objects on the runway, but would provide more time for the eyes to adjust to the dark.

2.7.2 Light discipline does not appear to have been emphasised in connection with the flight. The AIBN believes good light discipline is important in connection with night flights. This particularly applies for older people, as they need more time to adjust to the dark and because night vision declines with age (see Item 1.13.3). There is therefore reason to believe that the two people were virtually blinded after passing the runway and suddenly being in the dark.

2.7.3 The "strobe lights" were switched off for a period of four seconds immediately after take-off. The explanation for this could be that the incorrect light switch was turned off. The switches for landing lights and "strobe" are next to each other in a row of eight completely identical[9] switches. In order to hit the correct switch, one either has to remember the individual placement of the switch in the row or read the text on the switch. The AIBN believes the mix-up occurred when turning off the landing light. It is not possible to determine which of the two people operated the light switches. Regardless of who operated the switches, it could have entailed a distraction during a critical phase of the flight.

2.7.4 If the commander operated the switches, there is reason to believe that it had a very negative impact on the flight. At that time, the commander had passed the few references located in front of him and needed to focus on finding new references. If he then also had to move his gaze to switch off the landing light, then switching on "strobe" and then finding the correct switch for the landing light, it is highly probable that he became disoriented in the dark. It is a known fact that even minor turns of the head can impact the sense of balance when perceiving movement in space unless information is corrected using visual references (spatial disorientation).

2.7.5 In general, the AIBN believes that the positioning of eight identical switches in a long row is unfortunate. This could be called a poor man-machine interface. The design facilitates incorrect operation, particularly at night when minimal use of disruptive lights is desirable.

2.8 Flight pursuant to the night visual flight rules

2.8.1 A special privilege is required for flight pursuant to the night visual flight rules (night VFR). Since visual references are limited in the dark, the requirements relating to instruments and equipment in the aircraft are more stringent than for aircraft that can only fly during the day. In order to obtain the privilege, one must fly at least five hours of instrument training and five[10] hours night flying with an instructor The instruments in the

[9] The two switches on the right have red text, unlike the six others with black text.
[10] Previously, the requirements were 10 hours of instrument training and three hours in the dark. This is most likely the training that the commander completed.

aircraft and training in use of instruments shall compensate for the weaker visual references in the dark. However, the regulations were written with the precondition that visual references exist.

2.8.2 It is agreed that practice and training are required for flight by instrument flight rules (IFR). In many ways, flying night VFR can be considered to have a difficulty between visual flight (VFR) and instrument flight (IFR). It may therefore appear strange that the privilege for night VFR is granted without any time restrictions or requirements for continuous practice or training. On the other hand, instrument rights, simulator training or a minimum of three flights at night over the past 90 days are required in order to bring along passengers during night flights. These requirements were not met by the commander (see Item 1.5.1.2).

2.8.3 The commander had demonstrated sufficient skill to fly night VFR in 1996. The accident took place 22 years later without any verification that he had retained the skills. Night vision is also not checked when renewing the medical certificate for pilots.

2.9 Improving safety

2.9.1 The AIBN's investigation has revealed that flying night VFR touches on several factors that do not appear to have been given sufficient attention. A completely obvious safety issue is that the privilege for night VFR does not expire. Vision, including night vision, declines with age. Consequently, a person could retain the privilege while simultaneously developing significantly reduced night vision without this being checked. The extent to which a reduction in night vision was a factor in this accident cannot be determined. Another aspect is the lack of verification that the expertise is being maintained. This places great responsibility on the individual operator's ability to assess his/her own expertise and to consider whether a refresher is required to maintain the skill.

2.9.2 Night VFR does not appear to be widespread in Norway (see 1.18.3). Consequently, potential safety recommendations would only comprise a small number of people. However, it would be logical to believe that older people with privileges for night VFR must undergo a form of expanded vision test at regular intervals. However, such a regulatory requirement could be impaired by the fact that there is currently no practicable method for assessing a person's night vision. Nonetheless, the AIBN believes that the above factors should be considered by the Norwegian Civil Aviation Authority. The assessment should include whether, based on risk, special Norwegian measures should be introduced. Alternatively, the Norwegian Civil Aviation Authority could work towards changing the joint European requirements through their engagement in EASA.

2.9.3 Some of the night VFR flying takes place in flying clubs. The flying clubs should therefore take particular responsibility for the people flying night VFR. This could take place through training, renewal requirements from the club or for example by conducting a safety summit in the autumn, dedicating special attention to winter operations and night VFR.

