aibn Accident Investigation Board Norway

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REPORT ON AN AIR ACCIDENT AT SEA APPROX. 11 NM SOUTH OF MANDAL, NORWAY ON 22 JUNE 2019 INVOLVING A PIPER PA-28-161, LN-MTJ, OPERATED BY SOLA FLYING CLUB

Accident Investigation Board Norway • P.O. Box 213, N-2001 Lillestrøm, Norway • Phone: + 47 63 89 63 00 • Fax: + 47 63 89 63 01
www.aibn.no • post@aibn.no

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

Type of aircraft:	Piper Aircraft, Inc. PA-28-161
Nationality and registration:	Norwegian, LN-MTJ
Owner:	Norrønafly Rakkestad AS, Rakkestad
Operator:	Sola Flying Club
The Commander:	Deceased
Passengers:	2
Accident site:	At sea, approx. 11 NM south of Mandal, Norway (57,836°N 007,515°E)
Accident time:	Saturday 22 June 2019, at approx. 1250 hours

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

NOTIFICATION

On 22 June 2019, the AIBN duty officer was notified by the Avinor Air Navigation Services crisis team of a potential aircraft crash in the sea south of Kjevik involving a Piper PA-28 (LN-MTJ). There were three people on board, and the flight time with the reported amount of fuel had run out. A search had been instigated. At 1839 hours, the AIBN was informed that two survivors had been found in the sea. Later, it emerged that the third person had died. Early next morning, two accident inspectors set off for Kristiansand and started their investigation.

In accordance with ICAO Annex 13 "Aircraft Accident and Incident Investigation" the AIBN notified the investigation authority in the US (National Transportation Safety Board, NTSB), where the aircraft was manufactured.

SUMMARY

In the early hours of Saturday 22 June, the police operations center contacted the head of the voluntary organization Flight Service[1] in Agder Police District. The Flight Service was asked to assist in a search for a supposedly dead person in the sea south of Mandal. Three people were on board LN-MTJ as it took off from Kristiansand Airport Kjevik (ENCN) at 1217 hours heading for the search area assigned by the Coast Guard Ship KV Nornen. After a short search period, the aircraft lost its engine power and went into the sea. The engine power returned briefely before the aircraft hit the sea. All three people on board wore life jackets and evacuated the aircraft before it sank at about 1250 hours. At the time, the aircraft was outside radar coverage and the aircraft was unable to communicate with the Kjevik tower. The AIBN has not been able to determine with any degree of certainty why the engine on LN-MTJ lost power at low altitude.

As the afternoon progressed, the police became worried as there was no report from the aircraft. They contacted Kjevik tower and KV Nornen. No one had had any contact with the aircraft after

[1] 19 of the flying clubs that are members of the Norwegian Air Sports Federation (NLF) conduct organized public-utility flights via the Flight Service organization, cf. also Chapter 0

1235 hours, when they reported having discovered a potential object in the sea. A major rescue operation was initiated. The three people who had been on board were picked up after almost six hours in the sea. One person was unconscious and later died in hospital.

The AIBN has identified several deficiencies in the organization, planning and implementation of the search that took place. These relate in particular to communication and surveillance of the flight. Furthermore, the AIBN is of the opinion that the PA-28-161 aircraft model has several features that make it poorly suited for search operations above the open sea.

The AIBN issues two safety recommendations in connection with this investigation.

1. FACTUAL INFORMATION

1.1 History of the flight

1.1.1 During the night before Saturday 22 June, a person fell overboard from the passenger ferry MS "Stavangerfjord" approx. 11 NM south of Mandal. A major rescue operation was subsequently launched. Saturday morning the rescue operation transformed into a search for a presumed dead person (SEAO). This entailed that responsibility for the operation was transferred from the Rescue Coordination Centre to the Agder Police District operation center.

1.1.2 At 0610 hours, the Agder Police District operation center contacted the head of the Flight Service[2] in Agder Police District and asked for assistance in searching for a presumed dead person in the sea south of Mandal. The head of the Flight Service responded that it might be difficult as the club's aircraft was unavailable due to maintenance. However, Kjevik Flying Club collaborates with Sola Flying Club and he said he would check with them before giving a final answer.

1.1.3 At 0627 hours, the head of the Flight Service in Agder Police District called the head of the Flight Service in the South-West Police District. The head of the South-West Police District Flight Service replied in the affirmative and found that LN-MTJ could be used, even though it had been booked by another person for a flight on the same day. Flight Service operations had priority over other use of the aircraft. He has explained to the AIBN that he consequently traveled to the Sola Flying Club hangar to prepare the aircraft. Before moving the aircraft, the fuel tanks were checked to make sure there was no water in the fuel.

1.1.4 At 0652, the head of the Flight Service in Agder Police District called the operation center and confirmed that they accepted the mission. During their conversation, they agreed that the aircraft crew would communicate with the KV Nornen Coast Guard ship, which was the on-scene coordinator.

1.1.5 The head of the Flight Service in Agder Police District and the operation center in Agder Police District also had subsequent contact over the telephone. Except for stating that the weather was good for flying and a comment that the operation would take place 11 NM (approximately 20 km) off shore, the safety of the pilots was not discussed during their conversations. As regards follow-up of the operation, the head of the Flight Service said

[2] The Flight Service is affiliated with the Norwegian Air Sports Federation (NLF) and thus not part of the police (cf. Chapter 1.17.1).

they would be able to search the area for approximately five hours, before having to return to Kjevik Airport to refuel.

1.1.6 In connection with start-up of the operation, the police had telephone contact with the Rescue Coordination Centre, KV Nornen and the Armed Forces' operative headquarters. One topic of conversation was communication and establishment of a communication group on the Norwegian Digital Emergency Communication Network[3].

1.1.7 The head of the Flight Service in the South-West Police District contacted the person who had booked LN-MTJ to find a solution. This person had no specific plans other than conducting a navigation flight and immediately offered to assist in the planned search operation.

1.1.8 The head of the Flight Service took LN-MTJ out of the hangar. He put one liter of oil in the engine[4] and refilled the fuel tanks. Having performed the daily inspection, he bought two baguettes and two cans of soda before the person who had booked the aircraft arrived.

1.1.9 Together, they flew LN-MTJ from Stavanger Airport Sola (ENZV) to Kristiansand Airport Kjevik (ENCN). The head of the Flight Service was the Commander on the flight.

1.1.10 At Kjevik, LN-MTJ taxied to the fuel facility, where they met the head of the Flight Service in Agder Police District. At the fuel facility, they topped up with 28.3 liters of fuel. They estimated that they had about 150 liters on board after refueling, sufficient for a five hour-flight. They walked around the aircraft and checked the oil level to ensure that everything was in order.

1.1.11 In the meantime, the head of the Flight Service in Agder Police District had been in contact with the Coast Guard ship KV Nornen. They established that LN-MTJ could stay in the area for about four hours. Based on this information, KV Nornen prepared the coordinates for a rectangular search area and sent the following coordinates by e-mail:

- 5749,0N-00752,0E
- 5743,0N-00752,0E
- 5743,0N-00730,6E
- 5749,0N-00730,6E

1.1.12 The coordinates were entered into the Air Navigation Pro software on a tablet that they brought with them (cf. Figure 1). To save time and not have to explain the details over the aircraft radio, the head of the Flight Service in Agder Police District had also e-mailed the search area coordinates to Kjevik tower (TWR). No partial or complete flight plan was sent to Norway Control.

[3] Communications network for police, health services and fire services as well as other organizations in Norway with preparedness and emergency responsibilities. The network system is based on Terrestrial Trunked Radio technology (TETRA) and is encrypted. The crew used a hand held unit to communicate via this network.
[4] Until the dipstick reading showed 7 quarts.

Figure 1: Tablet screen shot showing the Air Navigation Pro software with the search area coordinates (magenta) and the course from Kjevik Airport. The Kristiansand Airport Kjevik (ENCN) control zone is indicated in blue (the smallest area around the airport). Source: Air Navigation Pro screen shot

1.1.13 Prior to departure from Kjevik, the crew assessed the operation and allocated the work tasks. They put on life jackets and loaded the aircraft with equipment and some baggage. They decided that the person who had initially booked the aircraft would fly the aircraft and function as Commander during the search. The head of the Flight Service in the South-West Police District (hereinafter referred to as the observer) took the back seat on the right hand side, and the head of the Flight Service in the Agder Police District

(hereinafter referred to as the navigator) took the front right seat. He assumed responsibility for navigation and communication with Norway Control. They also carried a handheld radio to be able to communicate with KV Nornen and the Agder Police District operation center over the Digital Emergency Communication Network. All three had headsets for internal communication.

