Norwegian Safety Investigation Authority

Published February 2026

REPORT AVIATION 2026/03

Air accident in the sea west of Sotra, Vestland County, Norway on 28 February 2024 with Sikorsky S-92A, LN-OIJ, operated by Bristow Norway AS

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

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

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

Photo: NSIA

Legal authority for the Norwegian Safety Investigation Authority's activities is enshrined in Section 12-6 of Act No 101 of June 11, 1993 relating to aviation (Aviation Act); cf. Section 3 of Regulations No 906 of July 7, 2016 on public investigations of accidents and incidents in civil aviation.

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Air accident report

Table 1: Data

Type of aircraft:	Sikorsky Aircraft Corporation S-92A. Serial No.: 920169
Nationality and registration:	Norwegian, LN-OIJ
Owner:	Aircraft MSN 920169 Trust
Operator:	Bristow Norway AS
Crew:	Six[1], one fatally injured
Passengers:	None
Accident site:	N 60.3100 E 004.8239, about 2 NM west of Løno island, about 3.5 NM west of Sotra, Øygarden municipality, Vestland county, Norway
Accident time:	Wednesday 28 February 2024, at 19:39:46 hrs

All times given in this report are local time (UTC + 1), if not otherwise stated.

Notification

On Wednesday 28 February 2024 at 2006 hrs Avinor notified the NSIA about a missing helicopter. Later it was established that the helicopter was a Search and Rescue helicopter on a training mission out of Bergen airport, Flesland (ENBR), Norway. It quickly became evident that the helicopter had crashed into the water. All six crew members were retrieved from the water. One person was declared deceased at the hospital. The NSIA started preparations to travel to Bergen to start the work salvaging the helicopter and gather information. The NSIA also sent one team to the helicopter operator's main base at Stavanger airport, Sola (ENZV).

The following authorities were notified according to ICAO Annex 13 and regulation (EU) 996/2010:

- The International Civil Aviation Organisation (ICAO)
- The European Aviation Safety Agency (EASA)
- The National Transportation Safety Board (NTSB)

The NTSB appointed a non-traveling Accredited Representative to be part of the investigation. The NTSB was aided by technical advisors from the helicopter manufacturer (Sikorsky, A Lockheed Martin Company) and the autopilot manufacturer (Collins Aerospace).

The Norwegian Civil Aviation Authority (CAA Norway) and Ministry of Transport were also notified.

[1] *The NSIA defines the SAR nurse as crew since the SAR has defined duties on board during flight.*

Summary

On Wednesday 28 February 2024 LN-OIJ, a Sikorsky Aircraft Corporation S-92A operated by Bristow Norway AS on contract for Equinor ASA, suffered a loss of control and impacted the sea approximately 3.5 NM west of Sotra. The helicopter was conducting a Search and Rescue (SAR) training mission for a rescueman (also known as rescue swimmer or winchman). There were six people onboard the helicopter. They were rescued after approximately 45 minutes in a hostile environment. One of the crew members were fatally injured.

The crew were in a process of retrieving a training beacon they had dropped into the sea earlier during the flight. They used the SAR Automatic Flight Control System mode “Mark on Top” to align the helicopter into the wind and descend towards 150 ft. The helicopter will normally pitch nose up to 10–12° to slow down and position itself over the desired position. In this case the pitch up manoeuvre was not automatically arrested until the crew realised that something was wrong. The helicopter had at that time reached a pitch up attitude of approximately 30° and had entered Vortex Ring State and was unrecoverable.

After impacting the sea, the helicopter immediately filled with water and capsized. Five of the six occupants managed to evacuate the helicopter. The emergency flotation system did not deploy automatically, and the crew were not able to release the life rafts. The helicopter sank after a short period of time. It is not certain what happened to the sixth person. When rescue helicopters arrived at the accident site, the person was found floating lifeless. Based on the investigation the NSIA believe they were unstrained in the cabin when the helicopter crashed into the sea and that they lost consciousness and subsequently drowned.

Based on a comprehensive and complex investigation, the NSIA concludes that it is likely that LN-OIJ’s pitch trim actuator failed and this led to the excessive pitch up attitude. The excessive pitch attitude was not recognised during a three to six second window where it could be identified as abnormal and corrected. The technical fault occurred during a critical phase of the flight. The pitch trim actuator is a non-redundant component, and the crew can always override the pitch trim actuator and take control of the helicopter. The NSIA has no indication that the crew of LN-OIJ differed significantly from other pilots that had received the same training during a major expansion of Bristow Norway’s SAR operation after winning a contract for Equinor ASA. There is no indication that they did not conform to the standards set by Bristow Norway and accepted by the CAA Norway.

The NSIA finds that Bristow Norway’s training regime during a major expansion combined with ambiguous procedures that lack a clear definition of task sharing during critical phases of flight might have manifested themselves in a greater variation amongst the pilots in the understanding of the nature of SAR operations. This might have led to an increased risk of undesirable occurrences. The NSIA finds that a combination of factors related to training during the mobilisation for SAR South might be undesirable. Bristow Norway’s training regime for the SAR South contract was markedly different from the previous way of training.

Even though both crewmembers were highly experienced S-92A pilots, both were new in their respective SAR roles for Bristow Norway.

Based on this investigation the NSIA holds the opinion that Equinor did not fully appreciate the complexity of changing operators as part of their tender process for SAR services. Both companies that replied to the tender clearly stated that 12 months from contract award to start-up was a tight timeframe. The NSIA has seen no evidence that Equinor used this information to reassess if this could affect flight safety. The NSIA finds that during the tender process for SAR South, the involved organisations focused primarily on mitigating risks that could affect the start-up date.

The investigation has identified lessons to be learned regarding occupant survivability. Several of these findings are already being acted upon. The NSIA issues nine safety recommendations based on this investigation. One of these was an immediate safety recommendation issued to Sikorsky to ensure that the behaviour of the autopilot system is known to pilots. This has been acted upon.

About the investigation

Purpose and method

The purpose of this investigation has been to clarify why LN-OIJ crashed into the water. The NSIA has also considered what can be done to improve safety and prevent the recurrence of similar accidents and consequences in future.

The investigation was conducted in line with the NSIA's framework and analysis process for systematic safety investigations.[2]

Sources of information

This report is based on numerous sources of information such as interviews, review of documentation and technical investigations.

The investigation report

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

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

The report ends with the NSIA's conclusions and safety recommendations.

[2] *See https://www.nsia.no/About-us/Methodology*

1. Factual information

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1.1 History of the flight

1.1.1 BACKGROUND

On a contractual basis, Bristow Norway AS (referred to as Bristow) carried out both transport and Search and Rescue (SAR) services for Equinor ASA[3], including operating a SAR base at Bergen Airport, Flesland (ENBR), see Figure 1.

The accident flight on Wednesday 28 February 2024 was a re-training flight for a rescueman[4] who had been on sick leave. An additional instructor (senior rescueman) was on board in addition to two cockpit crew members, a hoist operator[5], and a SAR nurse[6]. The flight crew remember few details about the seconds leading up to the accident, and the accident sequence itself. The description below is therefore based primarily on data from the flight data recorder (FDR) and cockpit voice recorder (CVR).

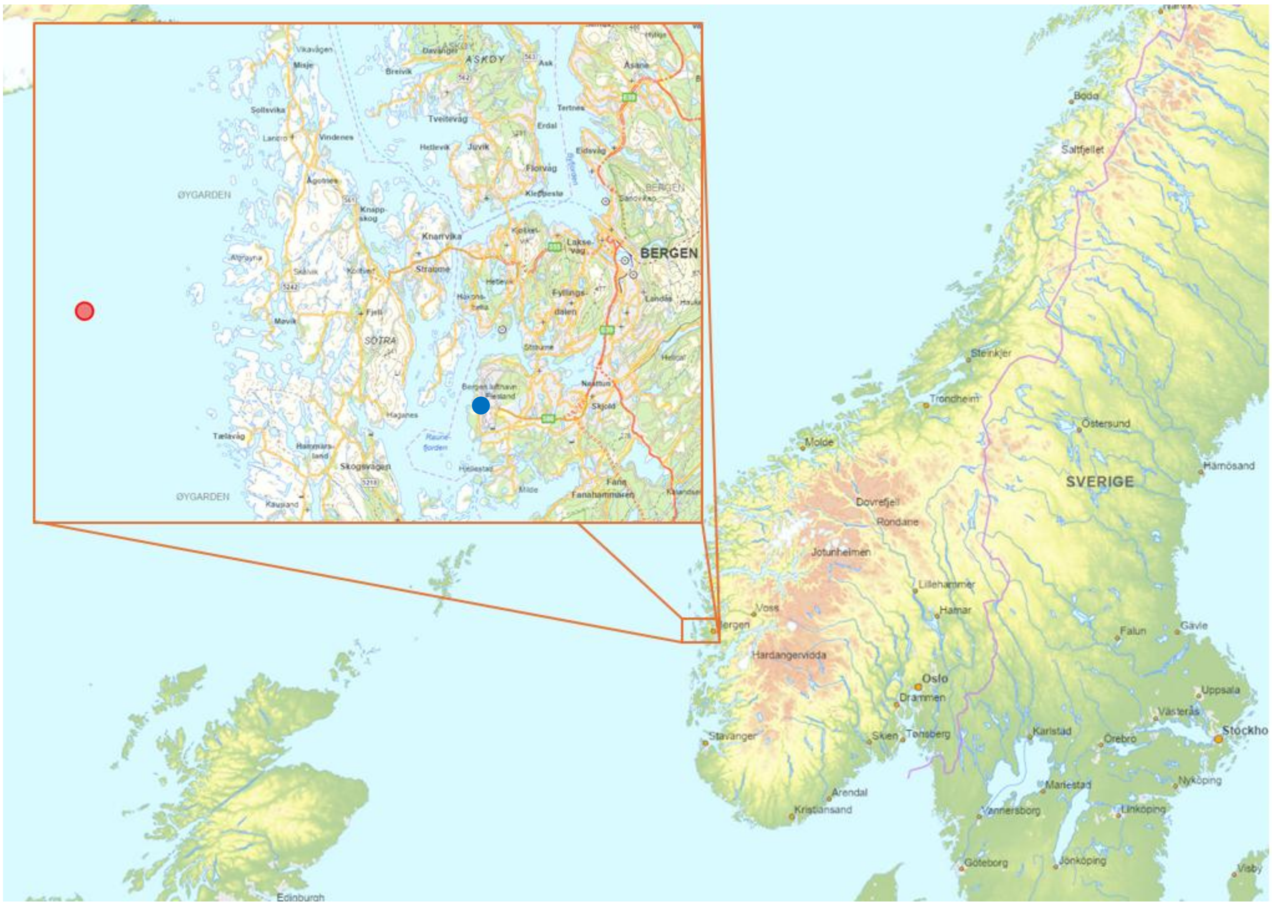

Figure 1: The location of Bergen. The blue circle is Bergen Airport, Flesland and the red circle marks the accident site. Map: © norgeskart.no. Illustration: NSIA

[3] Equinor is a Norwegian multinational energy company with headquarters in Stavanger, Norway.
[4] Also known as rescue swimmer or winchman.
[5] Also known as winch operator.
[6] Also known as medical crew member. The NSIA defines the SAR nurse as crew since the SAR has defined duties on board during flight.

1.1.2 PRE-FLIGHT PLANNING AND BRIEF

The helicopter operated out of Bristow's base at Bergen Airport Flesland. The whole crew was gathered and had dinner together at the SAR base before the flight. At around 1720 hrs the crew met for a pre-flight briefing. Documentation received by the NSIA shows that the commander had a thorough briefing on a whiteboard before departure. There was a clear plan for the flight, with three distinct segments. The plan was first to drop a training beacon that simulates an emergency position-indicating radio beacon (EPIRB), then perform hoist training with a ship and finally search for and retrieve the training beacon. They planned to use the SAR Automatic Flight Control System (AFCS) mode "Mark on Top" (MOT) during the trans down[7] to the training bacon. It had been some time since the commander had performed a MOT and the co-pilot was not that familiar with it. The briefing documentation also shows that the crew carried out threat and error management (TEM) in accordance with established Bristow procedures. This included a review of the weather, performance and special items to be aware of during the flight.

1.1.3 THE FIRST PART OF THE FLIGHT

A daily inspection (DI) was signed for by the hoist operator[8] 27 February at 1650 hrs. Before the flight the hoist operator signed for a pre-departure inspection at 1730 hrs and the commander signed for acceptance of the helicopter at 1810 hrs.

The flight crew of LN-OIJ contacted Flesland Ground on the radio and asked for start-up clearance. The intended flight was SAR training west and north-west of Øygarden using Visual Flight Rules (VFR) below 1,000 ft. The crew was asked to squawk 5107 and given QNH as 1,006 hPa. LN-OIJ, with call sign NORSAR6, departed Bergen Airport Flesland at 1824 hrs and set a westerly course, see Figure 2. Civil twilight ended, and night started, at 1843 hrs. The weather was similar the entire evening with winds between 25 and 35 kt from the southeast, light rain and a low cloud cover. The sea state was 5–6.

During this first part of the flight the co-pilot was the pilot flying (PF), and the commander was the pilot monitoring (PM). A review of the CVR indicates good cooperation and CRM in the cockpit, including the use of standard calls and checklists. The crew dropped the training beacon in the sea about 3.5 NM west of Sotra, abeam Telavåg, after descending from 500 ft using the SAR AFCS mode "Approach 2" (App2). The AFCS behaved as expected at this time. By that time, it was already dark. The crew then headed north towards the cargo ship *Wilson Twisteden* which was sailing south in Hjeltefjorden. During this reposition there was a handover of control, and for the remainder of the flight the commander was the pilot flying, and the co-pilot was pilot monitoring. The crew performed a manual trans down to the ship. Above the ship the crew trained on hoisting the rescueman, the SAR nurse, and a stretcher down to and up from the ship's deck. After about half an hour training with the ship, the crew climbed to 1,000 ft and set a south-westerly course to search for the training beacon.

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[7] *Transition from high speed & high altitude to low speed & low altitude operation.*
[8] *The hoist operator was a Part 66 licenced technician.*

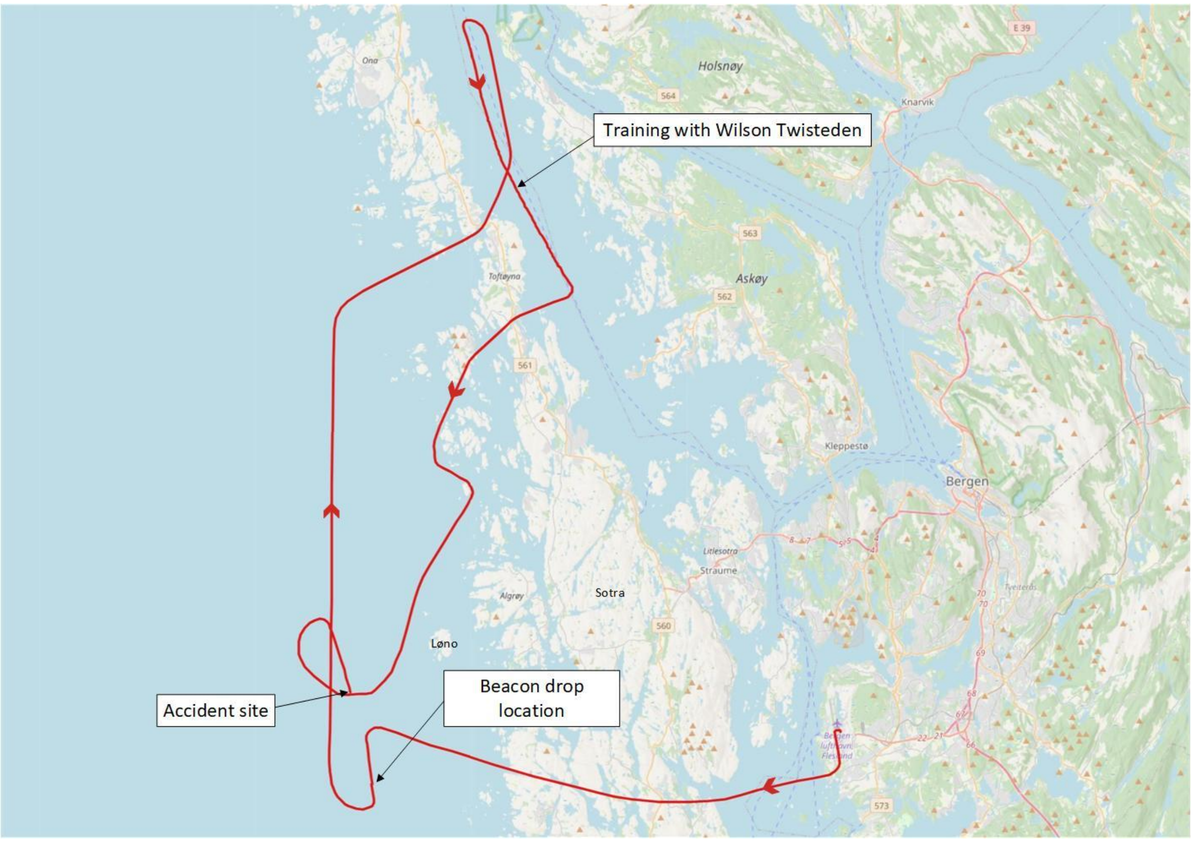

Figure 2: The route flown by LN-OIJ. Source: GPS Visualizer/NSIA

1.1.4 THE SEARCH FOR THE BEACON AND THE ACCIDENT

It was an overcast night, with no moon- or starlight. There were only a few distant lights, but otherwise hardly any visual references. Night Vision Goggles (NVG) was not part of the flight crew equipment, but three sets of NVG were available for the cabin crew in accordance with contract terms. The significant wave height was in the range of 3–4 metres with white crests. The wind 10 metres above the sea was southerly about 35 kt.

According to FDR information, the crew started the search for the beacon, initially descending to 500 ft on the radar altimeter, and shortly after to 200 ft using the SAR Automatic Flight Control System (AFCS) mode "Approach 1" (App1). According to the Commander, this was done to achieve a better accuracy when engaging the MOT. 47 seconds after descending to 200 ft the co-pilot spotted the light from the beacon at approximately 1 NM straight ahead. The beacon was found about 2.5 NM north of the position where it was dropped. The hoist operator took out a set of NVGs from a locker in the aft cabin to observe the beacon. The SAR nurse helped him with retrieving the NVG from the locker.

The commander manoeuvred the helicopter over the beacon and instructed the co-pilot to engage MOT. Once activated, the system is designed to command the helicopter through a turn, aligns it into the wind and brings it to a 50 ft hover 50 metres aft, and 50 metres left of the point where the MOT is engaged. See 1.6.3 for further information about the AFCS. Bristow Norway has as standard procedure to adjust the hover height to 150 ft.

Recorded data show that the AFCS brought the helicopter into a right turn, when it had aligned into the wind it then descended towards 150 ft above the sea. As the helicopter neared the hover point it decelerated as intended. During the turn, the crew completed the "Trans down" checklist and configured the helicopter for low level operations. According to Bristow procedures the checklists should be completed before engaging the MOT. The entire MOT took 4 minutes and 34 seconds from it was engaged to the helicopter crashed into the water and the checklist and configuration of the helicopter were completed 2 minutes and 35 seconds before the final descent began.

The configuration of the helicopter included arming the emergency flotation system when the helicopter decelerated below 80 kt. Shortly thereafter the hoist operator stated that he could see the light from the beacon very well using NVG. He subsequently put aside the NVGs and prepared for opening the door and retrieving the beacon.

The following is a complete transcript of the last 39 seconds of the CVR recordings[9] in addition to some information from the FDR:

At 18:39:06 hrs the commander stated: *"We just finish [the commander has stated that his intended statement was "we will just finish", i.e. let the helicopter complete the MOT] the mark on top; we will actually overfly it a little bit and we have to back up again"*[10]. The co-pilot immediately responded with: *"Yeah".*

At 18:39:13 hrs the commander stated: "Just *overflying it right now".* The co-pilot immediately responded with: *"Yep, coming below".*

At 18:39:19 the commander continued with: "*And the helicopter will stop shortly."*

At 18:39:25 hrs the co-pilot stated: *"Approach coupled"* followed 10 sec. later with the words: *"Radalt coupled"* and *"It should level out".*

At 18:39:41 hrs the commander grabbed the cyclic and pushes it forwards and shouts out: *"Hey the nose is coming up really…."*

At 18:39:43 the commander called *"going around, going around, going around."* and pulled the collective to initiate a go-around.

At 18:39:46 hrs the last recording on the CVR was the word MINIMUMS generated by the helicopter caution and warning system.

To slow down, the helicopter needs to pitch nose up, usually to about 10–12° according to the manufacturer. Bristow Norway has stated that up to 18° is not uncommon during the final declaration of a MOT. The flight crew told the NSIA that they could not remember exactly where they had their attention during the final part of the MOT. Everything was described as normal until they both got a sensation of the helicopter nose pitching up beyond the normal expected pitch attitude. FDR information shows that the helicopter pitch-up manoeuvre continued at an average rate of about 2° per second over several seconds.

The co-pilot has stated that he was waiting for the right moment to give the signal for opening of the door and arming the hoist when he felt that the helicopter did something unexpected.

The commander has explained to the NSIA that he saw the pitch attitude increasing, and that he felt that something was off. He then briefly glanced at the standby attitude indicator to verify that his primary attitude indicator was functioning correctly. He then realised that the helicopter attitude was wrong and tried to initiate a go-around by pushing the cyclic forward and pulling collective. The

[9] According to ICAO Annex 13 Article 5.12.2 and (EU) Regulation 996/2010 Article 16 CVR recordings should be disclosed "…only when pertinent to the analysis of the accident or incident. Parts of the records not relevant to the analysis shall not be disclosed.". The NSIA has informed, and received no objection to, the flight crew of the release this information.
[10] The commander has stated that his intention with these phrases was to keep the rest of the crew informed.

MOT finishes with the helicopter transitioning to a position hold AFCS mode. This never occurred, and MOT was still engaged when the commander took over.

The helicopter had at this time reached a nose up attitude of 30° and had already entered rearward flight. The action by the commander did not prevent the helicopter from descending into the sea. The helicopter was 15 ft above the sea when the last reliable information was recorded by the FDR. This data shows that the helicopter was traveling backwards at a groundspeed of 40 kt. The helicopter had a pitch up attitude of 11.7° and a 17.6° left bank. During the impact, several of the windows on the left-hand side were forced in due to the water impact forces. Further, the ramp door at the rear of the cabin was knocked in and off. The cabin quickly filled with water. The Emergency Floatation System did not deploy. The surviving crew evacuated and was later picked up from the sea. See details about the evacuation and rescue operation in chapter 1.15 Survival Aspects.

1.2 Injuries

Table 2: Injuries

Injuries	Crew	Passengers	Other
Fatal	1[11]	-	-
Serious	2	-	-
Minor/none	3	-	-

1.3 Damage to aircraft

The aircraft was destroyed both due to impact forces and because of corrosion due to salt water, see 1.12.3 for more details.

1.4 Other damage

Some minor oil and Jet A-1 spillage into the sea.

1.5 Personnel information

1.5.1 THE COMMANDER

The commander, male, 56 years old, started flying in 1992. He flew at SAR contracts for other companies before he was employed by Norsk Helikopter in 2008. In 2009 Norsk Helikopter became Bristow Norway. Initially, he started line-flying with the S-92A offshore but converted to be a SAR co-pilot in 2018.

In 2023 the commander was selected to become a SAR captain and went through a SAR captain course. The SAR captain course included 18 flights, in total 23 flight hours. The SAR captain completed his Company Check on 26 August 2023, and the SAR captain course was signed as completed 18 October 2023 (see chapter 1.17.6 for more information about SAR training).

The NSIA has reviewed Bristow Norway flight records and estimated the commanders operational experience as a SAR commander for Bristow Norway. He had approximately 39 flight hours

[11] *The NSIA defines the SAR nurse as crew since the SAR has defined duties on board during flight.*

whereas approximately 7 hours were logged during flights explicitly flagged as night flights. He also had some SAR experience from before 2008.

The commander had a valid airline transport pilot license for helicopter (ATPL(H)) with the following ratings/certificates/privileges: SK92, Instrument rating multi engine (IR(H)ME) and Instructor (TRI(H)). He had previously held examiner rights (TRE(H)) for the S-92A. The ratings were revalidated 11 August 2023 by proficiency check (PC).

He completed his semi-annual Operator's Proficiency Check (OPC) on 23 February 2024, five days prior to the accident.

His medical certificate Class 1 was valid until 25 August 2024 and had the following limitations: VNL – Valid only with correction for defective near vision[12]. The commander has stated that he has his glasses readily available.

The commander started his two-week duty cycle Monday before the accident and was at the time of the accident three days into his duty cycle. He felt rested and well prepared. The commander has stated that he had flown together with the co-pilot 10–15 flights prior to the accident flight. Log information from Bristow show that the commander and co-pilot have flown 14 missions together, 7 of these were ambulance flights and one was a repositioning flight. Of the 6 SAR training flights, one was a night flight.

Table 3: Flying experience commander

Flight time	All types	On type
Last 24 hours	1:47	1:47
Last 3 days	3:09	3:09
Last 30 days	9:09	9:09
Last 90 days	32:56	32:56
Total	Approx. 16,200	Approx. 7,800

1.5.2 THE CO-PILOT

The co-pilot, male, 49 years old, started flying helicopters in 1997. He was employed by Norsk Helikopter in 2006 and started line-flying with the S-92A as a co-pilot. He then advanced to become a commander in 2011, flying line duty until he was selected to become a SAR co-pilot in 2023.

According to the SAR Co-pilot Course Record provided by Bristow Norway, the co-pilot had completed 26 hours of ground training on 28 April 2023. In addition, he had completed the following training:

[12] *Correction for defective near vision: whilst exercising the privileges of the licence, the holder of the medical certificate should have readily available spectacles that correct for defective near vision.*

Table 4: Co-pilot SAR training hours

Type of training	Number of lessons	Total hours	Completed on
SAR simulator training	6	12:00	N/A
Flight Training	5	7:18	N/A
Company Check	1	1:20	8 June 2023
Line training	2	2:41	N/A
TOTAL	15	23:19	N/A

The Line Check lasted 1:26 hours and was completed on 15 August 2023. The SAR co-pilot course was signed as completed 18 October 2023 (see chapter 1.17.6 for more information about SAR training). During his SAR training all night flying was done in a simulator.

The NSIA has reviewed Bristow Norway flight records and estimated the co-pilot's operational experience as a SAR co-pilot for Bristow Norway after he completed his training. He had approximately 32 flight hours whereas approximately 7 hours were logged during flights explicitly flagged as night flights.

According to documentation from Bristow Norway, the co-pilot had completed two previous pick-ups from the sea in night conditions. One of these was with the commander of LN-OIJ.

The co-pilot had a valid airline transport pilot license for helicopter (ATPL(H)) with the following ratings/certificates/privileges: SK92, Instrument rating multi engine (IR(H)ME). The privileges were revalidated on 20 January 2024 by proficiency check, i.e. approximately one month before the accident.

He completed his semi-annual Operator's Proficiency Check (OPC) on 19 January 2024.

His medical certificate Class 1 was valid until 28 August 2024 and had the following limitations: VNL Valid only with correction for defective near vision[13]. The co-pilot has stated that he has his glasses readily available and that he still managed to read checklists and intstruments without issue.

The co-pilot has stated that he had a quiet day prior to the flight and did some exercising at the SAR base in Bergen. The co-pilot told the NSIA that he felt fit for flight and was rested.

At the time of the accident the co-pilot was halfway through the second week of his two-week duty cycle. Due to a surplus of personnel, there were two co-pilots on duty at the same time. The co-pilot of the accident flight was the primary co-pilot. The secondary co-pilot was on a 1-1-3[14] duty cycle, it was therefore important for the secondary co-pilot to get enough flights to stay current during his SAR week. Because of this the secondary co-pilot undertook most of the training flights during the week before the accident flight.

[13] Correction for defective near vision: whilst exercising the privileges of the licence, the holder of the medical certificate should have readily available spectacles that correct for defective near vision.
[14] One week flying line, one week flying SAR, three weeks off.

Table 5: Flying experience co-pilot

Flight time	All types	On type
Last 24 hours	1:47	1:47
Last 3 days	1:47	1:47
Last 30 days	11:03	11:03
Last 90 days	29:55	29:55
Total	9,567	6,800

1.5.3 THE HOIST OPERATOR

The hoist operator, male, 43 years old, was employed by Bristow Norway. He worked as a licensed aircraft technician at the Sola base but started to fly as a hoist operator on SAR operations in September 2023. His work schedule included one week as a hoist operator at the Flesland base, followed by 3 days as an aircraft technician at the Sola base and 2½ weeks off duty. The hoist operator was on his third day scheduled as hoist operator at the Flesland base.

1.5.4 INSTRUCTOR/SENIOR RESCUEMAN

The senior rescueman was a man, 35 years old. He was employed as a rescueman at Bristow Norway in 2014. He became an instructor in 2018 and senior instructor in 2021. In 2023 he became senior rescueman and the leader of the rescuemen. He had a background as an emergency medical technician and paramedic. The senior rescueman was based at Flesland.

1.5.5 RESCUEMAN ON RE-TRAINING FLIGHT

The rescueman on re-training was a male, 55 years old. He started his career as a rescueman at a SAR unit in the Royal Norwegian Air Force. He then started to fly as a rescueman on temporary basis for Norsk Helikopter in 2006 and became a full-time rescueman at Bristow Norway in 2009. In April 2023 he had an accident while working as an instructor and lost his medical certificate as a rescueman.

During his period without a valid medical certificate, he worked as a rescue equipment technician for Bristow in Stavanger. He has stated that he enjoyed this position but that it was only temporary while he did not have a valid medical certificate. In January 2024 he got his medical certificate back and started with re-training as an operational rescueman.

The rescueman told the NSIA that he felt rusty during his first re-training flight on the day before the accident. The accident flight was his second flight in a re-training programme of three flights.

1.5.6 SAR NURSE

The SAR nurse was a female, 61 years old. She was employed as a nurse by Equinor and belonged to a pool of personnel working part-time as SAR nurses on SAR helicopters. When not flying as a SAR nurse, she worked in Equinor’s Operational Health, Safety and Environment unit. When working as SAR nurses they stayed together with the rest of the SAR crew at the SAR bases and flew training flights with the other crew members. There were two SAR nurses sharing a 24-hour shift rotation.

When rescue helicopters arrived at the accident site, she was found floating lifeless with her face down in the water and without having inflated her lifejacket. She was later declared deceased at Haukeland University Hospital.

1.6 Aircraft information

1.6.1 GENERAL DESCRIPTION OF THE S-92A

The Sikorsky S-92A is a conventionally configured helicopter with two engines, one four-bladed main rotor rotating anticlockwise when seen from above, and one four-bladed tail rotor. The S-92A is certified according to FAA *14 CFR Part-29* and EASA *CS-29 Large Rotorcraft* certification specifications. The helicopter type can be operated in several different configurations. Bristow operates a passenger transport configuration that can carry up to 19 passengers and two pilots, and a SAR configuration.

