Accident
Investigation Board
Norway

Issued March 2018

REPORT SL 2018/03

REPORT ON AVIATION ACCIDENT AT HATTEN IN LESJA MUNICIPALITY, OPPLAND COUNTY, 24 SEPTEMBER 2015 WITH ALEXANDER SCHLEICHER GMBH & CO SEGELFLUGZEUGBAU ASW 24, LN-GNA

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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Photos: AIBN and Trond Isaksen/OSL

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REPORT ON ACCIDENT

Type of aircraft:	Alexander Schleicher GmbH & Co Segelflugzeugbau ASW 24
Nationality and registration:	Norwegian, LN-GNA
Owner:	Private
Operator:	Same as owner
Crew:	1
Passengers:	None
Accident site:	Hatten in Lesja municipality, Oppland County 62°13'10"N 009°00'04"E
Accident time:	Thursday, 24 September 2015 at 1904 hrs

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

ACCIDENT NOTIFICATION

The Joint Rescue Coordination Centre for Southern Norway (JRCC S-N) notified the Accident Investigation Board Norway (AIBN) at 2054 hours that a sailplane was missing following a flight originating from Bjorli airstrip, Lesja (ENLB). In accordance with ICAO Annex 13, AIBN notified Poland's State Commission on Aircraft Accident Investigation and the German Federal Bureau of Aircraft Accident Investigation, representing the home country of the missing pilot and the country of manufacture for the sailplane, respectively. AIBN mobilised the next day.

SUMMARY

On the evening of Thursday, 24 September 2015, a sailplane was reported as missing in connection with a flight from Bjorli airstrip. The sailplane was located on Monday, 28 September, four days later. It had crashed on the mountain Hatten in Lesja municipality, Oppland County, approx. 40 km east of the airstrip.

The pilot had started the flight from Bjorli airstrip at 1221 hours. After a flight of about five hours in the local area around Bjorli, the pilot set the course eastbound. The rest of the flight took place roughly between Digervarden to the west and Dovrefjell to the east, until the sailplane crashed at 1904 hours. The flight had then lasted for 6 hours and 43 minutes.

Just before the crash, the pilot sent out a distress call (mayday) that was received by other glider pilots located in the vicinity of Bjorli. The distress call included no details regarding the emergency situation or the location of the sailplane.

A large-scale search was organised over the following days. The sailplane was located on the fourth day of the search. The pilot was discovered deceased 56 metres from the sailplane with his parachute attached. The parachute's pilot chute had opened, but the main chute was still folded. The

investigation has revealed that the pilot attempted to bail out at an altitude too low above the terrain for the main chute to have time to open. No deficiencies have been found on the sailplane or the equipment on board that may have had an effect on the accident.

It has not been possible to determine with certainty how this accident occurred. However, AIBN finds it most likely that the accident occurred because the pilot unintentionally entered the clouds, or that the ground was obscured by clouds so when the pilot first became aware of its proximity, it was too late to find a suitable landing spot or to manoeuvre the sailplane out of the situation. Regardless of which situation occurred, the result was that the pilot had no option other than to try to save himself by parachute.

1. FACTUAL INFORMATION

1.1 History of the flight

1.1.1 Sequence of events leading up to the sailplane being reported missing

1.1.1.1 The pilot was participating in NTNUF's[1] autumn camp with his self-owned sailplane LN-GNA. He arrived at Bjorli on Wednesday, 23 September, the day before the accident occurred. The sailplane's FLARM unit (see Chapter 1.8) had a memory card that stored GPS data. Using GPS data stored on the FLARM unit, it has been possible to reconstruct the flight.

1.1.1.2 Standard procedures involve reviewing checklists before departure, e.g. repeating emergency procedures, which also include bail out. AIBN has no reason to presume that this did not take place for this flight with LN-GNA, which started on Thursday, 24 September, at 1221 hours. The pilot disengaged the tow-line four minutes after departure at an altitude of 1 254 m above sea level (670 m above ground level).

1.1.1.3 The first five hours of the flight took place in the area around Bjorli (see Figure 1). The flight had then mainly stayed at altitudes below 1 800 metres. The exception was a brief period after a few hours of flying where the sailplane reached an altitude of approx. 2 100 metres. The pilot then entered an area east of Bjorli with good lift. The character of the flight then changed from containing a number of course changes to a flight with long straight legs and relatively little manoeuvring.

[1] NTNU Flying Club. The Norwegian University of Science and Technology (NTNU) is not directly affiliated with the club.

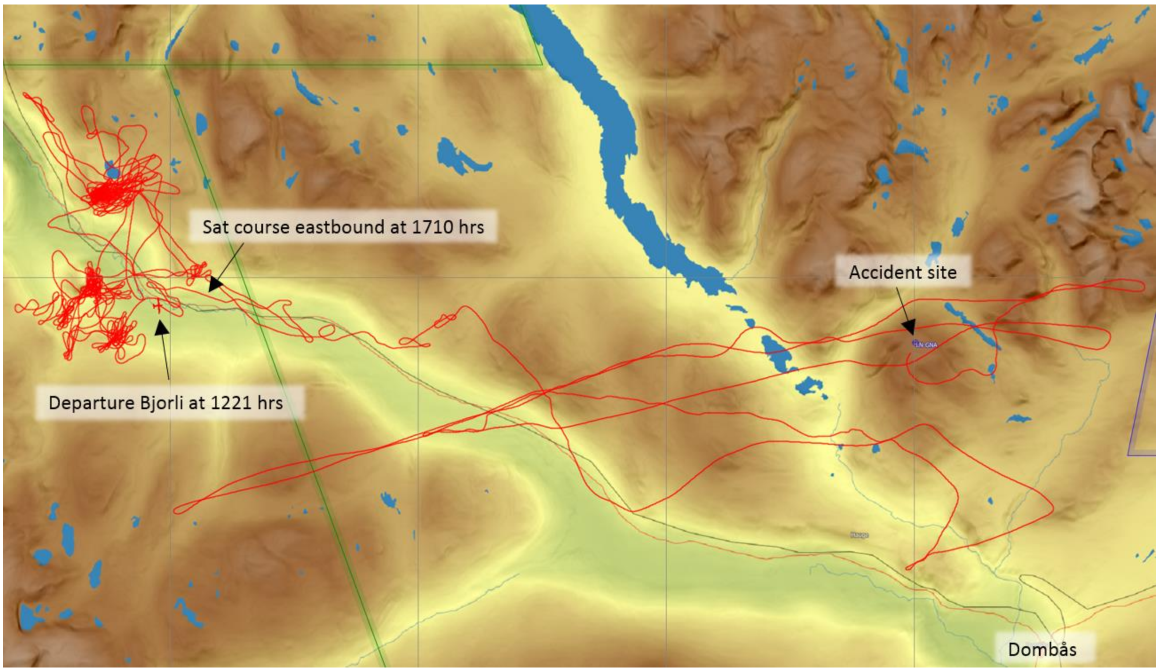

Figure 1: Tracker from FLARM. Source: FLARM/LN-GNA

1.1.1.4 The altitude profile shows that the sailplane was flown at considerably higher altitudes over the last hour and a half than during the first part of the flight. The highest altitude of 3 996 m (13 110 ft) occurred at 18:11:47 hours (see Figure 2).

Figure 2: Altitude profile LN-GNA. Time in UTC. For local time, add 2 hours. Source: FLARM/LN-GNA

1.1.1.5 At 1855 hours, approx. nine minutes before the accident occurred, the pilot turned the sailplane westward (see Figure 3). Three minutes after the course change toward the west, the pilot began a gradual course change to the south toward Dombås.

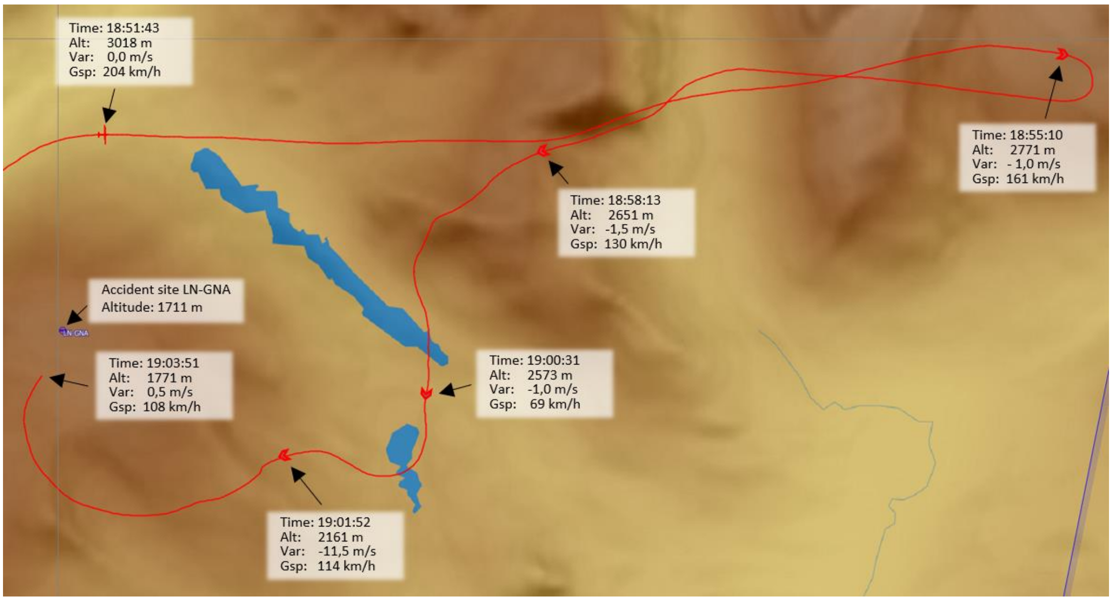

Figure 3: The last part of the flight with depiction of the crash site. Source: FLARM/LN-GNA

1.1.1.6 Three minutes before the crash, the sailplane was again turned toward the west, and eventually gradually to the north. At 19:03:51 hours, the tracker stopped recording the aircraft positions. At the start of this period, the sailplane was steadily losing altitude, but 3–4 minutes before the crash, the descent rate increased and it lost approx. 800 m of altitude during this time.