1.1.14 After a routine engine check, LN-MTJ took off from Kjevik Airport at 1217 hours. The navigator reported to the tower that they would conduct a search flight for a presumed dead person in the sea using the given coordinates. He also notified KV Nornen of their departure from Kjevik. Initially, LN-MTJ climbed to 1,500 ft, heading south-west to the north-eastern corner of the search area (SAR 1 in Figure 1). Just before reaching their destination, they descended to an altitude of between 500 and 600 ft, heading west. At 1229 hours, the navigator called up KV Nornen and reported that they had started the search. The search flight was conducted with an engine speed of 2,100–2,200 rpm, providing an airspeed of 80–85 kt (150–160 km/h).

1.1.15 Shortly after starting the search westward, the observer spotted an object in the sea. He told the Commander to make a right turn, but still lost sight of the object. They circled the area three or four times, but did not see the object again. The potential discovery was reported to KV Nornen at 1235 hours, so that KV Nornen could continue searching the area.

1.1.16 LN-MTJ continued flying west until reaching the north-westerly point of the search area. The plan was to turn around at that point and conduct a new search in an easterly direction. At that time, the Commander increased the engine speed and climbed slightly while turning left to start the new search 0.5 NM further south. At that point, the aircraft encountered tailwind.

1.1.17 The observer and the navigator have explained to the AIBN that everything was normal in the turn, but that they suddenly noticed that the engine rpm dropped as they were about to initiate the search eastward. The observer asked "What's happening?", after which the Commander remarked with displeasure that the engine had stopped. There is uncertainty to what happened next and regarding the sequence of events. The two survivors have explained to the AIBN that the Commander pushed the throttle and mixture forward and switched on the electrical fuel pump. Furthermore, the Commander was down by the tank selector and engaged the starter. The navigator called up KV Nornen and said that they had lost engine power and were descending towards the sea[5]. Someone called out that they had to check that the seat belts were OK.

1.1.18 There were no unusual engine sounds and, due to the relative wind, the propeller was windmilling. Just before the aircraft hit the sea, the engine revved up. The aircraft leveled off as the left wing hit the crest of a wave. The two survivors estimate that they hit the water across 2–4-meter-high waves and with a speed of just under 150 km/h. The observer and the navigator have stated that the aircraft then received a heavy blow as the right wing struck the water. They were both flung into the wall of the cabin, on the right. It was unpleasant, but they were not injured.

1.1.19 The aircraft was sinking quickly as the navigator and observer tried to open the door. They lost some time as they had problems with the upper lock. Before they managed to

[5] In retrospect, it was realized that they were flying too low to be able to make contact.

open the door, the water had already reached the window, and when they opened the door, the water gushed in. The observer and navigator have divergent opinions on who escaped first but agree that the Commander got out last. At that time, there was only a 10–15 cm clearing before the water level reached the cabin ceiling.

1.1.20 The observer climbed backward toward the tail and held on to an antenna. However, the aircraft sank with the nose first, approximately 15 seconds after they had evacuated. The observer and navigator had then inflated their life jackets. The Commander was floating heavily in the sea and had problems finding the pull cord on his life jacket. The other two had to help him inflate his life jacket.

1.1.21 All three gathered face to face and checked their cell phones. The Commander's cell phone worked briefly, but there was no mobile coverage. The navigator looked at his watch, which showed 1255 hours. They spotted one of the aircraft's main wheels floating in the sea 2–3 meters ahead. They thought the wheel would provide buoyancy if necessary and gathered around it.

1.1.22 The waves crashed over their heads and they had to constantly make sure they did not swallow any seawater. They were initially quite optimistic. They hoped that KV Nornen had seen their emergency landing, or that they had heard the distress call. However, the Commander ran into trouble and started vomiting. He also expressed serious pessimism. After a short while, he started to lose grip on the wheel and drifted away. The others called out to him to come back. When he stopped reacting to their calls, one of the two swam towards him and helped him back, so that all three were holding onto the wheel again.

1.1.23 The two others were exhausted as they had to swim off to get the Commander several times. At one point, he had drifted quite far from the others when they were separated by a large wave, and after that they lost sight of him. They concluded that they would be in danger of losing each other if they tried to retrieve the Commander. At that time, they had been in the sea for about four hours and the two concluded they had three alternatives: swim toward the shore, freeze to death or drown. Both have stated to the AIBN that they could not give up. Instead, they decided to swim slowly towards the shore. They agreed to be disciplined and only accept positive thoughts.

1.1.24 At times, they were shivering severely, and their teeth were chattering. After a while, the observer experienced intense pain in his groin caused by the life jacket strap between his legs. However, he was worried that if he adjusted it, the buckle that kept the life jacket in place might come loose. He perceived it to be critical should the life jacket come loose or puncture. If that were to happen, the only buoyancy aid would be the wheel. The navigator has explained that he almost fell asleep several times but was kept awake by waves breaking over his head. They got some heat from the sun by turning their faces to the south, but the waves were also breaking over them from that direction, which meant they had to alternate which way they turned their faces. When the waves carried them up, they could spot a strip of land and they noticed that currents were carrying them eastward. To stay on course and keep their spirits up, it became important to keep the strip of land within sight.

1.1.25 After about five hours in the sea, they were sure help was on its way as the aircraft had failed to return to Kjevik by the time the fuel tanks should have been emptied. After a while, they heard one of the Norwegian Armed Forces' Sea King rescue helicopters

approach them from the north-west. To their great disappointment, the helicopter passed overhead without stopping. A rescue helicopter passed above them another two times without spotting them. Shortly afterwards a cargo ship emerged from the east. The "Falkbris" cargo ship approached the two people in the sea from the north. "Falkbris" had aborted their search for the aircraft only a few minutes earlier and was heading toward Lista. The two people in the sea saw that there were people on the aft deck, and the observer tried to blow his whistle. This resulted in him blowing the whistle straight out of his mouth, as his lips were too cold to keep it in place. Consequently, he had to keep the whistle in place with one hand to be able to make a sound.

1.1.26 The two people in the sea saw one person running up to the bridge and one person waving to them from the deck. It was approximately 1822 hours. "Falkbris" slowed down and turned left. At the same time, two Sea King rescue helicopters approached and one hovered above the two people in the sea. Shortly after, both were hoisted into the helicopter and were taken care of. They had been in the sea for almost six hours. A member of the rescue team asked how many people had been on board the aircraft and where the third person might be. They believed the Commander was located a bit further south.

1.1.27 Just after 1830 hours, they learned that the Commander had been picked up from the sea by the other Sea King rescue helicopter. The Commander was unconscious and was taken to Ullevål University Hospital in Oslo where the intensive care continued. Two days later, the Commander was pronounced dead, on 24 June 2019.

1.1.28 The observer and the navigator were flown to the Hospital of Southern Norway in Kristiansand where they arrived at 1905 hours. The two escaped the accident with no physical injuries.

1.2 Injuries to persons

Table 1: Injuries to persons

Injuries	Crew	Passengers	Other
Fatal	1		
Serious			
Minor/none		2	

1.3 Damage to aircraft

The aircraft sank to about 470 meters depth and is considered lost.

1.4 Other damage

Discharge to the sea of about 132 liters of AVGAS 100 LL fuel and approximately 6 liters of engine oil.

1.5 Personnel information

1.5.1 The Commander

1.5.1.1 The Commander, 54 years old, obtained his private pilot license (PPL(A)) from Sola Flying Club in 2010. On 25 November 2018, his license to fly single-engine piston (SEP) airplanes was extended to operate VFR night flights. The night rating also included a

proficiency check (PC) provided by the club (club PFT). The Commander had been approved for service in the Flight Service.

1.5.1.2 The Commander held a valid medical certificate, Class 2, with limitations: VNL "*Shall have available corrective spectacles for near vision and carry a spare set of spectacles"* and RXO (routine eye examination required).