A full-scale version of the helicopter type was first presented in 1992. After completion of development and testing, a type certificate was issued by the US Federal Aviation Administration (FAA) in 2002, and a type certificate for Europe was subsequently issued by JAA/EASA in 2004. The helicopter was first put into service in Norway in 2005 to transport oil workers to and from offshore installations. As a result of the accident with an EC 225 Super Puma helicopter in 2016, the S-92A became the only[15] type of helicopter used for transporting passengers for the Norwegian oil and gas industry.

At the time of the accident 45 individual S-92A type helicopters were registered in the Norwegian Civil Aircraft Register. A total of more than 300 S-92s, both civilian and military versions, have been manufactured.

Table 6: General characteristics of the S-92A

Engines:	2 General Electric CT7-8A
Twin engine take-off power:	2,520 shp (1,879 KW)
Engine max continuous power:	2,043 shp (1,524 KW)
Maximum take-off mass:	26,500 lb (12,020 kg)
Never-exceed speed:	165 kt
Type of fuel:	Jet A-1

1.6.2 SPECIFIC INFORMATION ABOUT LN-OIJ

LN-OIJ was manufactured by Sikorsky Aircraft Corporation in 2012 configured as a SAR helicopter. It was initially operated by Bristow for the HM Coastguard in the UK until taken over by Bristow Norway from February 2023. The helicopter had been in storage and Bristow Norway tailored LN-OIJ for their SAR operations with rescue equipment, medical equipment and five seats in the cabin.

There were no relevant Minimum Equipment List (MEL) items recorded in the Aircraft Technical Log (ATL) or relevant Deferred Defect List (DDL) items.

The NSIA has briefly reviewed the maintenance documentation. No maintenance irregularities have been observed during this review for the period the helicopter was operated as LN-OIJ.

[15] *Some Airbus Helicopters AS 332L/L1 are still in operation, mainly for shuttle and SAR operations.*

Table 7: Specific data for LN-OIJ

Serial number:	920169
Total number of flight hours:	3,199 hours (including the accident flight)
Total number of landings:	3,751
Dry operating mass:	19,076 lb (8,653 kg)

1.6.3 FLIGHT CONTROLS

The basic flight control system, together with the Automatic Flight Control System (AFCS – see chapter 1.6.4) and the Flight Director (FD), adjust the blade-pitch angles of both the Main Rotor (MR) and the Tail Rotor (TR) blades for various flight configurations. The flight control system can be divided into three sub-assemblies: conventional cockpit controls, mixing unit and hydraulic servos. The cockpit controls (and the trim actuators[16]) send mechanical inputs to the flight control boost servo system via push-pull rods and bellcranks. The Stabilty Augmentation Sytem (SAS) Servos receive electronic inputs from the Flight Control Computers (FCCs) and sum mechanical inputs in parallel with the boost servos to stabilise the aircraft. The controls consist of four near identical parallel systems for respectively: yaw, roll, pitch and collective, see Figure 3. A Rotary Variable Differential Transformer (RVDT) in each system send flight control positions to, amongst others, the Flight Control Computers (FCC).

The four SAS/boost servos transfer the pilot or AFCS inputs to the mixing unit which adjust the inputs to achieve the proper outputs to the hydraulic MR servos and the TR servo. The hydraulic servos furnish the necessary mechanical force to transmit flight control movements to MR and TR and prevent aerodynamic feedback forces.

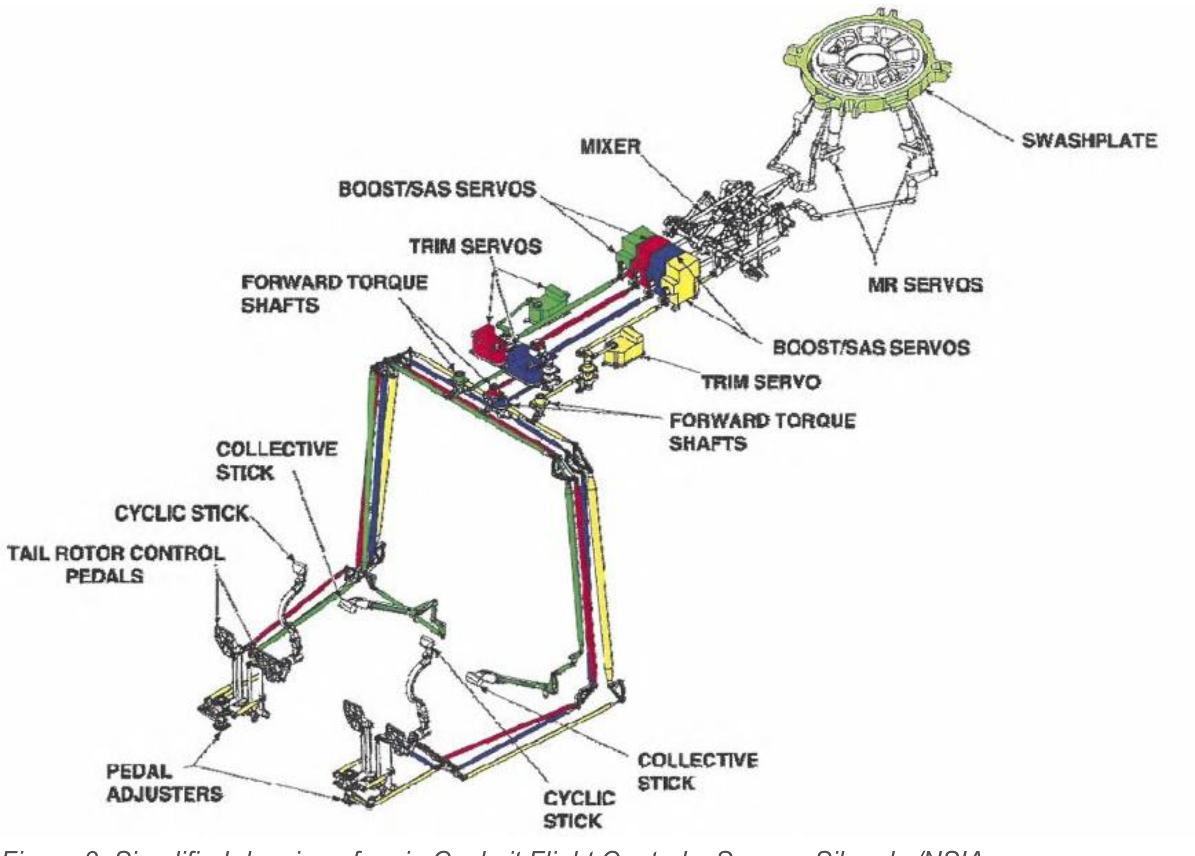

Figure 3: Simplified drawing of main Cockpit Flight Controls. Source: Sikorsky/NSIA

[16] *The trim actuators are sometimes also referred to as trim servos or trim actuator assembly.*

1.6.4 AUTOMATIC FLIGHT CONTROL SYSTEM (AFCS)

1.6.4.1 General description

The Automatic Flight Control System (AFCS) electronically enhances basic aircraft handling qualities through a trim system, Stability Augmentation System (SAS), Attitude Hold (ATT) features, and Coupled Flight Director (CFD). The AFCS is dual redundant in all features except trim actuators. It is controlled via a single AFCS control panel located on the centre console and two Mode Select Panels (MSP) located on both sides of the instrument panel, see Figure 4.

The core of the AFCS consists of two separate and identical Flight Control Computers (FCCs) which receive data from various aircraft sensors. The FCCs fitted to LN-OIJ were the latest hardware version, FCC-113. AFCS inputs to the flight control system are provided via electrically powered trim actuators and hydraulically powered SAS servos.

Figure 4: The cockpit of the S-92A. The blue boxes highlight the Mode Select Panels, and the green box highlights the control panel for the Automatic Flight Control System. Photo: NSIA

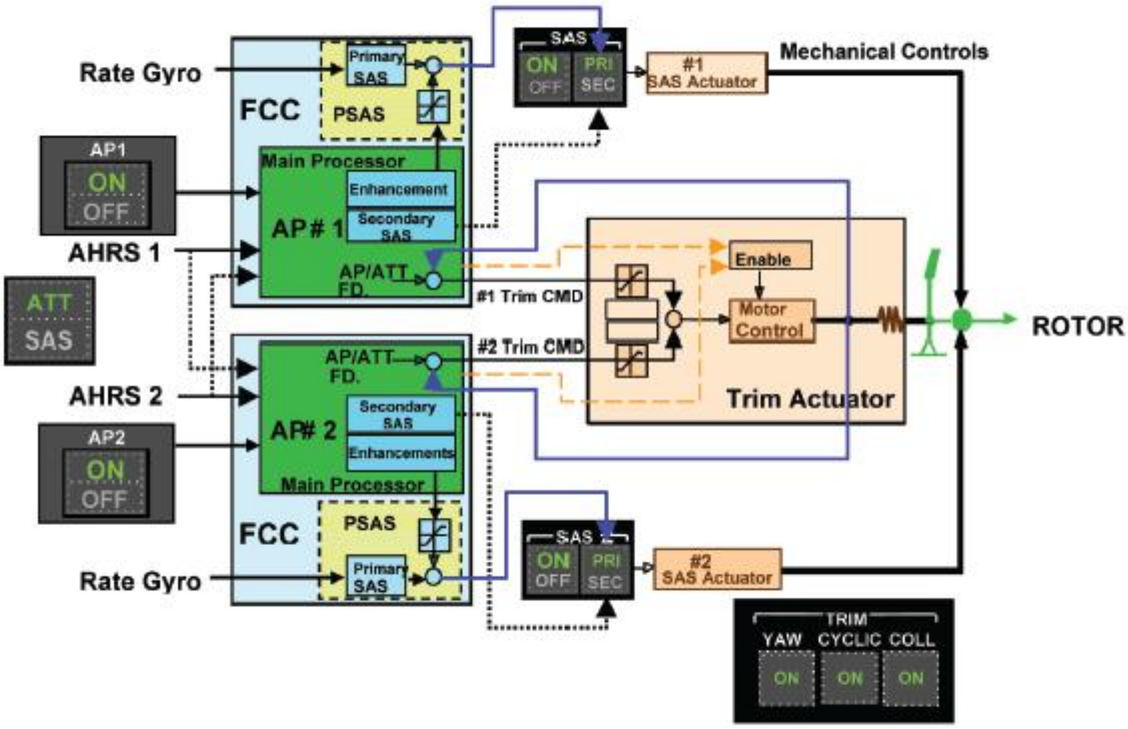

Figure 5: Schematic of some parts of the Automatic Flight Control System. The Flight Control Computers receive data and calculate desired inputs for the Stability Augmentation System and autopilot. Source: Sikorsky/NSIA

The Coupled Flight Director (CFD) allows for hands-off flight. The CFD utilizes the trim actuators to maintain the aircraft on a pilot-selected flight path. Several modes are available when using the CFD such as basic heading hold, airspeed hold, and barometric altitude hold in addition to several cruise and approach modes. There are also additional modes available only to SAR configured helicopters, see 1.6.4.4. The CFD uses the pitch, roll, yaw and collective axes to satisfy pilot commands to the system. The CFD uses the roll trim actuator to turn the aircraft and the pitch trim actuator to control airspeed. Depending on the selected mode either the pitch trim actuator or collective trim actuator controls vertical speed or altitude.

When discussing the CFD modes the term “two cue” (2Q) and “three cue” (3Q) are used:

- 2Q refers to those cases where vertical speed or altitude is controlled via the pitch axis.
- 3Q refers to those cases where vertical speed or altitude is controlled via the collective axis.

1.6.4.2 Trim actuators

The four trim actuators are almost identical except for a few minor differences. They consist of an electric motor, a gear train, an electromagnetic clutch, a torsional spring, a damper mechanism, an override clutch and three circuit cards. These three circuit cards are the Control Loop Card, the Motor Driver Card and the Power Supply Card. The four trim actuators on LN-OIJ are shown in Figure 6. The basic architecture of the trim servo is shown in Figure 7.

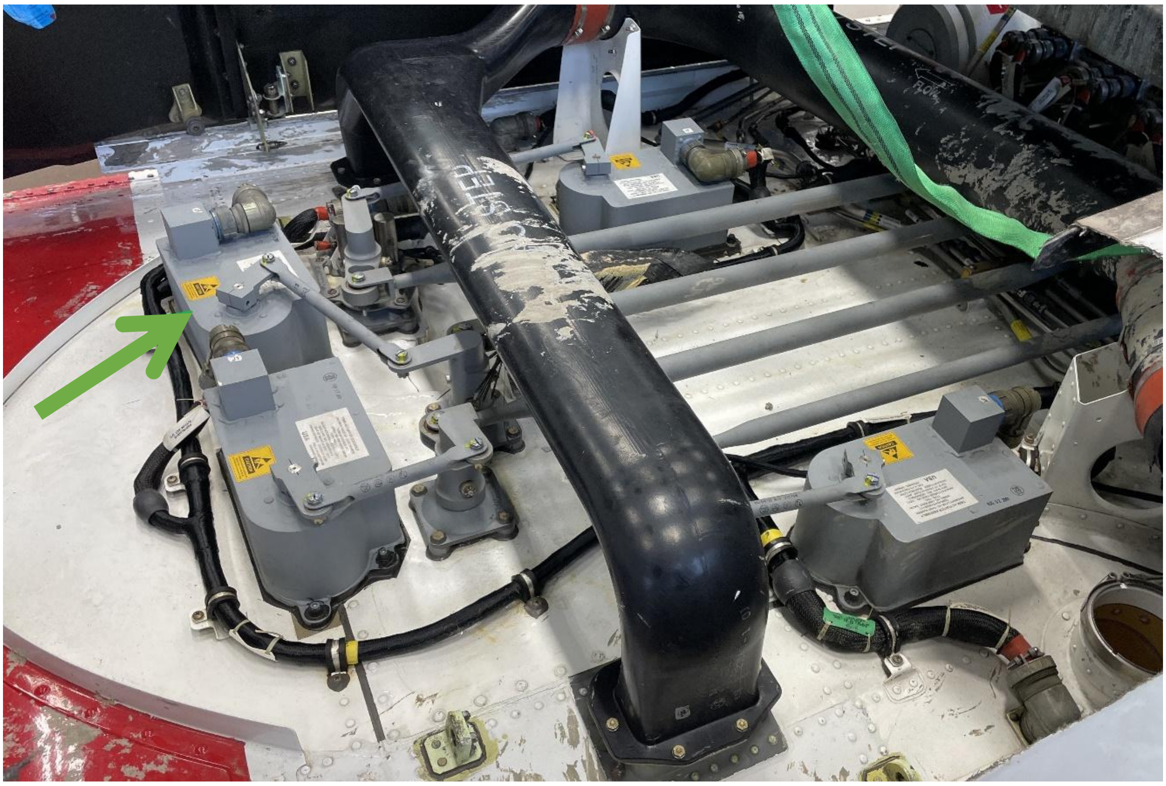

Figure 6: The four trim actuators installed on the upper deck above the cockpit on LN-OIJ. A green arrow points at the pitch trim actuator. Photo: NSIA

The pilot can control the trim actuators using the 4-way trim beeper switches located on the cyclic and collective. The effect of using the trim beeper switches depends on the mode selected. In addition, there is a trim release switch on all three controls (pedals, cyclic, collective). Depressing the trim release switch allows the pilot to move the controls without any trim force resistance and set a new trim reference point.

When flying using the CFD the trim actuators receive a command voltage from the FCCs which is translated internally to actuator movement. Each FCC can nominally command a maximum change of 5% per second which is electronically summed in the trim actuator to provide a maximum of movement of 10% per second. The FCCs can command within the full stick position range.

The trim actuators return a position signal and a spring force signal (from the Spring Deflection Sensor, see Figure 7) to the FCC. The spring force signal is used to indicate the force on the trim servo caused by the actual output arm position differing from the motor position, e.g. due to a restriction, or that the pilot is manually overriding the trim actuator. Both the commander and the co-pilot have stated that they did not interfere with the controls. The commander has explained that he guarded the controls and was ready to act if needed. This was his routine during a MOT, or any time the CFD was engaged.

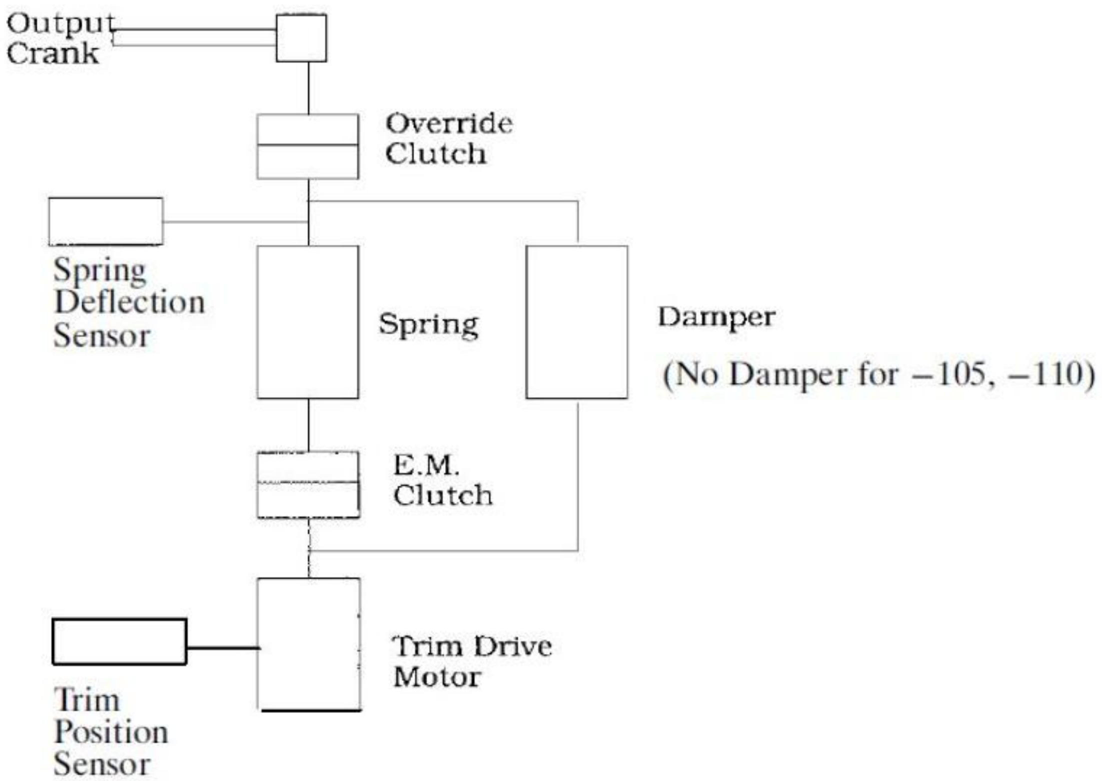

Figure 7: Basic trim servo architecture. Source: Sikorsky/NSIA

Trim hardover

One of the possible AFCS system failures is trim runaway, known as trim hardover. The Rotorcraft Flight Manual (RFM) states that *"Trim hardovers will cause slow, uncommanded aircraft attitude changes in one or more axes with a corresponding flightcontrol movement".* The following note is also cited from the RFM:

> *The SAS system will initially counteract a trim hardover resulting in a slow aircraft attitude change. If the pilot does not intervene before the SAS reaches saturation, the aircraft attitude change will become rapid.*

The RFM described corrective action if a pilot experiences a trim hardover is to:

1. *Depress cyclic and collective trim releases while adjusting flight controls to maintain aircraft control.*
2. *Reduce airspeed to 120 KIAS or less.*
3. *Disable the malfunctioning trim axis by pressing the appropriate TRIM button.*
4. *Continue the flight while actively monitoring the controls.*

The commander has stated that the motion of the helicopter during the accident did not feel like the trim hardovers they practice in the simulator.

1.6.4.3 Flight Director Pitch Degrade

The Flight Director (FD) axis degrade is a visual cue to the pilot that a FD channel may still be coupled with degraded system performance, or the axis could be uncoupled. The FD annunciation on top of the Primary Flight Display (PFD) goes from green to yellow for the affected axis, see Figure 8. In the accident with LN-OIJ it is the pitch channel that is of interest due to the pure pitch up motion.

Figure 8: Photo of the Primary Flight Display with an illustration of a degraded collective axis (yellow ALT). A strip on the PFD with flight director annunciations is expanded and highlighted with red lines. Photo: NSIA. Illustration: Sikorsky/NSIA

There are several reasons that any of the control axes can become degraded. The one that is relevant for this accident investigation, is when the FCCs detect a Pitch Stick Force of 3%. In other words, a displacement/difference between FCC commanded and actual cyclic stick position. The accident with LN-OIJ was a pure pitch-up manoeuvre

This degrade affects the control loop of the helicopter. To understand this effect a simplified explanation of the control loop is required first. When any form of airspeed control is engaged the helicopter compares an airspeed reference against the current airspeed to obtain an airspeed error[17] (ΔV). This ΔV is multiplied with a gain to obtain an acceleration command (a_C) which is limited to be no more than 1.5 kt per second. The FD can therefore tailor the response to the size of the error. For small ΔV the FD will command a small a_C. For larger ΔV the FD will initially command a larger a_C and then a smaller a_C as the helicopter nears the reference airspeed.

[17] In control theory, the term "error" is used to describe a difference between a desired output and a measured output.

The acceleration command, a_C, is compared with the airspeed rate to obtain an acceleration error (Δa). This Δa is fed into a Proportional Integral controller (shown schematically in Figure 9):

- The proportional path will convert the Δa to a pitch attitude command in degrees using a gain. This proportional command is limited to ±5° around a setpoint.
- The integral path determines the setpoint and uses a gain to convert Δa pitch rate command in °/s which is limited to 2°/s and an overall magnitude limit of ±20°, i.e. the integrator cannot command a helicopter pitch attitude of more than +20° or less than -20°.
- Both the proportional and integral commands are summed together to get the overall FD pitch attitude command, and this overall command is also subject to the overall magnitude limit of ±20° and the rate limit of 2°/s.

Another way to look at the description above is that the FD has a limited window of authority that shifts up and down to cover the overall full authority range of ±20°. The window of authority corresponds to the ±5° of proportional control available. The window is centred around the integral command. Effectively the proportional path is intended to provide initial correction only. In steady state the proportional command would be zero and the integral command should be holding the attitude required to maintain the desired airspeed. In other words, as the FD works toward steady state, command is transferred from the proportional path to the integral path.

The description above details the inner control loop. Similar logic applies to the outer control loop that takes the attitude command, compares it to the current attitude and generates a trim command. The proportional path in the outer control loop has an approximate ±8 % limit.

When the FD pitch degrade occurs, as a result of detected Pitch Stick Force, the integral is held at the current value. This is done because the assumption is that the pilot overrides the FD, and to prevent an integrator buildup that would result in large control deflections when the degrade clears, for example, when the force is removed. With the FD pitch degrade active the FD control authority is limited to current integrator value ± 5° in the inner control loop and ±8 % in the outer control loop.

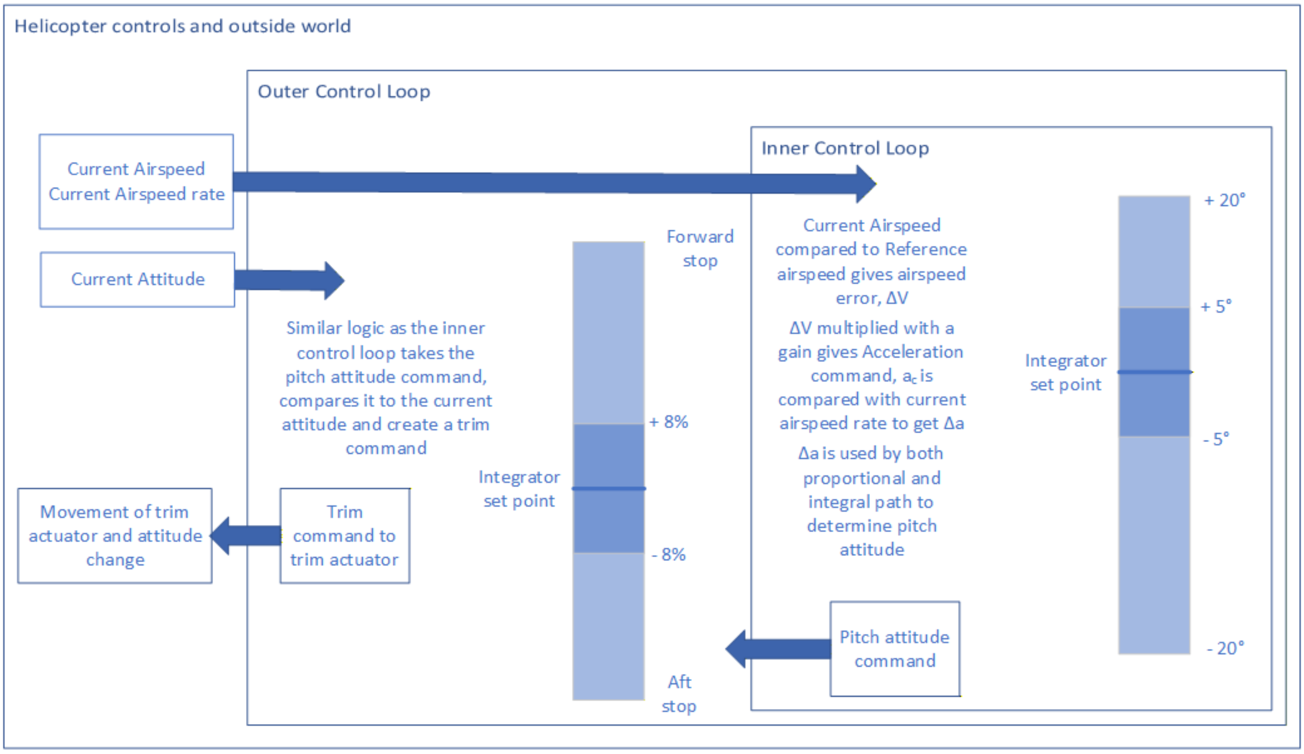

Figure 9: A simplified explanation of the inner and outer control loop for airspeed holds. Illustration: NSIA

1.6.4.4 AFCS Search & Rescue modes

SAR configured S-92s have eight CFD modes in addition to the modes standard in passenger transport configured helicopters. Four of these are modes that takes the helicopter from high speed & high altitude to low speed & low altitude (trans down modes). Three are different hover hold modes to aid SAR operations, and the final is a depart mode that transitions the helicopter from a low altitude & low speed to a high altitude & high speed.

1.6.4.5 Mark on Top

The “Mark on Top” (MOT) transitions the helicopter from a high-speed, high-altitude environment to a stable hover over a selected coordinate. To engage the MOT the following criteria must be met:

- Airspeed above 50 kt indicated airspeed.
- Radar altitude below 2,000 ft.

The MOT is selected with a soft key on the MSP.

When MOT is engaged the helicopter records the latitude (lat), the longitude (long) and the wind direction. The CFD then performs a right or left descending turn depending on wind direction. The approach ends up in a hover with the recorded target about 50 m to the front and 50 m to the right of the helicopter at a default radio altitude of 50 ft. This allows the pilot in the right-hand seat and the hoist operator to view the target. Bristow has stated in their Operations Manual that they always set the hover radio altitude to 150 ft.

Since MOT only stores the marked latitude and longitude position it is not uncommon for the pilot to have to adjust the helicopter position after the approach is completed before hoisting operations can begin. This might be due to inaccuracies in the engagement position or due to drift of the actual object to be hoisted.

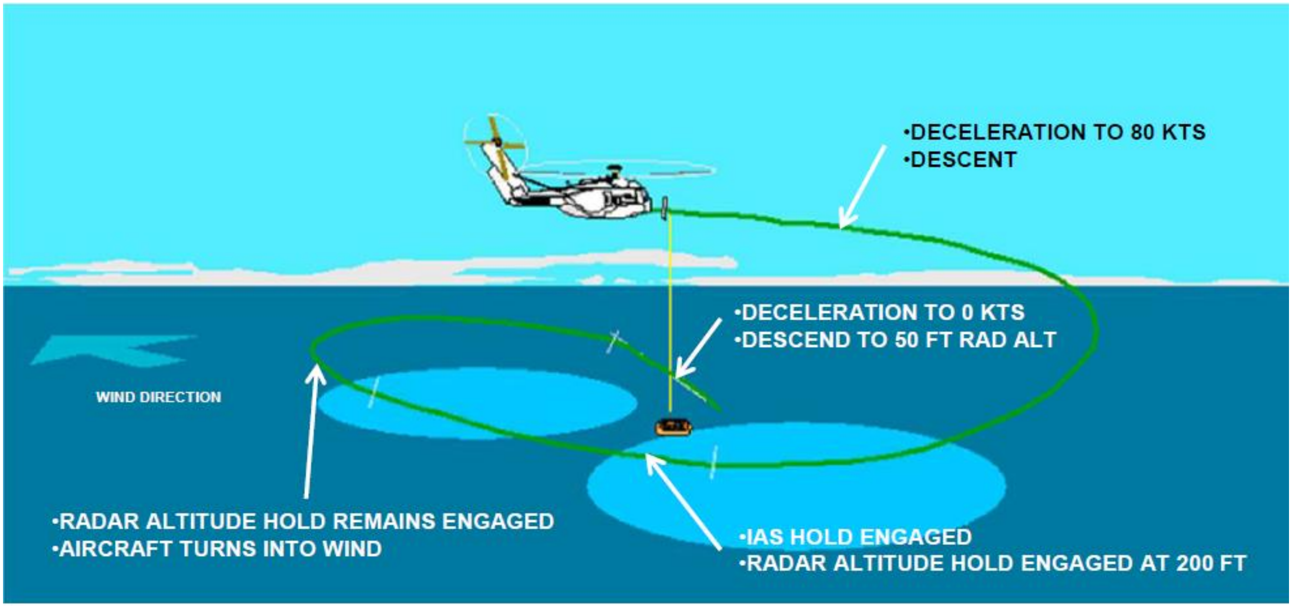

Figure 10: Illustration of the “Mark on Top” flight pattern. Illustration: Sikorsky/NSIA

1.6.4.6 Crew experience

The NSIA has discussed the AFCS on the S-92A with several pilots. In general, they express that the system is reliable. However, several pilots described the system as somewhat slow and imprecise. After the accident, the NSIA has received reports on occasions of the pitch attitude exceeding 12° nose up during trans down. Bristow Norway has stated to the NSIA that they have seen nose up attitudes of up to 18° and that a nose up attitude of 15° is not uncommon.

1.6.5 EMERGENCY FLOTATION SYSTEM

LN-OIJ was equipped with an Emergency Flotation System (EFS). A description of regulatory requirements for EFS is found in 1.18.1. The baseline system for the S-92A has three float bags, which it is possible to supplement with two extra sponson float bags. LN-OIJ therefore had five float bags total, see Figure 11. With the sponson bags installed the helicopter is designed to stay upright and afloat in the following conditions:

Helicopter weight	WMO Sea state
At or above 18,590 lbs (8,432 kgs)	6 (wave height 4–6 metres, wind speed of 27–33 knots)
Below 18,590 lbs (8,432 kgs)	4 (wave height 1.25–2.5 metres, wind speed of 17–21 knots)

At the time of the accident flight the mass of the helicopter was around 9,600 kgs and the sea state was 5–6.