1.1.1.7 Other glider pilots located near Bjorli could hear the pilot of LN-GNA call out "Mayday" on the frequency during the time in question. The distress call did not include any details, either about the sailplane's position or the nature of the emergency.

1.1.1.8 The flight had lasted for 6 hours and 43 minutes when LN-GNA crashed.

1.1.1.9 LN-GNA was located after a large-scale search operation four days after it was reported missing. The pilot was found deceased 56 m from the sailplane.

1.2 Injuries to persons

Table 1: Injuries to persons

Injuries	Crew	Passengers	Other
Fatalities	1		
Serious			
Light/none			

1.3 Damage to aircraft

The sailplane LN-GNA was totally destroyed. See Chapter 1.12.

1.4 Other damage

None

1.5 Personnel information

1.5.1 The pilot was a Polish citizen. He completed his glider education in Poland in August 2008 and was the holder of a Polish ICAO licence, which he maintained without converting to a Norwegian glider licence. He had been a member of Ostrowski Aeroklub in Poland since August 2008.

1.5.2 When he started flying in Norway, he joined Elverum flying club/the glider group in February 2010. He was checked out by the local instructors and used the club's aircraft fleet for his flights. In April 2013, he joined NTNUF and then flew flights from Oppdal and received an introduction to mountain flying. In January 2015, he joined Sandefjord glider club and was then most active flying gliders from Notodden. At the time of the accident, the pilot was a member of all three glider clubs, in addition to Ostrowski Aeroklub in Poland.

1.5.3 The pilot returned to Poland each year to fly and he flew his first competition there in 2012.

1.5.4 In April 2014, the pilot purchased his own sailplane, LN-GNA. Following this purchase, it was mainly used for his flights.

1.5.5 The pilot had some experience with "mountain flying", with flights e.g. from Bjorli, Frya and Oppdal.

1.5.6 The flight times in Table 2 were calculated using the log for LN-GNA, information from Elverum flying club/the glider group and the pilot's log.

Table 2: Flying experience Commander

Flying experience	All types	On type
Last 24 hours	7	7
Last 3 days	7	7
Last 30 days	21	14
Last 90 days	25	18
Total	608	184

1.6 Aircraft information

Generally: Alexander Schleicher GmbH & Co. Segelflugzeugbau ASW 24 is a single seat high performance sailplane. The aircraft has a glide ratio of 1:43 at 105 km/h and is approved for simple aerobatics. The flight manual lists the stall speed at 65 km/h (IAS) with a total mass of 320 kg, and 81 km/h (IAS) with a max total mass of 500 kg.

- Registration: LN-GNA
- Serial number: 24045
- Year of construction: 1989
- Winglets were installed on the sailplane in 1995
- Time of last annual inspection: 1 April 2015

- Total flight hours: approx. 2430 hours[2]
- Time since annual inspection: approx. 70 hours (see comment in footnote 2)
- Maximum allowed take-off mass: 500 kg
- Mass at time of accident: approx. 350 kg[3]
- Centre of gravity at time of accident: Within permitted limits.

LN-GNA had a valid Certificate of Airworthiness and Airworthiness Review Certificate at the time of the accident. There were no outstanding remarks in the Journal of remarks and inspections.

1.7 Meteorological information

1.7.1 Introduction

1.7.1.1 Upon request from AIBN, the Norwegian Meteorological Institute prepared a report on the weather conditions on the day of the accident in the area in question. There are no weather observations from the actual site itself and there are few observations from the mountain areas. The closest measuring stations, satellite images with precipitation radar and analysis of the weather situation are provided in Chapter 1.7.2.

1.7.1.2 The weather situation where the flight took place is well-documented through observations from other pilots participating in the event. The pilot had also taken photos and recorded video during the flight. The last photos and the video recording were taken approx. one hour before the accident occurred. This will be addressed in Chapter 1.7.3.

1.7.2 Report from The Norwegian Meteorological Institute (MET)

1.7.2.1 Regarding the weather situation at 1700 hours on 24 September 2015, MET writes the following:

> *A 996-hPa low-pressure system is over the Norwegian Sea. An occluded front is located near the coast of Western Norway and is moving to the north-east. The wind direction in advance of the front is south to south-east. Microbursts were observed to the north-east of the front. The conditions in front of an occlusion are favourable for the formation of mountain waves. The satellite image from 1624 hours UTC shows a clear wave pattern in the clouds. Forecasts show that there has been an unstable layer up to FL060, and stable layering above this. Stable air from mountain top altitude and above is favourable for the formation of mountain waves. The area in question has mountain top altitudes around 6000 feet. This stability appears to decline somewhat towards 1800 hours UTC, which means that TCU/CB could extend beyond FL060.*

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[2] The aircraft was flown on 19 September 2015 without the time being registered in the sailplane's log. The exact time without this registration but including the time from the day of the accident was 2427:13 hours. The exact time since the last annual inspection with the same method of calculation was 65:36 hours.

[3] The sailplane's empty weight at the weight inspection carried out on 30 March 2014 was 255.6 kg.

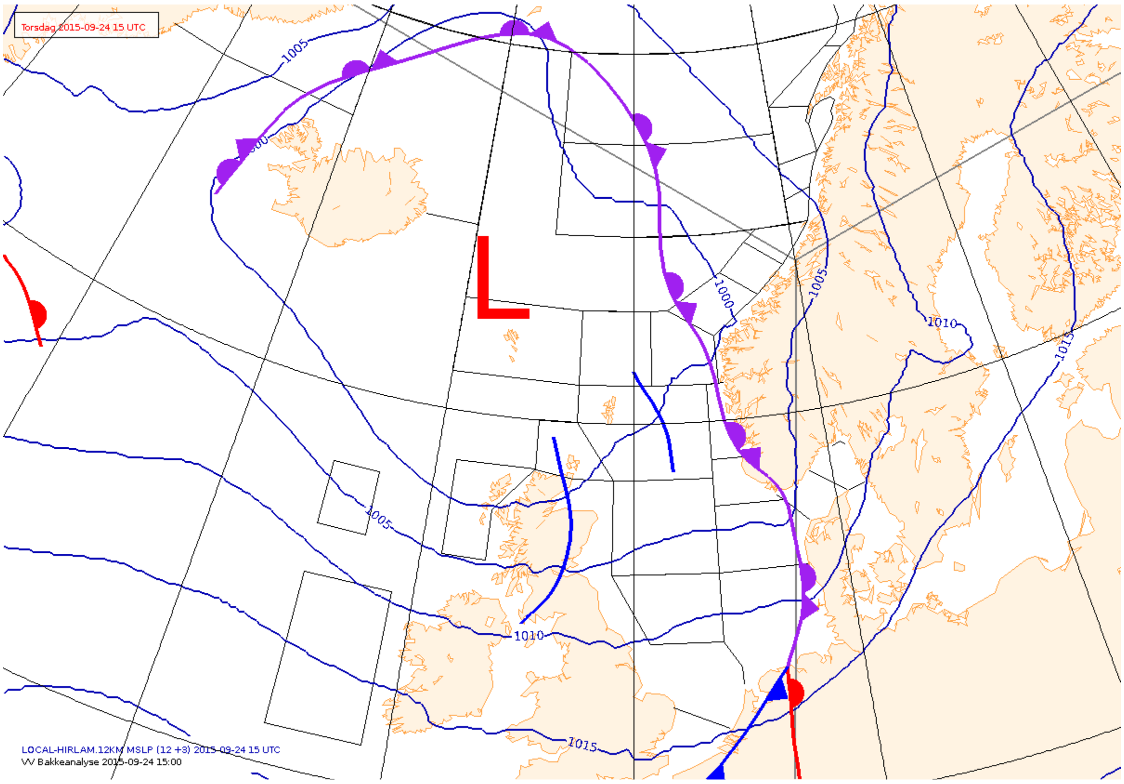

Figure 4: Analysis at 1700 hours local time. Source: The Norwegian Meteorological Institute

1.7.2.2 MET's assessment of cloud base altitude:

Visual observations of clouds south-east of the accident site yield cloud base altitudes 300 m above the Fokstugu station, which is located at 973 MASL, i.e. approx. 1300 MASL. Other observations are from Bråtå (664 MASL), Bjorli (579 MASL) and Oppdal (604 MASL). Here the lowest observed cloud base altitudes were 600, 600 and 1000 m, respectively. This means about 1200, 1300 and 1600 MASL. These altitudes are lower than the accident site. Clouds exhibit significant local differences, and there could be differences in cloud base altitude in valleys and mountain areas. Based on the observations, we can neither rule out nor confirm that there were clouds as far down as the mountains at the accident site.