Table 2: Flying experience Commander

Flying experience	All types	On type
Last 24 hours	0:30	0:30
Last 3 days	0:30	0:30
Last 30 days	0:30	0:30
Last 90 days	1:20	1:20
Total	188 hours	Unknown

1.5.2 The navigator

The navigator was the head of the Flight Service for Agder Police District. He had no formal role on board the aircraft, but assumed responsibility for navigation, lookout and partly for communication with other units. The navigator started flying private aircraft in 2012 and held a valid private pilot license (PPL(A)). His total flight experience was approx. 150 hours.

1.5.3 The observer

The observer was head of the Flight Service for the South West Police District. He had no formal role on board but provided lookout during the search. The observer started flying in 2008 and held a valid private pilot license (PPL(A)). His total flight experience was approx. 300 hours.

1.6 Aircraft information

1.6.1 General

This aircraft is a single-engine low-wing aircraft that seats four people, two in the front and two in the back. The wings, fuselage and all control surfaces are of conventional aluminum construction. The cockpit is equipped with flight controls on both sides. Access to the cabin is through a door on the right, just above the wing. The door is kept locked by two individual locks: one at its rear edge and one at the top.

1.6.2 Aircraft data

Manufacturer:	Piper Aircraft Inc.
Type/model:	PA-28-161 Warrior II
Serial number:	28-8216021
Year of manufacture:	1982

Calculated total flight time	11,875:23 hours[6]
Engine type:	Lycoming O-320 D3G
Propeller:	Sensenich 74DM6-0-60
Maximum take-off mass:	1,055 kg (2,325 lb)
Fuel type:	AVGAS 100 LL

The aircraft Airworthiness Review Certificate was valid until 17 September 2019.

Figure 2: LN-MTJ. Photo: Erlend Karlsen

1.6.3 Equipment

1.6.3.1 The PA-28-161 model is equipped with two fuel tanks in the wings. Each tank holds 24 US Gal (91 liters). There is a fuel tank selector on the side panel in front of the Commander's seat with the settings OFF, L TANK and R TANK. The fuel tank selector is equipped with a safety catch to prevent it from accidentally being set to the OFF position. An engine driven fuel pump supplies fuel to the carburetor. For take-off and landing, and in case of a failure in the engine driven fuel pump, the aircraft is also equipped with an auxiliary electrical fuel pump.

1.6.3.2 LN-MTJ was equipped with a Narco AR-500 encoder. The encoder transmits information about identity and altitude to air traffic control's secondary radars. According to Kjevik control personnel, the encoder functioned as it should in periods when the aircraft was within radar coverage.

1.6.4 Mass and balance

1.6.4.1 It has not been possible to establish the exact amount of fuel left in the aircraft when it crashed. If the aircraft had 150 liters on board when it took off from Kjevik (cf. section 1.1.10), consumption up to the crash would have reduced the amount by approx. 18 liters.

[6] The pilot who flew the aircraft on the day before the accident has photographed the aircraft's flight log after the flight. It shows that the aircraft had flown a total of 11,873:45 hours.

This means there would have been about 132 liters of fuel left in the tanks when the aircraft came down. The mass of the three people on board included clothes, various equipment, food and drink, etc. A rough estimate of 5 kilos have consequently been added to each.

Table 1: Estimated mass and center of gravity.

	Mass (lbs)	Arm (in)	Momentum (in x lbs)
Empty weight LN-MTJ	1,544.4	87.1	134,517
Estimated amount of fuel[7]	206.6	95.0	19,627
The Commander	240.3	85.5	20,546
The navigator	231.5	85.5	19,793
The observer	220.0	118.1	25,982
Total	2,442.8	90.3	220,465

1.6.4.2 The aircraft's mass at the time of the crash was 2,442.8 lb. This means an approximate 117.8 lb (53.4 kg) above the maximum permitted mass. With a mass of 2,442.8 lb the arm would be between 88 and 93 in. Consequently, the aircraft's estimated arm of 90.3 in was within the limitations.

1.6.5 Maintenance

1.6.5.1 The flight log sank together with the aircraft. Consequently, it has not been possible to obtain all the maintenance details for the aircraft.

1.6.5.2 According to the aircraft technical records, LN-MTJ was subject to a 100-hour inspection, combined with an annual inspection, on 24 August 2018. A 100-hour inspection was also performed on the aircraft on 6 February 2019. At the time of inspection, the aircraft had a total flight time of 11,790:40 hours.

1.6.5.3 After this, Sola Flying Club performed a 50-hour inspection on 23 May 2019. The total flight time was then 11,842:35 hours. There were no identified problems or comments relating to the aircraft at that time.

1.7 Meteorological information

1.7.1 General

1.7.1.1 According to a report from the Norwegian Meteorological Institute, the weather situation in the area south of Mandal on 22 June was dominated by a high pressure (1,025 hPa) with its center just west of Denmark. There was no precipitation and visibility in the area was good.

[7] Based on one liter of fuel weighing 1.57 lb (0.71 kg).

1.7.1.2 The Norwegian Meteorological Institute has no weather observations for the sea area south of Mandal. They have some wind and temperature observations for the coast and have assessed weather and wave conditions based on these observations and data from atmospheric models and wave models. They consider that the average wind speed was 15–20 kt (8–10 m/s), measured at a 10-meter altitude and over a 10-minute period, and that the wind was strongest at the beginning of the period, from 1250 to 1830 hours.

1.7.1.3 Model calculations have shown that the significant wave height[8] was 1.25 meters at the beginning of the period and that it decreased to 1.0 meter toward the end of the period. The maximum wave height could have been around 2.5 meters initially. The surface temperature in the sea was 14 °C.

1.7.1.4 The navigator has stated that the sea was choppy at the time they were rescued.

1.7.1.5 The Norwegian Meteorological Institute has no air temperature or dew point measurements for the sea area south of Mandal. An operational atmospheric model shows that the air temperature at 1300 hours at an altitude of 2 meters, was 13 °C and the dew point temperature 7.5 °C. Correspondingly, the model shows that the temperature was 11 °C at 150 meters altitude and the dew point temperature just below 6 °C.

1.7.2 TAF and METAR

1.7.2.1 The following terminal aerodrome forecasts (TAF) and routine weather observations (METAR)[9] applied to Kristiansand Airport Kjevik (ENCN) for the relevant period (times in UTC):

1.7.2.2 TAF

ENCN 221100Z 2212/2221 28010KT CAVOK=

ENCN 221400Z 2215/2221 30010KT CAVOK=

1.7.2.3 METAR

ENCN 220950Z 29009KT 230V320 9999 FEW049 17/06 Q1022=

ENCN 221050Z 29010KT 250V330 CAVOC 18/05 Q1022=

ENCN 221150Z 28010KT 230V330 9999 SCT055 18/04 Q1022=

ENCN 221250Z 32008KT 230V360 CAVOK 20/06 Q1022=

ENCN 221350Z 30010KT 250V330 CAVOK 18/04 Q1022=

ENCN 221450Z 28009KT 240V320 CAVOK 18/04 Q1022=

ENCN 221550Z 270008KT 230V320 CAVOK 19/04 Q1022=

ENCN 221650Z 26011KT 230V320 CAVOK 18/06 Q1022=

[8] The average of the highest one-third of the wave.
[9] For an explanation of meteorological abbreviations, see: https://www.ippc.no/ippc/index.jsp

1.8 Aids to navigation

The instruments on LN-MTJ were in conformance with instrument flight rules (IFR) In addition, the three people on board had brought with them a tablet with the program Air Navigation Pro. The program was also installed on a cell phone as back-up. On the same units, they had installed the program Topo GPS for plotting any discoveries.

1.9 Communications

1.9.1 LN-MTJ was equipped with a VHF aircraft radio. While LN-MTJ was in the Kjevik control zone, the aircraft maintained two-way communication on the 119.95 MHz frequency. There was no communication between the units after the aircraft left the control zone. In the area in question, there is no requirement for two-way communication with air traffic control when an aircraft is below 2,500 ft. Generally, aircraft radio communication within the 118–136 MHz (VHF) frequency range requires a free line of sight. The aircraft was flying at a low altitude over the sea south of Mandal and communication may consequently have been lost.

1.9.2 At approximately 1600 hours, Kjevik tower tried to establish contact with LN-MTJ through an SAS airplane that took off from Kjevik and flew over the area, but without success.