Each float bag has two separate independent pockets. In case of a single pocket failure the remaining pocket will provide sufficient buoyancy for that section of the helicopter.

LN-OIJ had a total of six bottles that holds the compressed nitrogen required to inflate the float bags:

- Two under the floor in the front part of the cabin. Each bottle inflates one pocket in both the right and left forward float bags.
- One in each wheel well, for the corresponding sponson float bag.
- Two bottles in the tail boom. Each bottle inflates one pocket of the rear float bag.

All the bottles were found to have approximately 2,800 psi of nitrogen in them after the accident, which is the normal amount. The pressure was released by the NSIA for safety reasons.

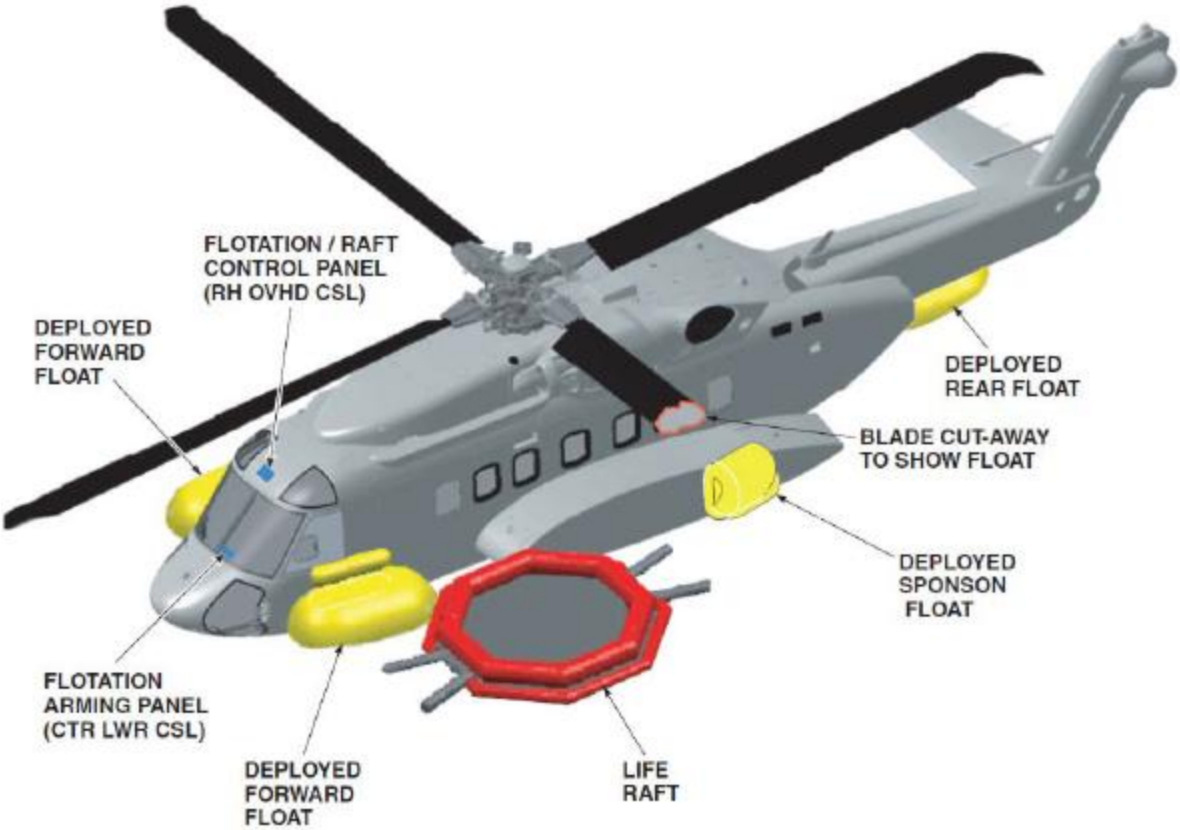

Figure 11: Illustration of a system with five flotation bags (yellow) and the life raft close to where it is stowed. The right sponson float and life raft is not visible in the illustration. Illustration: Sikorsky/NSIA

Power for the EFS is provided by two sources:

- NO. 1 DC PRI bus through a circuit breaker marked FLOAT PWR. This DC bus requires AC power from generators on the Main Gear Box (MGB).
- BATT bus through a circuit breaker marked FLOAT PWR.

These two circuit breakers were found closed (not popped) after the accident.

1.6.5.1 EFS control and deployment

Control of the EFS is done via the flotation control panel (located on the overhead console above the right-hand seat) and the flotation arm panel (located on the centre console), see Figure 12 and Figure 13. The ARM/SAFE toggle switch supplies electrical power to the flotation control panel when the switch is set to the ARM position. The SAFE position of the switch removes electrical power from the flotation control panel.

The flotation control panel contains one toggle switch and one rotary switch. The toggle switch selects if the EFS is in normal operations or test mode. The rotary switch is used for ground testing of the system. The test assures proper operation of both the primary and secondary squib circuitry and proper operation of the left and right immersion switches. Test lamps will illuminate to indicate correct operation.

The EFS can be deployed manually or automatically. Manual deployment is always available when the system is armed and is achieved by pressing either EMER FLOATS switch on the pilot or co-pilot collective stick. For automatic deployment, both immersion switches located in each wheel well must activate, i.e. must be submerged. The right immersion switch is powered by the BATT bus while the left immersion switch is powered by the NO. 1 DC PRI bus. At least one DC converter must be powered to provide automatic deployment. Automatic deployment will not occur on battery power only.

On LN-OIJ the floats were found to be armed, but they did not automatically deploy. The crew did not attempt manual deployment due to loss of consciousness and the helicopter capsizing. The system is not designed to be deployed before water entry.

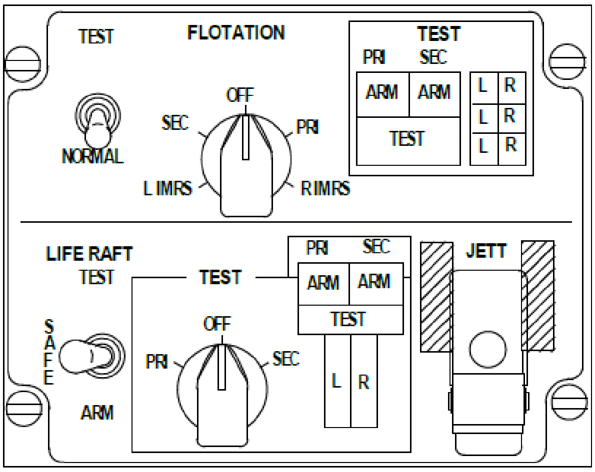

Figure 12: Flotation and Life Raft Control panel. Illustration: Sikorsky/NSIA

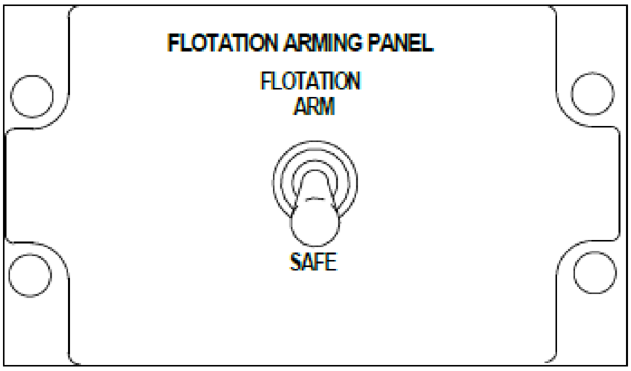

Figure 13 : Flotation arm panel. Illustration: Sikorsky/NSIA

1.6.6 LIFE RAFTS

LN-OIJ was equipped with two life rafts, one in the front part of each sponson, see Figure 11. The two rafts can be deployed electrically or manually. Each raft has a capacity of 14 people with an overload limit of 21. Each raft contains medical, signal and maintenance supplies plus an Emergency Locator Transmitter (ELT). The rafts are fully reversible and include a sea anchor, mooring line, heaving ring, ballast bag, canopy (tent), insulated floor and boarding ramps.

1.6.6.1 Electrical Jettison

The LIFE RAFTS control panel, see Figure 12, is located on the overhead console over the right-hand seat. Setting the SAFE/ARM switch to ARM will apply power to the JETT switch for electrical deployment of the rafts. Unguarding and moving the JETT switch to the JETT position will detonate the squibs deploying and inflating the life rafts.

1.6.6.2 Manual Jettison

If the system cannot be jettisoned electrically, passengers can manually deploy the life rafts. Pulling the D-ring on the top front access panel of each sponson causes the rafts to inflate and deploy.

Figure 14: Picture showing the location of the D-ring, blue circle. Photo: Bristow Norway / NSIA

1.6.7 EMERGENCY LIGHTING SYSTEM

LN-OIJ had several emergency lights installed.

- Three cabin emergency lights are located adjacent to the cabin dome lights. All three are controlled by the EMERG LTS CABIN OFF/ARM/ON switch on the EMERG LTS control panel.
- Six external emergency lights are designed to illuminate the exit areas when helicopter electrical power is lost. Four lights are installed near the four main cabin emergency exits and two at the cargo ramp. The EXT EMERG OFF/ARM/ON switch on the EXT LIGHTS control panel controls these lights.
- Helicopter Emergency Egress Lighting System (HEELS) lights outline each of the four cabin emergency exits, the cockpit emergency exits, and the cabin push-out windows (if installed). The HEELS OFF/ARM/ON switch on the EMERG LTS control panel and the HEELS ON/OFF switch on the cabin EMERGENCY LIGHTS control panel control these lights. The HEEELS is capable of operating under water for at least 10 minutes and have a self-contained power supply.

All the emergency light control switches were found set to arm after the accident. This means that they should have activated automatically. The functionality of the emergency lightning system during the accident as experienced by the survivors are described in 1.15.2.

1.7 Meteorological information[18]

1.7.1 INFORMATION FROM THE NORWEGIAN METEOROLOGICAL INSTITUTE

1.7.1.1 Introduction

The NSIA sent a request for a weather report to the Norwegian Meteorological Institute. Relevant information from the received report is mentioned below.

1.7.1.2 The general weather situation

A low pressure (974 hPa) was positioned south of Iceland at 1900 hrs. A front system moved northeast in the following hours.

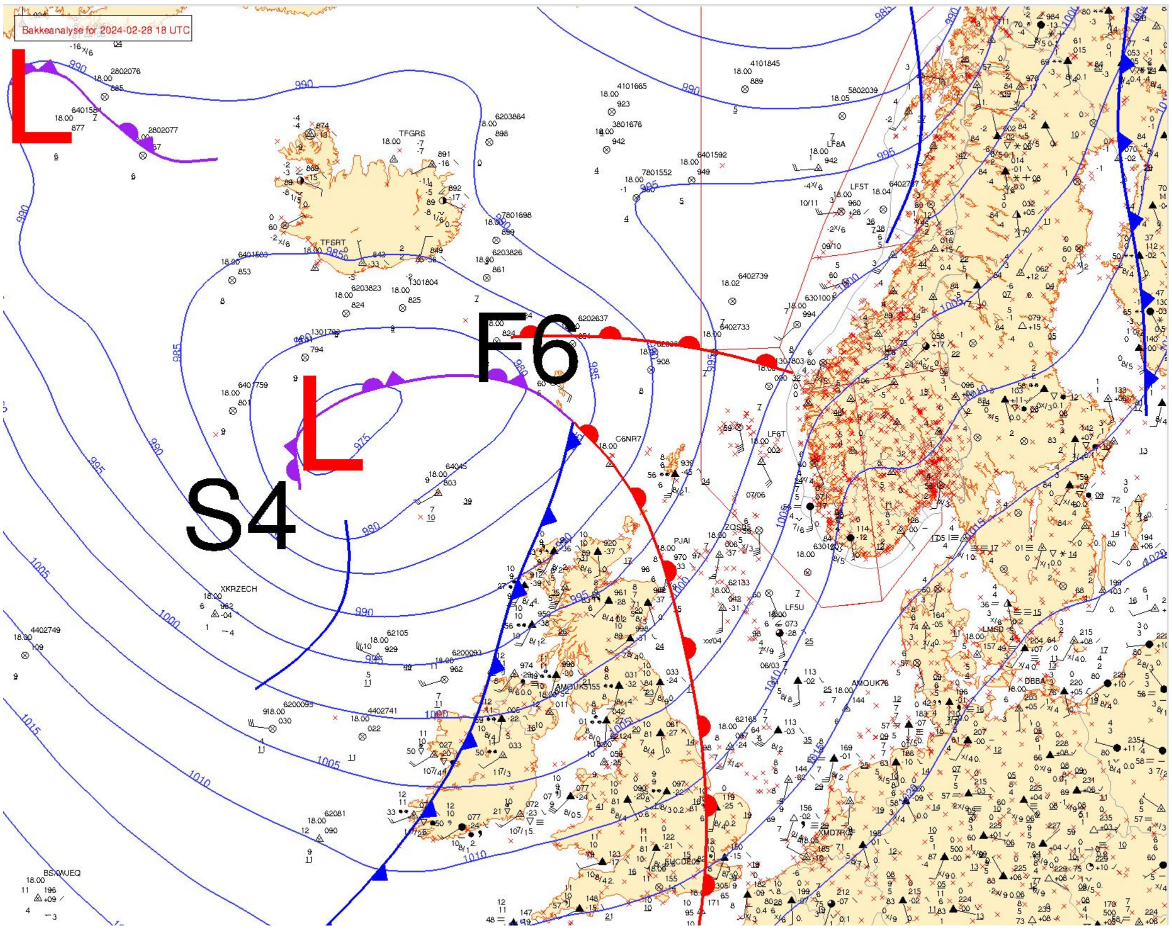

Figure 15: Surface weather chart at 1900 hrs. Source: Norwegian Meteorological Institute / NSIA

The 0-isotherm was at 2,500–3,000 ft. Vertical profiles taken at Bergen Airport, Flesland (ENBR) at 1900 hrs show unstable air masses up to 5,000–6,000 ft.

1.7.1.3 Local weather conditions

There were light rain showers near the coast up until the time of the accident. The rain was coming in from the west. Earlier that day Bergen Airport, Flesland reported light rain and scattered clouds at 700 ft and broken clouds at 1,000 ft. At 1420 hrs it was no rain and broken clouds at 1,000 ft. At 2020 hrs broken clouds at 1,400 ft were observed. Bergen Airport, Flesland did not report visibility below 10 km during the day in question.

[18] *For decoding of meteorological abbreviations, see: https://www.ippc.no/ippc/index.jsp*

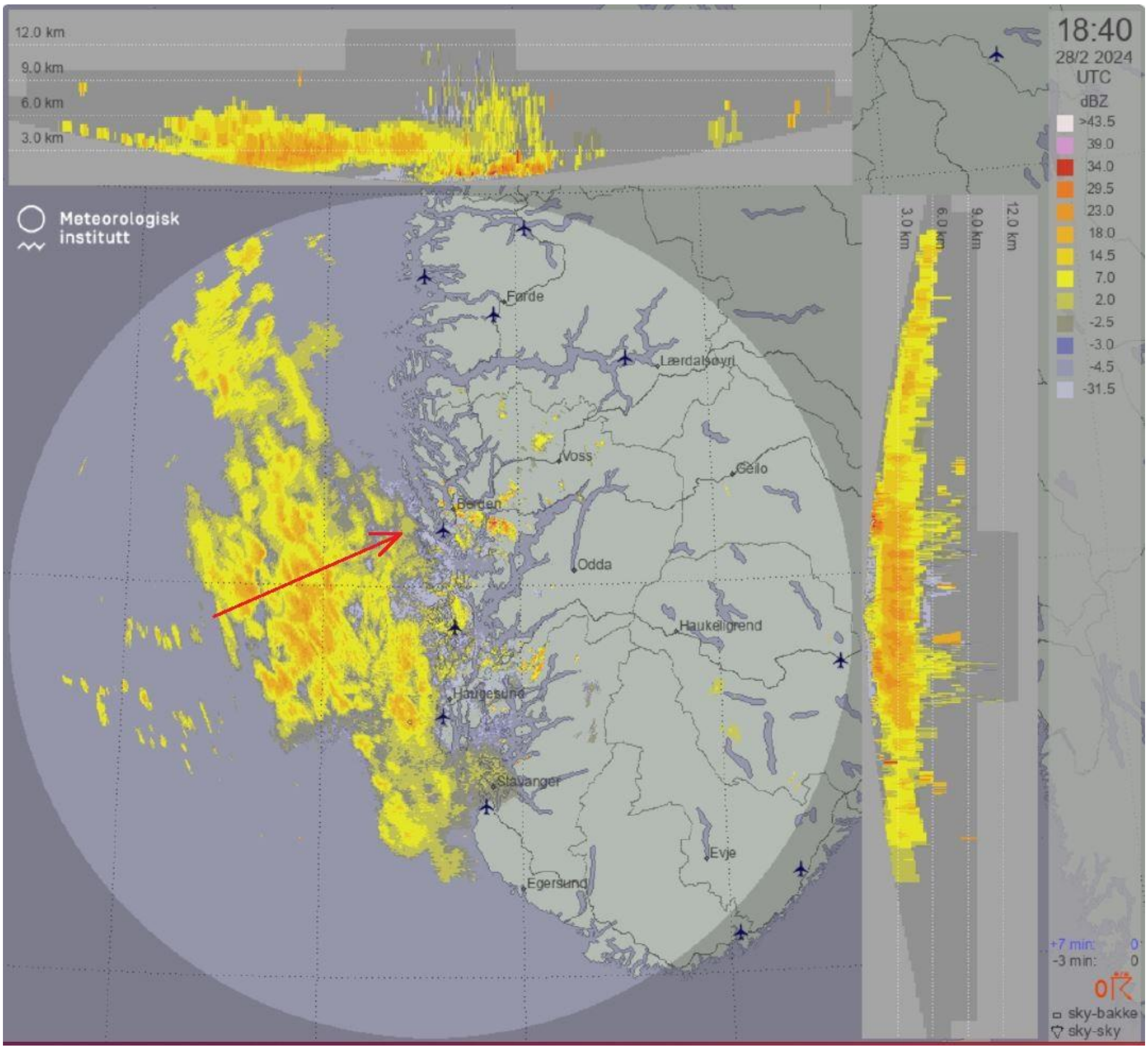

Figure 16: Radar image of precipitation at 1940 hrs, the accident site is shown with the red arrow. Weak return near Sotra (yellow) This can be rain that do not reach the surface or only gives light rain at surface level. Source: Norwegian Meteorological Institute / NSIA

1.7.1.4 Wind

The wind from south-southeast was increasing in the area west of Sotra in the relevant period. At 1950 hrs Bergen Airport Flesland observed 20 kt from 160° while an anemometer at Liatårn at Sotra (1,200 ft) measured 26 kt from 150°.

The surface wind at Fedje (about 34 NM north of Bergen Airport Flesland) at 2000 hrs was moderate gale at 32 kt from 168°. 33 kt maximum average wind with gusts up to 41 kt was observed during the 1900–2000 hrs period.

The surface wind at Bergen Airport, Flesland at 2000 hrs was 19 kt from 158°. 22 kt maximum average wind with gusts up to 28 kt was observed during the 1900–2000 hrs period.

The surface wind at Slotterøy (about 17 NM southwest of Bergen Airport, Flesland) at 2000 hrs was 19 kt from 168°. 21 kt was maximum middle wind with gusts up to 29 kt was observed during the 1900–2000 hrs period.

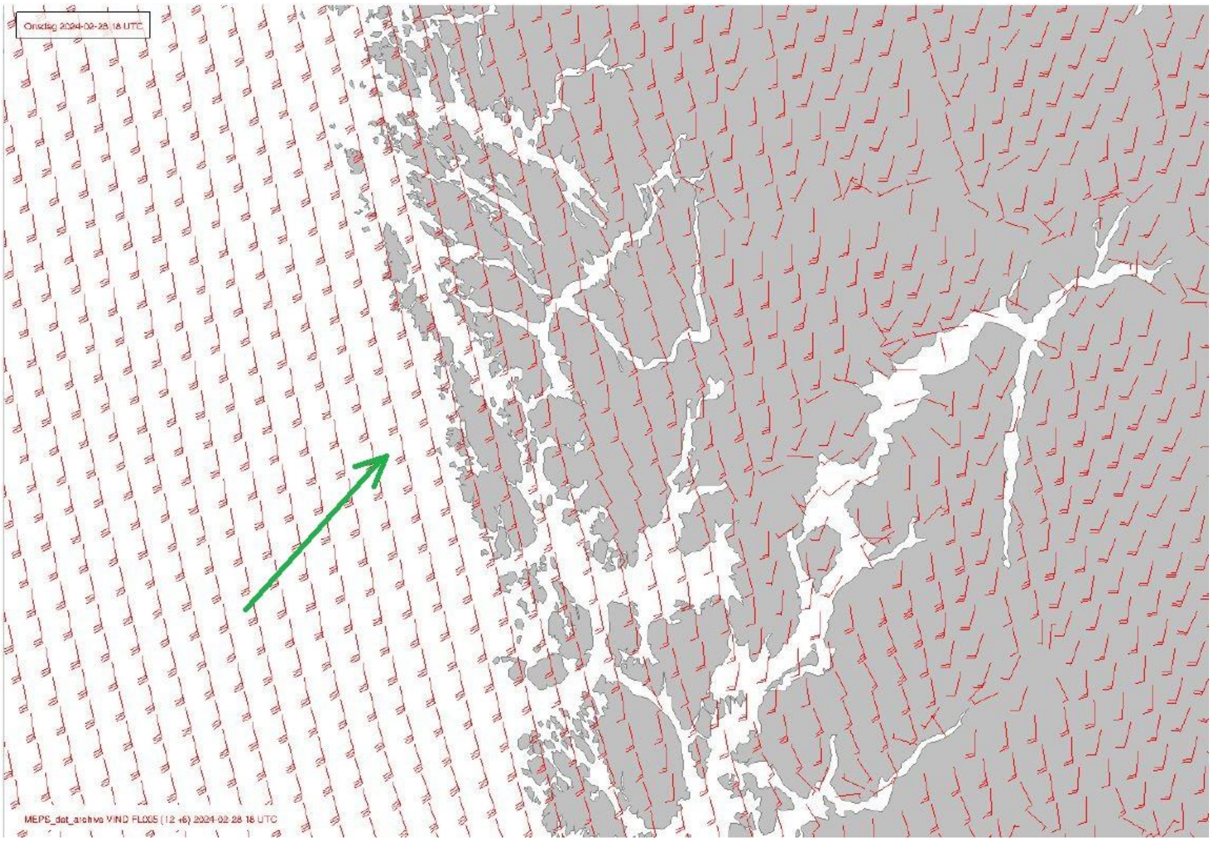

Figure 17: Wind simulations at 500 ft indicates 30 kt from 150–160° at 1900 hrs at the accident site (green arrow). Source: Norwegian Meteorological Institute / NSIA

1.7.1.5 Icing

There were no valid AIRMET/SIGMET for the actual area. No icing was reported. Relative humidity at Bergen Airport, Flesland was 90–95% at the time of the accident.

1.7.1.6 Turbulence

There were no valid SIGMET for the actual area. There were no reports or warnings about wind shear at Bergen Airport, Flesland.

Wind and direction could create light turbulence (FBL) or light to moderate turbulence (FBL/MOD) near or over land. This was mechanical turbulence generated by the terrain. Modelling made after the accident has indicated severe turbulence over the highest peaks, but it was unlikely that this turbulence has moved offshore towards the accident site.

1.7.1.7 Wave height

Observed significant wave height (H_s) near Fedjeosen southwest (N 60.7318 E 004.661) was between 3.5 and 4 metres at the time of the accident, see Figure 18. The maximum wave height observed was between 6 and 7 metres. The wave height decreased in the period between 1800 and 2200 hrs.

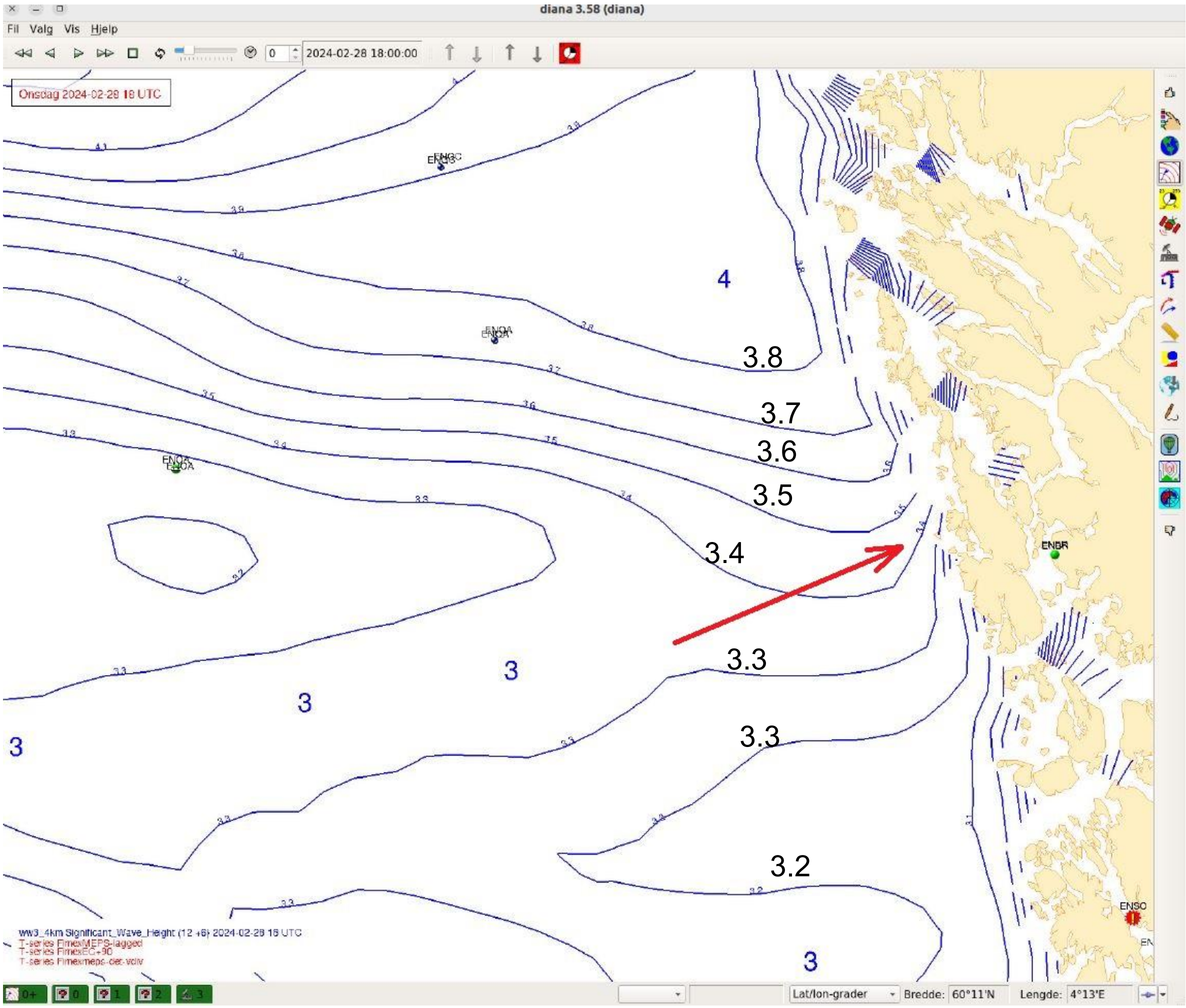

Figure 18: Prognosis chart for significant wave height at 1900 hrs at the accident site (red arrow). The thin lines denote increments of 0.1 metre wave height. At the accident site the wave height is 3.4 metres increasing towards the north. Source: Norwegian Meteorological Institute / NSIA

1.7.1.8 Ocean current

The general current direction is northerly in the area west of Sotra and Øygarden. There are large variations, but generally the current is 0.4–0.7 m/s, maximum 0.9 m/s.