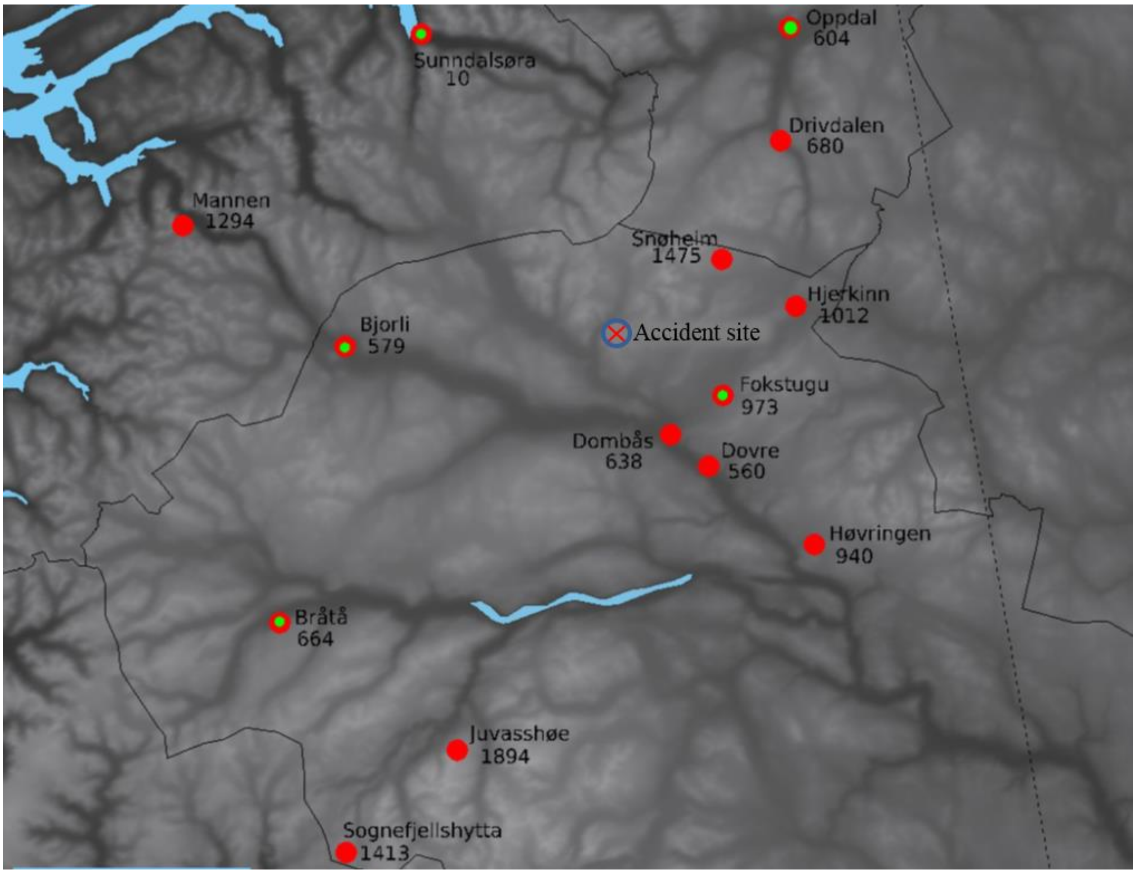

Figure 5: Locations of weather observations in the area surrounding the accident site. The stations are indicated with name and elevation above sea level (metres). The accident site is indicated by a red X. The red dots indicate stations with wind measurements. The locations indicated by green dots also indicate observations of clouds, visibility and precipitation. Source: The Norwegian Meteorological Institute

	Fokstugu 973 moh	Bjorli 579 moh	Oppdal 604 moh	Bråtå 664 moh
Skymengde	6/8	7/8	7/8	8/8
Mengde lave skyer	4/8	6/8	6/8	8/8
Skyhøyde (m)	300	600	1000	600
Sikt (km)	12	65	45	30
Vær ved observasjonstiden	Lette regnbyger	Nedbør innen synsvidde som når bakken på en avstand mer enn 5 km	Omtrent uendret skymengde, ingen nedbør	Lette regnbyger
Lave skyer	Stratucumulus. Bukleskyer som dannes ved at haugskyer (CU) brer seg ut.	Stratocumulus. Bukleskyer som ikke er dannet av haugskyer (CU). Er ofte i sammenhengende flak satt sammen av tydelige baller eller ruller.	Cumulus congestus (TCU)	Cumulonimbus (bygeskyer) (CB)
Midlere skyer	Altocumulus translucidus. Tynne rukleskyflak i bare ett nivå.	Altostratus og altocumulus	Fjellbølgeskyer/ linseskyer	
Høye skyer	Cirrus spissatus.	Cirrus. Lette trådformede fjærskyer	Cirrus. Lette trådformede fjærskyer	
Været siste 6 timer	Byger, mer enn halvparten av himmelen dekket av skyer	Byger, mer enn halvparten av himmelen dekket av skyer	Ingen nedbør, mer enn halvparten av himmelen dekket av skyer	Byger, mer enn halvparten av himmelen dekket av skyer

Figure 6: Visual observations in the area surrounding the accident site made at 2000 hours local time on 24 September 2015. Visibility, clouds and weather are visually observed by an observer at certain times throughout the day. Source: The Norwegian Meteorological Institute

1.7.2.3 MET's assessment of cloud types and weather:

Visual observations from Bråtå, Bjorli and Fokstugu have rain showers in the period from 1200 to 1800 hours UTC. Radar images show that the front zone is to the west of the accident site. There are rain showers to the north-east of the accident site. The area where the sailplane was discovered is poorly covered by precipitation radar. It is located about 180 km from the Rissa radar, which means that the radar does not receive information from altitudes lower than 4000 MASL (due to the curvature of the earth). The showers could thus be lower than what the radar can register.

The blue-white clouds on the satellite image at 16.30 hours UTC means high cloud tops. There are somewhat more blue-white clouds in the same area in the satellite image one hour later, at 17.30 hours UTC. It is difficult to determine based on the image whether these are cirrus clouds or whether CB may have developed in the area. Powerful turbulence is possible in the event of CB development. At 1800 hours UTC, Fokstugu and Bjorli report Stratocumulus, Altostratus and Altocumulus, as well as Cirrus. At the same time, Oppdal has Cumulus congestus (TCU), mountain wave clouds/lenticular clouds and Cirrus. Bråtå reports CB. This station is further to the west, so this may also be connected to the front showers were also observed on synoptic charts and radar, which *indicates that there has at least been TCU. A summary of information from visual observations, satellite and radar images, as well as forecasts means that we cannot rule out that the stable level is broken down and that CB has developed in the area.*