1.9.3 The people on board LN-MTJ carried a Motorola Terrestrial Trunked Radio (TETRA) for use over the Digital Emergency Communication Network. The radio was in communication group 05, cooperation group 1 (05-SAVM-1) for communication between LN-MTJ, Agder police operation center and the Coast Guard Ship KV Nornen. The navigator had connected the emergency radio to his headset via Bluetooth. To make sure that they could reach everyone in the group, the signals were transmitted via a station on shore. The system is dependent on an almost free line of sight to the stations. When the navigator contacted KV Nornen at 1235 hours at an altitude of approx. 500 ft above the sea, the signals reached the onshore station and were subsequently transmitted to KV Nornen. However, neither the Agder police operation center nor KV Nornen received the distress call that had been made at a lower altitude, just before LN-MTJ struck the sea.

1.9.4 After the accident, the captain of KV Nornen has told the police that they did not have responsibility for the aircraft or it’s surveillance during the search. At 1257 hours, they nevertheless sent an SMS to the LN-MTJ navigator asking: *"How's the search going? We couldn't establish contact with you on the emergency communication network"*.

1.9.5 The captain of KV Nornen was of the opinion that it would have been natural for KV Nornen and LN-MTJ to communicate if a discovery were made. Other than that, he assumed the aircraft was in contact with Kjevik tower.

1.10 Aerodrome information

1.10.1 The airport has access to secondary radar data that communicate with aircraft encoders, making it possible to track an aircraft on radar showing its identity, speed, altitude and course. According to Kjevik tower personnel, the LN-MTJ encoder functioned as intended for as long as the aircraft was in the airport's control zone.

1.10.2 A secondary radar generally requires a free line of sight. This means that an aircraft flying at low altitudes above the sea south of Mandal may disappear from the radar.

1.11 Flight recorders

Not mandatory and not installed.

1.12 Wreckage and impact information

1.12.1 The accident site

1.12.1.1 The accident happened approximately 11 NM south of Mandal in an uncontrolled Class G airspace.

1.12.1.2 The sea depth in the area is 400–500 meters.

1.12.2 The wreckage

1.12.2.1 After interviews with the survivors, it was established that the engine revved up just before impact with the sea. Determining whether water contamination of the fuel was a potential cause of engine failure, would not be possible after the crash.

1.12.2.2 It was decided not to raise the wreckage from the seabed (se also chapter 2.2).

1.12.2.3 One of the aircraft's main wheels, including the lower part of the landing gear leg, was discovered floating in the ocean.

1.13 Medical and pathological information

1.13.1 The Commander was unconscious when he was picked up from the sea at 1830 hours. Life-saving procedures were performed immediately, but the Commander was pronounced dead at Oslo University Hospital, Ullevål on 24 June.

1.13.2 A post-mortem was performed by the Department of Forensic Medicine at Oslo University Hospital. The post-mortem established that the cause of death was hypothermia and lack of oxygen to the brain. The post-mortem also revealed a hemorrhage on the heads right side. There were no indications of intoxicants.

1.14 Fire

No fire occurred in connection with the accident.

1.15 Survival aspects

1.15.1 General

1.15.1.1 LN-MTJ was not specially equipped for flights above the sea or for landing on water.

1.15.1.2 There was no life raft on board LN-MTJ. A life raft for up to six people weighs between 25 and 35 kg.

1.15.1.3 LN-MTJ was equipped with an emergency locator transmitter (ELT) of the Artex ME406 type. It activates automatically with high g-forces or it can be switched on manually. The

emergency locator transmitter cannot transmit signals under water. No emergency signals was received from LN-MTJ.

1.15.1.4 The surface temperature in the sea was 14 °C.

1.15.1.5 According to a table in *Review of probable survival times for immersion in the North Sea and Survival in cold water (Robertson & Simpson, 1996; Brooks, 2001)* a person will survive for about 75 minutes in water with a temperature of 14 °C. These estimates apply to young, slim and healthy men dressed in workwear in calm seas (few waves).

1.15.1.6 The report *Survival in Cold Waters: Staying Alive. (Transport Canada, 2003)* describes, e.g. how long a person can survive in water. The chapter *Long-term immersion or hypothermia* refers to various experience and research results. Without specifying the type of clothing, it is estimated in Figure 5 (page 14) that a person can survive for 3–9 hours in a water temperature of 15 °C.

1.15.1.7 A number of tables describe body temperature and the level of criticality during hypothermia. Most tables states that shivering stops when the body temperature drops below 32 °C and that any temperatures below this might lead to unconsciousness and cardiac arrest.

1.15.2 Personal equipment/clothing

1.15.2.1 The three people on board wore dark blue flying suits with a minimum of clothing underneath. The observer was only wearing underwear underneath his suit. The Commander and navigator also wore a t-shirt. According to their explanations, the reason for the light clothing was that it was hot inside the aircraft.

1.15.2.2 All three were wearing yellow life jackets during the flight. They wore yellow reflective vests under the life jackets.

1.15.2.3 All three were strapped in with three-point seat belts.

1.15.2.4 All aircraft must be equipped with a permanent emergency locator transmitter. Alternatively, one or several people on board must have a Personal Locator Beacon (PLB) which submits signals on the 121.5 MHz and 406 MHz frequencies. These beacons must be manually activated, are watertight and submit signals provided the antenna is not submerged. The use of PLBs is regulated by the national communication authority and there is an annual sector fee of NOK 460 for carrying the equipment. None of the three carried a PLB.

1.15.3 The rescue operation after LN-MTJ was reported missing

1.15.3.1 At 1528 the Agder police operations center called up Kjevik tower and asked if they had contact with LN-MTJ. The tower replied that the aircraft was probably flying too low to be picked up by the primary or secondary radar and for radio contact. The reason for the concern was that KV Nornen had not had any contact with the aircraft either. An attempt to call the navigator on board failed as the cell phone went straight to voicemail.

1.15.3.2 During the period after 1600 hours, the police operations center, KV Nornen, Kjevik tower and the Rescue Coordination Center stayed in contact with each other to clarify who had had contact with the aircraft and when, and what could be expected with regard

to the aircraft's maximum flight time. There was uncertainty related to this as the aircraft had not submitted a flight plan.

1.15.3.3 At approximately 1615 hours, the Rescue Coordination Center decided to initiate a search for the missing aircraft. At first a communication search was initiated at the same time as one of the Norwegian Armed Forces' rescue helicopters at Rygge (Saver 60) was notified. The helicopter set course for Kjevik. Shortly after, one of the Norwegian Armed Forces' Sea King helicopters from Sola (Saver 50) joined the search.

1.15.3.4 At 1635, the coast radio station for Southern Norway broadcast the following message:

> *All boats, Coast Radio South, we are looking for a small aircraft between Lindesnes, Kristiansand and Denmark. Anyone who has observed a small aircraft for 2-4 persons, in the last 4 to 5 hours please contact Coast Radio South. This is Coast Radio South, channel 16.*

1.15.3.5 After the call, the tanker "Ingrid Knutsen" contacted the coast radio at 1637 hours stating that a person on board thought he had seen an aircraft descending toward the sea at approx. 1300 hours (cf. Chapter 1.15.4)

1.15.3.6 Based on this information, Coast Radio South issued a new Mayday relay at 1705 hours instructing all boats to look for a missing aircraft in the specified area:

> *Mayday relay, Mayday relay, Mayday relay. All boats, all boats, all boats, this is Coast Radio South, Coast Radio South, 002570000, Mayday. A small aircraft in the Lindesnes, Kristiansand area, direction Denmark has gone missing. It may have crashed in the Mandal-Kristiansand area, some nautical miles towards Denmark. Immediate assistance required. 2-4 people are presumed to be on board. Assisting boats, please report. Sola Joint Rescue Coordination Center is coordinating. Communication is on Coast Radio South, channel 16. This is Coast Radio South.*

1.15.3.7 Several vessels participated in the search, including the rescue vessels "Bent Rasmussen" and "Askeladden". A number of other vessels also passed through the area and kept a lookout.

1.15.3.8 The observer and the navigator were found by the cargo ship "Falkbris" at 1822 hours. Shortly after, the Commander was also found and all three were hoisted on board the Norwegian Armed Forces' Sea King rescue helicopters at approximately 1830 hours.

1.15.3.9 When the navigator arrived at Sørlandet Hospital he had a body temperature of 36.2 °C. The observer's body temperature was 33 °C.