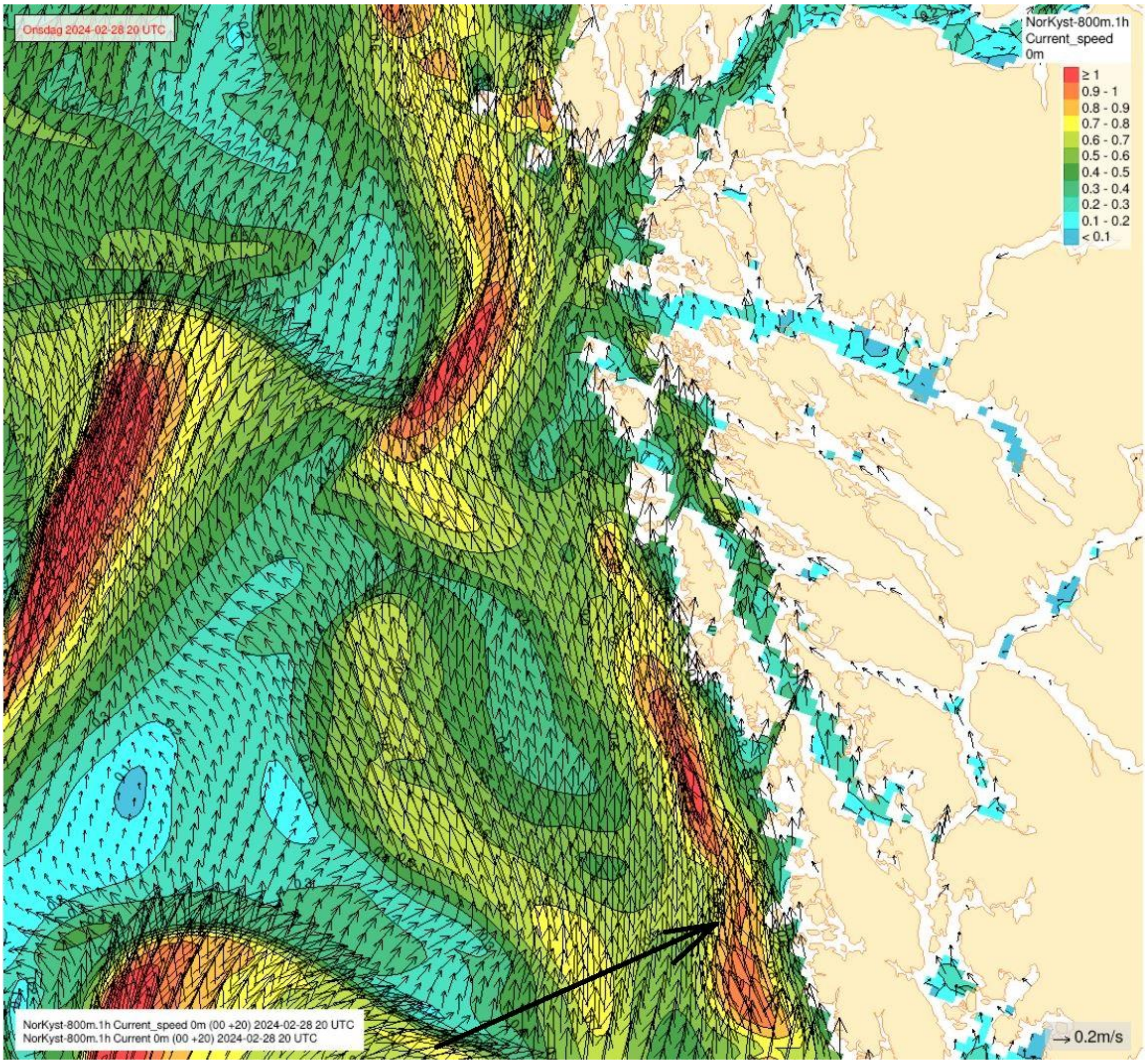

Figure 19: Prognosis chart of surface current at 2100 hrs. Accident site indicated with black arrow. Source: Norwegian Meteorological Institute / NSIA

1.7.2 METAR AND TAF

1.7.2.1 Meteorological Aerodrome Report (METAR) for Bergen Airport Flesland (ENBR)

ENBR 281650Z 17017KT 9999 FEW012 SCT019 BKN048 06/05 Q1007 NOSIG RMK WIND 1200FT 16023KT=
ENBR 281720Z 16018KT 9999 FEW013 SCT019 BKN048 06/05 Q1006 NOSIG RMK WIND 1200FT 16024KT=
ENBR 281750Z 16019KT 9999 SCT019 BKN043 06/04 Q1006 NOSIG RMK WIND 1200FT 16024KT=
ENBR 281820Z 16021KT 9999 BKN019 06/04 Q1006 NOSIG RMK WIND 1200FT 16026KT=
ENBR 281850Z 16020KT 9999 SCT014 BKN018 06/04 Q1005 TEMPO BKN012 RMK WIND 1200FT 15026KT=
ENBR 281920Z 16019KT 9999 VCSH BKN014 BKN039 06/04 Q1005 TEMPO BKN012 RMK WIND 1200FT 15027KT=
ENBR 281950Z 16018G18KT 9999 SCT015 BKN022 06/04 Q1004 TEMPO BKN012 RMK WIND 1200FT 15029KT=
ENBR 282020Z 16019KT 9999 SCT012 BKN017 06/04 Q1004 TEMPO 16020G30KT BKN012 RMK WIND 1200FT 16030KT=

1.7.2.2 Terminal Aerodrome Forecast (TAF) for Bergen Airport Flesland (ENBR)

ENBR 281100Z **2812/2912** 20012KT 9999 -SHRA SCT012 BKN020 PROB40 TEMPO 2812/2820 BKN012TCU TEMPO 2817/2912 17018G30KT TEMPO 2820/2902 BKN012 TEMPO 2902/2911 4000 RA BR BKN008=

ENBR 281700Z **2818/2918** 16018KT 9999 -RA SCT012 BKN020 TEMPO 2818/2912 17022G35KT TEMPO 2818/2902 BKN012 TEMPO 2902/2911 4000 RADZ BR BKN006 PROB40 2908/2911 BKN004 TEMPO 2911/2918 BKN012=

1.7.3 OTHER OBSERVATIONS

Wind data computed and recorded by LN-OIJ, and stored on the FDR, show a wind speed of 33–35 kt from the south during the last 3 minutes of the flight.

The crew on the rescue helicopters all commented that the night was unusually dark at the accident site. Due to the cloud cover, there was no moon- or starlight. The moon was at the time of the accident almost full and about 25° under the horizon.[19]

Crewmembers on the rescue helicopter SAVER50 and RESCUE8 had helmet-mounted cameras. The videos show a rough sea with occasional white caps and a few bigger waves that washed over people laying in the sea.

The surface sea temperature in the area was 5 °C according to the Norwegian Marine Research Institute.

1.8 Aids to navigation

The flight was carried out as a Visual Flight Rules (VFR) night flight.

LN-OIJ was equipped with a standard avionics package from Rockwell-Collins Avionics Management System (AMS) which consisted of four Multi-Function Displays (MFD’s) and two Data Concentrator Units (DCU). The primary function of the AMS is to collect on-board data from flight instruments, navigation sensors, engines, fuel systems, and hydraulic systems and present the data to the crew. Additionally, warnings, cautions, advisories, health, and utility data are displayed. The four portrait-oriented Multi-Function Displays were installed in the cockpit instrument panel, two located on each side of the cockpit. Each MFD was an Active-Matrix Liquid Crystal Display (AMLCD).

1.9 Communications

The communication between the crew on LN-OIJ and relevant ATC units during the flight was normal. LN-OIJ was initially on the Flesland Tower frequency 119.100 MHz, but was handed over to the Flesland Approach frequency 121.000 MHz at 1829 hrs. The last communication between any ATC units and LN-OIJ was at 1840 hrs (approximately 1 hour before the accident) when the crew confirmed to Flesland Approach that they were aware of a restriction area in Hjeltefjorden.

1.10 Aerodrome information

Not relevant to this investigation.

[19] Depending on the moon-phase and the moon’s altitude some moonlight might still be seen even with the moon under the horizon.

1.11 Flight recorders

1.11.1 MULTIPURPOSE FLIGHT RECORDER

The helicopter was fitted with a Curtiss-Wright D51615-142-090 multipurpose flight recorder with serial number A26212-003 manufactured in 2022. The recorder is a combined voice and flight data recorder (CVFDR) and stores two hours of audio from four channels and 25 hours of flight recorder data. The recorder was fitted with an Underwater Locator Beacon, which starts to operate when the recorder is submerged. The recorder was retrieved from inside the helicopter wreck, kept submerged in fresh water and transported to the Air Accident Investigations Branch in the United Kingdom for data extraction. Both cockpit voice and flight recorder data were successfully downloaded.

1.11.2 HEALTH AND USAGE MONITORING SYSTEM

The helicopter was fitted with the Sikorsky Health and Usage Monitoring System (HUMS). HUMS is intended to provide diagnostic and health and usage monitoring functions on aircraft drive train, propulsion, auxiliary and structural components.

In addition to vibration and maintenance data the system records several flight parameters. The memory card with the stored HUMS data was retrieved from inside the helicopter wreck and transported to the Air Accident Investigations Branch in the United Kingdom for data extraction. Data for the flight was successfully downloaded.

1.11.3 FLIGHT CONTROL COMPUTERS

After the accident both Collins Aerospace flight control computers (FCC) with part number 78286-92900-0182-113 and serial E201-00117 and E201-00462 were removed from the helicopter and submerged in fresh water to prevent further corrosion. After rinsing the FCCs were dried out in a drying rack. The FCCs store eight minutes of data in a circular buffer at a recording frequency of 1 Hz and it was decided to download this data. The NSIA hand carried the FCCs to the manufacturer Collins Aerospace in Phoenix, Arizona for read out. Due to water ingress, it was not possible to power the computers.

The printed circuit board (PCB) with the memory unit was removed from the FCC and inserted into a test unit. The PCB had not sustained any major damage, and it was possible to download the circular buffer without issue. A full eight minutes of data was retrieved from both FCCs.

1.11.4 HOIST CAMERA

The rescue hoist had a camera installed which was set to record. The memory card with the video (including voice recordings) was retrieved and successfully downloaded. Due to poor light conditions the video recording was not of significant aid in this investigation. This gave the NSIA an indication of the light conditions during the flight.

1.11.5 DATA AND PLOTS

The NSIA verified that the HUMS data and FDR data were equivalent. In this report the HUMS data is shown due to superior visualisation. Figure 20 shows the pitch attitude, the cyclic stick position for pitch, groundspeed, pitch stick force and the pitch capture degrade (high is degraded) during the final deceleration of the “Mark on Top” (MOT) manoeuvre from the HUMS data. The graph spans a period of 47 seconds. All values appear normal until the helicopter starts pitching up at about 15 seconds from the end of the recording. Figure 21 shows the same parameters for the last 16 seconds of the flight. Neither HUMS nor the FDR recorded any AFCS cautions being set during the accident.

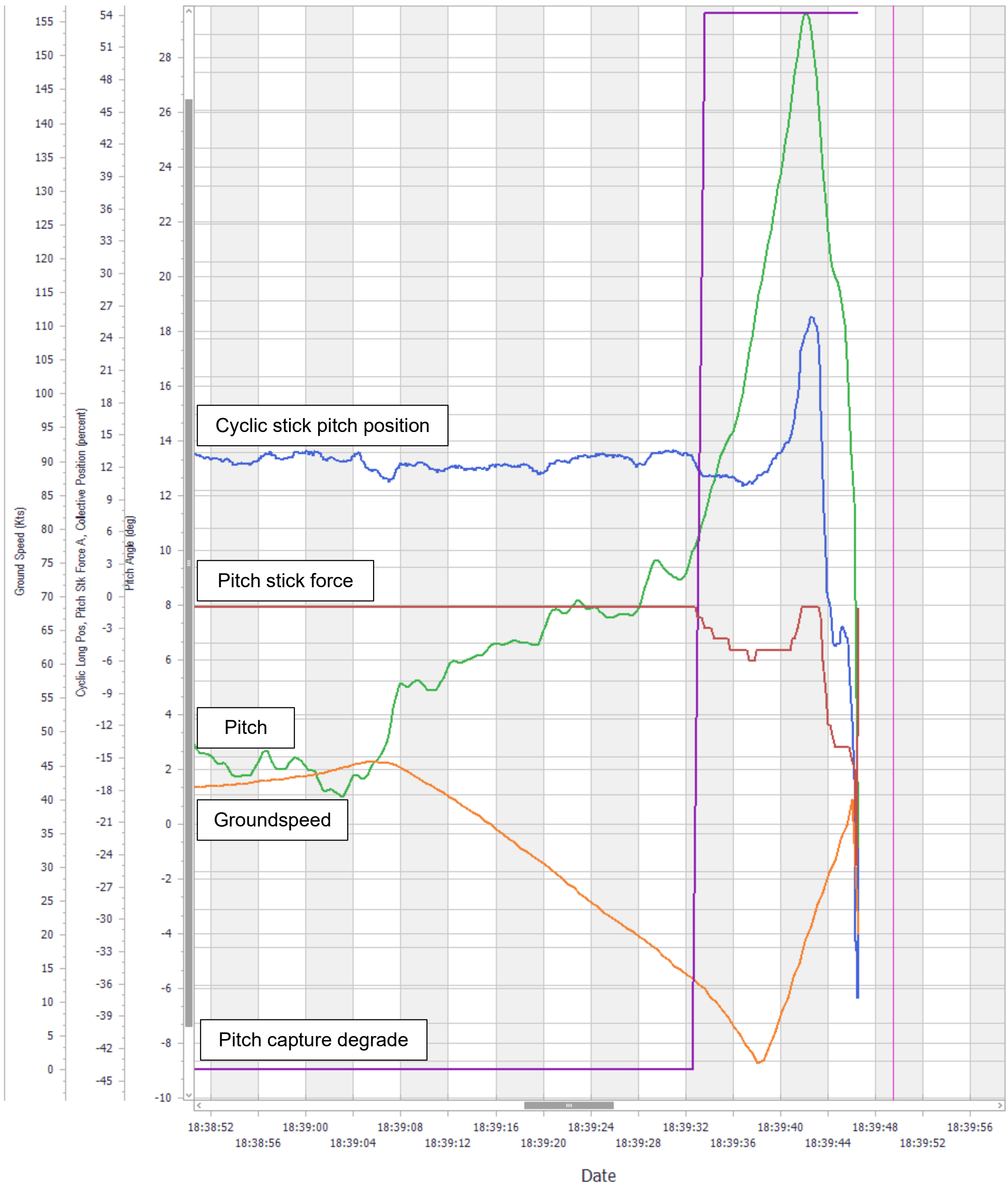

Figure 20: The pitch angle (green), cyclic stick pitch position (blue), ground speed (orange), pitch stick force (red) and the pitch capture degrade (purple) from the HUMS data. Source: NSIA

The helicopter pitched up from 8.9° to 29.6° over a period of 10 seconds. Two seconds after the pitch up started, the FD pitch degrade was illuminated due to the stick force reaching -3%, the force reaches a maximum of -6% six seconds after the pitch up started. About a second after the pitch-up manoeuvre started, the cyclic stick moved backwards (negative, nose up), the ground speed was at this time 13.5 kt. The cyclic stick position then remained constant for 4 seconds before a forward motion is recorded (positive, nose down). The ground speed is steadily decreasing, until it reaches zero, at which point it starts increasing. HUMS cannot record negative ground speed and so in reality the helicopter had at this time started to fly backwards. Maximum rearward speed right before impact with the water is 40 kt.

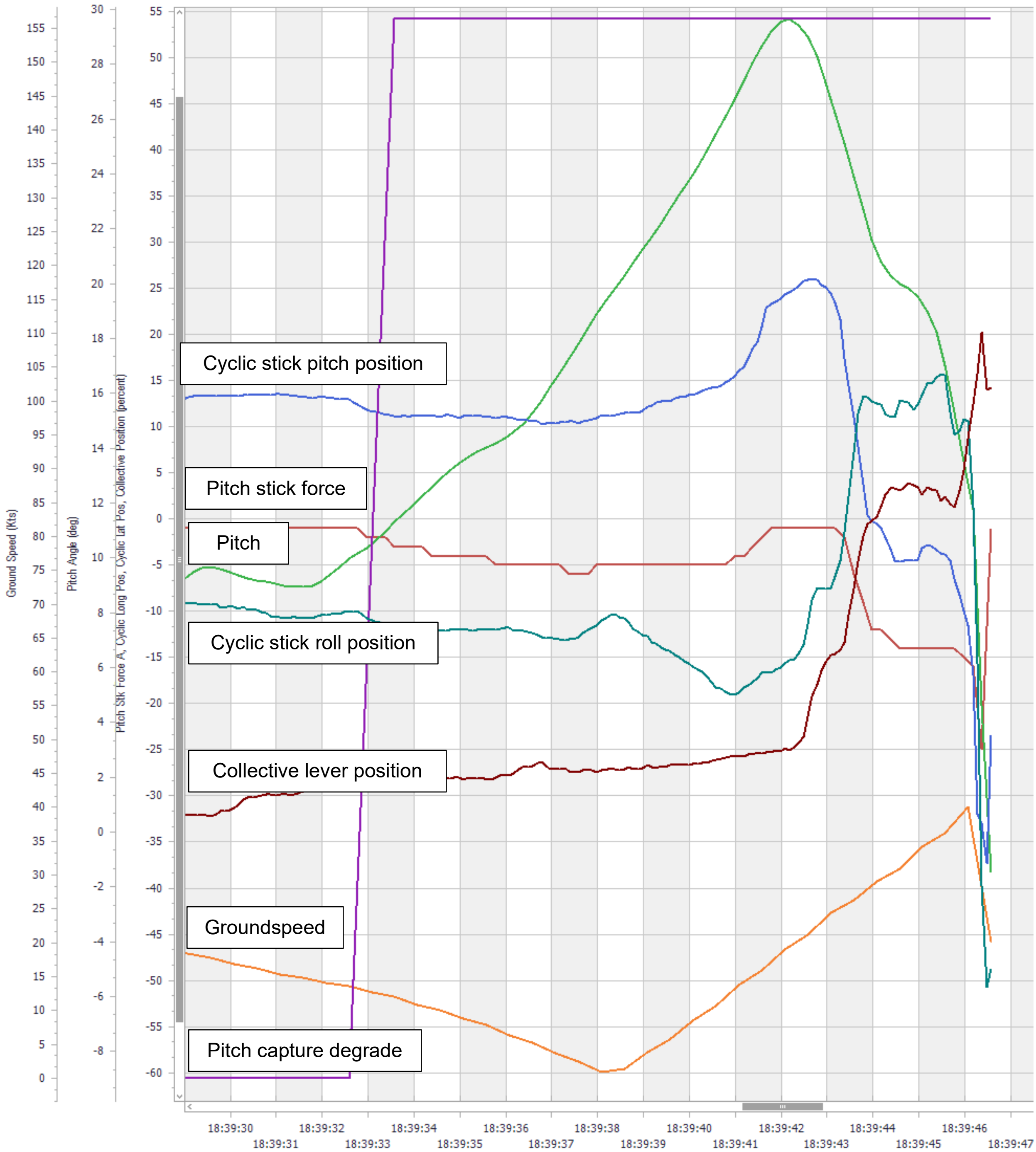

Figure 21: The last 16 seconds of HUMS data for the flight. Pitch angle (green), cyclic stick pitch position (blue), cyclic stick roll position (turquoise), collective position (dark brown), ground speed (orange), pitch stick force (light brown) and the pitch capture degrade (purple). Source: NSIA

Figure 22 shows the last 20 seconds of the FCC circular buffer. Trim position and trim command are only stored in the circular buffer. At t=464 (approximate HUMS time 18:39:33), the trim position is zero but start increasing steadily until it reaches about 11.5 % before decreasing again. A positive trim position means a nose down trim command.

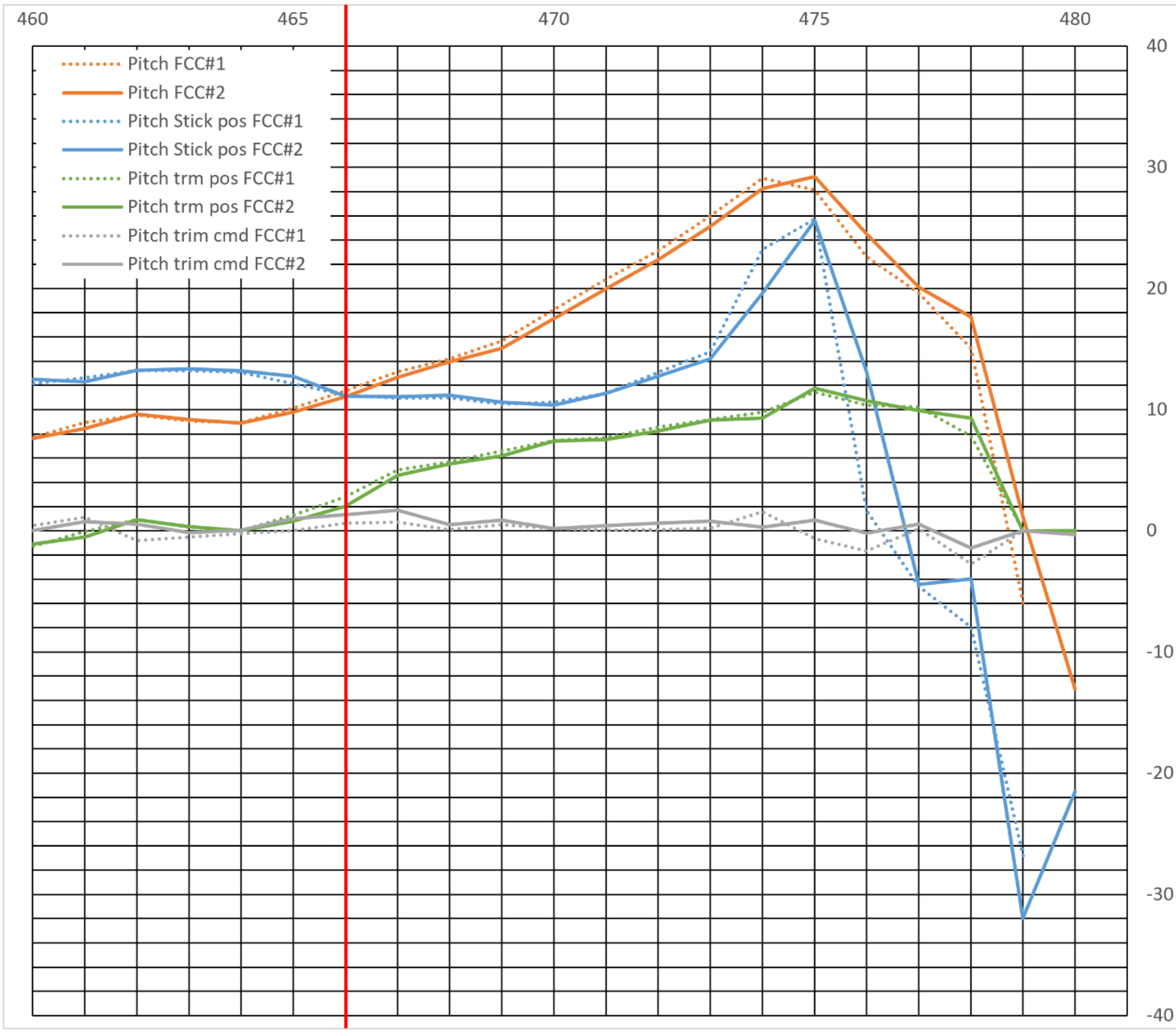

Figure 22: The last 20 seconds from the FCC circular buffer. The data plotted is pitch (orange), cyclic stick pitch position (blue), pitch trim position (green) and pitch trim command (grey). The dashed lines are from FCC 1 and solid lines are from FCC 2. The red line is approximately where the pitch degrade is activated. Source: NSIA

1.11.5.1 Recorded HUMS data from another flight with LN-OIJ on 11 February 2024

Data from the final deceleration of a MOT LN-OIJ performed on the 11 February 2024 is shown in Figure 23. This MOT completed as normal and can be considered expected behaviour. Of note is that a negative cyclic pitch trend is seen as the helicopter ground speed goes below 14.5 kt. This trend is seen in data the NSIA has collected from several flights. A comparison of cyclic position, pitch attitude and ground speed between the flight on 11 February and 28 February is provided in Figure 24. This illustration is synced to groundspeed, and shows how a normal MOT might look for LN-OIJ.

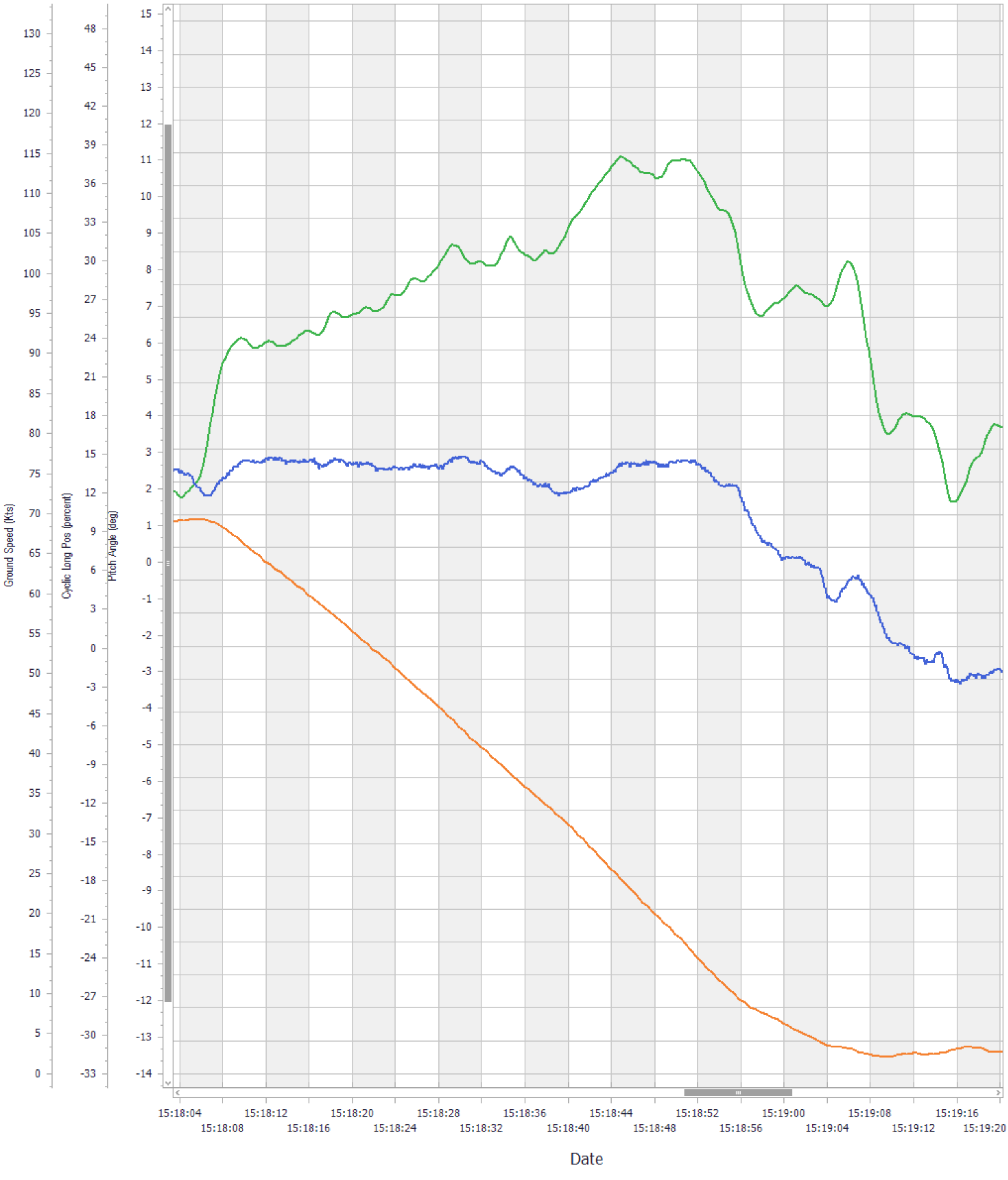

Figure 23: The HUMS data from the final deceleration of a MOT LN-OIJ performed on the 11 February 2024. Pitch (green), cyclic pitch position (blue) and ground speed (orange). Source: NSIA

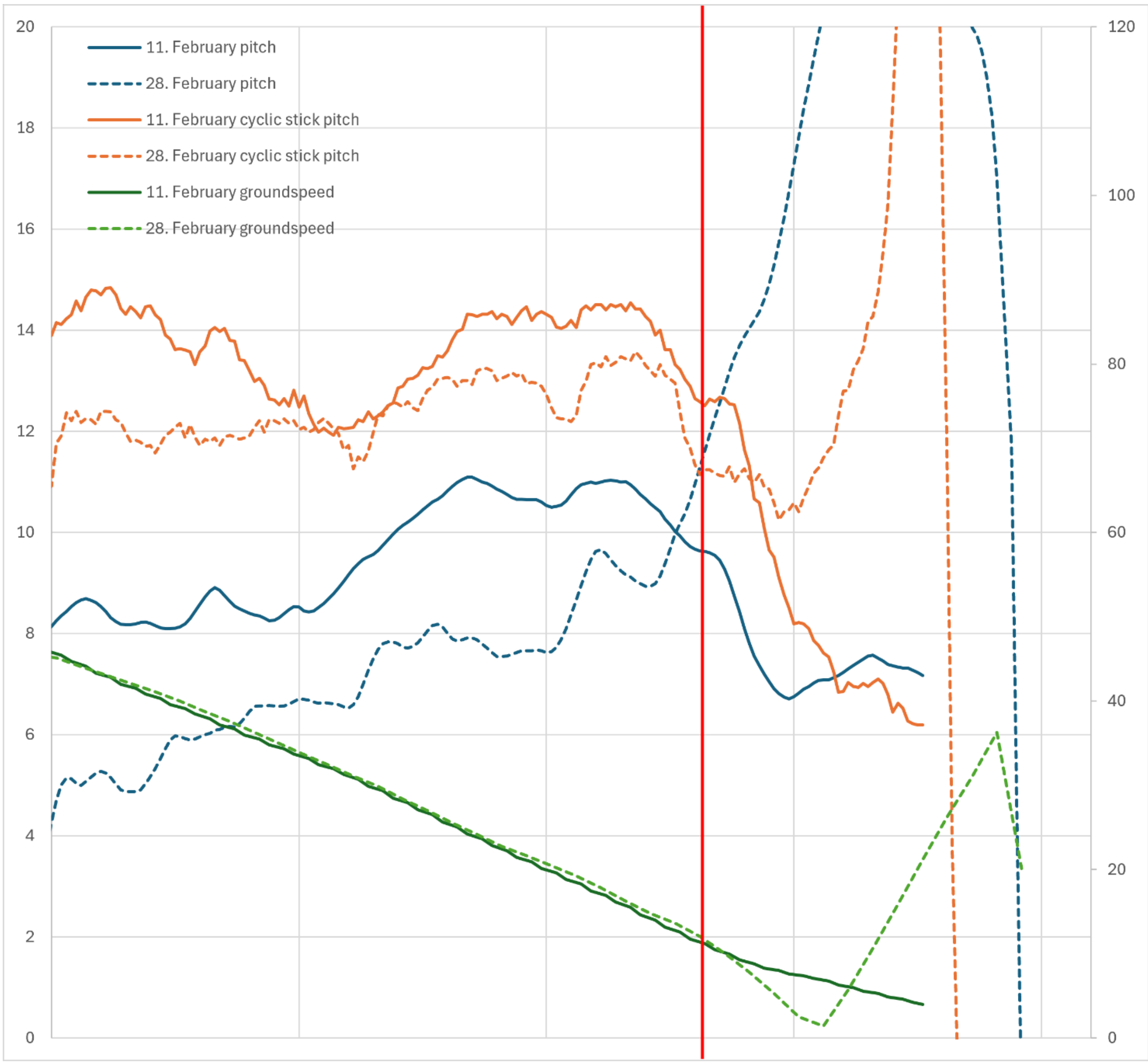

Figure 24: Comparison of the final deceleration of the MOT performed by LN-OIJ on the 11 February (solid lines) and 28 February (dashed lines). Cyclic stick pitch position is in orange; pitch is in blue (both plotted on left axis) and ground speed in green (plotted on right axis). The solid red line approximates when the pitch capture degrade occurs. Source: NSIA

1.12 The accident site and wreckage information

1.12.1 THE ACCIDENT SITE

The helicopter sank to a depth of 218 metres. The seabed was muddy and sloped slightly towards the west. The helicopter was found at position N 60.3181 E 004.8265 approximately 3.5 NM west of the island Sotra.

1.12.2 THE SEARCH AND RECOVERY OF THE HELICOPTER

The approximate location of the helicopter became clear as soon as data was available from the Joint Rescue Coordination Centre. Normand Ocean, a multipurpose construction vessel was made available by Equinor and contracted by the NSIA to locate and retrieve the helicopter wreckage from the seabed. The vessel carried two constructor work class remotely operated vehicles (ROV) and heave compensated cranes.

The NSIA had previous experience that HiPAP, a Dynamic Positioning (DP) system by Kongsberg could aid in the search for wrecks. This system could detect the Underwater Locator Beacon (ULB) frequency of 37.5 kHz used by the ULB attached to the CVFDR, although the system was not initially designed with this in mind. Therefore, the NSIA made sure that the vessel contracted had this system on board.

Normand Ocean left harbour Friday 1 March at 1230 hrs. On board were three investigators from the NSIA and a licenced technician from Bristow. The search started slightly south of the estimated crash position. The vessel slowed down to 0.5 kt and continued a northerly course following the ocean current. The DP system was configured to detect the Underwater Locator Beacon (ULB) attached to the Flight Recorder. The two ROVs were lowered into the sea, one on each side of the vessel. Objects discovered along the route by the ROV sonar, mainly rocks, were inspected visually. The first parts from the helicopter were located close to the crash position. These were fragments from main rotor blades. It was estimated that the sea current would bring the helicopter wreckage further north, so the search continued north. A target was located by the dynamic positioning system about 80 metres left of the search vessel, see Figure 25. At 2015 hrs this was confirmed to be the helicopter, laying upside down about 0.5 NM north of the estimated crash position, see Figure 26.