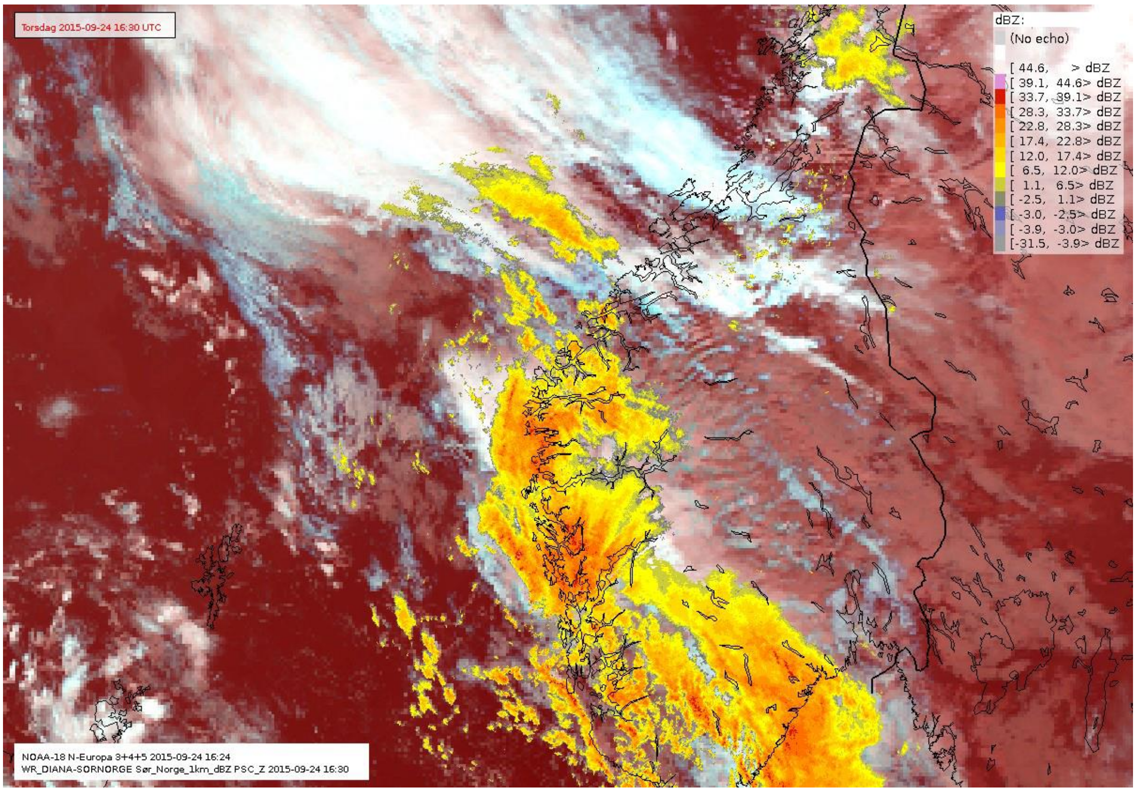

Figure 7: Satellite image at 1830 hours local time. Source: The Norwegian Meteorological Institute

1.7.3 <u>Other observations</u>

1.7.3.1 One glider pilot who participated in the event has explained that, on the day in question, there were varied cloud layers over the areas they were flying in. He took multiple photos that provide a clear impression of the weather situation for large parts of the day of the accident. One of these can be seen in Figure 8.

Figure 8: The photo was taken toward the east at 1712 hours, 1 hour and 52 minutes before the accident. Lesjaskog and the western part of Lesjaskogvatn are shown in the lower part of the image. Photo: Private

1.7.3.2 The pilot of LN-GNA filmed a small part of the flight. A still image from the video is shown in Figure 9.

Figure 9: Still image from video. It was taken just to the north of Lesjaskogvatnet toward the east at an altitude of approx. 3 300 m. Time approx. 1720 hours, 1 hour and 44 minutes before the accident. Source: Pilot of the crashed aircraft

1.8 Aids to navigation

A glider computer and navigational system of the type Triadis Altair was installed on board the sailplane. The sailplane was also equipped with a FLARM (Flight and Alarm) anti-collision unit. In order to utilise FLARM, the same technology must be installed and switched on onboard other aircraft. The system notifies the pilot of nearby aircraft and shows the position and identity of the aircraft on the navigational system. The FLARM unit had a memory card that stored GPS data.

1.9 Communications

The flight took place in uncontrolled airspace. All communication in connection with the flight from Bjorli was carried out over the general NLF (Norwegian Air Sports Federation) frequency 123.5 MHz.

1.10 Aerodrome information

Lesja airstrip Bjorli (ENLB) is located in Lesja municipality in Oppland County. The asphalted runway 12/30 is 835 m long and 12 m wide and is situated 1 915 ft / 584 m above sea level. This is a private airstrip and is owned/operated by Lesja skydiving club.

1.11 Flight recorders

Not mandatory and not installed.

1.12 Wreckage and impact information

1.12.1 Accident site

The sailplane crashed on the mountain Hatten, 18 km north-north-west of Dombås. The crash site was located at an altitude of approx. 1700 metres (see Figure 14).

1.12.2 Wreckage

1.12.2.1 Investigations at the accident site indicate that the sailplane struck the rocky ground at a relatively flat angle with its nose first. It then rotated about 90 degrees to the right, thus coming to rest with its nose in a northerly direction approx. 15 metres from first contact with the ground.

Figure 10: The sailplane LN-GNA as it was discovered after the accident. The image also shows the rocky ground. Photo: Gudbrandsdal police district

1.12.2.2 The sailplane was discovered with its landing gear deployed, potentially caused by forces affecting the sailplane when it impacted the ground. The right wing and tail boom were broken (see Figure 10, Figure 11 and Figure 12). The left wing suffered damage at the wing root where it attaches to the fuselage. Both winglets, as well as smaller parts from the aircraft's nose, fuselage and wings had come loose. The aircraft's nose was punctured and scratched. The canopy was missing and a search was carried out along the presumed direction of travel without finding it. A mountain ranger discovered it approx. two years later. The location of the canopy was close to the last registered GPS position.

Figure 11: Damage to left wing root. Photo: Gudbrandsdal police district

Figure 12: Damage on the sailplane's nose section. Photo: Gudbrandsdal police district

1.12.2.3 There were a number of items outside the aircraft, for example part of the instrument panel, GPS/navigation units, a battery, plastic folder of aircraft documents, mobile phone, video camera and digital camera.

1.12.2.4 The sailplane was transported to AIBN's premises at Lillestrøm, where it was investigated in detail to determine its condition. All faults and damage were found to be consistent with the crash.

1.13 Medical and pathological information

1.13.1 The pilot was autopsied at the Norwegian Institute of Public Health in Oslo, Department of Forensic Pathology and Clinical Forensic Medicine.

1.13.2 The autopsy report showed that death occurred immediately as a result of injuries sustained from falling from a substantial altitude. No medical factors were proven to have caused the crash.

1.13.3 No signs of illness or traces of intoxicants/sedatives were found which could have affected the pilot's flying.

1.14 Fire

No fire occurred.

1.15 Survival aspects

1.15.1 Search and rescue operation, introductory phase

1.15.1.1 Gudbrandsdal police district[4] was notified at 1917 hours by the glider club that a sailplane was missing. The Joint Rescue Coordination Centre South Norway (JRCC S-N) was furthermore notified by the Police at 1919 hours.

1.15.1.2 JRCC S-N has the overall responsibility for coordinating search and rescue operations in the southern part of Norway. They coordinate search and rescue efforts through Rescue Sub Centres (RSC). Gudbrandsdal police district was the Rescue Sub Centre (RSC) for the area relevant to search for the sailplane. The on-scene commander from the police district represented the RSC in its coordinating efforts for JRCC S-N. One police patrol, along with the on-scene commander, immediately travelled to Bjorli airstrip to coordinate the search from there.

1.15.1.3 The missing sailplane's last known position was stated to have been approx. 15 km southeast of Bjorli, in the area around Digervarden and Lordalen (see Figure 13). This information was based on an observation made by another glider pilot at approx. 1835 hours, who was then in the same area as LN-GNA. Based on the last known position, the early part of the search phase therefore focused on this area.

1.15.1.4 Over the course of the evening and night, a Sea King ambulance helicopter and an air ambulance helicopter flew for one and two hours, respectively, in the relevant search area without making any findings. LN-GNA was reported missing approx. 20 minutes before darkness. The weather was changing, with low clouds in certain areas, particularly over higher terrain and mountain tops. The weather conditions, combined with darkness, made it extra challenging to carry out an efficient and comprehensive search from the air over the areas in question.

1.15.1.5 Over the course of the evening and night, crews from the Norwegian Red Cross and Norske Redningshunder (rescue dogs) were used for ground search and listening posts.

1.15.2 The expanded search and rescue operation

1.15.2.1 In the following days, until the pilot and sailplane were discovered on the fourth day of the search on Monday, 28 September, at 1130 hours, significant resources were used in the search and rescue operation, both on ground and in the air.

1.15.2.2 The following units were involved in the search on the ground:

- The police (RSC) with on-scene commander and personnel from Lesja/Dovre police station at Dombås.

- Fire crews from Lesja and Dovre fire brigade.

[4] On 1 January 2016, Gudbrandsdal police district became part of Innlandet police district, which consists of the previous Vestoppland, Gudbrandsdal and Hedmark police districts

- Red Cross with units from Møre og Romsdal, Oppland and Hedmark counties.
- Norske Redningshunder (rescue dogs) with teams from the Hedmark and Oppland departments.
- Norwegian Civil Defence with units from Oppland.
- Norwegian Home Guard with units from Nord-Gudbrandsdal and Dovre HV district.

1.15.2.3 The following units participated in the air search:

- Royal Norwegian Air Force:
    - P-3C Orion was used to search for potential electronic emission from the sailplane
    - Sea King rescue helicopters
    - Bell 412 helicopters
- Police helicopter
- Air ambulance helicopter
- Civilian aircraft (powered aircraft, including NAK's aviation service, ultralight aircraft and sailplanes)

1.15.2.4 The sailplane operations leader from NTNUF coordinated the civilian air search along with the police on-scene commander and JRCC S-N. The majority of air searches were registered electronically. One example of map plots from the "light aircraft search" can be found in Figure 13, which shows the search carried out the day after the sailplane was reported missing. The different aircraft movements are shown in different colours. Equivalent plots were also created for flights carried out by the Air Force helicopters and Police helicopter.