1.15.4 The observation from the tanker "Ingrid Knutsen"

1.15.4.1 The "Ingrid Knutsen" tanker was on its way from Slagentangen oil refinery to the Gullfaks oil field in the North Sea. It was traveling about 20 NM off shore in the search area when LN-MTJ lost engine power and descended towards the sea. At about 1200 hours, the first officer of the ship was contacted by Coast Radio South and asked to keep lookout for a person who had fallen overboard from a passenger ferry. After receiving the message, a person was instructed to keep lookout from the bridge.

1.15.4.2 The lookout has told the police that he spotted an aircraft to the right of the vessel, just before 1245 hours. The aircraft was descending and landed on the water. It subsequently disappeared. He reported that the plane had disappeared to the first officer. They looked for the aircraft with binoculars but did not spot anything. The first officer did not think that an accident had occurred. It was not until the coast radio reported an aircraft missing in the area at 1635 hours, that "Ingrid Knutsen" reported the observation they had made earlier in the day.

1.16 Tests and research

After it was established that an accident had occurred, routine samples were taken of the Kjevik fuel facility tank. Samples taken from the pistol muzzle and the bottom of the tank showed no signs of water in the fuel.

1.17 Organizational and management information

1.17.1 The Flight Service

1.17.1.1 *General about the Flight Service (Flytjenesten)*

LN-MTJ was operated by Sola Flying Club, a member of the Norwegian Air Sports Federation (NLF). 19 of the NLF flying clubs conduct organized public-utility flights via the Flight Service organization. The Flight Service offers public services that can be carried out using the clubs' aircraft and voluntary crew. The Flight Service offers mainly:

- Forest fire surveillance and assistance during forest fires.
- Rescue services (search) upon request from the Rescue Coordination Centre or the police. This includes searches for persons presumed dead (SEAO).

The Flight Service is a member of the voluntary umbrella organization Norwegian Forum for Rescue Organisations (FORF). The Rescue service has been operative since 1974.

Pilots receive no remuneration for their services. However, direct expenses are covered by a fixed hourly price of NOK 2,120.

1.17.1.2 *Statues for NLF's Flight Service*

The Norwegian Air Sports Federation's Flight Service is governed by the Federation's Statutes, most recently revised on 21 August 1995, when the NLF was called the Norwegian Aero Club (NAK). We site the following selected paragraphs:

> *Section 2-2 (Management of the NAK's Flight Service)*
>
> *The Board of the powered aircraft section shall appoint a head for NAK's Flight Service and a number of members to a management team, depending on the approved organization at any given time (cf. Chapter 3).*
>
> *Section 2-3 (Local Flying Corps)*
>
> *Each flying corps that conducts flight missions pursuant to Section 1-3 under the direction of NAK's Flight Service must establish a flight corps and appoint its head (cf. Chapter 4). The flying corps is organizationally subordinate to the Board of Aero Club, and under the technical authority of NAK's Flight Service.*

(…)

Section 3-1 (Composition)

The NAK Flight Service management team must consist of a:

Head of the NAK Flight Service

Technical manager of the Rescue Service

Technical manager of the Forest Fire Services

Training manager

Other specialist staff as required

(…)

Section 3-4 (Technical manager Rescue Service)

The technical manager shall be responsible vis-à-vis the contracting party for ensuring that the service is provided in a professional and safe manner (quality assurance).

The technical manager shall by authority be responsible for e.g.:

- *Maintaining daily professional contact with the Ministry of Justice's rescue and readiness section, the Rescue Coordination Center, and the police/police sergeants.*
- *Coordinating, managing and supervising the rescue service of clubs providing such services.*

The technical manager for the Rescue Service is subordinate to the NAK Flight Service president.

1.17.1.3 *The safety of all personnel who participate in the Flight Service*

The NLF conducts courses for all Flight Service participants. A special booklet has been prepared for these courses. The course material specifies certain requirements for participating service personnel. It establishes requirements relating to qualification, quality assurance and authorization of personnel. To serve as Commander for the Flight Service, the following are required:

- *a total of minimum 200 flying hours, of which 100 must be as a commander*
- *a minimum of 20 hours over the last 12 months*

The course material states that once a search or rescue mission has been accepted, a briefing must be held with the operation manager in charge. The briefing must cover:

- *allocation of search area*
- *altitude and type of search pattern that will be flown*
- *the report system that will be used*
- *issuing notifications and alternative methods of communication*
- *the route to the target, relevant weather information, notifications from the area*

- *other resources deployed on the ground and in the air*

The course material contains the following safety remarks:

> *For many years, accident reports have described accidents that should never have taken place:*
>
> - *Insufficient flight preparations – pilots having inadequate basic knowledge*
> - *An indifferent attitude to flight safety – special flight environment hazards*
>
> ***This must not take place on any of our missions! This is particularly important on our missions, as all assistance or rescue service resources are busy with another assignment!***

The course material also states:

> *During search and rescue missions, we must aim for an even higher safety level than during ordinary club flying.*

As regards navigation plans, we quote the following:

- *An ATC flight plan must be completed and submitted. The ATC should also be sent by fax to the Rescue Coordination Center. There is an example of a completed flight plan in the appendices to the course booklet.*

1.17.1.4 *Procedures for the Flight Service in Agder Police District*

The Flight Service in Agder Police District has prepared a job description for all parties who take part in missions for the Flight Service. The document contains the following text:

> *If a person on board believes safety is compromised during the flight, the mission must be aborted!*

1.17.2 Rescue service organization

The Norwegian Ministry of Justice and Public Security has issued a manual for the rescue service. Chapter 10.1 of the manual states the following with regard to responsibility for safety:

> *All parties have independent responsibility for ensuring that all operations are conducted as safely as possible. This means that everyone must help identify and handle any risk elements. Correspondingly, each person must ensure that they act in as safe a manner as possible. Beyond this, special responsibility rests with the management of each government department/organization. The response manager has overall responsibility for safety during the operation. Depending on the type of incident, the response manager receives assessments from other parties involved such as the response commander for fire services in the event of fire, accidents and chemical incidents, or the head of voluntary organizations in the event of landslides/avalanches, challenging terrain searches and alpine rescue.*

1.17.3 Search for a person presumed dead (SEAO)

1.17.3.1 *Flight guidelines*

The Civil Aviation Authority has defined SEAO as state aviation. At the time of the accident, there were no special regulations governing such activity. As a minimum requirement, such flights must therefore be conducted pursuant to the general rules for private aviation in Norway.

The Civil Aviation Authority finds that the flight in question should also be defined as *Specialized Operations.* The pan-European regulations for *Non-Commercial Air Operations NCO.SPEC.105 Checklist* apply for such operations:

> *(a) Before commencing a specialized operation, the pilot-in-command shall conduct a risk assessment, assessing the complexity of the activity to determine the hazards and associated risks inherent in the operation and establish mitigating measures.*

In May 2020, the Ministry of Transport adopted new regulations FOR-2020-05-26-1076 *Regulations on civil state aviation with public law purpose, etc.* with effect from 1 January 2021. These regulations also apply to operations conducted by voluntary personnel.

1.17.3.2 *Agreements with the police*

In their circular letter 2014/010, the Norwegian Police Directorate prepared guidelines for searches for people that are assumed dead. Chapter 6.1 discusses operational aspects:

> *Responsibility for operational management rests with the police. The safety of rescue personnel must be given top priority during all operations. This is crucial for all plans that are made and all agreements that are entered into. Necessary risk assessments must be performed in each case.*

The detailed comments to section 6.1 of the agreement state the following:

> *Participants in search operations must under no circumstances be subjected to danger or put his or her own life and health at risk.*
>
> *Rescue personnel must at all times be subject to the laws and regulations, guidelines, restrictions etc. concerning HSE and use of equipment. It is a prerequisite that risk assessments and safe job analyzes are carried out.*

In 2012, the police signed a framework agreement with the voluntary organizations affiliated with the Norwegian Forum for Rescue Organisations (FORF). We quote the following from the agreement:

> ***2 General***
>
> *The expertise represented by FORF is important to the police in searches for a person presumed dead. This must consequently be taken into consideration when assessing voluntary resources against commercial and public resources.*
>
> *(…)*

4 Management

Searches subject to this agreement shall be managed by the police.

5 Request for assistance

Requests for assistance shall be forwarded to the operational manager for the resource in question, in the same way as for rescue operations.