During the search, the NSIA noted that the search vessel had to be very close to the helicopter wreckage before it was detected by the DP system, and the detected signal was intermittent. During a previous search with similar equipment, the target was detected at 0.5 NM. It was also noted that the helicopter marker became clearer when the ROVs were either stationary or pulled out of the sea. This phenomenon was discussed and might indicate that the propellers on the ROVs interfered with the DP system’s ability to communicate on the 37.5 kHz frequency. In addition, the helicopter wreck was largely intact, with the CVFDR still fitted inside the helicopter, which would attenuate the signal from the ULB.

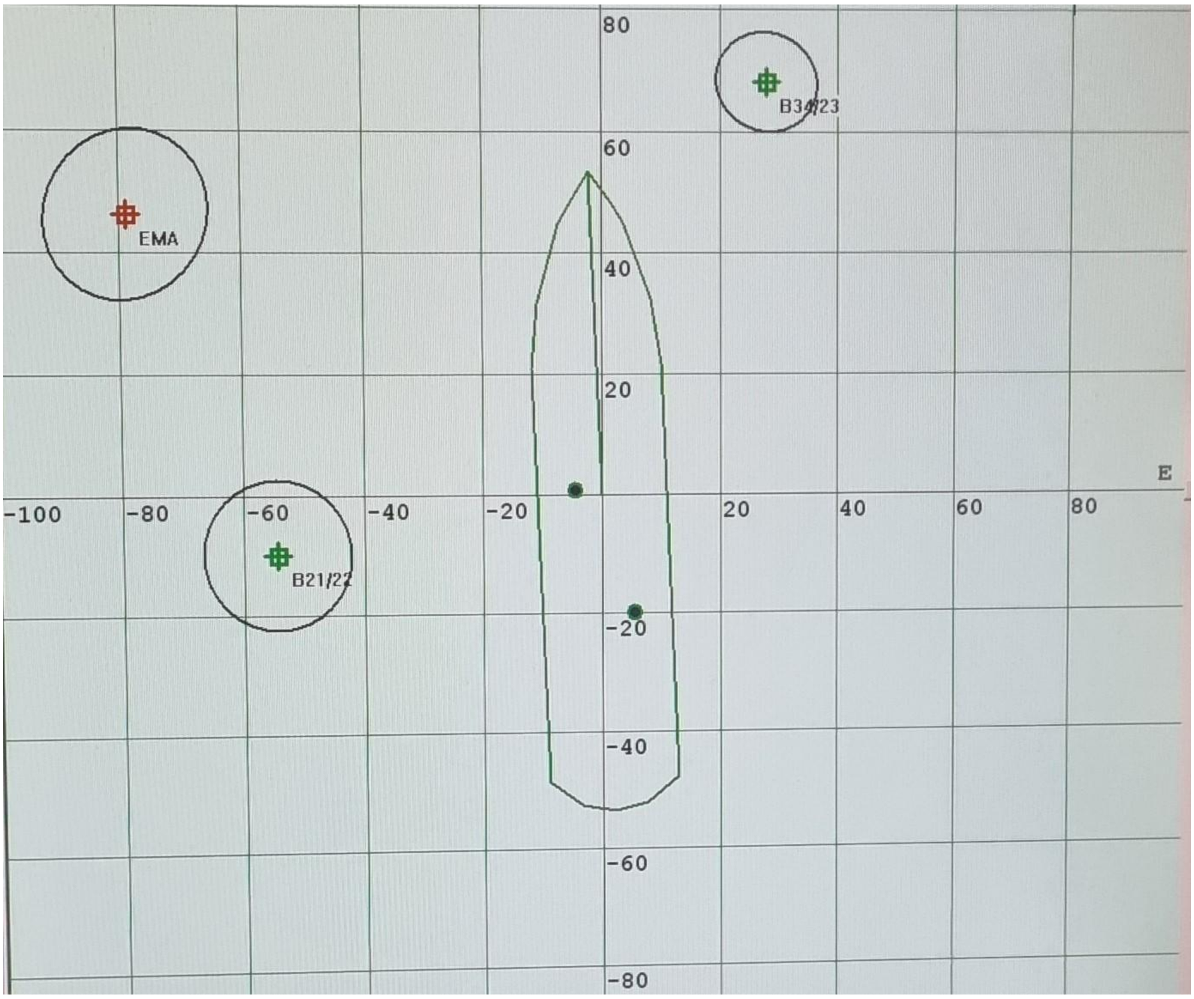

Figure 25: The helicopter located by the DP system on board Normand Ocean. The two green markers are the ROV, while the red marker is the helicopter. Photo: NSIA

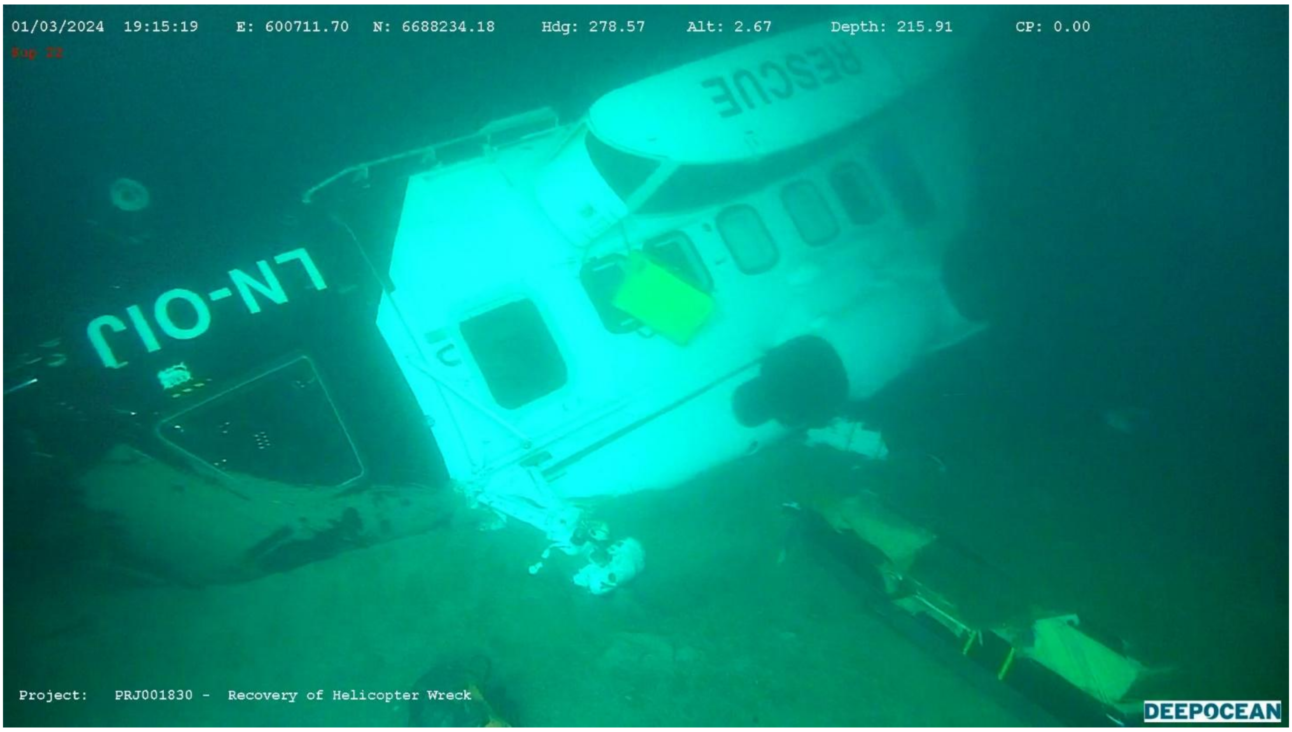

Figure 26: LN-OIJ as found on the seabed. Photo: Deepocean/NSIA

Since the helicopter was lying on its back, it was first hoisted by attaching slings on each main landing gear and on the nose gear. When the helicopter reached the surface, the vessel was rolling, making the crane boom on the port side heave significantly. The wave height was about one meter. This resulted in an uneven and jerking pull, and both main wheels were pulled loose from the gear leg, see Figure 27. To prevent losing the last attachment, the helicopter was carefully lowered down to the seabed again. Standing on its tail, a line from a second crane was attached in a way that allowed the helicopter to be lowered down to the seabed on its belly. A ROV was used to thread a chain between the main rotor mast and the pitch links. With this attachment it was possible to hoist the helicopter out of the sea, see Figure 28. The helicopter was on the deck of Normand Ocean at 0510 hrs on Saturday 2 March.

The helicopter was transported to a hangar at the Haakonsvern naval base on the outskirts of Bergen.

Figure 27: The moment when the left main wheels were pulled loose during first attempt of hoisting the helicopter. Note water flowing through all the windows at the left side. Photo: NSIA

Figure 28: LN-OIJ being hoisted out of the water. Photo: NSIA

1.12.3 WRECKAGE INFORMATION

1.12.3.1 Brief description of the helicopter

A few parts from the helicopter were seen floating in the accident area a short time after the accident occurred and later recovered. This included some personal belongings, small pieces of a main rotor blade, the aft cargo ramp door and two Personal Locator Beacons (PLB).

The helicopter was found relatively intact laying upside down on the seabed. The most obvious damage being to the main rotor blades. When the helicopter was on the ship deck, the following could be observed:

- All windows and emergency exits were missing on the helicopter left side, See Figure 29.
- The aft cargo ramp door was missing, and the ramp actuators were broken, allowing the ramp to flap freely.
- The aft right emergency exit was missing.
- The forward right emergency exit (with bubble window) was found loose inside the cabin.
- All four main rotor blades were severely damaged and large parts were missing.
- The upper forward sliding fairing was damaged on the left side (likely to be from contact with a main rotor blade)
- The aft section of the left sponson was missing. Damage on the fuselage side adjacent to the sponson indicate that the missing part had been forced into the fuselage.

- Areas on the aft left fuselage side had signs of hydro-deformation.
- All four tail rotor blades were crushed flat.
- The tail section aft fairing was damaged.
- The search light (Night Sun) on the left side belly was missing.
- No sections of the flotation gear were deployed.
- Both life rafts were missing. Both deployed and drifted away during the salvage operation and were later salvaged.
- The upper aft attachment for the medical wall had come loose.
- All four main landing gear wheels were missing (lost during the salvage operation).

Figure 29: The helicopter seen from the aft left quarter. The aft part of the left sponson is missing. A hole on the fuselage side adjacent to the sponson indicate that the missing part was forced into the fuselage (yellow arrow). The green arrow points towards hydro deformation. Also noticeable is the missing aft door and the damaged tail boom. Photo: The NSIA

1.12.3.2 Components

Following a brief documentation of the cockpit and cabin some reusable rescue and medical equipment was removed. For better access, the remains of the main rotor blades were removed, and several access panels were opened or removed. Further, the main battery was disconnected and removed. The helicopter was then hosed down with fresh water to remove clay and prevent corrosion.

Components initially expected to be vital during the investigation were removed and put into fresh water. This included:

- Multi-Purpose Flight Recorder
- HUMS Memory Card
- FCC #1
- FCC #2
- Pitch gyro L/H
- Pitch gyro R/H

Later it was decided to remove the following components:

- All four autopilot actuators (yaw, roll, pitch and collective)
- The pitch SAS/boost servo

Detailed examinations of removed components are described in chapter 1.11 Flight recorders and chapter 1.16 Tests and research.

1.12.3.3 Examination in the hangar at Haakonsvern

Based on information from the crew the following was of particular interest. With support from a licensed technician from Bristow the NSIA examined the mechanical parts of the flight controls from the cockpit to the SAS/Boost units. The four inputs (yaw, roll, pitch and collective) were mechanically disconnected successively from the SAS/Boost units to the control sticks. All movements were free without restriction. The only exception was restrictions on the collective torque shaft caused by a damage in the cockpit ceiling due to water pressure.

Inside the cockpit the following could be observed:

- No loose foreign objects that could have affected the flight controls.
- The arming switch on the Flotation Arming panel was set to Arm.
- The test switch on the Flotation panel was set to Normal.
- The HEELS switch and Cabin light switch on the Emergency light panel were set to Arm.
- The life raft switch on the Flotation panel was set to Safe.
- The test switch on the Flotation panel was set to Normal.

1.13 Medical and pathological information

The SAR nurse was autopsied at the Gades Laboratory for Pathology at the University of Bergen. The following information is deemed relevant:

- Large amounts of blood and fluid were found in both lungs, which were twice as heavy as normal lungs. There were also air-filled areas. Their appearance was stated to be compatible with “drowned lungs”.
- A subcutaneous[20] bleeding was found in the left part of the forehead. It could not be stated with certainty if this had led to reduced consciousness.
- No signs of bruising around the hip area were found. Other crewmembers had bruising consistent with being restrained by the seatbelts at impact.

The police routinely tested the flight crew for alcohol or drug use; all tests were negative.

1.14 Fire

There were no signs of fire prior to, during, or after the accident.

[20] *Bleeding under the skin.*

1.15 Survival aspects

1.15.1 PERSONAL SURVIVAL EQUIPMENT

1.15.1.1 Introduction

The NSIA has investigated the personal survival equipment each individual crew member was equipped with during the accident to better understand the situation during the crash, subsequent evacuation and finally the waiting period in the sea before being rescued. This investigation includes a thorough review of individual details, footage from the rescue operation and interviews with the surviving crew members.

1.15.1.2 Survival Suits

The crew used survival suits from two different manufacturers, see Figure 30. The survival suits worn by the two rescuemen were produced by Survitec. The remaining crew members had survival suits produced by Viking. Survival suits are personal to each crew member to ensure, among other things, that the rubber seals around the neck and wrists fit properly so that water does not enter the suit. Two of the crew experienced some leakage of water into the suit through the neck seal.

There is no insulation in the survival suits worn by the crew, and the only heat retaining effect is from the air contained within the suit. Insulation against the cold must be ensured by the clothing, preferably in several layers, worn underneath the suit. The crew used different clothing underneath their suits. Some had woollen base layers, while other had cotton-based clothing.

When donning the suit, it is normal procedure to try and force as much air as possible out of the suit. This is to ensure that the suit is practical in use. In addition, trapped air can lead to complications during underwater evacuation due to the extra buoyancy. The Viking survival suits have valves on the shoulders that can be opened in circumstances where it is desirable to force all the air out of the suit while being in the water. The water will force the remaining air out and reduce the buoyancy, provided the legs are the lowest point.

None of the two types of survival suits had gloves attached but did have attached socks worn inside the chosen footwear. In addition, the survival suits had a neoprene hood stored in a pocket on the calf. This hood meant to protect against the elements when not wearing a helmet. Two crewmembers removed their helmet, one before evacuation the helicopter and the other after reaching the surface. These two did not use the hood.

The survival suits produced by Viking had gloves stored in a dedicated pocket on each arm.

Figure 30: The two types of survival suits in use during the accident. The Viking PS4043 to the left and the Survitec Rescue Swimmer suit to the right. Photo: NSIA

1.15.1.3 Helmets

The entire crew wore helmets. Helmets from two different manufacturers, MSA and Alpha were used. Both helmet types fulfil the same requirements. The helmets functioned satisfactory during the crash and subsequent evacuation. No damage has been found on the helmets.

Several of the crew members did however experience that the chinstrap caused problems during the waiting period in the sea. The combination of buoyancy from the survival suit, the inflated life jacket and periodically large waves and strong wind, caused the chinstrap to be tight. Several of the crew members have stated that they felt suffocated. Because of this, one person chose to remove his helmet after the evacuation from the helicopter.

All helmets had communication, with built-in headphones and either a boom microphone or mask microphone. The microphones have to be connected to the helicopter communications system to function.

1.15.1.4 Gloves

There were several different gloves in use after the accident occurred. Two of the crew did not use gloves, two used fabric work gloves (one of these persons were missing one glove), while one used insulating neoprene gloves.

Those not wearing gloves have stated that they quickly got very cold hands and lost full use of their fingers. This affected the use of emergency equipment such as Personal Locator Beacons (PLB), and other equipment stored in their pockets.

1.15.1.5 Personal Locator Beacon, PLB

There were two different Personal Locator Beacons (PLB) used by the crew. Five of the crew members had the ACR Resqlink 400, while one had an ACR Aqualink 350, see Figure 31. Both types of PLB transmit on both 406 MHz and 121.5 MHz and can transmit GPS-position. Bristow was in the process of replacing all Aqualink 350 with the Resqlink 400. This swap occurred while the rescueman on re-training had been away from operational duty due to a loss of medical certificate, and he was less familiar with the new type.

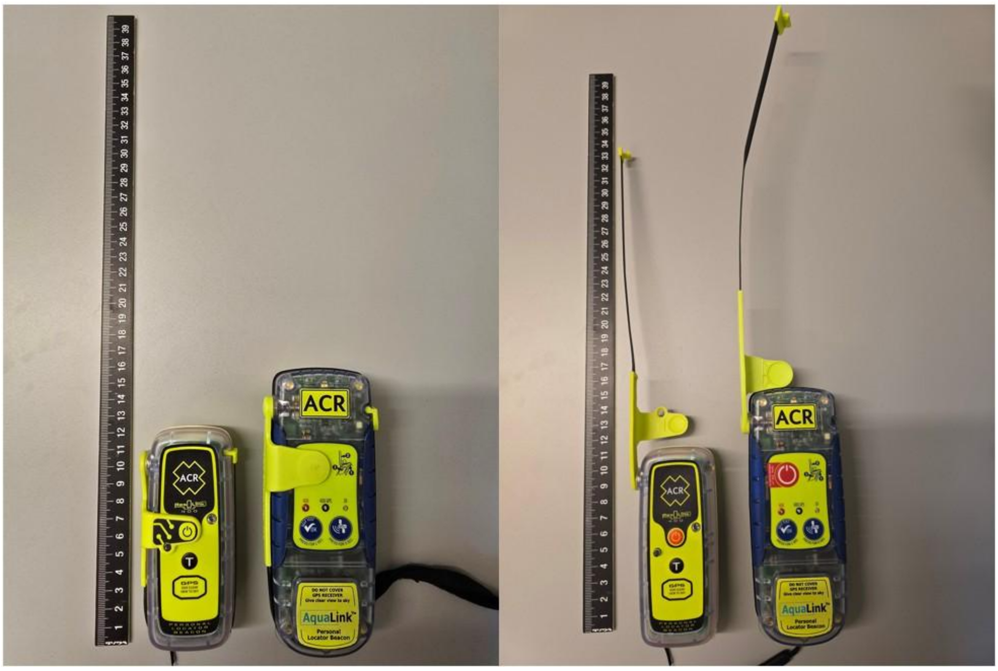

Figure 31: The two types of PLB involved, Resqlink 400 left and Aqualink 350 right in both photos. The photo to the left shows the PLBs with the antenna stowed, and the photo on the right shows the PLBs with the antennas deployed and the red activation button is visible. Photo: NSIA

Both PLBs require two steps for activation after being retrieved from the life jacket pocket:

1. Unclip the antenna latch from the case and rotate the antenna into upright position.
2. Depress the ON/OFF button for two seconds.

The Resqlink 400 has two buttons on the front with a similar tactile feel. One is the ON/OFF button (⏻) while the other is a self-test button (T). The self-test includes GPS testing. The Aqualink 350 has two test buttons in addition to the activation button. One is a self-test button, and one is a GPS test. There is no light on the PLB, apart from a small LED indicating that the unit is turned on.

The crew has told the NSIA that both PLBs were difficult to activate in the situation they experienced. With no lights and with cold fingers they stated that it was difficult to find the correct button.

1.15.1.6 Life jacket

The rescueman on re-training used an LSC HSAS life jacket. The LSC HSAS is only used by rescuemen. All the other crew members used a Beaufort MK44 life jacket, see Figure 32. All life vests used in aviation must be manually inflated to provide buoyancy.

The MK44 has two variants, one with single inflation chamber and the other with dual inflation chamber (only the SAR Nurse used the dual inflation chamber MK44). The main difference is that the dual chamber construction uses two gas cartridges. The LSC HSAS also has a dual chamber construction and uses two gas cartridges.

The Beaufort MK44, see Figure 33, is fitted with:

- Gas cartridge for inflation (one or two)
- Compressed air (CAT-A) Emergency Breathing System (EBS)
- Pocket for PLB
- Pocket with a strobe-light
- Whistle
- Mouthpiece for manual inflation
- Buddyline, used to keep multiple people together
- Light attached to the inflatable element with its own battery. This light is automatically turned on when the life jacket is inflated. The switch is a plastic pin attached to the battery and a nylon string attached to the life jacket. When the life jacket inflates the plastic pin is pulled which activates the light.
- Extra reflective material which is visible when the life jacket is inflated to aid search and rescue.

The major difference between the LSC HSAS and the Beaufort MK44, is that the latter is equipped with a light. The LSC HSAS also has a pocket with a “pengun” (a small handheld emergency flare) with 10 shots. Only one of the chambers of the rescueman on re-training’s life jacket inflated. Both gas cartridges were found pierced and empty. There were no holes or other faults with the inflation chambers and the NSIA has not been able to determine why only one chamber inflated.

All life jackets had been service tested according to their maintenance schedule.

Figure 32: The two types of life jacket in use. The Beaufort MK44 at the top and the LSC HSAS on the bottom. Photo: Bristow/NSIA

Figure 33: Life jacket type Beaufort MK44 unpacked and with equipment shown. The emergency breathing system bottle to the left in the picture. Photo: NSIA

1.15.1.7 Emergency Breathing System (EBS)

All crew members had CAT-A EBS as part of the equipment fitted to their life jacket. The EBS consist of:

- A small bottle of compressed air.
- A manometer.
- A valve.
- A hose with a mouthpiece.

Standard procedure is to check that the valve is open before each flight. This will allow the air to flow from the bottle when the user breathes through the mouthpiece. Investigations after the accident found that the valve on the commander's bottle was closed. The other crew members' valves were all found open. The crew has told the NSIA that due to the position of the bottle, it would be difficult for a user to reach the valve with an inflated life jacket.

A review of the air content in the bottles found that the crew members in varying degree had used the EBS. The bottles belonging to the commander and the SAR nurse were found to be full. All crew members that used EBS have told the NSIA that the use of the EBS worked as expected according to training and practice.

In addition to CAT-A EBS there exits CAT-B EBS[21]. This is a rebreather system, which consist of a plastic lung with a mouthpiece to breathe in and out of. Each time a person breathes out, there is enough oxygen left to be able to rebreathe the same air. If a person manages to fill their lungs before an impact, it is possible to breathe the same air for some time. The system require that one is prepared to use it, and its effectiveness relies on the air content in a person's lungs.

1.15.1.8 Strobe-light

In addition to the strobe light attached to the life jacket, all the crew members had a strobe-light in a pocket in their life jacket, to be able to attract attention in an emergency. The strobe-light has two settings, one with full intensity and one with reduced intensity to preserve battery life. Unlike a traditional torch, both settings give off an intense blinking light, which is unsuitable for general lighting. The strobe-light is also equipped with Velcro, for it to be attached to a helmet for optimal placement. None of the crew members attached the strobe-light to their helmet. The senior rescueman used his strobe-light to attract the attention of the rescue helicopter.

1.15.1.9 Tethering equipment

Bristow allows crew members to perform essential or necessary tasks in the cabin during flight without being secured when all doors are closed. If any door is to be opened, all on board should be secured either by sitting in their seat with seatbelts fastened or secured to the helicopter with alternate means.

During hoisting operations, the hoist operator is normally secured using a belt with an attached lanyard, called a monkey-strap. The lanyard is attached to anchor points in the helicopter floor or ceiling via a carabiner, see Figure 34. A securing mechanism must be twisted before it can be pushed down, and the carabiner can be opened. The belt can be opened with a quick release mechanism. If they are not supposed to be hoisted, the SAR nurse also use a monkey-strap if required to enter the seatray (a rubber tray on the floor in the forward part of the cabin for collecting water after winching operations) and the door is open.

There were two types of lanyards in use at the time of the accident. Both types had carabiners in each end, while one type also had a quick release mechanism, see Figure 35. The rescueman on re-training has told the NSIA that after the accident Bristow no longer uses the lanyard without a quick release mechanism.

Crew who needs to be hoisted use a harness suited for this, see Figure 36. If they are to be hoisted the harness is connected to a Quick Release Box. The harness also has a loop for attaching a lanyard, that can be used for example to secure them from falling out of the helicopter.

[21] The European legislation mandates CAT-A EBS for offshore flights. There exits a Norwegian Alternative Means of Compliance that allows the use of CAT-B EBS for offshore flights.

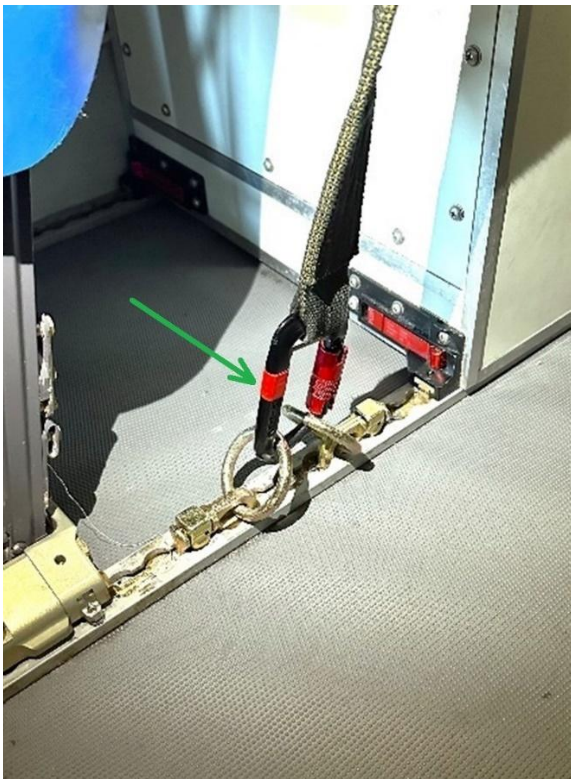

Figure 34: Lanyard secured to the cabin floor with a carabiner (green arrow). Photo: NSIA

Figure 35: Lanyard with quick-release (green arrow). Photo: NSIA

Figure 36: Fully equipped hoist operator secured with a monkey-strap and rescueman with harness hanging in the hoist via a Quick Release Box (inside yellow circle). Photo: Bristow Norway / NSIA

1.15.2 THE EVACUATION AND SUBSEQUENT PERIOD IN THE SEA

Figure 37 is an illustration showing the location of the different personnel when the helicopter crashed into the sea. It is uncertain if the SAR nurse was seated in her seat or moving towards it. The crew used different clothing underneath their suits. Some had woollen base layers, while other had cotton-based clothing. There is no indication that anyone had unsuitable layers underneath, and personal factors and water ingress into the survival suit are the most important when it came to how cold people became. For example, the persons that became the coldest wore two layers of wool.

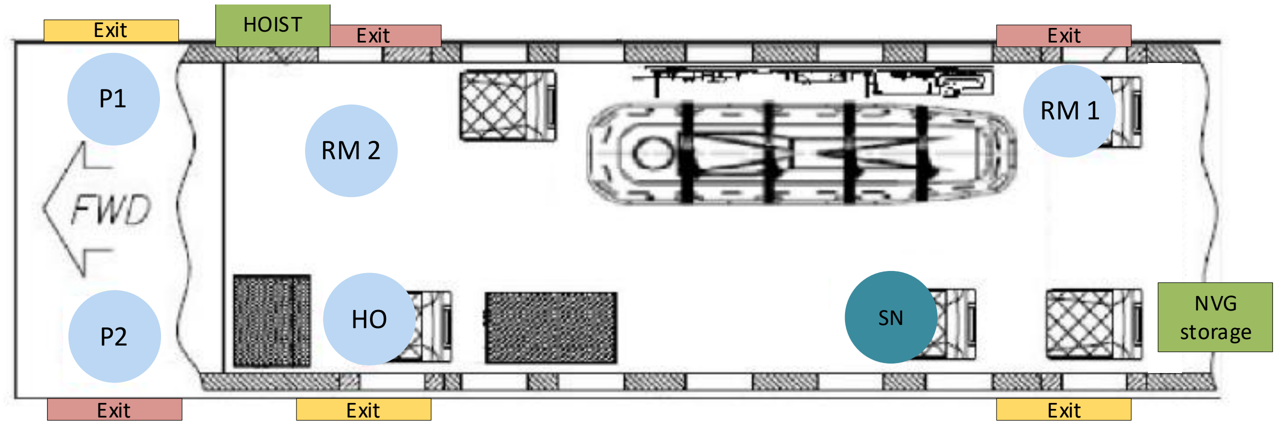

Figure 37: Illustration of the location of the different people in the cockpit and cabin at impact. P1= Commander, P2=Co-pilot, RM2=Rescueman on re-training, HO=Hoist operator, SN=SAR nurse, RM1=Senior rescueman. Emergency exits which are known to have been used are marked in red, while the other emergency exits are marked in yellow. In addition, all the windows can be used as an emergency exit Illustration: NSIA

1.15.2.1 The commander

The commander stated to the NSIA that he grabbed the controls when he understood that something was wrong. Immediately afterwards the helicopter crashed into the sea with the left side first. He is not sure if he lost consciousness for a short time. The next thing he remembered was water coming over his face. He managed to take one last breath before he unbuckled his seatbelt. He then removed his helmet and swam to the cabin to aid with the evacuation. He saw no one and felt that the helicopter rolled further over on its side. This led to him losing overview of where the emergency exits were. The commander has stated that during the evacuation he did not remember that he had EBS.

He felt the need to breathe and started to look for an emergency exit. He swallowed large amounts of water and believed that he would not survive. When he saw the HEEL-lights around one of the small window emergency exits on the left-hand side, he managed to find extra strength. He punched the window out and swam out of the helicopter. It is also possible he punched out the window on the front left-hand side emergency exit, which was found broken after the accident.

He heard the voice of the hoist operator when he reached the surface. The hoist operator grabbed him and inflated his life jacket. Shortly after they found the co-pilot and then a bit later the senior rescueman. The commander has stated that the life jacket obstructed him from looking around, due to its size and placement. He therefore asked if the others could see the helicopter, which they confirmed. Shortly after this the helicopter sank. He had no recollection of how long they were in the sea, but he became very cold, especially on his hands since he did not wear gloves. The commander stated that before they were picked up, he was so cold that the only thing he could focus on was breathing.

1.15.2.2 The co-pilot

The co-pilot has stated that he was waiting for the right moment to give the signal for opening of the door and arming the hoist when he felt that the helicopter did something unexpected. His notion was confirmed by the commander shouting, “going around”. Immediately afterwards everything was black. He does not remember much from the evacuation but has vague memories of using his own emergency exit in the left-hand cockpit window, and that he saw the HEEL-lights around it. Further, he remembered water entering his suit through the neck while moving to get out of the helicopter and that he used his EBS. The next thing he remembered was seeing the helicopter floating upside down in the water without the EFS or life rafts deployed.