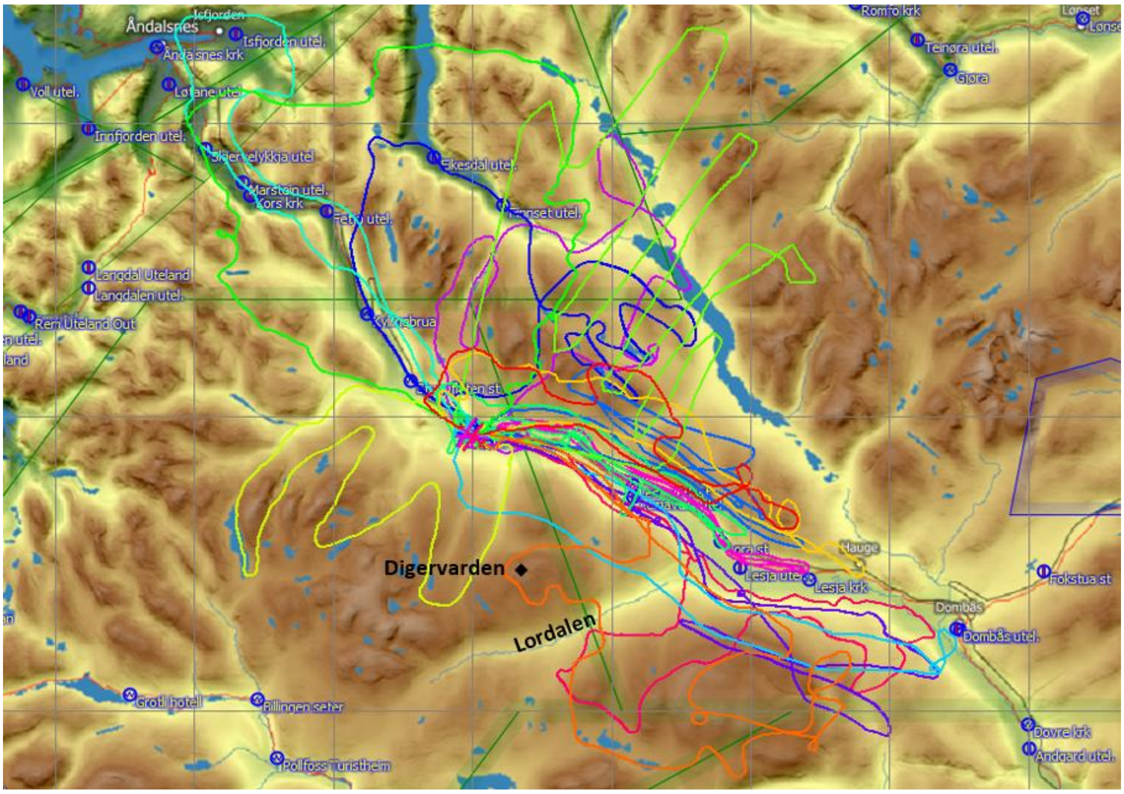

Figure 13: Search with light aircraft on Friday, 25 September. Source: NTNU Flying Club

1.15.2.5 The day after the sailplane was reported missing, JRCC S-N was contacted at 1110 hours by the Norwegian Armed Forces' Control and Reporting Centre Mågerø. They informed that they had registered an unknown object on primary radar[5] in the area north of Dombås.

1.15.2.6 The radar plot showed an object moving toward the east, and later turns to the west (see Figure 14). The object disappeared from the radar approx. five minutes before the distress call was sent on the radio frequency. AIBN presumes that the sailplane disappeared under the radar's coverage area as it was losing altitude.

1.15.2.7 On the morning of Friday, 25 September, this information was forwarded to RSC. For some unknown reason, RSC perceived that these plots should not be used to prioritise search areas. AIBN has attempted to find out why this occurred, but has been unsuccessful in finding an explanation. What we can see in hindsight is that all light aircraft activity was mainly organised from Bjorli, and the aircraft were kept away from the areas where the helicopters would be searching (ref. Figure 13). In the following days, JRCC S-N prioritised using the police helicopter, air ambulance, Sea King and Bell 412 from the Royal Norwegian Air Force in areas around the radar plot.

[5] Primary radar is what one traditionally associates with radar. The antenna sends out radio wave pulses that are reflected when they hit an object, for example an aircraft. The direction a return signal comes from and the time the radio wave takes to return after the pulse was sent out, are used to plot the object on the radar screen. Secondary radar "communicates" directly with transponders installed in aircraft and provides tracking information, for example position, altitude and speed. The sailplane was not equipped with a transponder, which would have made it possible to follow the aircraft's movements on secondary radar. Norway does not require that sailplanes be equipped with a transponder.

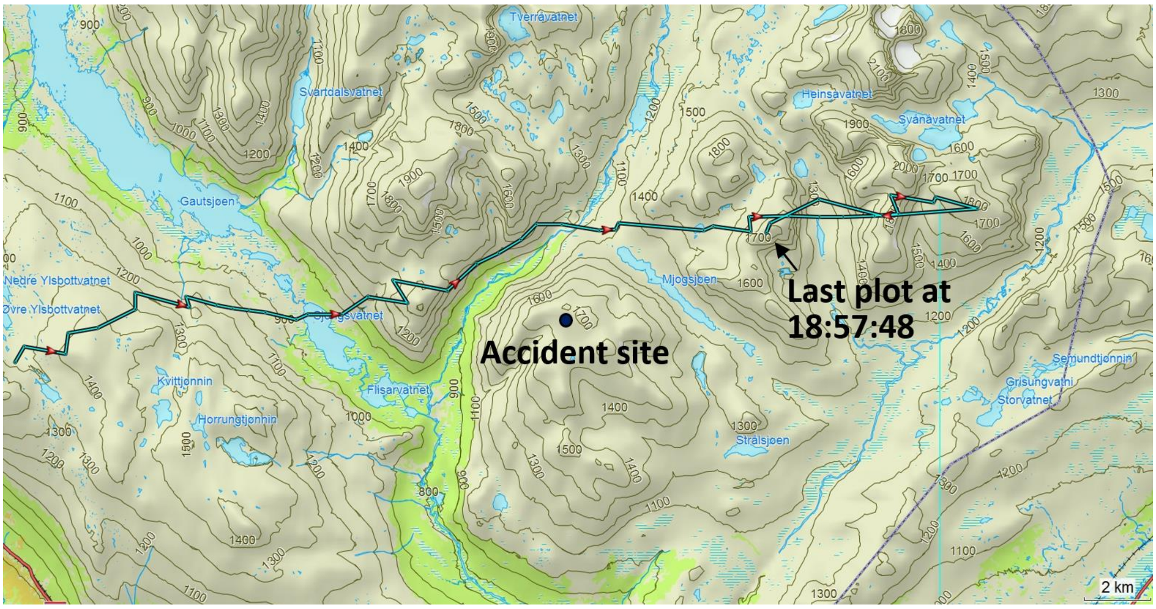

Figure 14: Radar plot from Friday, 25 September, from the Royal Norwegian Air Force. The plot is reproduced with permission from the Royal Norwegian Air Force. Text in black added by AIBN. Source: Royal Norwegian Air Force's Control and Reporting Centre Mågerø

1.15.2.8 Multiple daily flights were flown in the area. Over the first four days, the cloud layer covered the highest peaks, including the mountain area where the sailplane was later discovered. The plot in Figure 15 shows the police helicopter's search, which was carried out on Friday, 25 September, the day after the sailplane was reported missing. It shows that it could not fly over the highest mountain peaks. In hindsight, one can see from the map plot that it passed the crash site on a few occasions by only a few hundred metres without spotting the sailplane.