6 Operational aspects

A search for a person presumed dead is not an urgent mission on par with search and rescue missions. The safety of rescue personnel must be given top priority during all operations. This is decisive for all plans that are made and all agreements that are entered into. Operational actions must be conducted in accordance with plans prepared by the police.

Other than this, the agreement mostly relates to financial aspects such as costs, compensation and invoicing.

1.18 Additional information

None

1.19 Useful or effective investigation techniques

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

2. ANALYSIS

2.1 Introduction

2.1.1 The investigation has been unable to determine with certainty why the aircraft lost its engine power for a brief period before it went into the sea. However, the impact with the sea was survivable, and the three people on board managed to stay afloat in the sea for an extended time. The AIBN has looked at the framework for the mission and what preparations and assessments were made prior to the flight. The AIBN analysis starts by Chapter 2.2 looking at potential reasons why the engine stopped supplying power. It then goes on to discuss the rescue operation in Chapter 2.3. The formal framework for the search is discussed in Chapter 2.4, responsibility for safety during the search operation is discussed in Chapter 2.5 and the planning of the operation, including risk assessments, is discussed in Chapter 2.6. In Chapter 2.7, the AIBN discuss the actual aircraft suitability of conducting safe searches above the open sea and finally in chapter 2.8, safety equipment and clothing are discussed.

2.2 Why did the engine stop supplying power?

2.2.1 <u>Fuel supply failure</u>

The AIBN assumes that LN-MTJ engine was fully functional and that it operated as normal until it suddenly stopped supplying power. Shortly after, however, the engine suddenly revved up. This indicates that the engine had no mechanical defects as the aircraft hit the ocean. The most likely explanation for such loss of power is lack of fuel supply to the engine. There are several reasons for insufficient fuel supply to the engine:

- The engine may have stopped supplying power for a brief period due to water in the fuel. However, as a result of wind milling the engine continued to rotate and, as the navigator and observer have stated, the Commander also activated the engine starter. Any water would have passed through the engine, new fuel would have reached the cylinders and the engine would have resumed normal operation. However, fuel samples taken at Kjevik verified that there was no water in the fuel (cf. Chapter 1.16). Moreover, it is unlikely that there would be water in the fuel as the aircraft was normally parked in a hangar and the tanks were checked for water contents before the aircraft took off from Sola. It is not possible to verify water in the fuel of a sunken aircraft. Consequently, there would be no answer to this question even if the wreckage were salvaged.

- A leak or blockage may have occurred in the aircraft fuel system which prevented fuel from reaching the engine. Switching to the other fuel tank with the fuel tank selector could have rectified this problem (cf. section 1.1.17). The fuel system on LN-MTJ is considered to be very simple and reliable. The AIBN finds it unlikely that such a problem occurred.

- Failure of the engine driven fuel pump. The engine would have restarted after the electrical fuel pump was switched on. The fuel pump on LN-MTJ is considered to be very simple and reliable. The AIBN finds it unlikely that the engine fuel pump stopped working.

- Incorrect operation of the aircraft engine or systems may have interrupted the supply of power. The aircraft had just climbed somewhat during a turn. It was descending toward the search altitude of 500–600 ft when the rotational speed continued to drop. During the turn, it is possible that the Commander adjusted the engine speed. The engine speed is reduced by pulling the throttle backward. The lever next to the throttle controls the mixture. Pulling the mixture lever back can result in the air/fuel mixture becoming too lean and the engine losing power. It cannot be documented whether this took place. The actions performed by the Commander, i.e. pushing the throttle and mixture forward, turning on the electrical fuel pump switch and running the engine using the starter would, together or separately, have re-started the engine.

2.2.2 Carburetor icing

Ice formation in the carburetor may cause engine failure. When the engine stops, the ice will melt quickly as the engine and engine compartment are warm. The engine can then be re-started. Carburetor icing most often occurs when there is little difference between the OAT and dew-point temperature. There are tables indicating the risk of carburetor icing. The phenomenon most often occurs with temperatures of 5–15 °C. The Norwegian Meteorological Institute has estimated that the temperature was 11 °C during the flight with a dew-point temperature of 6 °C. This gives a temperature difference of 5 °C, indicating a high risk of carburetor icing. Moreover, the risk of carburetor icing is higher the lower the power output. LN-MTJ was operating at relatively low engine power output, which increases the risk of carburetor icing.

Unfortunately, the tables are very general. They do not distinguish between the various engine types and engine installations. The PA-28-161 Lycoming O-320 engine installation is well-enclosed. Moreover, the carburetor and air inlet pipes are partially

integrated in the hot oil sump. This makes the PA-28-161 model relatively resistant to carburetor icing.

If ice starts to form on the carburetor, it is normally discovered as the engine rpm will drop somewhat[10] before the engine starts to run rough and eventually stops. The two survivors have explained that the engine rpm suddenly dropped without warning. This indicates that the engine did not stop because of carburetor icing. Although the AIBN finds it unlikely that the loss of power was caused by carburetor icing, it cannot be ruled out completely.

2.2.3 The ignition was turned off

It is possible that the engine lost power because the ignition was inadvertently switched off. However, if the engine is run by activating the engine starter, it will reignite, and the engine will start again. This course of event is unlikely as there was no real possibility of incorrect operation of the ignition switch.

2.3 The rescue operation after LN-MTJ went into the sea

2.3.1 The nature of the operation south of Mandal changed twice in a short time. What started as a rescue operation changed into a search for a person presumed dead (SEAO). When it emerged that LN-MTJ might have crashed into the sea, the operation changed again and turned into a rescue operation.

2.3.2 There are several indications that the lookout on the bridge of the tanker "Ingrid Knutsen" did in fact see the aircraft come down into the sea. The time and location fit the observation, and no other aircraft were known to be in the area at the time. If the observation had been understood and reported immediately, it is likely that attempts to contact the people on board LN-MTJ would have taken place earlier. In such a case, it is also likely that the rescue operation would have been initiated much earlier.

2.3.3 As the information from "Ingrid Knutsen" was not reported immediately, it was only the lack of communication with LN-MTJ that caused the police to be concerned (cf. Chapter 1.15.4).

2.3.4 The distress call that the navigator made when they realized that the aircraft would plunge into the sea (cf. sections 1.1.17 and 1.9.3) was not registered. This was most likely because the aircraft was flying too low over the sea at the time and thus the radio signals did not reach the base station.

2.3.5 Suspecting that the aircraft may have had an accident, the police contacted Kjevik tower at 1528 hours to inquire whether they had had any contact with the crew on LN-MTJ. For a period after 1528 hours, there was uncertainty relating to the communication with the aircraft. However, it emerged that no one had had any contact with LN-MTJ after 1235 hours. It took less than one hour from the time this uncertainty arose until the Rescue Coordination Center had launched a major rescue operation. However, it may seem mere chance that the three people were found in just over two hours, as the cargo ship "Falkbris" had terminated its search when the three people were spotted in the sea.

[10] This does not apply to engines with Constant Speed propellers

2.3.6 Had at least one of the three brought with them a personal locator beacon (cf. section 1.15.2.4) the accident could have been reported as early as at 1300 hours. This would also have provided an exact indication of their location. It is therefore a paradox that an annual fee of NOK 460 is charged for such safety equipment. The Ministry of Transport should consider whether the fee act as a barrier to procurement and use.

2.3.7 The Sea King helicopter passed above the two people with life jackets in the sea three times without spotting them. This illustrates how difficult it can be to spot people in the sea, especially if the sea is choppy with breaking waves. The dark blue flying suits blended in with the color of the sea. At the best, only the yellow life jackets were a contrasting color. There are dyes like Sea Dye Marker available at the market. The dye is released in the water in order to increase the visibility from air. This appears to be a convenient survival equipment when flying over open sea.

2.3.8 It is worth noting that the two survivors survived longer in the sea than is considered possible according to the table mentioned in section 1.15.1.5. The reason for this cannot be determined. The positive psychological effect of being gathered around a floating wheel may have been one factor.

2.4 The formal framework for the mission

2.4.1 As far as the AIBN can see, the police contacted the Flight Service and requested a search for a person presumed dead in line with the current instructions for a SEAO search. The Flight Service then accepted a mission which seems to have been formally in line with the intentions and guidelines for the Flight Service. The three people on board held the required certificates and type ratings to fly the aircraft, and the aircraft was formally airworthy. It had also been established that KV Nornen would be the on-scene coordinator.