His strongest memory from the time in the water while waiting to be rescued was the intense feeling of cold. He managed to get his neoprene gloves on shortly after the evacuation, but at that time his fingers were already cold. This contributed to him not being able to activate his PLB, and the fact that the buttons were small and not very tactile did not help. He also remembers that he did not manage to activate the light on his life jacket which had not activated automatically. He also felt that the chin strap for his helmet was very tight due to the inflated life jacket, and he therefore opened his chin strap. Moments before he was hoisted out of the sea a large wave washed his helmet away.

1.15.2.3 The hoist operator

The hoist operator has explained to the NSIA that he had been using NVGs to view the blinking light on the training beacon and that he heard the pilots activate MOT in the cockpit. He was seated in his seat in the front left part of the cabin secured to the roof with his monkey-strap. At some point he noticed that the helicopter motion was not normal, but it was difficult to remember details. He remembers hearing “go-around” was stated in the cockpit, and moments later they were in the sea.

The cabin was immediately filled with water, and he remembered the screeching sound of the gearbox. He was tossed about in the cabin and had trouble locating the mouthpiece for his EBS. After some time, he managed to establish EBS and focused on orienting himself in the cabin. After a little while he managed to understand what was up, and what was down. After some searching, he found a handle that felt like one of the emergency exit handles. The NSIA investigation has gathered that this was most likely the emergency exit on the sliding door on the front right part of the helicopter. When he was on his way out of the emergency exit, he felt that he was still connected to the helicopter via the monkey-strap. He focused on remaining calm, remembering to breathe and opened the quick release of the monkey strap with both hands. He then exited via the emergency exit. When he reached the surface, he inflated his life jacket. The hoist operator was still wearing his helmet and felt it had become very tight around his neck. His helmet also had a mask type microphone, and this caused some issues before he managed to remove the microphone. He saw the helicopter upside down in the water and that there was some sort of green light.

He then saw a blinking light and swam over to it. He saw that this was the commander, and to ensure that they would not float away from each other he locked his legs around him. He then saw another person, which turned out to be the co-pilot. They briefly discussed to swim back to the helicopter to release a life raft but deemed this impossible due to the handle being submerged and the fuel that had leaked into the water.

Shortly after this he has explained that the senior rescueman made contact with the group. The hoist operator has stated that he then felt a sense of relief, since the rescuemen has a lot of experience with being in rough seas. The hoist operator saw that the senior rescueman had activated his PLB and wanted to do the same. After some problems of getting the PLB out of its pocket he managed to activate it. Then the four used their buddy lines to stay floating together and not be separated. They decided to start swimming to keep warm.

He has further explained that after a good while they saw some search lights. He first thought it was a boat but quickly understood that this was a rescue helicopter. The rescue helicopter stopped some way off and hoisted up one person. The helicopter then came over to the group of four survivors and started hoisting. The commander was hoisted first, since he was in a bad shape. Then the co-pilot was hoisted since his physical state was deteriorating. Finally, the hoist operator and the rescueman instructor were hoisted together. The hoist operator ended up getting some water in his suit and was cold after the period in the sea. Particularly on his feet and fingers. He was wearing work gloves and not neoprene gloves.

1.15.2.4 Instructor/Senior rescueman

The senior rescueman told the NSIA that he chose to sit in the back seat on the right-hand side of the cabin after they had finished the hoist operation with the boat. His tasks as an instructor were mostly done.

He heard a terrain warning from the cockpit during the approach to the beacon, which was acknowledged by the pilots. During the approach to the beacon, everything seemed normal. It was dark in the cabin, and he could see some lights on the horizon from land. Suddenly, he heard "go-around" from the cockpit. Immediately afterwards they hit the sea. His perception was that the helicopter did a somersault forward and to the left. The cabin immediately started to fill with water.

He quickly found the closest emergency exit, established EBS and tried to open the emergency exit. Because of a Velcro-strip over the emergency exit handle[22] it was slightly problematic to open and took longer than expected. After a few moments he managed to open the emergency exit and exit the helicopter. He has further explained that he remembers the emergency lighting inside the cabin being on for a few seconds after the helicopter was filled with water, before going dark.

After surfacing he saw the helicopter floating upside down and that neither floats nor life rafts had been deployed. Neither did he see any outside lights on the helicopter. He quickly smelt fuel and desired to get away from the helicopter. He also stated that he deemed it impossible to release the life rafts.

He then inflated his life jacket and immediately felt how tight it became around his neck due to the combination of inflated life jacket and helmet. He felt suffocated and decided to remove his helmet. Some time after this he saw a blinking light and quickly established that this was the hoist operator, the commander and the co-pilot and swam over to them. He stated to the NSIA that he was unsure if the ELT of the helicopter had deployed and therefore wanted to activate his PLB. This was problematic due to the darkness. He remembered that he had a strobe-light on his helmet and thought that this might be crucial during a search, so he removed it and stored it in a pocket within easy reach in the case he heard a boat or helicopter. He did not have gloves on, and his hands quickly became extremely cold. His fingers hurt and were almost useless. This led to extra problems when they tried to connect to each other using the buddy lines. The darkness also made this difficult, but the strobe light helped somewhat, and they managed to connect the buddy lines after some time.

The senior rescueman saw that only three of the four life jackets had functioning lights. The flight crew's condition and consciousness also deteriorated as time went on. He has further explained

[22] Normally a "tell-tale" wire is installed on the handle for easy check if the handle has been used. Bristow did a fleet wide inspection after the accident, and no other aircraft had Velcro fitted. It is believed that the Velcro was installed pre-delivery.

that he concentrated on keeping morale up and focusing the group on survival. This became more and more challenging. To keep warm, he decided together with the hoist operator that they had to start swimming. This helped somewhat. After a while they saw a light on the horizon. They first thought it was a boat, but it turned out to be the rescue helicopter. The senior rescueman took out his strobe-light and used this to mark their position. The helicopter flew straight overhead and stopped some way off. They saw that one person was hoisted out of the water, before the helicopter moved over to the group of four. The senior rescueman prioritised the four survivors based on their condition and told this to the rescueman from the rescue helicopter. The commander was hoisted first, then the co-pilot and finally both the hoist-operator and the senior rescueman in a triple-lift.

1.15.2.5 Rescueman on re-training

The rescueman on re-training told the NSIA that during the approach to the beacon he was squatting on the floor and was attached to the ceiling of the helicopter with a lanyard without a quick release. The lanyard had one carabiner at each end, one attached to the helicopter, and one attached to a loop on his harness. He was preparing the equipment used to recover the training beacon out of the water. He suddenly heard “go-around” shouted from the cockpit, and immediately afterwards he felt he was thrown forwards in the cabin. He felt the lanyard tighten and he ended up on his back on the floor. The cabin was immediately filled with water, and he felt like he was inside a washing machine. Shortly after this he pulled water into his lungs. He was surprised at how this felt, and the water pressure held him down, so he pulled in more water.

He ended up under a bench due to the motions of the helicopter. He has explained to the NSIA that this might have been the hoist operator console. He did not see any of the other crew members. He then remembered that he had EBS in his life jacket. He managed to retrieve the bottle, find the mouthpiece and purge the water from his mouth and the mouthpiece. He remembered he took three breaths from the EBS before getting a very strong desire to get out of the helicopter.

When he bent over to release the carabiner attaching the lanyard to his harness, he felt water entering his suit through the neck seal. He had to perform two actions before he could open the carabiner. His harness was relatively new, so the hoop was tight, and he experienced this as an unnecessary obstacle. When he struggled to free himself, he was certain he would die. He eventually managed to free himself and was floating in the cabin. He said that at this time it was completely dark, and he was disoriented. He did not remember which of the emergency exits he used, but it was tight, and he had to wriggle to escape. He felt it took a long time before he reached the surface.

When he reached the surface, it was dark. He did not see the helicopter and neither saw nor heard any of the other crew members. He has told the NSIA that the fact that he was trained in these kinds of situations aided him greatly. He inflated his life jacket, kept his helmet on and tried to stay warm. Both the strobe-light and a torch he normally had attached to his helmet were missing.

Further, the rescueman has explained that he wanted to activate his PLB. He was not very familiar with the type of PLB that was in his life jacket. It was dark, so he struggled to locate the buttons on the PLB. He had a non-neoprene work glove on one hand, and the gloveless hand was off little use due to the cold. At some point he saw a green light on his PLB and realised it was turned on. He spent the remainder of his energy to ensure that the PLB’s antenna was out of the water and that he stayed floating on his back. The relatively large waves and his reduced condition made him fear that he would not have the energy to rotate back if he was flipped over on his belly due to the waves.

He has told the NSIA that every wave felt like a struggle and he was coughing almost constantly. He had a "pengun" flare, but did not consider using this as he did not have the strength to open the pocket it was stored in. At some point he saw a bright light and heard a helicopter. After being hoisted out of the water, he remembers parts of the flight to the hospital in Bergen, Haukeland.

1.15.2.6 SAR Nurse

None of the crew members could say for certain what happened with the SAR nurse. Several crewmembers have indicated that she was in the process of stowing away the NVGs the hoist operator had used when the helicopter hit the sea. It is a possibility she was unrestrained in the cabin when the helicopter crashed.

After the accident, Bristow Norway has revised their procedures and the SAR nurse shall be seated in their primary seat, secured with a four-point harness during the trans down phase.

1.15.3 THE SEARCH AND RESCUE OPERATION

1.15.3.1 Introduction

The Joint Rescue Coordination Centre (JRCC) has the overall responsibility for all Search and Rescue, including designated area of responsibility on the Norwegian Continental Shelf. [23] The area of responsibility is divided between two departments, JRCC-South (JRCC-S) located at Sola outside Stavanger and JRCC-North located in Bodø. JRCC mobilise resources included in the national search and rescue service, as well as request resources from other nation's search and rescue services.

The following are some of the airborne resources the JRCC can mobilise, which are relevant for this accident:

- The national search and rescue helicopter service is organised under the Ministry of Justice and Public Security and is operated by the Royal Norwegian Air Force's 330 squadron operating Leonardo Helicopters AW 101 (SAR Queen). The base in Florø was during a transition period, and at the time of the accident, operated by CHC Helikopter Service using Airbus Helicopters AS 332 Super Puma. The national SAR helicopters are crewed by a commander, a co-pilot, a hoist operator, a sensor operator, a rescueman and an anaesthesiologist.

- Civil search and rescue helicopters include the SAR helicopters stationed in the North Sea on contract by the energy companies. The closest helicopters to the accident site were the S-92As stationed at the offshore installation Statfjord B (with callsign NORSAR9) and Johan Sverdrup (with callsign NORSAR4). These two helicopters were contracted by Equinor. The civil SAR helicopters are crewed by a commander, a co-pilot, a hoist operator, a rescueman and a nurse anaesthetist (SAR nurse). The accident helicopter belonged to this category.

- Air Ambulance Services of Norway is owned by the four regional health authorities in Norway. Norwegian Air Ambulance AS (NOLAS) is contracted as their HEMS operator. NOLAS operates Airbus Helicopters H135 and H145 and Leonardo Helicopters AW 139. The air ambulance is crewed by a pilot, a rescueman and an anaesthesiologist. Currently the air ambulance is not fitted with a rescue hoist.

[23] *For more Information see JRCC's webpage: https://www.hovedredningssentralen.no/english/*

1.15.3.2 Mobilisation of resources

The time stamps in the description below are mainly from the JRCC-S's action log and radar data / ADS-B from the Norwegian Air Traffic Service (ATS) provider Avinor.

On the 28 February 2024 at 1939 hrs the international satellite-based SAR system Cospas-Sarsat detected an emergency signal from an Emergency Locator Transmitter (ELT) west of Sotra. According to the JRCC-S action log, they received the first emergency signal at 1941 hrs. The ELT was registered to the SAR helicopter LN-OIJ (using call sign NORSAR6 but will be denoted LN-OIJ) contracted by Equinor to cover the Oseberg field in the North Sea and operated by Bristow.

JRCC-S called Bristow's operations centre which stated that LN-OIJ was out on a training mission. JRCC-S then contacted Avinor Air Navigation Services at the air traffic control centre at Sola and the tower at Bergen airport, Flesland and asked them to contact LN-OIJ on the radio. Air traffic control received no response to these calls.

Two minutes after the signal from the ELT was received, JRCC-S received the first signal from a PLB originating from the area LN-OIJ had operated in. The PLB was registered to Bristow. During the rescue operation, JRCC-S received three distinct PLB signals registered to Bristow.

JRCC-S started to mobilise airborne and maritime resources and established Nødnett-groups[24] as communication for the different resources. According to the JRCC-S's action log, at 1948 hrs they contacted the national SAR helicopter with callsign SAVER50 using Nødnett. SAVER50 is based at Sola and was at this time on a training mission. The helicopter was out of range and did therefore not hear the call. [25]

JRCC-S did know that SAVER50 was on a training mission over the sea west of Stavanger. The rescue coordinators could see the real-time position of SAVER50 in their systems. In addition to calls using Nødnett, JRCC-S asked the coastal radio to contact SAVER50 using maritime VHF emergency channel 16, but they did not get a response. The investigation has found that SAVER50 most likely had turned down the volume on their maritime VHF radio by mistake while they were conducting hoisting operations. The coastal radio also sent out a "mayday-relay"[26]. JRCC-S also tried to use satellite communication (SATCOM) to reach SAVER50 without success. The 330 squadron has told the NSIA that they have had issues with some of the cables in their SATCOM system and these will be replaced as soon as possible during maintenance.

At 1951 hrs JRCC-S used Nødnett to mobilise the national SAR helicopter based in Florø with callsign RESCUE8 operated by CHC. The helicopter was on the ground and had a scramble time of 15 minutes.

At 1952 hrs, four minutes after the first call, JRCC-S reached SAVER50 via the air traffic services and airborne VHF radio. SAVER50 acknowledged the scramble one minute later via Nødnett. Since SAVER50 already was airborne and had enough fuel, the crew set a direct course towards Sotra. SAVER50 had a 50 kt tailwind the entire way, which shortened the flight time substantially.

The Air Ambulance Service had heard the radio communication regarding the accident and contacted JRCC-S at 2005 hrs to offer the use of two air ambulance helicopters as assistance. JRCC-S accepted the offer and sent both helicopters, with callsigns DOC60 and DOC61, to assist.

[24] Nødnett is a national, digital communication network for the police, fire and health services, as well as other preparedness users.
[25] This is not unusual, since the helicopters often have missions far from shore.
[26] Mayday on behalf of someone else.

The JRCC-S has stated to the NSIA that they did not deem it necessary to allocate any more airborne resources than the two helicopters from the national SAR service, SAVER50 from Sola and RESCUE8 from Florø and the two HEMS helicopters.

Due to weather, wind and wave height, the mobilised maritime resources' assistance was limited and will not be covered further in this report.

Figure 38 below shows the situation at 1948 hrs with different resources and locations in relation to the accident site.

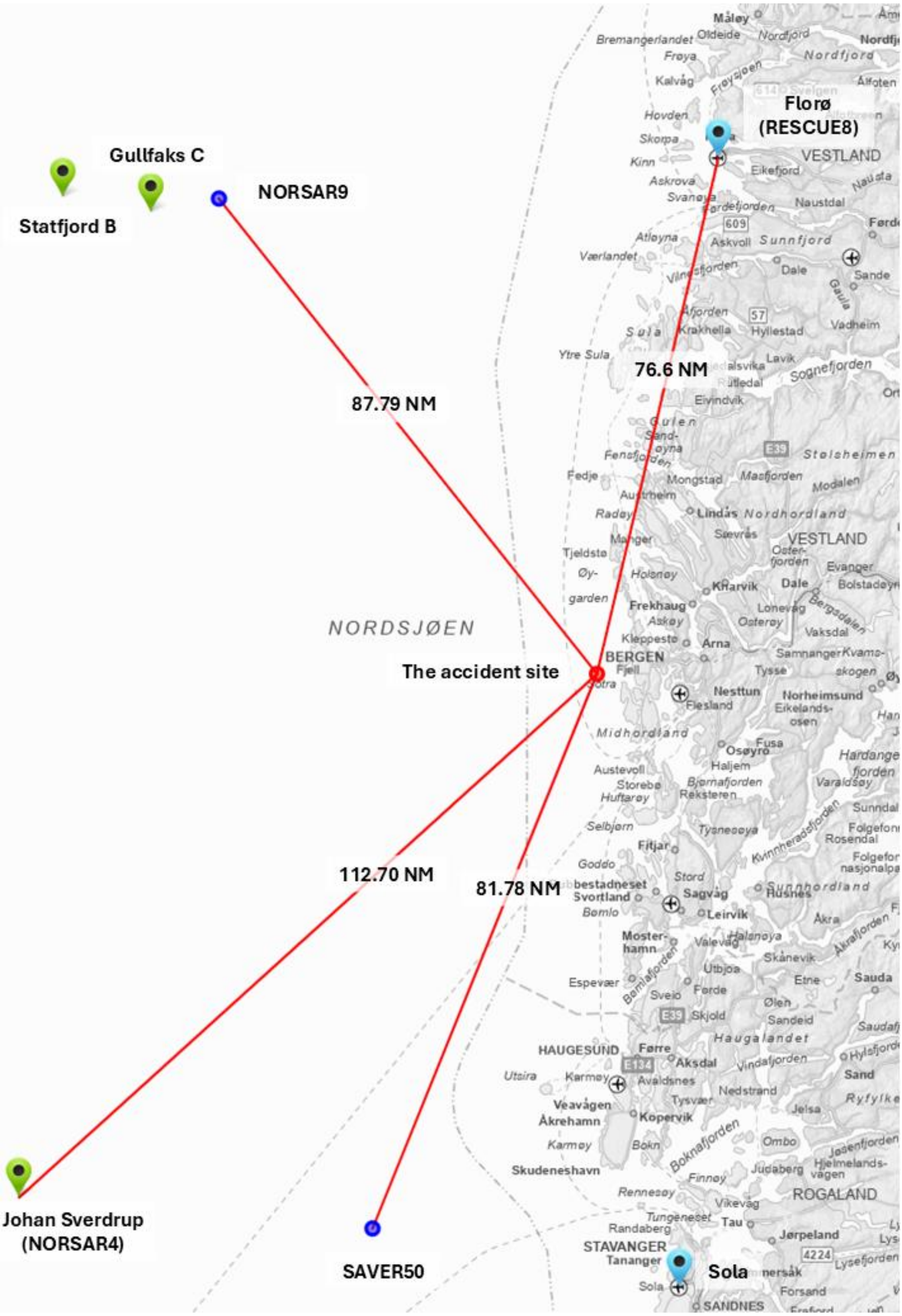

Figure 38: The situation at 1948 hrs with distances in nautical miles. The accident site is marked with a red dot. On-shore locations Florø and Sola are marked with blue pins. The offshore installations Johan Sverdrup, Statfjord B and Gullfaks C are marked with green pins. Statfjord B and Gullfaks C are both located in the Tampen-area. The airborne SAR helicopters SAVER50 and NORSAR9 are marked with blue dots, and their position is based on radar data. On-ground helicopter resources are stated in parentheses.
Map: © norgeskart.no. Illustration: NSIA

1.15.3.3 Helicopters used in the search and rescue operation

SAVER50 – From Sola

At 2003 hrs SAVER50 told the JRCC-S that their estimated arrival time was 2018 hrs. They also estimated that they would have enough fuel for about 15–20 minutes of SAR operation before they had to leave the area to refuel. The commander of SAVER50 has told the NSIA that they flew in instrument meteorological conditions to the search area by Sotra where they came below into visual flight conditions. When they arrived, they immediately started to search for survivors using NVGs.

Two minutes after arrival, at 2023 hrs, SAVER50 informed JRCC-S that they had observed a group of four persons in the sea. Both the PLB location data as well as lights and reflective material on the survival gear contributed to finding the people quickly. The commander of SAVER50 has told the NSIA that it was an unusually dark night, since the cloud cover blocked all moon- and starlight. The crew on board SAVER50 never saw LN-OIJ or any wreckage.

During the manoeuvring towards the group of survivors, the crew on board observed one possible lifeless person floating in the water alone. They saw no movement or other signs of life, but the person did have an inflated life jacket and their head above the water. They hoisted the rescueman down at 2030 hrs and discovered that the person was alive. This was the rescueman on re-training from LN-OIJ. The commander of SAVER50 has told the police that they felt a strong sense of urgency and time pressure. The first person was hoisted on board less than two minutes after the rescueman was hoisted down. The anaesthesiologist took care of the person immediately.

The helicopter then moved about 150 metres to something they thought might be a person but turned out to be the training beacon that LN-OIJ had dropped earlier. The crew on board SAVER50 then saw another person. They quickly established that the person was floating lifeless in the water without an inflated life jacket, with a helmet on and their face down in the water. The crew therefore decided to prioritise the group of four survivors about 200 metres ahead. The first two survivors were hoisted in single lifts, while the two last were hoisted in a triple lift together with the rescueman from SAVER50. At 2041 hrs five survivors had been hoisted aboard SAVER50 and one person without any signs of life were still in the sea. This person was later determined to be the SAR Nurse and retrieved by another rescue helicopter.

The commander of SAVER50 considered that they had enough fuel for one attempt to hoist the last person. He did not use NVGs, and because of the strong wind he chose to back up towards where he expected the person to be, having taken wind and sea drift into consideration. They tried this for about six minutes but could not locate the last person.

The crew in the cabin informed the flight crew that the co-pilot from LN-OIJ had entered cardiac arrest. They therefore stopped the search at 2050 hrs and set a course towards Haukeland hospital where they landed at 2100 hrs. When they landed the general condition of the crew members from LN-OIJ was poor, the commander had a body temperature of less than 35 °C while the co-pilot had a body temperature of less than 25 °C.

When SAVER50 landed at Haukeland hospital they had a minimum of fuel left. The commander of SAVER50 has explained that the fuel situation was monitored and under control the entire flight. Depending on the remaining fuel, and the medical situation they could primarily fly directly to Haukeland hospital. Alternatively, they could land at Sotra and the air ambulance helicopters from NLA or ambulance could provide transportation to the hospital.

The crew on board SAVER50 was aware that the SAR helicopter from Florø, RESCUE8, would shortly arrive in the search area and retrieve the last lifeless person from the sea.

Much of the rescue operation was recorded by both helicopter and personal crew cameras. These recordings have aided the NSIA investigation, among other things to document the actual conditions at the accident site.

RESCUE8 – Based in Florø

Playback of radar data the NSIA has received from Avinor, show that at 2008 hrs RESCUE8 had just lifted off from Florø and was 77 NM north of the accident site. RESCUE8 had significant headwind while heading south, which affected the groundspeed and arrival time.

At 2035 hrs RESCUE8 informed the JRCC-S that they estimated arrival at the search area at 2103 hrs. Playback of the radar data show that they arrived at 2104 hrs, 14 minutes after SAVER50 had left the area. At 2108 hrs, RESCUE 8 told the JRCC-S that they had located the last person which was hoisted aboard three minutes later and that they had begun cardiopulmonary resuscitation. RESCUE 8 then headed for Haukeland hospital where they landed at 2122 hrs.

One of the crew members on board RESCUE 8 had a helmet mounted camera that recorded the rescue operation and all internal and external communications. These recordings have aided the NSIA investigation, among other things to document the actual conditions at the accident site.

Air ambulance helicopters (Helicopter Emergency Medical Service – HEMS)

Two HEMS helicopters, with callsigns DOC60 and DOC61, were at the base in Bergen. The Air Ambulance Service West offered these to the JRCC-S if they would be of help, which the JRCC-S accepted. The JRCC-S wanted them to use NVGs and search lights to locate people if possible. The helicopters were not fitted with a rescue hoist. One of the helicopters did not have an emergency flotation system. The crew prioritised to arrive at the accident site quickly and therefore did not have suitable survival equipment to operate above rough seas if an emergency landing would be required. The two helicopters arrived close to the accident site at 2025 hrs.

While waiting for RESCUE 8 to arrive, the air ambulance helicopters used search lights to mark an object in the sea that turned out to be the training beacon dropped by LN-OIJ earlier this evening. The last person was later found by RESCUE 8 a little distance from the training beacon.

1.15.3.4 Considerations by the Joint Rescue Coordination Centre

Shortly after the accident, the media questioned the JRCC-S' resource allocation. This was particularly regarding the decision to use the national SAR helicopter RESCUE8 based in Florø, rather than the civil SAR helicopter, NORSAR9,[27] stationed at the offshore installation Statfjord-B. The primary function of NORSAR9 is preparedness for the cluster of oil and gas fields known as the Tampen-area.

The rescue coordinators at JRCC-S have explained to the NSIA that they viewed the national SAR service as more readily available than the SAR helicopters on contract for the energy companies in the North Sea, see 1.15.3.6 and 1.15.3.7. For example, the contract between the energy companies and the helicopter operator can state that the energy company has exclusive rights to the SAR helicopter. JRCC-S has explained to the NSIA that they therefore had to ask energy companies (such as Equinor) before they could requisition these SAR helicopters. The national SAR helicopters are on 15 minutes readiness for immediate response when scrambled by JRCC. JRCC-S chose therefore to mobilise national SAR helicopters. They deemed it unnecessary to requisition further SAR helicopters. The closest civil SAR helicopters were the S-92A helicopters stationed at the offshore installations Statfjord B and Johan Sverdrup.

[27] *The SAR helicopters on contract for Equinor is called NORSAR when they are not flying a live mission, such as a training mission. When flying live SAR mission, the callsign is changed to RESCUE.*

The JRCC-S has also told the NSIA that another important factor in their assessment is what kind of equipment and personnel the different helicopters have. For example, the civil SAR helicopters do not have an anaesthesiologist on board and do not have the same search equipment as the national SAR helicopters.

Therefore, the JRCC-S did not ask Equinor to mobilise their SAR helicopters. The JRCC-S informed both Bristow's and Equinor's operation centres, which forwarded information internally.

1.15.3.5 Potential helicopters not utilised

NORSAR9 at Statfjord B

NORSAR9 had lifted off from Statfjord B at 1903 hrs to perform training with a full SAR crew on board in the Tampen area with a tanker. When SAVER50 was mobilised by JRCC-S at 1948 hrs, NORSAR9 was east of Gullfaks C, and according to the commander they had enough fuel to fly directly to the accident site.

At 1957 hrs Bristow called the SAR-coordinator[28] for the Oseberg oil and gas field to ask if they were in contact with LN-OIJ which they were not. At 1958 hrs, the SAR coordinator for Oseberg could hear the "Mayday-relay" sent out by the coastal radio on maritime VHF channel 16. Neither the SAR-coordinator for the Tampen-area nor NORSAR9 heard this "Mayday-relay". Maritime VHF, like all radio communication, has a limited range, and which transmitter is chosen will affect who can hear the message.

The SAR-coordinator for Oseberg contacted the air traffic control central at Sola at 2003 hrs to get the status of LN-OIJ. They were informed that JRCC-S had sent a SAR helicopter from Sola (SAVER50) and Florø (RESCUE8) to the area where the emergency signal from LN-OIJ had originated. The SAR-coordinator for Oseberg informed internally to the SAR-coordinator for Tampen that LN-OIJ was missing west of Sotra at 2007 hrs.

At 2012 hrs the SAR-coordinator for Tampen called the crew of NORSAR9 and informed them about the missing SAR helicopter LN-OIJ. At this time NORSAR9 had just delivered the rescueman and the SAR nurse to the tanker they were training with. After retrieving both and having refuelled at Gullfaks C, NORSAR9 lifted off at 2049 hrs and set a course towards the area where LN-OIJ was missing.

The crew of NORSAR9 estimated that they would arrive at the search area at 2142 hrs after 53 minutes of flight. This information was forwarded to the air traffic services. Enroute, the crew tried to contact JRCC-S several times. At 2121 hrs they succeeded in contacting JRCC-S and were told they could return to Tampen. They were informed that all six crew members aboard LN-OIJ had been retrieved, and their assistance was not needed. NORSAR9 continued to Bergen before returning to Tampen later that evening.

NORSAR4 at Johan Sverdrup

The civil SAR helicopter stationed at Johan Sverdrup, NORSAR4, was about 113 NM south-west of Sotra. Since the accident occurred after 1900 hrs, they had a response time of 20 minutes. The wind conditions for NORSAR4 would be like those SAVER50 experienced. Assuming that SAVER50 and NORSAR4 would have a similar ground speed, and a flight time of about 35 minutes. It could have been at the accident site after about 55 minutes after a possible mobilisation for example at 2052 hrs if scrambled at the same time as SAVER50.

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[28] Equinor employs SAR-coordinators to oversee and manage SAR operations with their contracted helicopters to ensure they are carried out safely and effectively.

1.15.3.6 Overview of resources and access to real time information

In addition to their internal crisis management system the JRCC actively use tools under the BarentsWatch[29] umbrella such as the Shared Resource Information Repository (Felles ressursregister – FRR) and the Ocean Surveillance Programme to get an overview of available resources.[30] Equinor's SAR resources were at the time of the accident only presented as static information of their stationed location, without real-time position. Position of resources with an AIS-transponder[31] could be shown in real-time.

In addition, the systems did not estimate arrival times of different resources. The rescue coordinators at JRCC made an estimate of arrival time based on experience and the current weather conditions.

On the evening of the accident, the three SAR helicopters contracted by Equinor were reported as having preparedness status "Normal" to the JRCC-S. Preparedness status of the helicopters were routinely sent from the SAR-coordinators for Tampen, Johan Sverdrup and Oseberg to all relevant actors, including the JRCC-S. The last statuses before the accident were sent for Oseberg and Tampen on the 24 February 2024, both were Normal. For Johan Sverdrup the last status before the accident was sent on the 26 February 2024, and this was also "Normal".

After the accident with LN-OIJ the JRCC, Equinor, Bristow and CHC Helikopter Service began work to ensure the civil SAR helicopters were registered in FRR. Real-time position information could then be visible in the map tool with the possibility of retrieving updated information about preparedness status and active missions. This work has been completed, and the civil SAR helicopters are visible in the same way as the national SAR helicopters are. The JRCC also has a project to replace their aging crisis management tool. The project seeks to consolidate all the different systems under the BarentsWatch umbrella.

1.15.3.7 Access to ADS-B data

At the time of the accident the JRCC did not have the ability to see real-time position of data from ADS-B in their map tool. To have a better overview the JRCC has for a long time wanted to be able to see real-time position data from ADS-B as they do with AIS data and had worked to get access to this data.

Avinor has comprehensive ADS-B coverage in the Norwegian Continental Shelf and can see helicopters down to a low altitude. ADS-B position data is available in the Air Traffic Services systems. Avinor has the capability to combine radar and ADS-B position data and send these to other organisations. The JRCC has over several years had an ongoing dialogue with Avinor to be able to receive these data. There have been uncertainties as to how to cover the cost of sharing the data. The JRCC has told the NSIA that they believe the data should be shared cost-free according to the Organisational plan for rescue services – "Organisasjonsplan for redningstjenesten".[32]

Both Avinor and JRCC are different types of state enterprises. Avinor is a wholly-owned state limited company under the Norwegian Ministry of Transport. The JRCC is organised under the Ministry of Justice and Public Security.