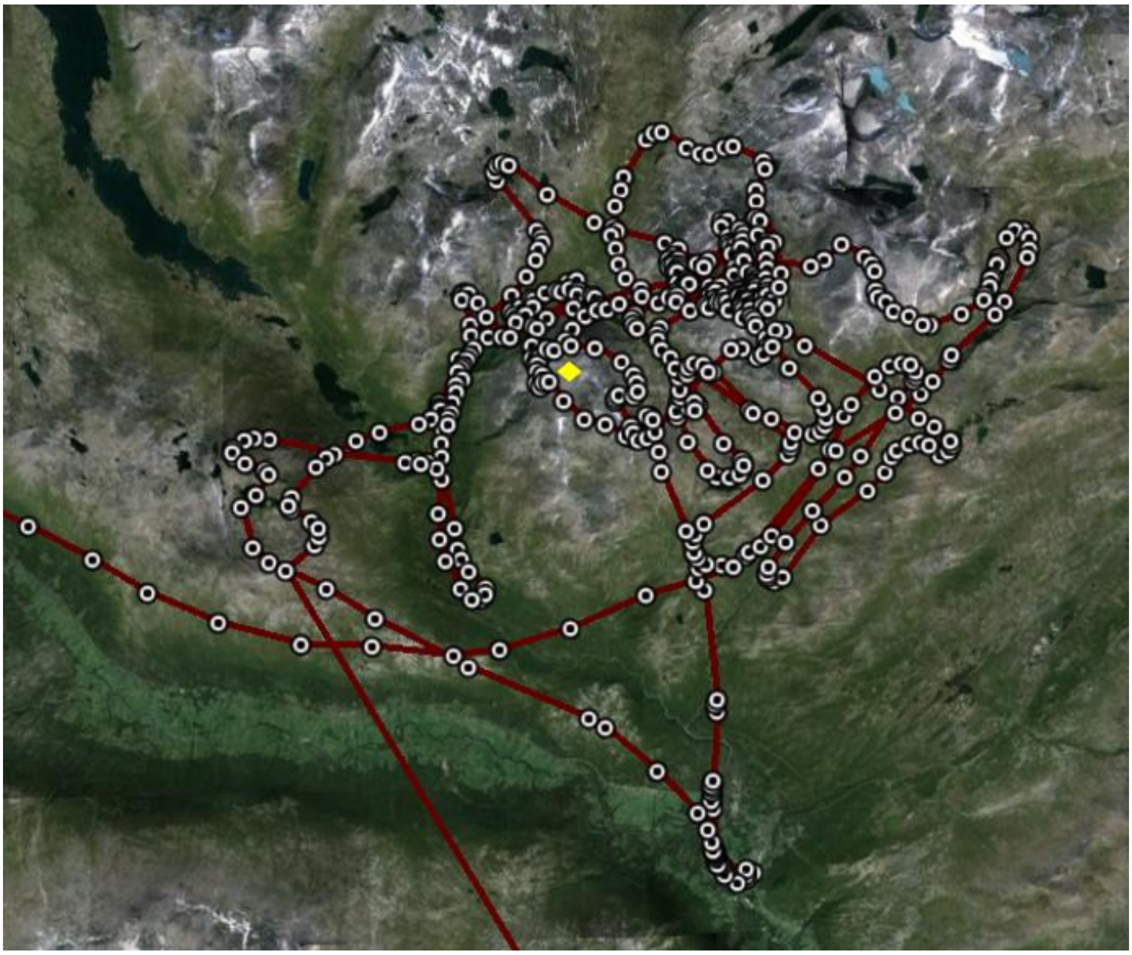

Figure 15: Map plot from the police helicopter's search. The yellow mark shows the crash site. Source: the Police

1.15.2.9 A review of available logs from NTNUF shows that 64 flights were registered in connection with the search before the sailplane was discovered. A handful of flights were also carried out without electronic registration. Including these unregistered flights, AIBN estimates that between 70 and 75 flights were flown during the search period. The total size of the area searched by aircraft is approx. 7 000 km^2.

1.15.2.10 In addition to air searches, JRCC S-N e.g. wanted to place personnel on various mountain tops, including Hatten, to scout the areas in question with binoculars. The weather conditions limited both the opportunities to transport personnel out into the search area and flights over the highest peaks.

1.15.2.11 At 1130 hours on the fourth day of the search, Monday, 28 September, the sailplane and pilot were discovered by the crew of one of the Armed Forces' Bell 412 helicopters.

1.15.2.12 When the sailplane was discovered, it was observed that snow had fallen in the area. This, combined with the fact that the sailplane was primarily white, low cloud cover and a snow-covered area, resulted in little to no contrast. The sailplane was periodically camouflaged by the snow.

1.15.2.13 The missing sailplane pilot had a mobile phone with him. Tracking of the phone showed that it was connected to the Jetta mobile base station. The mobile disconnected from the base station at 1903 hours, the same time the pilot issued the MAYDAY over the radio. The Jetta mobile base station is located approx. 20 km south of Dombås.

1.15.2.14 The pilot was not equipped with a personal emergency beacon or tracking equipment. According to the next-of-kin, the pilot had owned a personal emergency beacon. However, this was stolen from him when he was flying outside Norway a few months before the accident on Hatten, and he had not yet procured a new personal emergency beacon. This beacon must be activated by the user when an emergency occurs. Since the pilot perished in the impact with the ground and the beacon does not automatically activate, it would most likely not have been of assistance in locating him in this instance, unless he had been able to activate it before the bail out.

1.15.2.15 The sailplane had neither a "tracker" on board nor an installed ELT (Emergency Locator Transmitter), which are also not aviation requirements for sailplanes registered in Norway. NLF has introduced tracking for certain competitions and has had good experience with this.

1.15.3 Parachute

1.15.3.1 The pilot utilised a parachute produced by the Czech company MarS a.s. The type designation is ATL–88/90-1 and the manufacturer has e.g. listed the following technical parameters for the parachute:

- Weight: 6.9 kg
- The parachute's area: 36 m^2
- Max user weight: 115 kg
- Max chute opening speed: 277.8 km/h (150 kt)
- Minimum altitude for use: 100 m with minimum 110 km/h speed

1.15.3.2 The parachute was manufactured in March 2010. Annual inspections of the chute have been documented and the last inspection was conducted on 31 March 2015, and this was valid until 30 March 2016.

1.15.3.3 The parachute was white in colour and will, similar to the sailplane, provide little contrast against a white background, for example in snow-covered areas.

1.15.3.4 The normal procedure is for the user to exit the aircraft and pull the release handle. This deploys the pilot chute using a powerful coil spring under tension. The pilot chute will then be filled with air and pull out the parachute lines before the actual parachute opens. The parachute has 20 lines bundled individually with elastic bands.

Figure 16: The pilot chute was found deployed. Photo: AIBN

1.15.3.5 The last FLARM (GPS) plot was registered at 19:03:51 hours (see Figure 3). AIBN presumes that the power supply came loose when the pilot released the canopy before the bail out and that the last plot could therefore be the precise point where the pilot started the sequence of bailing out from the sailplane. The pilot was found 650 m from the last registered plot. The speed at this plot was 108 km/h (30 m/s). Based on this, as well as NLF's projected bail out altitude (see Chapter 1.15.5), AIBN has estimated that up to 18–19 seconds elapsed from the bail out was initiated by triggering the canopy until the pilot was out of the aircraft.

1.15.4 The parachute's functionality

1.15.4.1 After the accident, life support specialists at Norwegian Defence Materiel Agency (NDMA) at Kjeller reviewed the parachute's functionality. The inspection showed that the deployment handle had been pulled and that the pilot chute had been deployed. Several of the parachute lines had been released from the elastic bands keeping them together, while most of the lines were still bound together. The specialists concluded that the parachute's deployment sequence had started and was in accordance with the specifications.

Figure 17: The parachute's lines bound together. Photo: AIBN

1.15.5 The NLF parachute section's assessment of the bail out

1.15.5.1 AIBN contacted the NLF's parachute section to have them assess the bail out. This was both with regard to how the parachute had been deployed, and whether it was possible to estimate at what altitude above the terrain the bail out had occurred.

1.15.5.2 In a hypothetical instance, the opening sequence could have been initiated as a result of the handle being pulled out when the pilot hit the ground and that the pilot chute, parachute and lines were untangled after the impact with the ground. If so, there should have been clear damage in the form of scratches and scrapes on the actual handle, which was not the case. The "loop" (wire from handle to the deployment mechanism on the parachute sack) was also in one piece, which also indicates that the pilot himself deployed the parachute. Based on this and the general condition of the equipment, the section is of the opinion that it is likely that the commander pulled the deployment handle before he hit the ground.

1.15.5.3 In order to calculate at what altitude the pilot bailed out, NLF compared the sailplane's last registered altitude over the terrain with the altitude of the terrain where the pilot was found. The difference in altitude was 81 m. They have also assessed the condition of the terrain at the accident site and used other relevant information.

1.15.5.4 The conclusion from NLF is that the pilot has most likely bailed out from a considerably lower altitude than 100 m above the terrain. They emphasise that it is difficult to give a precise answer, but presume that the altitude may have been as low as 30 to 50 m when the bail out occurred.

1.15.6 Experience from sailplane accident in Sweden

1.15.6.1 The Swedish Accident Investigation Authority published a report[6] in connection with a sailplane accident that occurred on 6 April 2015 at Pirttivuopio, west of Kiruna. The

[6] Report from the Swedish Accident Investigation Authority Slutrapport RL 2016:03

accident occurred with a Grob G 103 C Twin with two people on board. One of the two perished because he failed to jump out in time with a parachute.

1.15.6.2 In connection with the accident, the Swedish Soaring Federation conducted an experiment where they measured the time it took four people to carry out a simulated bail out from a sailplane. They were given a standard briefing before the flight. None of these people had previous experience with sailplanes. The experiment showed that, on average, it took 23 seconds from when they were told to "jump" until they were on the outside and pulled the deployment handle for the parachute. The quickest ones did this in 12 seconds.