2.4.2 Of the three on board, only the observer fulfilled the Flight Service's own minimum requirement for flight hours required to operate as a Commander. Otherwise, the search seems to have been implemented and conducted within the formal available framework. However, the AIBN has identified several deficiencies relating to the flight preparations (cf. Chapter 2.6) and to the suitability of the type of aircraft (cf. Chapter 2.7). Furthermore, one might ask whether the search took place in a safe and prudent manner, and to what degree the various parties assumed responsibility for safety during the mission (cf. Chapter 2.5).

2.4.3 In general, it may also be a question whether the Flight Service is qualified for conducting sea searches far from the shore. If the Flight Service is to conduct searches above the open sea in future, an assessment should be made of what improvements are necessary in terms of equipment, communication and the possibility of sending emergency alerts. The Ministry of Justice and Public Security, in dialogue with the Civil Aviation Authority should consider whether searches above the open sea should be conducted by professional services with equipment suitable for the increased risks associated with operations above the open sea. A safety recommendation is issued in this connection (Safety recommendation SL no. 2020/10T).

2.5 Safety responsibility during the search

2.5.1 It may seem that several of the parties involved assumed that safety responsibility during the search rested with another party. However, the guidelines for searches for a person presumed dead (SEAO) state that (cf. Section 1.17.3.2):

> *Responsibility for operational management rests with the police. The safety of rescue personnel shall be given top priority during all operations. This is crucial for all plans that are made and all agreements that are entered into. Necessary risk assessments must be performed in each case.*
>
> and
>
> *Participants in search operations must under no circumstances be subjected to danger or put his or her own life and health at risk. Rescue personnel must at all times be subject to the laws and regulations, guidelines, restrictions etc. concerning HSE and use of equipment. It is a prerequisite that risk assessments and safe job analyzes are carried out.*

2.5.2 This clearly shows that the formal safety responsibility rested with the police. However, maintaining flight safety is quite a complex and specialized task. The police cannot be expected to have the necessary expertise for assuming such responsibility for searches conducted by aircraft. That the police did not assume this responsibility during the aircraft search is confirmed by the fact that flight safety was not explicitly mentioned during the police's conversations with the head of the Flight Service for Agder Police District. These conversations focused mainly on whether the Flight Service could provide an aircraft, when they could start and coordination of communication between the various parties.

2.5.3 The AIBN is of the opinion that neither the police nor the Coast Guard assumed overall responsibility for the pilots' safety during the mission. One reason for this was that neither party was on board the aircraft, nor were they present when the Flight Service conducted detailed planning of the search. Another explanation may be that the police and the Coast Guard largely trusted the Flight Service and the pilots to handle any potential risks associated with the mission in a professional manner. However, the AIBN investigation has shown that the Flight Service did not perform an adequate risk assessment. All on board had flying as a hobby and this was thus not something they had professional experience with.

2.6 Preparations before the flight

2.6.1 When the Agder Police District operations center contacted the head of the Flight Service in their district and requested assistance to conduct a search, it emerged that Kjevik Flying Club did not have an available aircraft. This did not have any major operative impact, as Sola Flying Club had the same aircraft model available. One consequence was that the mission was somewhat delayed. However, this is not likely to have had any impact on the outcome of the accident.

2.6.2 As far as the AIBN is aware, none of the parties involved, neither the police, Coast Guard, nor the three people on board, conducted an actual risk assessment of the mission. When it comes to aviation, it is the Commander who has the formal responsibility for ensuring a safe flight. In this case, however, the other two people on board held key

positions in the Flight Service and important roles in the flight planning. A thorough risk assessment would have considered some key factors:

- The flight would take place more than 11 NM (20 km) from the shore.
- LN-MTJ had only one engine. A potential engine failure could result in an emergency landing at sea, far from the shore.
- When flying at an altitude of 500–600 ft, loss of engine power would mean that the aircraft would hit the water in less than one minute. This would give the crew very little time to handle the situation.
- The low sea temperature would entail a statistically relatively short survival time in the sea without the use of a survival suit or a life raft.
- The flight took place at low altitude and it was unlikely that there would be any radar coverage or air radio contact.
- The on-board emergency locator transmitter will not transmit signals once the aircraft has sunk. Unless they have a waterproof cover, cell phones will not work in contact with water. In the event of an emergency landing in the sea, the crew would, in practice, not be able to make a distress call.

2.6.3 A critical assessment of these factors would have revealed that the three people on board would quickly end up in the sea, should they encounter engine problems or other serious problems. Once in the sea, they would be out of sight from the shore and without a real chance to report an emergency situation. This means they would have to rely on somebody reporting them missing and launching a rescue operation.

2.6.4 Furthermore, the three people launched the rescue operation without submitting a flight plan to Norway Control. This constituted a breach of the Flight Service regulations (cf. Chapter 1.17.1.2) and meant, in practice, that they renounced their right to the search and rescue service that Norway Control provides. Among other information, a flight plan would contain information about the aircraft's endurance. If an aircraft has not landed within the predetermined time, the alarm will be raised. However, the lack of a flight plan did not, in fact, have any significant impact as the rescue operation was launched at 1615 hours. Based on the information in a potential flight plan, a rescue operation would not have been launched until the aircraft's endurance had expired at 1717 hours[11].

2.6.5 Furthermore, the AIBN finds that the search was conducted without a robust communication plan. This is based on the following factors:

- It is a well-known fact that air radio communication often fails when flying at low altitudes. This could have been solved had the aircraft climbed necessary for instance every 30 minutes to report that the flight was proceeding as normal. Such an arrangement would have had to be agreed by the Kjevik tower prior to take-off.

[11] Based on the navigator's statement that they could search the area for approximately four hours and that they estimated the flight to and from the search area to take approx. 30 minutes each way.

- It is also well known that there may not be radar coverage at low altitudes. This became particularly critical combined with lack of communication over the aircraft radio and in this case the Digital Emergency Communication Network.

- The parties involved did not agree to keep in regular contact via the emergency communication system. Consequently, it was not clear at what time the aircraft stopped participating in the search operation.

- No emergency communication equipment had been brought on board for sending a distress signal if the aircraft went into the sea. The three people on board could each have brought with them a personal locator beacon (PLB). Such a beacon would have continued to transmit signals even after the three on board had landed in the water.

2.6.6 The AIBN is of the opinion that the police, as head of SEAO operations, must assume special responsibility for establishing a robust communication plan to maintain the safety of all personnel involved in the search.

2.6.7 The AIBN's review of the relevant provisions and guidelines indicates that the Flight Service takes safety for granted during their flights. A search at low altitude over the open sea involves a number of challenges which are only to a limited extent emphasized in the general provisions for private aviation. Nor has this been included in the rescue service's or police guidelines. In fact, such an operation is in many ways similar to commercial operations and should thus be governed in a way that reflects this. In this connection, it is worth noting the SEAO requirements given in Chapter 1.17.3.1. The AIBN believes the Flight Service should revise its guidelines for such operations so that each mission is subject to a thorough risk assessment before the flight commences. A safety recommendation is issued in this connection (Safety recommendation SL no. 2020/11T).

2.7 Aircraft suitability

2.7.1 The search was conducted with an aircraft type that has several limitations for such operations. The AIBN is in general of the opinion that the flight times beyond gliding distance from land should be limited for single-engine aircraft.

2.7.2 Piper PA-28 is a low-wing aircraft. This means it will limit the field of view towards the ground or sea. Furthermore, the PA-28-161 has a relatively limited load capacity. In this case, the aircraft mass was an estimated 53.4 kg above the limit at the time of the accident (cf. section 1.6.4.2). At take-off from Kjevik, the mass was a few kilos more. There is nothing to indicate that the high mass was a contributing cause of the accident. In conclusion, however, the passenger weight or the fuel quantity must be reduced if this type of aircraft is to be used for such operations within the permitted limitations.

2.7.3 The aircraft type has only one door. This may delay evacuation, particularly if the fuselage is damaged or the aircraft inverted.

2.7.4 As mentioned, the aircraft is low-winged. This can be an advantage when landing on water because the wings will usually float for a while before filling up with water. A high-winged aircraft would also float on its wings for a while, but parts of the cabin would already have filled up with water. The AIBN has not assessed any other aircraft types, but based on the above-mentioned factors, we believe that the PA-28-161 model is poorly suited for search operations above open sea.