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[29] *"BarentsWatch will collect, develop and share information about Norwegian coastal and marine areas". For more information see https://www.barentswatch.no/en/contact-us/about-us/*
[30] *For more information see https://www.barentswatch.no/en/restricted-services/*
[31] *The automatic identification system (AIS) is an automatic tracking system that uses transceivers on ships and is used by vessel traffic services. AIS information supplements marine radar.*
[32] *Forskrift 6 desember 2019 nr. 1740, Organisasjonsplan for redningstjenesten*

After the accident with LN-OIJ this work was again restarted. The issues have been resolved and the JRCC has access to ADS-B data such that aircraft with an ADS-B transponder can be shown with real-time position information in the systems the JRCC use.

1.15.4 SEA SURVIVAL AND EMERGENCY TRAINING

Helicopter crews operating offshore must regularly conduct emergency and safety equipment training including helicopter water survival training. According to Bristow OM-D 2.14.17 some of the training is done yearly and other parts are every three years. The following is an extract from Bristow OM-D 2.14.17:

> *When performing Emergency and Safety Equipment training/check an aircraft must be available for the type being trained/checked on.*
>
> *The period of validity of the Emergency and Safety Equipment Training/Checking shall be 12 calendar months in addition to the remainder of the month of Training/Checking. If performed within 90 days of validity of a previous Training/Checking, the period of validity shall extend from the date of issue until 12 calendar months from the expiry date of that previous Emergency and Safety Equipment Training/Checking.*
>
> *The instructor will sign the Emergency and Safety Equipment Report in chapter 1 after completion of the Training/Checking.*
>
> *The yearly Emergency and Safety Equipment Training and Checking shall contain;*
>
> *a) Actual donning of a lifejacket*
> *b) Actual donning of protective breathing equipment, where fitted.*
> *c) Actual handling of fire extinguishers of the type used*
> *d) Instruction on the location and use of all emergency and safety equipment carried on the helicopter*
> *e) Instruction on the location and use of all types of exits*
> *f) Security procedures*
> *g) Installation of stretchers and MEDEVAC routines*
> *h) Dry dinghy drill and emergency evacuation*
>
> *Every third year the program shall include a wet practice drill and practical training in;*
>
> *a) Actual operation of all types of exits*
> *b) Actual fire fighting using representative equipment*
> *c) Training and demonstration of the effects of smoke in an enclosed area*
> *d) Demonstration in the use of life jackets and the appropriate life-rafts*
> *e) First aid training*
>
> *SAR crew shall undergo annual spare air training [also known as emergency breathing system, NSIA Note]*

The wet practice drill is provided by an external company. The equipment provided by the external company was of a generic type and not always the same equipment as the crews use when they fly normal operations. After the accident this has changed, and the crew utilizes the actual equipment they fly with during training.

The SAR nurse was employed by Equinor and underwent emergency training organized by Equinor. Equinor’s SAR nurses underwent training every three years. They do not train with the SAR crews they normally fly with. Like other SAR crew members, during training they do not use the same equipment they fly with.

After the accident, the training frequency has been changed. All SAR nurses now complete training annually together with the helicopter operator and crew, if the operator conducts yearly training. If the helicopter operator does not provide annual training, the SAR nurse completes the standard training course separately, without the rest of the crew. They also train using the same equipment that is utilized during flights.

1.16 Tests and research

1.16.1 NSIA TEST IN THE FLIGHT SAFETY INTERNATIONAL SIMULATOR AT SOLA

The NSIA travelled to Sola to spend a day in the S-92A simulator operated by Flight Safety International to better understand how the SAR AFCS functions. This is the same simulator Bristow Norway use to train their personnel. Personnel from Bristow were present to demonstrate how a MOT is performed and to introduce how Bristow teach that a trans down should be performed. The activity gave the NSIA insight into “work-as-imagined” by Bristow and cockpit instrumentation and layout.

Even though the main goal was to get a better understanding of the entire MOT manoeuvre and relevant Bristow procedures, the NSIA tried to recreate the accident based on the recorded data extracted from the FDR. It became apparent that to get the pitch attitudes seen in the accident FDR data the cyclic had to be moved a lot further aft than recorded in the accident. Sikorsky also reported similar experiences when doing a similar activity in their own simulator. This topic is explored further in section 1.16.2.

1.16.2 GENHEL MODEL ANALYSIS

1.16.2.1 Introduction

Both the NSIA and Sikorsky tried to recreate the accident in a simulator. It became apparent that to get the pitch attitudes seen in the accident FDR data the cyclic had to be moved a lot further aft than recorded in the accident. To investigate if any abnormal flight characteristics were present, Sikorsky initiated work with their internal GenHel model. The GenHel model is Sikorsky’s in-house developed flight dynamics model.

GenHel is a generalised, modularised and analytical representation of a total helicopter system. The model is nonlinear, incorporates multiple degrees-of-freedom and has been refined over several years. The primary purpose of the model at Sikorsky is for engineering work. There are several GenHel models (due to the modularity), and each model is driven by requirements, e.g. not every model supports ground operations.

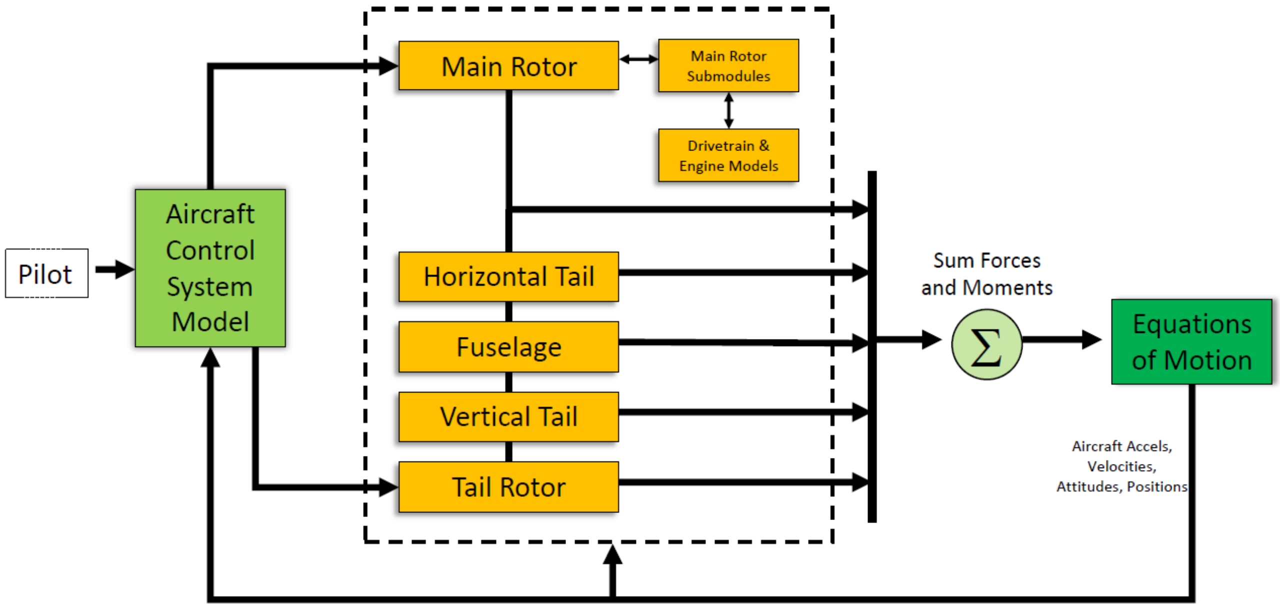


Figure 39: GenHel overview. Source: Sikorsky/NSIA

For this analysis the GenHel “S-92A Trainer Model” was used since it was deemed most representative of the aircraft. This model has had its physics tuned to meet FAA part 60 Level 7 Flight Training Device requirements.

The “playback” method chosen for this analysis was to input selected data of the accident flight recorded by HUMS into the GenHel model, and to review if the outputted GenHel data was within specified tolerances. The wind conditions used were the ones recorded by HUMS, 33.8 kt from a direction of 176°. FAA Part 60 allows for control positions to be manipulated within tolerances to meet the aircraft state data tolerances. This is to correct for the buildup of small differences in the model over longer time histories. If they matched the recorded states from the accident flight within a set of tolerances, the flight dynamics were deemed to be representative. If they did not match further investigation was required.

The HUMS data for LN-OIJ was obviously unique and engineering judgment was needed to determine the most appropriate input and output tolerances for the GenHel playback analysis. Based on the situation it was determined that the FAA Part 60 Table D2A Entry 1.j.1 “All Engines Landing” most closely resembled the time history data. The All Engines Landing typically entails a descent followed by a flare to hover. The tolerances are shown in Table 8.

Table 8: FAA Part 60 Table D2A Entry 1.j.1 All engines landing tolerances.

Parameter	Tolerance
Airspeed	± 3 kt
Altitude	± 20 ft
Engine Torque	± 3%
Rotor Speed	± 1.5%
Pitch Attitude	± 1.5%
Roll Attitude	± 1.5%
Heading	± 2°
Longitudinal Cyclic Control Position	± 10%
Lateral Cyclic Control Position	± 10%
Directional (pedal) position	± 10%
Collective Control Position	± 10%

1.16.2.2 Main Rotor Wake Impingement

The playback showed that the GenHel model did not match LN-OIJ's pitch attitude. Excessive aft cyclic was required to get GenHel to output the same nose-up attitude seen in the accident. The aft stick movement did not only fall out of tolerance but also contradicted the trend observed in the aircraft data, see Figure 40. This indicates that the helicopter experienced more nose up pitching moment than GenHel was predicting. This discrepancy in pitching moment was investigated. Main rotor stall and atmospheric variations (i.e. wind gusts) were quickly ruled out as possibilities since they were either ineffectual or insufficient to account for the difference. This left Rotor Wake Impingement as a possible explanation for the excessive pitching moment.

Main rotor wake impingement is when the main rotor wake affects the empennage aerodynamics. It is most pronounced during translational lift where the helicopter is transitioning between low and high-speed flight and vice versa. GenHel modelling of the main rotor wake impingement primarily relies on the rotor wake skew angle. By making the GenHel model follow the pitch attitude in the aircraft data, the rotor wake skew angle could be extracted, see Figure 41.

The extracted wake skew angle shows the wake skew angle was transitioning from a high angle. Therefore, it was concluded that the main rotor wake was impinging on the empennage during the pitch up, in particular during the 20° to 30° pitch up.

The magnitude of the main rotor wake impingement is modelled in GenHel using maps that determine the value of three non-dimensional coefficients for the three body axes: EKX, EKY and EKZ. The term of most interest when trying to effect a change to the aircraft pitching moment from the empennage was the z-axis, EKZ.

Since GenHel models main rotor wake impingement, the initial playback results suggested that the magnitude of the effect was being underpredicted by the model. Consequently, the main rotor-on-empennage interference maps in GenHel were adjusted to attain the additional pitch up moment such that the playback matched, see Figure 42.

After tuning main rotor-to-empennage interference maps in the GenHel model to better match the playback result, it was important to determine if the changes were reasonable. Based on the analysis it was concluded that when LN-OIJ reached ~20° nose up, the main rotor wake started to impinge on the horizontal tail. This resulted in an increased nose up pitching moment. Although the increased nose up pitching moment was counteracted by moving the longitudinal stick forward, the aircraft experienced an additional 10° increase of pitch attitude to ~30° before the aircraft pitch attitude started to reduce. This behaviour is synonymous with what would be expected when moving through translational lift.

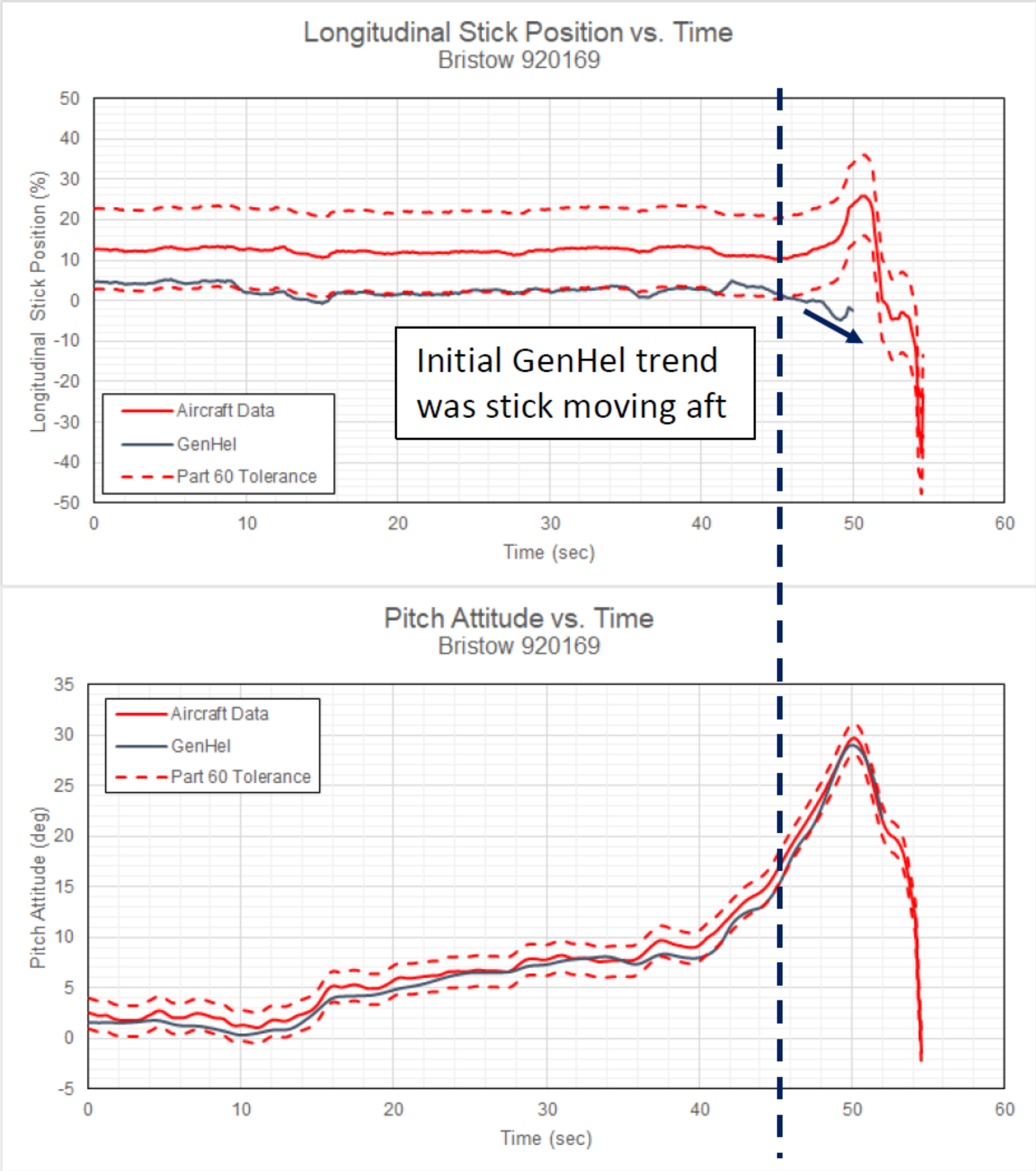


Figure 40: GenHel playback analysis of pitch and longitudinal cyclic position. The solid red lines are the stick position and pitch attitude recorded by LN-OIJ. The dashed red lines are the tolerance bands from FAA Part 60. The grey lines are the outputs from the GenHel model. At around time t=45 it can be seen that to recreate the pitch attitude from the accident the cyclic has to move out the tolerance band and is also moving opposite to the recorded data. Source: Sikorsky/NSIA

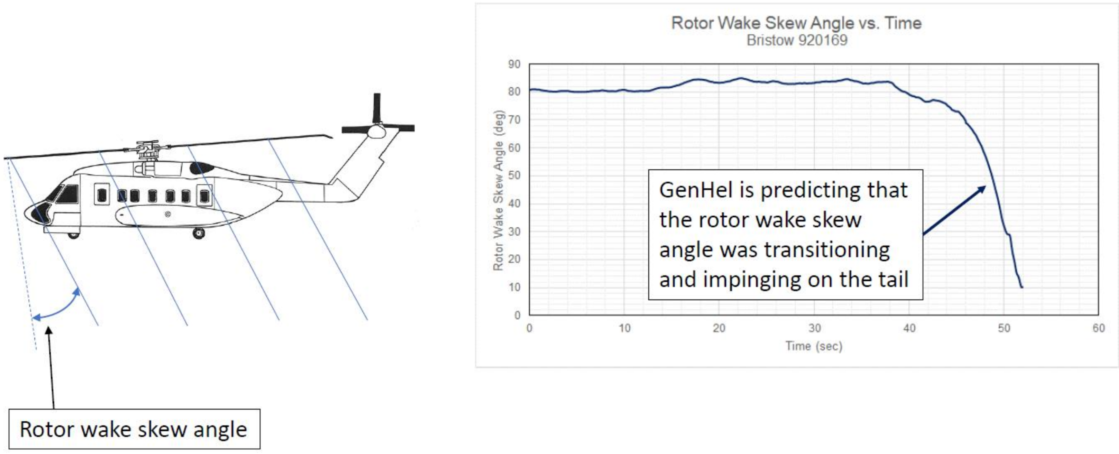


Figure 41: Definition of and estimation of the Rotor Wake Skew angle from the accident. Source: Sikorsky/NSIA

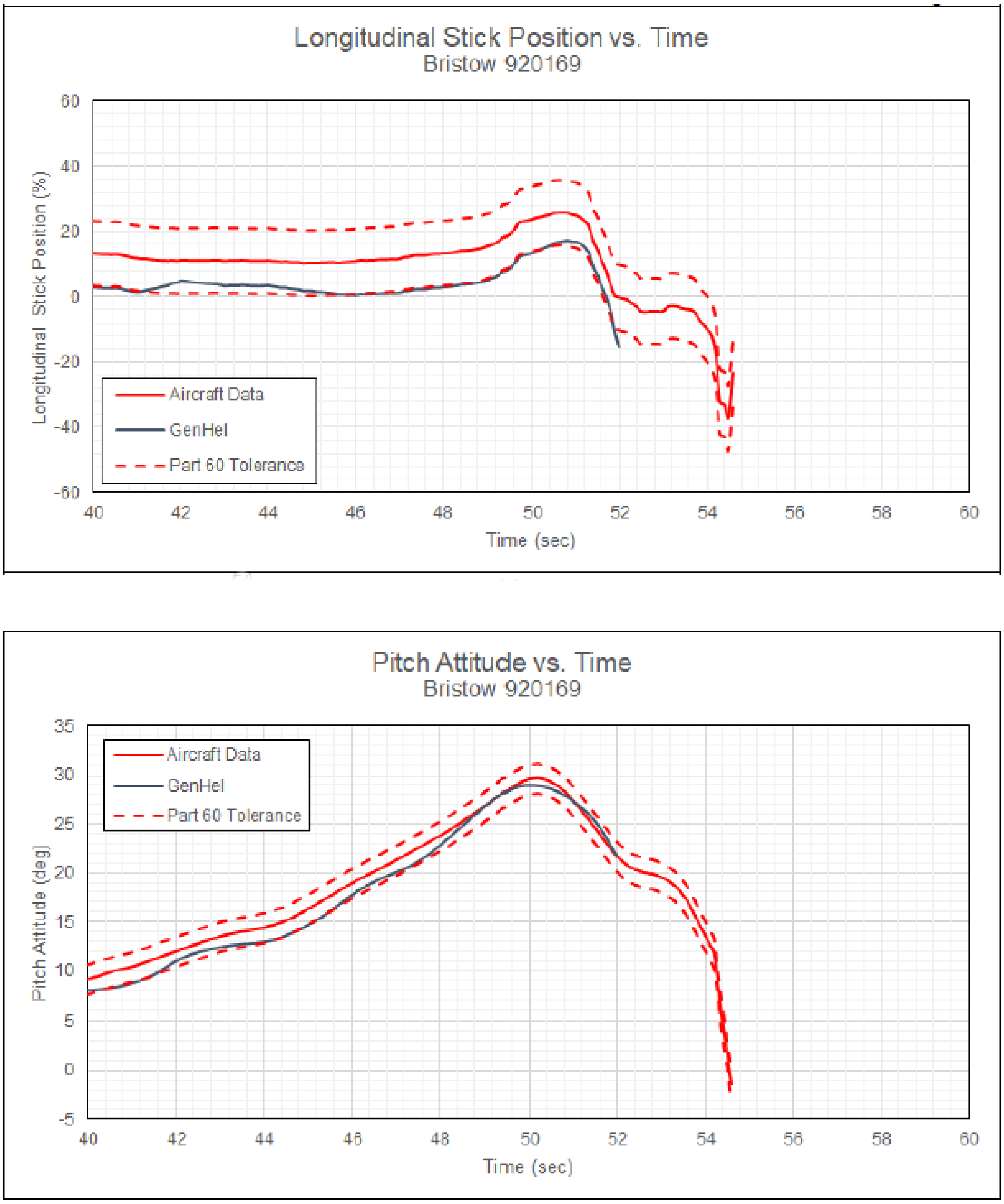


Figure 42: The result of the tuning of the main rotor-to-empennage maps. Source: Sikorsky/NSIA

1.16.2.3 Vortex ring state

Shortly after the aircraft recovered from the 30° nose up condition (around t=50) the engine torque correlation between the GenHel S-92A model and the aircraft data diverged. Engine torque correlation had been quite good during the playback until this point was reached. An example of this divergence is presented in Figure 43 below.

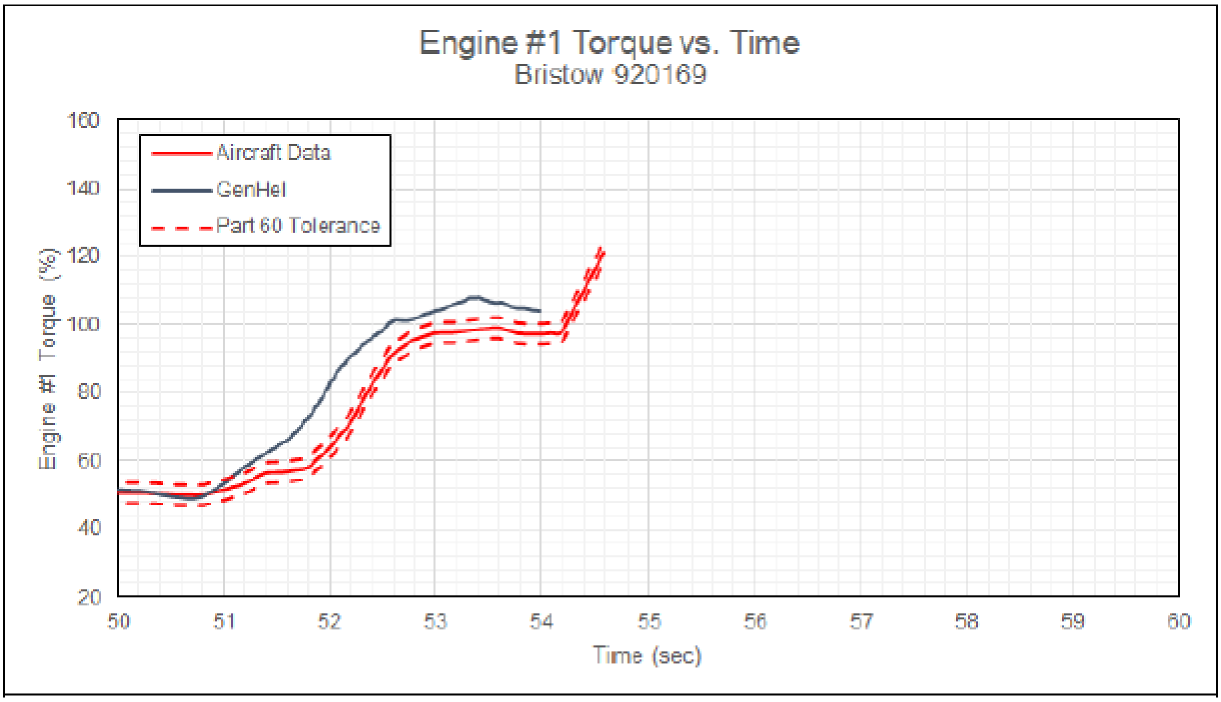


Figure 43: The recorded and GenHel predicted engine torque. The solid red line is the engine torque recorded by LN-OIJ. The dashed red lines are the tolerance bands from FAA Part 60. The grey line is the outputs from the GenHel model. Source: Sikorsky/NSIA

The engine torque divergence indicated that the aircraft had experienced a reduction in main rotor thrust. The GenHel model was not predicting the same reduction in main rotor thrust. It was suspected that this was a result of the aircraft entering Vortex Ring State (VRS). VRS is an aerodynamic state where a toroidal vortex forms around the main rotor of the helicopter and drastically reduces the lift. For VRS to occur three conditions must be present.

1. The helicopter must be in powered flight
2. There is a relatively high rate of descent
3. The helicopter must be travelling at a relatively low airspeed

VRS was not initially modelled in the chosen GenHel "S-92A trainer model" since it isn't required for FAA Part 60 Level 7. However, a crude VRS model existed for other GenHel models. The conditions for entering VRS are defined in the shaft axis system. These were defined in the VRS model as the advance ratio in the x-y plane, μ_{xy}, and the ratio of the climb velocity, V_C, to the hover induced velocity, V_h. The two parameters were used by the VRS model to form a boundary. The boundaries were based on input from the Sikorsky Aerodynamics group, qualitative tuning with experimental test pilots as well as textbook references. The boundaries for the VRS model are depicted in Figure 44. The advance ratio in the x-y plane and climb velocity to hover induced velocity ratio for LN-OIJ is shown in Figure 45.

As can be seen from Figure 45 the conditions for entering VRS is satisfied at time 50 seconds when the climb velocity to hover induced velocity ratio becomes less than -0.6. The Full VRS boundary is then crossed around half a second later as that value becomes less than -0.8.

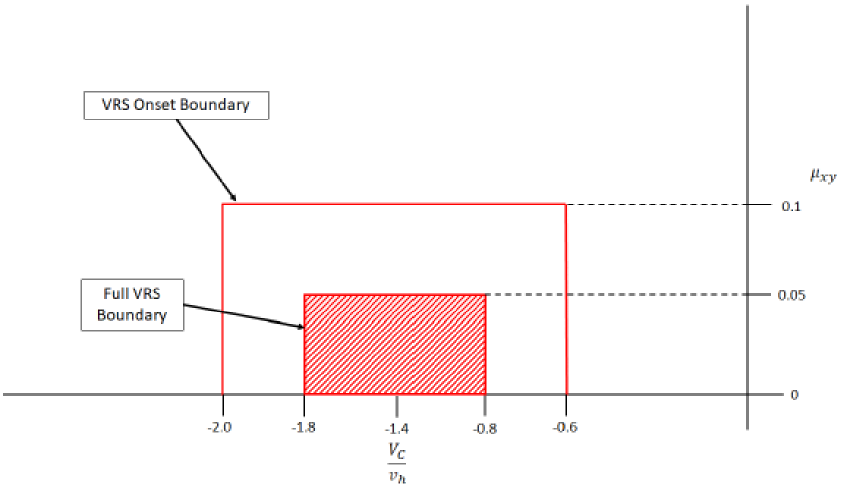
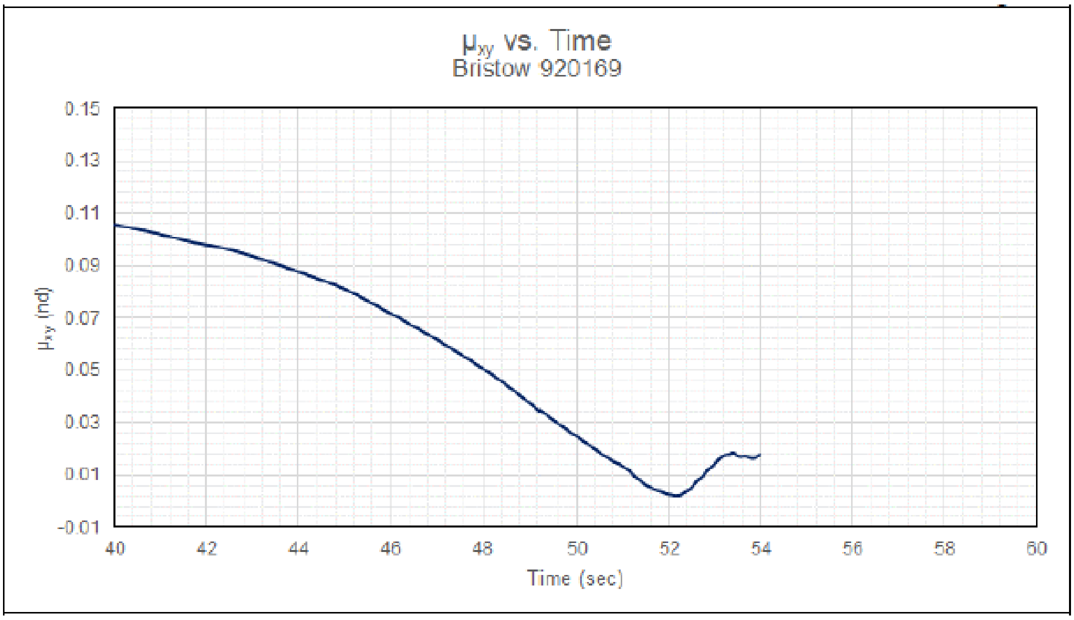


Figure 44: The boundaries for VRS onset in the GenHel modelling. Source: Sikorsky/NSIA



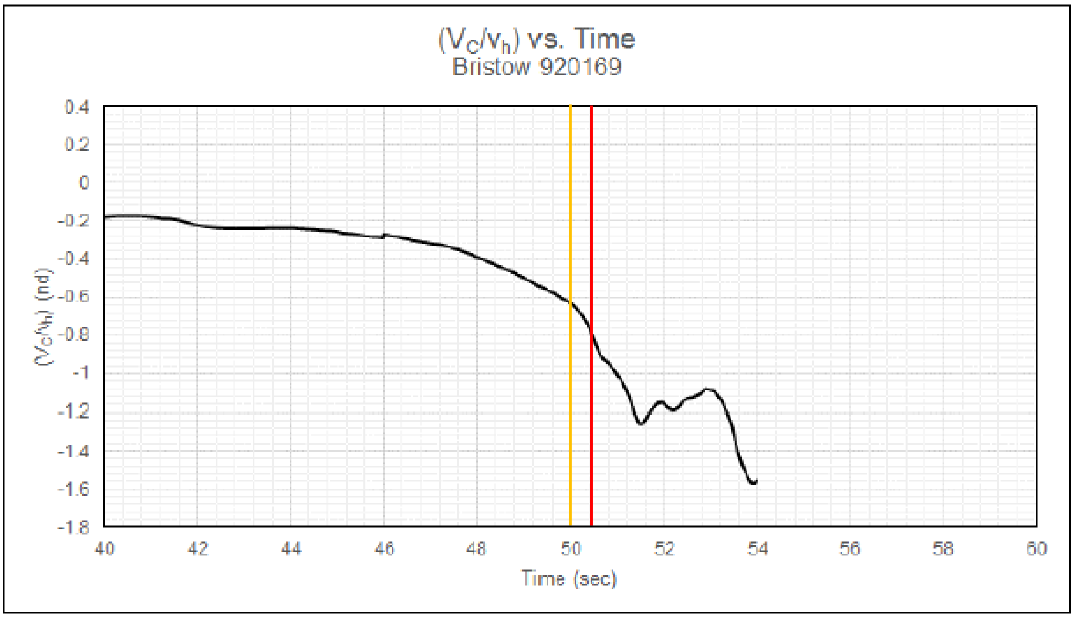


Figure 45: The advance ratio in the x-y plane and climb velocity to hover induced velocity ratio. The orange line marks when the helicopter crossed the VRS onset boundary, while the red line marks when the helicopter crossed the full VRS boundary. Source: Sikorsky/NSIA

1.16.3 OBSERVATION FLIGHT IN ANOTHER S-92A SAR HELICOPTER

To better understand the pilot-vehicle-interface (PVI) the NSIA conducted an observation flight in February 2025. The reasoning behind the flight was two-fold. First it would provide the NSIA an opportunity to see how the collaboration was in the cockpit. Secondly the flight was conducted at night to see how the colour scheme of the cockpit screens was in darkness.