1.15.7 Use of oxygen

1.15.7.1 When flying in aircraft without a pressurised cabin, and when the altitude exceeds 10 000 feet (3 050 m), the flight medical recommendation is to always use extra oxygen[7]. The pilot was found with an oxygen hose connected. The oxygen regulator was of the type MH EDS Model D1 (see Figure 18).

Figure 18: Oxygen regulator MH EDS Model D1a. Photo: Gudbrandsdal police district

1.15.7.2 The oxygen regulator supplies oxygen only when it registers the user breathing in and not breathing out, breaks in breathing or when talking. There are multiple alternative modes on the apparatus and when the regulator was found, it was set to D5. According to the user manual, "D" stands for "Day" or "Delayed". The D5 setting means that the regulator does not supply oxygen when breathing in until it registers a pressure altitude of 5 000 feet (1 525 m) or higher.

1.15.7.3 The oxygen regulator uses a 9-volt battery as a power supply. When the voltage drops below 5 volts, the regulator will cease to function. With the battery connected to the regulator, the voltage after the accident was measured at 8.05 volts.

1.15.7.4 The oxygen bottle was attached to the right side in the back of the cockpit (see Figure 19). When the sailplane was found, the pressure gauge on the bottle indicated approx. 1 400 psi. The oxygen bottle was in the open position with the valve handle attached above

[7] Ref AIC-N 45/04

the gauge. The low level marking on the gauge, indicated with a red field, runs from 0 to approx. 400 psi.

Figure 19: The sailplane's oxygen bottle. Photo: AIBN

1.16 Tests and research

None.

1.17 Organizational and management information

1.17.1 NTNUF's main headquarters is in Trondheim and it is a member of Norwegian Air Sports Federation - NLF. Through this membership, it is also a member of the World Air Sports Federation FAI (Fédération Aéronautique Internationale). The club has approx. 100 members and owns five sailplanes.

1.17.2 The sailplane club organises events twice per year; the Easter camp, which is held in Oppdal and the "fall camp" or "wave camp", which is held at Bjorli. The fatal accident occurred during that year's fall camp/wave camp.

1.17.3 The sailplane activity were organised and carried out in accordance with NLF's procedures. The daily activity was led by the the sailplane operations leader from NTNUF, which is a designated member of the club. As long as the sailplanes were within viewing distance, the operations leader maintained radio contact with the pilots.

1.18 Additional information

1.18.1 The Norwegian Air Sports Federation has updated and published the 2nd edition of Seilflyhåndboken (sailplane manual), which is NLF's safety system for sailplanes. Article 690 from Seilflyhåndboken concerns provisions for flying at high altitude with sailplanes. This article has been included in Appendix B. When flying above certain altitudes, there are e.g. requirements for theory training, use of oxygen, knowledge of bail out and use of personal tracker equipment (combined tracking and personal emergency beacon).

Seilflyhåndboken has multiple standardised checklists (Article 693), one of which concerns bail out. This does not mention activation of personal emergency beacon before bail out.

1.18.2 In order to increase visibility, there are requirements as regards marking of aircraft used in mountainous and desolate areas, which is regulated by national regulation BSL D 1-8, Section 8. This regulation does not apply for sailplanes.

1.19 Useful or effective investigation techniques

No methods qualifying to be specially mentioned have been used in this investigation.

2. ANALYSIS

2.1 Introduction

Based on the discoveries at the accident site, the distress call, the medical findings, as well as the NLF parachute section's assessment of the bail out altitude, AIBN finds it to be most likely that a situation occurred which led the pilot to attempt to save himself through a parachute bail out from LN-GNA. However, the altitude above the ground was insufficient for the parachute to open. The pilot perished immediately in the impact with the ground. AIBN has not made any discoveries which indicate that the accident is due to a technical error or that a structural fault occurred in the sailplane. The analysis below therefore concerns operational conditions and the subsequent search and rescue phase.

2.2 Operative factors

2.2.1 The weather conditions at the time of the accident, with layered clouds and clouds surrounding the mountaintops, indicate unfavourable flight operation conditions with a risk of being inadvertently "locked" above, or between, cloud layers without having adequate visual references to the ground. If one finds oneself in areas with little lift and the clouds below the aircraft are solid, one could end up in an undesirable situation where the only alternative is to enter the cloud layer. Without instrumentation for IFR flying or IFR flying experience, such a situation must be perceived as critical. Disorientation can quickly lead to losing control of the aircraft and one could end up in a situation where the only alternative will be to abandon the aircraft with a parachute.

2.2.2 Based on the available facts, it has not been possible to positively determine whether LN-GNA was in such a situation when the pilot chose to abandon the aircraft. However, AIBN believes that there are indications that this may have occurred:

- The weather conditions, with layered cloud formations and with clouds covering the peaks, led to an increased risk of losing visual contact with the ground.

- The relatively frequent course and altitude changes over the last three minutes of the flight could indicate that the pilot was attempting to avoid ending up in clouds. It is not unlikely that LN-GNA nevertheless ended up in the clouds.

- A *distress call* (mayday) should normally be followed by a *distress message* which e.g. indicates the position, altitude and nature of the emergency. The fact that the pilot did not transmit such information could mean that the situation was so dire that he did not have time to complete the message.

- The fact that the pilot bailed out at low altitude over rocky, mountainous terrain, while the aircraft was headed for higher terrain, could be a sign of a lack of visual references to the ground, or that the ground was not visible until it was too late.

2.2.3 Based on the tracker and altitude log, video and photos taken by the pilot, as well as a simple review of breathing equipment, AIBN finds it to be unlikely that the pilot was exposed too hypoxia.

2.2.4 However, AIBN finds it most likely that the accident occurred because the pilot unintentionally entered the clouds, or that the ground was obscured by clouds so when the pilot first became aware of its proximity, it was too late to find a suitable landing spot or to manoeuvre the sailplane out of the situation. Regardless of which situation occurred, the result was that the pilot had no option other than to try to save himself by parachute.

2.2.5 The incomplete distress message and altitude when bail out occurred could indicate that the pilot had limited time when he decided to bail out. It is uncertain why it took up to 18-19 seconds from releasing the canopy until the actual bail out was carried out. Even though it was better than the average time of 23 seconds it took for untrained people to get out in the experiment conducted by the Swedish Soaring Federation, this nevertheless appears to be a somewhat long time. AIBN does not want to speculate on various causes why it took the pilot this long to exit the aircraft, but generally believes that attention surrounding bail outs could be an important lesson to learn from the accident. For example through mental reviews and repeated training in the procedures for bail out, thus giving oneself, where there is a choice, the best possible margin for succeeding in a bail out. This is part of the emergency check list that is reviewed before each departure. Bail outs are also discussed in Article 690 of Seilflyhåndboken (Appendix B).

2.2.6 The check list for bail outs listed in Article 693 lacks an item concerning activation of a personal emergency beacon before the bail out. AIBN believes this should be incorporated into the check list.

2.2.7 Flying sailplanes has a large aspect of competition, both against others and to improve one's own results. Performance is often measured in altitude, distance travelled and time flown. This could challenge aviation safety. AIBN is familiar with the purposefully safety work that is taking place centrally and in the clubs, and there have been relatively few fatal accidents involving sailplanes in Norway. However, the accident involving LN-GNA is a reminder of the risk factors in this activity. The VFR rules regarding weather minima also bear mentioning.

2.2.8 Glider pilots who read this report may be served by making their own reflections about how they balance the desire to improve their results against the consideration for exercising the sport in a sufficiently safe manner.

2.3 Search and rescue phase

2.3.1 The fact that the pilot was able to send out a distress call before bailing out, clearly contributed to rapid reporting of the accident. In turn, this meant that the search and rescue operation could start as early as the same evening and night. AIBN believes the planning, coordination and implementation of the rescue operation were good, viewed in relation to the available information. The considerable efforts expended by volunteers bears particular mention.

2.3.2 Nevertheless, it took four days to find the pilot. There were several challenges associated with the search. For example, the sailplane was not equipped with either a tracker or a transponder, which meant that there was no definite radar information available for the flight. The Air Force's plot from Mågerø was an important contribution toward eventually finding the sailplane, even though it was not entirely certain that this plot was from the missing sailplane. Other factors included:

- The lack of an ELT (Emergency Locator Transmitter).
- A personal emergency beacon, or equivalent tracking equipment, could have been useful if one had been brought along and activated before the bail out. See AIBN report 2017/12[8].
- The weather conditions limited both the opportunities to transport personnel out into the search area and flights over the highest peaks.
- The fact that the sailplane was primarily white, combined with low cloud cover and a snow-covered area, resulted in little to no contrast. The same applied for the parachute. The sailplane was periodically camouflaged by the snow.
- The police helicopter passed close by the crashed sailplane multiple times. Better visibility would have increased the probability of discovering the sailplane.
- The sailplane was found in a relatively inaccessible area where a search on foot had been a very demanding task, particularly since one initially could not restrict the search and thus had a particularly large search area.