2.9.4 This investigation covers several topics that should be relevant for private pilots in general, as well as instructors and operative management in flying clubs. Important safety topics are:

- Night VFR flights in areas where few visual references can be expected. Visible visual references must also be present in order to assess whether the flight can take place pursuant to the visibility requirements.

- Impairment of night vision with increasing age.

- That the person operating the aircraft is sitting in the intended seat in the cockpit.

- Awareness surrounding use of lights in night VFR flights.

2.9.5 Night VFR flights are governed by joint European provisions. The AIBN does not submit safety recommendations to the EASA in this investigation. The decision is based on the fact that the accident took place in near total darkness with few or no visual references and thus appears to be unique.

3. CONCLUSION

The AIBN believes there were several contributing causes of the accident. It was unusually dark that night and there were few lights to serve as visual references north of the airport. Furthermore, the two people exercised poor light discipline by using headlamps in the cockpit up until the aircraft started taxiing towards the runway. The ability to adjust to night vision varies considerably, but generally declines with increasing age. Furthermore, it is known that older people do not achieve the same sensitivity to light as younger people. It is therefore probable that the two people on board lost the visual references after take-off so that they lost control over the aircraft.

3.1 Investigation results

a) LN-TOS had a valid registration and airworthiness certificate.

b) The aircraft's mass and centre of gravity were within limits at the time of the accident.

c) The AIBN has not uncovered faults or irregularities in the aircraft during the investigation that could have affected the course of events.

d) There was sufficient fuel on board and the engine was supplying power until the aircraft impacted the ocean.

e) Both pilots had privileges to be the commander on board the aircraft.

f) The commander and passenger often flew together and switched between being the commander.

g) The oldest person on board was the formal commander during the take-off.

h) A number of factors indicate that the commander also operated the aircraft.

i) The commander was sitting on the right side of the cockpit and consequently could not see the aircraft's instruments on the left side very well.

j) The commander had not trained in the simulator, had an instrument rating or flown three required flights at night during the last 90 days, which is required in order to bring along passengers at night.

k) The wind during take-off was moderate and stable. There is nothing to indicate that wind conditions or poor visibility contributed to the accident.

l) Several witnesses have explained that it was unusually dark that evening.

m) Darkness and very few visual references north of the airport were a decisive factor in the accident taking place.

n) The two people on board most likely lost control over the aircraft due to spatial disorientation.

o) Video recordings show that the aircraft started turning right shortly after take-off. The turn gradually became tighter, causing the aircraft to eventually lose altitude and crash into the sea in a steep angle and with significant force.

p) Based on the video and damage to the aircraft, the AIBN has found that the aircraft hit the ocean at an angle of approximately 45° (nose down) and a roll of 60 – 70° to the right.

q) It was not possible to survive the impact with the ocean.

r) The AFIS officer at the airport witnessed the accident and immediately sounded the alarm.

s) Personnel from the fire and rescue service arrived at the crash site shortly after the accident took place.

t) LN-TOS had a row of eight nearly identical light switches that could facilitate incorrect operation.

u) Incorrect operation of light switches could have caused a momentary distraction that negatively affected the flight during a critical phase.

v) The privilege for night VFR flights does not expire.

w) Night vision is significantly impaired with increasing age.

x) Transitioning to night vision takes longer with increasing age.

y) There is currently no practicable method for assessing a person’s night vision.

z) Night VFR flights do not appear to be widespread in Norway.

4. SAFETY RECOMMENDATIONS

Night VFR flights are governed by joint European regulations. The AIBN does not submit safety recommendations to the EASA in this investigation, e.g. because the accident appears to be unique in several aspects.[11]

Accident Investigation Board Norway

Lillestrøm, 3 July 2019

[11] EASA also will receive this report.

APPENDICES

Appendix A: Abbreviations

APPENDIX A: ABBREVIATIONS

AIS/MET	Aeronautical Information Services (AIS) and Meteorological (MET) Information Services
AFIS	Aerodrome Flight Information Service
EASA	The European Aviation Safety Agency
FFS	Full Flight Simulator
hPa	hectopascal
lb	pound(s) (0,454 kg)
LDG	Landing gear
MHz	megaHertz
QNH	Altimeter pressure setting to indicate elevation amsl
RIB	Rigid Inflatable Boat
RWY	RunWaY
AIBN	Accident Investigation Board Norway
UTC	Coordinated Universal Time
VFR	Visual Flight Rules
VHF	Very High Frequency (30 – 300 MHz)