2.8 Emergency equipment and clothing

2.8.1 The above factors also make it difficult to bring a life raft on board. A life raft is quite heavy, which means the maximum permitted mass could constitute a problem. Furthermore, it would be necessary to bring the raft into the aircraft cabin. This raises the question of whether there would be enough time to evacuate the aircraft and launch the raft before the aircraft would sink.

2.8.2 The three people on board wore very light clothing. This was because it can get hot in the aircraft cabin. Survival suits or warmer clothing, e.g. wearing wool underneath their flying suits, would have delayed hypothermia once they were in the water. It is a good rule to always dress to survive an emergency en-route. This is clearly illustrated in the investigation reports (SL REP 2020/04) about the accident with RA-22312 on 26 October 2017 near Barentsburg on Svalbard and the accident with LN-OMY 5 December 2012 in Neustädter Bucht in Germany.

2.8.3 None of the three people on board wore a survival suit. Special flight crew survival suits are available, and it should be considered whether such suits should be worn during aircraft searches far from shore.

2.8.4 The accident highlights the importance of wearing life jackets and not just storing them in the cabin. Had they not worn their life jackets, it is unlikely that they would all have managed to find them before the aircraft sank. The use of personal locator beacon is described in Chapter 2.3.6. Visibility is described in Chapter 2.3.7.

3. CONCLUSIONS

3.1 Main findings

The AIBN has not been able to determine with any degree of certainty why the engine on LN-MTJ lost power at low altitude over the sea. When the engine revved up again, it was too late, and the aircraft came down in the sea. That two of the three on board survived for almost six hours in the cold sea, must be characterized as unusual. The AIBN has identified several deficiencies related to the organization, planning and implementation of the search for the presumed dead person (SEAO) that took place. These particularly relate to communication and observation of the flight. Furthermore, the AIBN is of the opinion that the PA-28-161 aircraft model has several features that makes it poorly suited for search operations above the open sea.

3.2 Investigation results

3.2.1 General

a) All three people on board held valid licenses and type ratings for the aircraft type.

b) The observer was the only one who fulfilled the Flight Service's own minimum requirement relating to minimum flight experience.

c) At the time of the crash, the aircraft was 53.4 kg over the maximum limit. In reality, this had no significant impact on the course of events.

d) The AIBN is of the opinion that many of the features of the PA-28-161 aircraft model make it poorly suited for search operations above the open sea.

e) There was no real option to bring a life raft on board the aircraft.

f) The weather was good during the search, as were the flying conditions.

3.2.2 The search operation

a) The police in Agder Police District requested assistance from the Norwegian Air Sports Federation's Flight Service to search for a person presumed dead.

b) The Flight Service is a member of the umbrella organization Norwegian Forum for Rescue Organisations (FORF).

c) The police had overall responsibility for operational management during the search.

d) The Coast Guard Ship KV Nornen was the on-scene coordinator for the search.

e) It may seem that the parties involved assumed that safety responsibility during the search rested with another party.

f) None of the parties conducted an actual risk assessment of the operation.

g) The search was conducted without a robust communication plan.

h) LN-MTJ carried enough fuel for about five hours' flight.

i) The three people on board wore life jackets.

j) The search was conducted at an altitude of 500–600 ft.

k) 11 NM (20 km) south of Mandal, Kjevik tower had no radio and radar contact with the aircraft due to its low altitude.

3.2.3 The accident

a) During the search, the engine lost power while flying over the sea at low altitude.

b) The engine restarted, but it was too late, and the aircraft went into the sea.

c) The AIBN has not found any information to indicate that the loss of engine power was due to a technical fault with the aircraft.

d) The AIBN has not been able to determine with certainty why the engine stopped supplying power.

e) As the aircraft was flying at a low altitude when the problem occurred, the TETRA distress call did not reach its recipients.

f) The aircraft sank shortly after and the three people on board evacuated and ended up in the sea.

g) The aircraft sank at a depth of approximately 470 meters.

h) The aircraft's ELT do not work under water.

i) None of the three on board had a personal locator beacon (PLB) and were thus unable to alert the rescue services after they ended up in the sea.

j) There was no cell phone coverage in the area and their cell phones were destroyed by sea water.

k) No distress calls or emergency signals were received in connection with the accident.

l) The three managed to gather around a floating wheel for about four hours. Eventually, the Commander drifted off from the others and was later found unconscious in the sea.

m) The sea temperature was 14 °C and the significant wave height was 1.25 meters, dropping to 1 meter towards the time when they were rescued.

3.2.4 The rescue operation

a) The crew had not submitted a flight plan prior to their departure from Kjevik, and no regular communication times had been established. Consequently, the three people were in the sea for three hours before they were reported missing.

b) Considerable resources were deployed in the search for LN-MTJ, including two of the Norwegian Armed Forces' rescue helicopters and two rescue vessels.

c) Coast Radio South alerted all ships in the area and asked them to keep lookout for a missing light aircraft. Hearing this, the tanker "Ingrid Knutsen" contacted the coast radio stating that a person on board thought he had seen an aircraft descend toward the sea at approx. 1300 hours.

d) Had the observation from "Ingrid Knutsen" been reported immediately, LN-MTJ would have been reported missing earlier.

e) Furthermore, had at least one of the three on board brought with them a personal locator beacon, the accident could have been reported at approximately 1300 hours. This would also have provided an exact indication of their location.

f) The three people in the sea were wearing dark blue clothing, which could have been one reason why they were difficult to spot from the air.

g) The cargo vessel "Falkbris" spotted the two survivors after they had been in the sea for almost six hours.

h) They survived longer in the sea than could have been expected.

4. SAFETY RECOMMENDATIONS

The Accident Investigation Board Norway issues the following safety recommendations:[12]

Safety recommendation SL no. 2020/10T

On 22 June 2019, the police requested assistance from the voluntary Flight Service to search for a person presumed dead (SEAO) in the sea south of Mandal. During the search at low altitude over the sea, LN-MTJ's engine lost its power and the aircraft ended up in the sea. The AIBN has identified several deficiencies related to the organization, planning and implementation of the search, which led to the death of one person and two people being left in the sea for about six hours before they were rescued.

The Accident Investigation Board Norway recommends that the Ministry of Justice and Public Security, in dialogue with the Civil Aviation Authority assess whether, in future, searches above the open sea should be conducted only by professional services with equipment suitable for the increased risks associated with such operations.

Safety recommendation SL no. 2020/11T

On 22 June 2019, a search for a person presumed dead (SEAO) was conducted at low altitude over the sea south of Mandal when the engine of LN-MTJ lost its power and the aircraft ended up in the sea. One of the three people on board died and two were saved after almost six hours in the sea without survival equipment. The AIBN's investigation has revealed that no actual risk assessment was conducted prior to the search (SEAO) and that the search was conducted without a robust communication plan.

The Accident Investigation Board Norway recommends that the NLF revise its guidelines for the Flight Service to ensure that each mission is subject to a through risk assessment, that a communication plan is prepared and that the required measures are implemented prior to the flight.

The Accident Investigation Board Norway

Lillestrøm, 26 June 2020

[12] The Ministry of Transport forwards safety recommendations to the Norwegian Civil Aviation Authority and/or other involved ministries for evaluation and monitoring, see Norwegian Regulations regarding public investigations of accidents and incidents in civil aviation, Section 8.

APPENDICES

Appendix A: Abbreviations

APPENDIX A: ABBREVIATIONS

AIBN	Accident Investigation Board Norway
E	East (Eastern longitude)
FORF	Norwegian Forum for Rescue Organisations
ft	Feet – (0.305 m)
hPa	hectoPascal
GPS	Global Positioning System
in	inch (2.54 cm)
kt	knot(s) – Nautical Mile(s) (1,852 m) per hour
lb	pound(s) (0.454 kg)
MHz	megahertz
m/s	meter per second
N	North (North latitude)
NAK	Norwegian Aero Club
NLF	Norwegian Air Sports Federation
NM	nautical miles (1,852 m)
PFT	Periodic Flight Training
SEAO	Search for a person presumed dead
TETRA	Terrestrial Trunked Radio
UTC	Coordinated Universal Time
VHF	Very High Frequency (30–300 MHz)