2.3.3 There are no regulatory requirements for contrast colours for sailplanes used in mountainous and desolate areas. AIBN is not recommending at this time that sailplanes be included in national regulation BSL D 1-8, but is encouraging NLF and the Norwegian Civil Aviation Authority to both consider whether requirements for increased visibility should be introduced. Increased visibility could have contributed to the sailplane being observed at an earlier point in time.

2.3.4 However, what is perhaps the most important factor, in addition to the size and condition of the search area, is that the cloud layer in the first four days covered the highest peaks, including the mountain area where the sailplane was later found. This prevented an effective air search in the area around where the aircraft was last seen on radar.

2.3.5 The fact that significant resources were searching in the "wrong" part of the area and not where the Norwegian Armed Forces' radar plot indicated, had less of an impact since the area in question was covered during the helicopter search. Simultaneous searches with light aircraft in the same area would have resulted in increased risk for the personnel participating in the air search.

[8] AIBN report 2017/12

2.3.6 Use of a tracker would have limited the search area. AIBN is familiar with the fact that NLF has introduced tracking in a few competitions and believes that this could be an important life-saving aid.

2.3.7 The time it took for the pilot to be found was not significant for survivability since he perished immediately in the actual accident.

3. CONCLUSIONS

It has not been possible to determine with certainty how this accident occurred. AIBN finds it most likely that the accident occurred as a result of the pilot inadvertently entering the clouds. The ground could also potentially have been obscured by clouds so that he discovered too late that he was close to the ground and did not see any opportunity to land or manoeuvre himself out of the situation. Regardless of which situation occurred, the result was that the pilot had no option other than to try to save himself by parachute.

3.1 Investigation results

a) The pilot had a valid Polish sailplane licence.

b) At the time of the accident, the pilot was a member in Elverum flying club/the glider group, NTNUF and Sandefjord sailplane club.

c) The pilot owned the crashed sailplane LN-GNA.

d) The pilot most likely attempted to save himself by bailing out with a parachute from LN-GNA.

e) The bail out took place at an altitude too low above the ground for the parachute to have time to open, which meant that the pilot perished in the impact with the ground.

f) The pilot bailed out at low altitude while the aircraft was headed for rising terrain.

g) No findings were made to substantiate that the situation which occurred was of a technical nature, such as structural failure or a fault in the sailplane's controls.

h) The weather conditions constituted a risk of becoming "locked" above, or between, cloud layers. Some mountain tops were covered by clouds.

i) The pilot's distress call most likely contributed to the rapid start-up of an extensive search and rescue operation.

j) AIBN considers the search and rescue operation to be thorough and carried out with significant resources.

k) Increased visibility and use of an ELT and/or activated personal tracking equipment/ emergency beacon would most likely have made the search easier and the aircraft could have been located faster.

l) The weather conditions during the first days after the accident were of significance for it taking four days from when the accident occurred until the pilot was found.

m) The time it took until he was found was not significant for the pilot's survivability, since he perished immediately in the actual accident.

4. SAFETY RECOMMENDATIONS

AIBN is making no safety recommendations.

Accident Investigation Board Norway

Lillestrøm, 22 March 2018

APPENDICES

Appendix A: Abbreviations

Appendix B: Seilflyhåndboken (sailplane manual) Article 690: Provisions for flying at high altitude with sailplanes (in Norwegian only)

APPENDIX A

Abbreviations:

AIBN	Accident Investigation Board Norway
ELT	Emergency Locator Transmitter
FLARM	Flight and Alarm
GPS	Global Positioning System
JRCC S-N	Joint Rescue Coordination Centre South Norway
IFR	Instrument Flight Rules
MET	The Norwegian Meteorological Institute
NAK mountain service	Norsk Aeroklubb mountain service
NLF	Norwegian Air Sports Federation
NTNUF	Norwegian University of Science and Technology Flying Club
RSC	Rescue Sub Centre

BESTEMMELSER FOR HØYDEFLYGNING MED SEILFLY

1.0 Innledning

Høydeflygning med seilfly medfører høyere risiko for fly og pilot. En bestemmelse for høydeflygning kan ikke ta ta for seg alle farene med høydeflygningen. Bestemmelsene kan kun sette noen rammebetingelser som må være oppfylt for å opprettholde en akseptabel risiko. Seilflygeren må ha gode kunnskaper om høydeflygning slik at han/hun tar de rette valgene under flygningen ut i fra de aktuelle forholdene.

2.0 Teorikrav ved flygning over 3500m QNH

Deltatt på et SVEDANOR kurs i fjellflygning eller tilsvarende.

Aktuelle læreverk:

Kompendium fjellflyging	Teorikurs i fjellflygning av Robert Danewid
Bølgeflygning	Presentasjon laget for opplæring i klubbene (Tilsvarer SVEDANOR kurset sammen med teoripensumet)
Dancing with the wind	Bok om hang og bølgeflygning av Jean-Marie Clément

3.0 Oksygen og oksygenutstyr

Oksygenutstyret skal være godkjent av produsenten for bruk opp til aktuell flyhøyde.
Utstyret skal være vedlikeholdt etter fabrikantens vedlikeholdsinstruks.
Alle batterier skal være fulladet før turen starter.
Oksygenutstyret skal være tilpasset og testet for den aktuelle pilot.
Funksjonstest av oksygenutstyret skal utføres før flygningen.
Tilgjengelig oksygen for flyturen skal beregnes. Flygingen skal planlegges slik at det er oksygen for minst 30 minutters forbruk når 3000 m passeres på vei ned.

3.1 Oksygen og oksygenutstyr under 3500 m QNH

Piloten skal ha kunnskaper om oksygenmangel ved lavere høyder enn 3500m QNH.
Ved flyging under 3500 meter kreves det ikke oksygen. Det anbefales alikevel at det tilføres litt oksygen ved flyging mellom 1500 og 3500 meter for å opprettholde oksygenmetningen i blodet.

3.2 Oksygen og oksygenutstyr mellom 3500 m og 7000 m QNH

Det er krav til bruk av oksygenutstyr.
Pusting av oksygen bør påbegynnes ved bakkenivå og senest ved 1500 m.
Alle om bord skal ha grundige kunnskaper om oksygenmangel og trykkfallsyke, og kjenne de fysiologiske begrensningene for flyging i store høyder.

3.3 Oksygen og oksygenutstyr over 7000m QNH

Det skal brukes et dobbelt oksygensystem som er fastmontert.
Svikter det ene systemet skal det andre kunne ta over automatisk.
Pusting av oksygen skal påbegynnes ved bakkenivå og avsluttes ved bakkenivå.
Alle om bord skal ha grundige kunnskaper om oksygenmangel og trykkfallsyke, og kjenne de fysiologiske begrensningene for flyging i store høyder.
Alle om bord skal ha gjennomgått trening i lavtrykkskammer for å kjenne sine personlige reaksjoner på oksygenmangel.

4.0 Fly og utstyr over 3500m QNH

Fallskjerm er påbudt.
Prosedyren for nødutsprang skal kunnes av alle i flyet.
Tracker på kroppen eller montert på fallskjermen er påbudt. Tracker skal testes før avgang.
Varme klær, vann og mat skal tas med etter forholdene og etter hvor lenge man skal fly.
Det skal være en tabell i seilflyet med VNE IAS i forskjellige høyder.
Alle batterier i fly og utstyr skal være fulladet før turen starter.

5.0 Flygning mellom 7000 m og 10000m QNH

5.1 Fly

Seilflyet skal være i god stand uten noen nedsatt begrensning på flyhastighet eller G-krefter.
Det skal være en tabell i seilflyet med VNE IAS i forskjellige høyder.
Seilflyet skal ha fastmontert Flight computer med GPS og kart.
Seilflyet skal ha transponder.

5.2 Flygeordre

Ved flygning i lokale arrangement i definerte luftsportsbokser skal lokale regler mot ATC følges.
Ved enkeltflygninger skal det utarbeides en detaljert flightplan til Avinor som aktiveres.
Dokumentet «Flightplan_NE-0150.pdf» skal benyttes /leses.
Squak kode settes inn og transponder aktiveres før flygningen starter.

5.3 I tillegg til flygeordre tas dette med i seilflyet:

En detaljert beskrivelse av hva man skal gjøre.
Maksimal høyde for turen.
Beregnet oksygenforbruk for turen.
Luftromskart med alternative landingsplasser hvis skydekket tetter seg over avgangsplassen.
Liste over aktuelle frekvenser.

6.0 Flygning over 10000m QNH.

Flygning over 10000 meter QNH tillates normalt ikke, men det kan være enkelt tilfeller hvor det planlegges spesielt for dette.
Flygning over 10000 meter QNH kan da godkjennes etter skriftlig søknad til Fagsjef S/NLF.
Søknaden skal inneholde detaljerte opplysninger om hensikten med flygningen, pilot, fly og utstyr.