As discussed in 1.6.4.3 the Flight Director provides a cue to the pilot that an AFCS axis is degraded by changing the colour of current coupled mode in that axis from green to yellow, see Figure 8. The NSIA was interested to investigate the contrast between the green and yellow at night, with the screens dimmed down. Several pilots the NSIA has talked to have stated that the colour scheme, and general layout of the Primary Flight Display (PFD) at times require extra focus to pick out details.

The flight consisted of the following elements:

1. Flight to a safe area
2. A MOT from 500 ft altitude to 150 ft followed by a departure
3. An APP1 descent from 500 ft to 200 ft
4. A MOT from 200 ft to 150 ft
5. A conscious lateral manipulation of the cyclic to trigger the FD degrade in the roll axis.
6. Return to base

Items 2–6 were observed by the NSIA from cockpit between the pilots. The NSIA also recorded a video from the cockpit using a GoPro camera. It is important to state that this was a single flight, and external light conditions and individual eyesight will affect the results. In general, the NSIA-observer’s experience was that it was not straightforward to determine the colour of the text. At one point the NSIA-observer experienced difficulties to determine if the colour was yellow or green, even though they knew that the colour was yellow at that time.

1.16.4 THE EXAMINATION OF THE PITCH SAS/BOOST SERVO

Before removal from the helicopter, the pitch SAS/boost servo P/N 92410-04800-111 and S/N B073-00828 was sprayed externally with a preservative oil to prevent corrosion. It was later shipped to Parker Aerospace in Irvine USA in a sealed container. The servo was examined and tested at Parker Aerospace under supervision by the NTSB in mid-May 2024.

According to Parker Aerospace records, the servo was original to the accident helicopter and had not been returned to Parker Aerospace for repair since the manufacture in 2012.

The exterior of the servo was found to be in good condition. However, some corrosion deposits were found at various surfaces, including in the connector plugs. All safety wiring and safety cables remained intact.

The SAS1 and SAS2 did not pass electrical acceptance test criteria, but there was no evidence of a short or an open circuit. No functional anomalies were observed during hydraulic bench tests that would preclude SAS and boost function, see Figure 46. During disassembly of the boost portion of the servo it was observed to have only wear from service. The SAS portion of the servo was disassembled to a lesser degree. Oil samples taken from the unit were outside the acceptance criteria, but not to a degree that it could hamper normal operation.

A contact mark between the input link and the SAS housing cutout was cleaned with cloth. A tactile check of the contact mark using a soft metal scribe revealed no evidence of a wear step on either the input link or the housing cutout. A slight change in surface profile was felt on the housing cutout, but no discernible change in surface profile was felt on the contact mark. This was considered not to hamper normal operation.

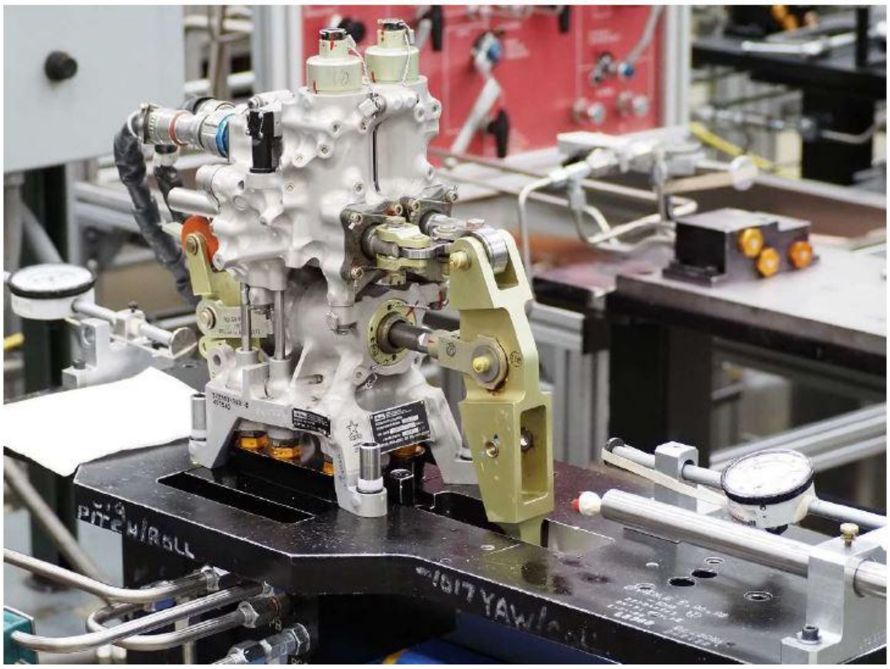


Figure 46: The pitch boost/SAS servo installed on the hydraulic test bench at Parker Aerospace. Photo: NTSB/NSIA

1.16.5 THE EXAMINATION OF THE TRIM ACTUATORS

All four (pitch, roll, yaw, collective) trim actuators were shipped to Collins Aerospace in Vergennes, Vermont in the USA. They were not preserved before shipment. When they arrived at Collins they were opened and cleaned. The three circuit cards in each actuator were subjected to a desalination process. All four actuators were severely damaged and corroded by sea water. All actuator covers imploded allowing saltwater ingress into the internal volume of the actuators. Severe corrosion and contamination were observed on all internal components, see Figure 47.

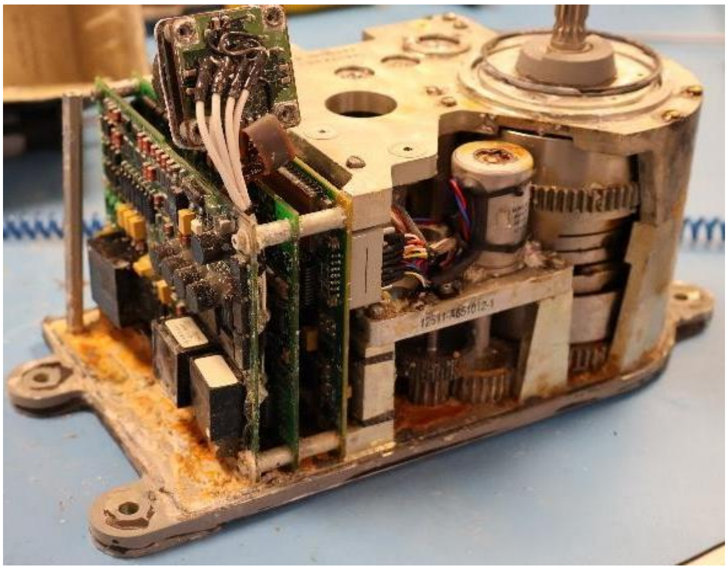


Figure 47: Photo showing the internal corrosion of the trim actuators and the three circuit cards. Photo: Collins Aerospace / NSIA

After desalination was completed the NSIA travelled to Collins Aerospace to supervise the investigation. The NTSB and Sikorsky were also present. The twelve circuit cards were put through an Acceptance Test Procedure (ATP). The results are highlighted in the following table:

Table 9: Summary of trim actuator circuit card test results

	Pitch Actuator	**Roll Actuator**	**Yaw Actuator**	**Collective Actuator**
Control Loop Card	Passed ATP	Passed ATP	Passed ATP	Passed ATP
Motor Driver Card	Failed some ATP items	Passed ATP	Passed ATP	Passed ATP
Power Supply Card	Physically damaged	Passed ATP	Passed ATP	Physically damaged

Two of the Power Supply cards were physically damaged since the casing had been deformed by the water pressure after the helicopter crashed. The pitch trim actuator motor driver card did not pass the ATP. It initially failed 16 of 66 test items. The 16 test items were related to the spring deflection circuit (SP-DEFL) and the trim position circuit (TR-POS). It was decided to subject the card to further cleaning to determine if salt deposits might be the cause of the failed test items. After a thorough cleaning the card was retested and continued to fail some of the same test items. After cleaning, only 12 of 66 items failed. The relevant test points of the pitch trim actuator motor driver card are summarised in Table 10.

The preliminary bench testing resulted in two ATP step failures. The first was that the pitch trim actuator would report its own position erroneously to the FCCs. The trim actuator counted hall clicks[33] correctly but did not translate that into the correct voltage reported back to the FCC. The second was that the spring deflection signal was found to be zero, when it should be equal and opposite to the trim position signal.

After further troubleshooting it was determined that at least one electrical component had failed, see Figure 48. This was a Schmitt Trigger[34] used in the spring deflection circuit and in the current feedback circuit.

To determine the effects of the fault, the faulty circuit card was installed in an engineering test unit that was known to be functional. This confirmed the findings of the circuit card testing, and it was also found that the trim actuator would stop moving due to an internal fault check. This check should also be reported to the pilots and cause an AFCS degrade caution on the EICAS display.

[33] A Hall effect sensor monitors magnetic fields and can be used to sense the position and movement of objects in a system.
[34] This is a simplified explanation. A Schmitt Trigger is used to eliminate noise in an electric signal. It takes a voltage as an input and returns a voltage as an output. The Schmitt Trigger has one high and one low threshold. When the input is higher than the high threshold, the output is high. When the input is below the low threshold, the output is low. When the input is between the two levels the output retains its value, i.e. if the output is low, the input must cross the high threshold for the output to change.

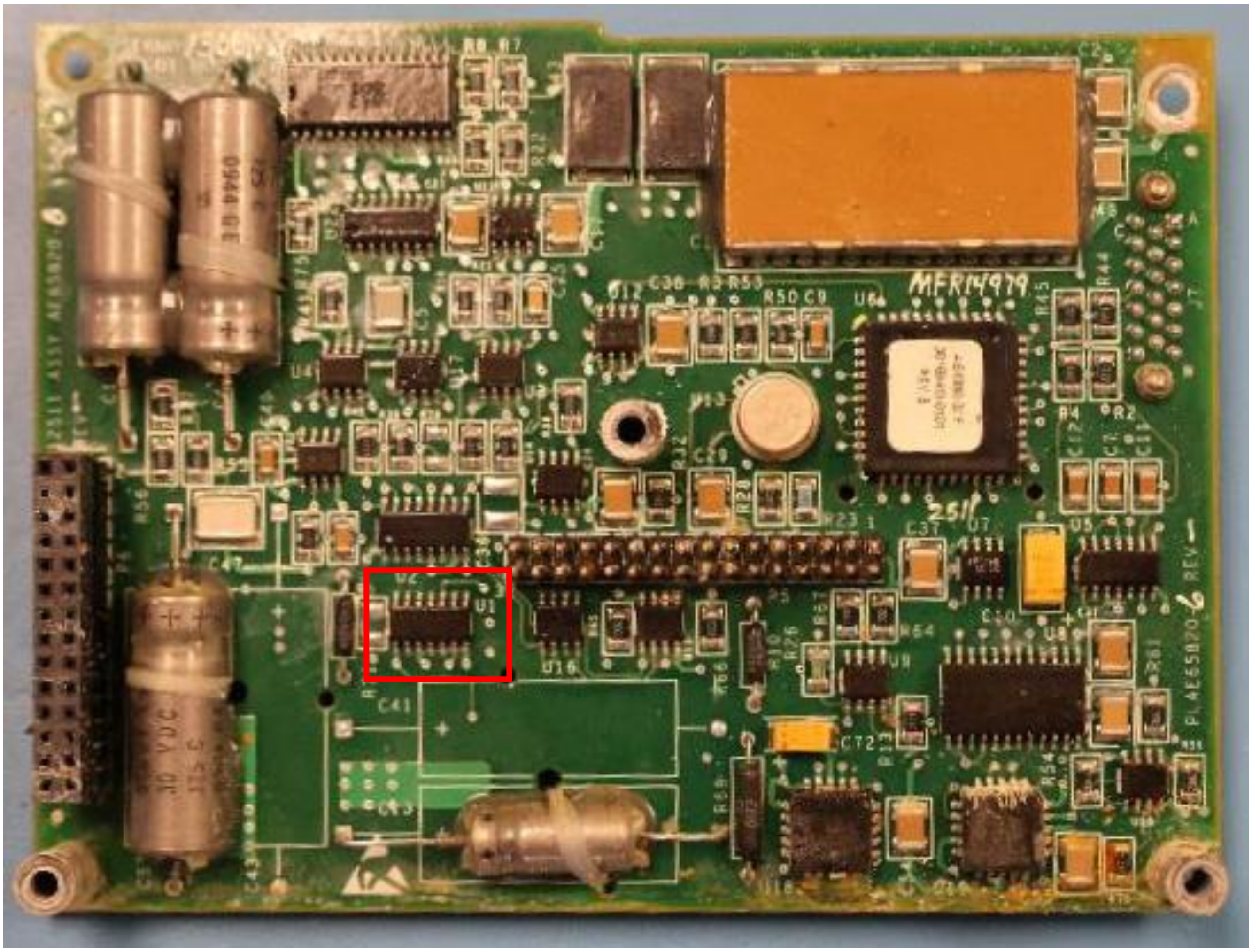


Figure 48: Photo of the motor driver card from LN-OIJ's pitch trim actuator with the failed component highlighted in red. Photo: Collins Aerospace. Illustration: NSIA

No AFCS degrade caution was logged in the HUMS data.

The NSIA has reviewed Bristow Group occurrence reports relating to the AFCS from 2007 to 2024. Among the occurrences the NSIA has positively identified at least 25 occurrences detailing trim actuator abnormal behaviour. Many of these faults cleared after a simple AFCS reset, others required a replacement of the trim actuator.

The NSIA has reviewed LN-OIJ's maintenance documentation. The pitch trim actuator has been installed in LN-OIJ since new. The manufacturer, Collins Aerospace, have informed the NISA that the pitch trim actuator has never been returned to them for service.

Table 10: Table showing the failed test results from the ATP test of the pitch trim actuator motor driver card.

Test item	**Expected value**	**Test 1**	**Test 2**
Input Cmd = +2 V ±0.1 V:			
Initial condition:			
TR-POS-1 HI and LO (0±0.05 V)	0	0	0
TR-POS-2 HI and LO (0±0.05 V)	0	0	0
SP-DEFL-1 HI and LO (0±0.05 V)	0	0	0
SP-DEFL-2 HI and LO (0±0.05 V)	0	0	0
300±20 counts X 0.0066 V/count = Measured Output Voltage ±5%:			
TR-POS-1 HI and LO (0±0.05 V)	~ -2	-0.54	-0.97
TR-POS-2 HI and LO (0±0.05 V)	~ -2	-0.54	-0.97
SP-DEFL-1 HI and LO (0±0.05 V)	~ +2	0	0.04
SP-DEFL-2 HI and LO (0±0.05 V)	~ +2	0	0.04
1500±20 counts X 0.0066 V/count = Measure Output Voltage ±5%:			
TR-POS-1 HI and LO (0±0.05 V)	~ -10	-2.69	-4.9
TR-POS-2 HI and LO (0±0.05 V)	~ -10	-2.69	-4.9
SP-DEFL-1 HI and LO (0±0.05 V)	~ +10	0	0.045
SP-DEFL-2 HI and LO (0±0.05 V)	~ +10	0	0.047
Input Cmd = -2 V ±0.1 V:			
Initial condition:			
TR-POS-1 HI and LO (0±0.05 V)	0	0	0
TR-POS-2 HI and LO (0±0.05 V)	0	0	0
SP-DEFL-1 HI and LO (0±0.05 V)	0	0	0
SP-DEFL-2 HI and LO (0±0.05 V)	0	0	0
300±20 counts X 0.0066 V/count = Measured Output Voltage ±5%:			
TR-POS-1 HI and LO (0±0.05 V)	~ +2	0.66	1.99
TR-POS-2 HI and LO (0±0.05 V)	~ +2	0.66	1.99
SP-DEFL-1 HI and LO (0±0.05 V)	~ -2	0	0.03
SP-DEFL-2 HI and LO (0±0.05 V)	~ -2	0	0.03
1500±20 counts X 0.0066 V/count = Measure Output Voltage ±5%:			
TR-POS-1 HI and LO (0±0.05 V)	~ +10	3.3	9.9
TR-POS-2 HI and LO (0±0.05 V)	~ +10	3.3	9.9
SP-DEFL-1 HI and LO (0±0.05 V)	~ -10	0	0.03
SP-DEFL-2 HI and LO (0±0.05 V)	~ -10	0	0.03

1.16.6 TESTING IN THE SIKORSKY SYSTEMS INTEGRATION LAB

The Sikorsky Systems Integration Lab (SIL) is a hardware-in-the-loop simulator located at the Sikorsky facilities in Stratford, Connecticut. Sikorsky uses the SIL in their flight control development. It was decided to see if it was possible to install the faulty circuit card from LN-OIJ in the pitch trim actuator in the SIL and see how the SIL would behave.

On August 21–22, 2024, a test was conducted with various configurations of the S-92A pitch trim actuator. The NSIA was not present, so the NTSB was present as a representative of the NSIA. In addition, personnel from the FAA, Sikorsky, and Collins were present.

There were three distinct configurations of the pitch trim actuator tested:

1. Use of a Sikorsky-owned pitch trim actuator normally installed in the SIL, see section 1.16.6.1.
2. Use of the Sikorsky-owned pitch trim actuator with the accident motor driver circuit card installed, see section 1.16.6.2.
3. Use of a Collins-owned yaw trim actuator modified to work as the pitch trim actuator in the SIL. This Collins-owned unit had its original control card, a modified motor driver circuit card that had a fault switch installed, and the power supply card from the Sikorsky-owned pitch trim actuator, see section 1.16.6.3.

The NSIA would like to mention the following limitations of the SIL testing:

- The SIL was not updated with the corrected rotor wake tail impingement data as detailed in 1.16.2.2. This means that the SIL does not accurately model the control forces seen in the accident.
- Although the SIL modelled steady state wind it did not model gusts or turbulent air.
- The modified trim actuator prepared by Collins only introduced one of the two faults identified during the investigation, see 1.16.5.

Despite these limitations the SIL testing provided valuable insight.

1.16.6.1 Sikorsky owned SIL actuator

Using the SIL's pitch trim actuator, two flights with MOT were accomplished to establish a baseline for MOT performance in the SIL. The hover height was set to 150 ft for MOT. Near the end of the MOT profile, as the helicopter approached the target, the maximum pitch attitude was about 11.6 degrees. After the successful completion of MOT, the MSP showed MOT had transferred to position hold control (i.e. MOT no longer showed as "on" on the MSP). The FDR data and the FCC data were downloaded at the end of the second flight.

1.16.6.2 LN-OIJ Motor Driver Card

The SIL pitch trim actuator was removed from the SIL and opened. The stock motor driver circuit card was removed, and the motor driver circuit card from LN-OIJ's pitch trim actuator was installed. During the pre-flight-built-in-test (PFBIT) several fault codes were raised. The fault codes related to the pitch trim actuator are found below.

Table 11: PFBIT fault codes

Problem area	Fault code	Explanation
AFCS 2 – Pitch Trim	064	Fault Code 64 indicates a PBIT test failure of dual autopilot's ability to command the trim actuator at 10% per second for one second. Failure condition is +/-2% from the 10% expected driven.
AFCS 1 – Pitch Trim	064	Fault Code 64 indicates a PBIT test failure of dual autopilot's ability to command the trim actuator at 10% per second for one second. Failure condition is +/-2% from the 10% expected driven.
AFCS 1 – Pitch Trim	144	Fault Code 144 is related to a function of the trim inhibit signal from the FCC in a single AP configuration. Mishap data shows that the mishap aircraft was in dual AP configuration and this fault would not apply.

When trying to use the beep trim switch to move the actuator with both autopilots (AP) engaged, the master caution illuminated and the fault code *AFCS 2 – Pitch Trim: Fault Code 032* appeared on the cockpit displays. This fault code (032) is triggered when the trim actuator is being commanded to drive at velocity greater than 6%/s but the calculated velocity of the trim in less than 2%/s for a .5 second measured interval. This indicates a slower than expected travel when driven above 6%/s authority. The accident data shows that the overall trim command never exceeded 4%/s.

When doing the same with single AP enabled, moving the cyclic to both the forward and aft stops, no master caution illuminated for either direction. With single AP, the trim rate would be half that of double AP. With the stick centred, the cyclic was manually pushed against trim to the forward and aft stops with no master caution illumination.

A total of seven MOT tests where run with LN-OIJ's pitch trim actuator motor driver card installed. For all tests both autopilots were engaged, and the wind was set to 35 kt from the north:

- For the first test IAS, ALT, and HDG modes were coupled with no degraded channels (all green). MOT was enabled with nominal performance of the mode. MOT transferred to position hold after reaching target (MOT no longer showed "on" on the MSP). The maximum pitch angle did not exceed 12 degrees during the entirety of MOT.
- For the second test, IAS, ALT, and HDG modes were coupled with no degraded channels (all green). MOT was enabled and initially had no degrade, but IAS for pitch showed degraded (yellow) while enroute to the target, about 4 minutes after MOT was enabled. IAS degrade changed to an APP degrade (for pitch) as it approached the target. MOT overflew the target but continued flying straight ahead at 80 kt, maintained 200 ft RADALT and MOT never disengaged. No remarkable pitch excursions were observed throughout the flight. Pitch trim error code 008 was logged. Error code 008 is a miscompare between stick position, trim position, and trim force. Due to a recording error, only HUMS data is available from this test. It is therefore not possible to compare the HUMS recording with the FCC recording at failure onset. When the fault first manifests itself, there is a steady increase in force, even with the cyclic being relatively stationary, see Figure 49.

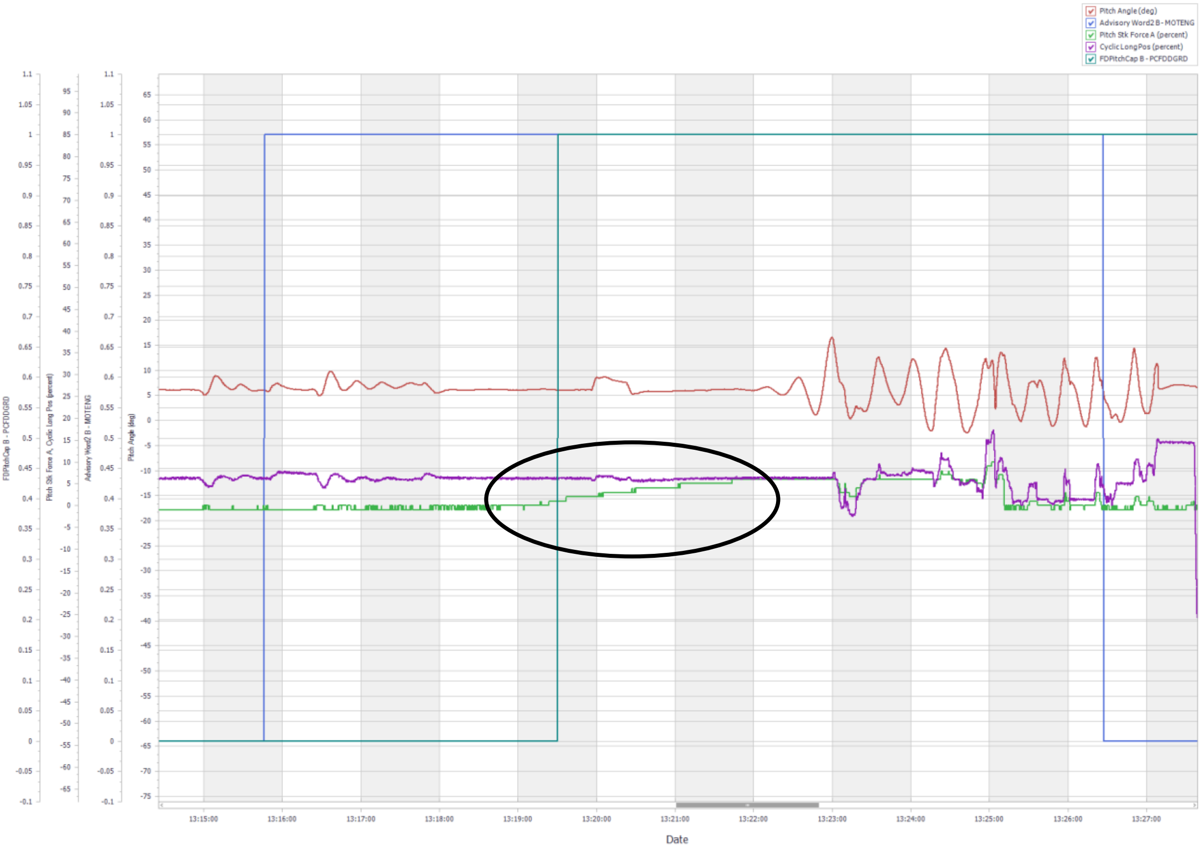


Figure 49: HUMS data for the second SIL trial with the pitch trim actuator motor driver card from LN-OIJ. The black circle marks where the stick force (green) starts increasing, while the cyclic (purple) is relatively stationary. Source: Sikorsky/NSIA.

- For the third test, the SIL was reset and the SIL was flown to the initial operating conditions of the first two tests. The AFCS was functional and ALT and HDG were engaged, but the IAS for pitch showed degrade from the start. MOT was activated and initially showed 80 kt as the selected airspeed, but the selected airspeed changed to about 140 kt. The helicopter reached its target airspeed and flew about 140–145 kt, which resulted in the helicopter making a wider radius turn (to target) and the target was overshot. MOT overflew the target but continued flying straight ahead about 140–145 kt and held selected RADALT, and MOT never disengaged. No remarkable pitch excursions were observed throughout the flight.
- A fourth test was performed in which force trim release on the cyclic control was used to fly the helicopter to a steady-state condition of 80 kt before engaging MOT. This was intended to reduce the amount of accumulated errors in the pitch trim channel of the AFCS to delay the onset of the degrade in the pitch channel near the end of MOT. There were no degrades in any trim channel until near the end of MOT, when APP for the pitch channel showed as degraded once the helicopter's airspeed reduced to about 42 kt. Due to a HUMS recording error, HUMS data was not recorded for this MOT flight.
- A fifth test was accomplished using similar initial conditions to the fourth test, with the purpose of the NTSB representative (seated in the right-seat) to gain a tactile feel of force against trim on the cyclic control near the end of MOT as the helicopter decelerated to transition to a hover. Additionally, the cyclic control was pulled aft to determine its travel required in order to increase helicopter pitch substantially. Due to the HUMS recording error, HUMS data was not recorded for this fifth flight.
- A sixth test was accomplished to test the repeatability of the fourth test, using similar initial conditions to the fourth MOT flight. There were no degrades in any trim channel until near the end of MOT, when APP for the pitch channel showed as degraded once the helicopter's

airspeed reduced to about 42 kt. Due to the HUMS recording error, HUMS data was not recorded for this sixth flight.

After the group determined that HUMS was not recording for test four to six, the HUMS recording error was resolved and a seventh MOT flight was accomplished. The seventh MOT flight showed results similar to the fourth and sixth MOT flights.

1.16.6.3 Engineering Circuit Card

Colins had modified a motor driver circuit card with a fault switch. This allowed pin 10 of U1, the component identified with a fault in 1.16.5, to be turned on and off on command. This allows for the introduction of both intermittent and steady state faults.

The engineering card with the fault switch and the power card from the Sikorsky-owned pitch trim actuator were installed on a Collins-owned yaw trim actuator. The control card was original to the Collins-owned yaw trim actuator. The output arm from the Sikorsky-owned pitch trim actuator was used. Functionally, only the damper and force gradient spring were different between the pitch and yaw trim actuators, but these do not have an effect on the ability of the FCC to command the trim motor.

As a control, MOT was successfully performed without any failures introduced into the engineering board. The MOT performance was similar to the unmodified Sikorsky owned pitch trim actuator, see 1.16.6.1.

Five tests were conducted with the engineering circuit card:

- For the first test, the steady-state fault was activated when the helicopter was about 700 yards from the MOT point. The APP in the pitch channel showed a degrade when airspeed was about 40 kt. At the conclusion of MOT, the helicopter went into position hold with HOV in the pitch channel showing degrade (yellow). MOT did not show as “on” on the MSP at the conclusion of MOT. No pitch excursions were observed, and the pitch attitude did not appear abnormal for MOT.
- For the second test, the helicopter was flown to 120 kt airspeed, after which the steady-state fault was activated. The selected airspeed (for IAS mode in pitch) was changed to 70 kt airspeed using beep trim on the cyclic control. Once 70 kt airspeed was achieved, MOT was engaged. At no time leading up to MOT engagement was a degrade observed on the pitch channel. During MOT, the APP in the pitch channel showed a degrade when airspeed was about 43 kt. At the conclusion of MOT, the helicopter went into position hold with HOV in the pitch channel showing degrade (yellow). MOT did not show as “on” on the MSP at the conclusion of MOT. No pitch excursions were observed, and the pitch attitude did not appear abnormal for MOT.
- For the third test, the steady-state fault was activated prior to MOT engagement, with the helicopter flying at 120 kt airspeed. About 22 seconds into MOT, during a turn, the APP in the pitch channel showed a degrade for about 1 second, but showed no other degrades until near the end of MOT when APP in the pitch channel showed a degrade when airspeed was about 43 kt. At the conclusion of MOT, the helicopter went into position hold with HOV in the pitch channel showing degrade (yellow). MOT did not show as “on” on the MSP at the conclusion of MOT. No pitch excursions were observed, and the pitch attitude did not appear abnormal for MOT.
- For the fourth test, MOT was engaged with no fault introduced. MOT was flown normally until near the end of the MOT profile, when the steady-state fault was activated when the helicopter was about 14 kt groundspeed. As the helicopter slows down, airspeed data becomes unreliable, and groundspeed is more reliable. In the accident, the pitch excursion to LN-OIJ

started at about 14 kt groundspeed. There was no degrade observed until HOV in the pitch channel showed a degrade when the helicopter came into a hover. At the conclusion of MOT, the helicopter went into position hold with HOV in the pitch channel showing degrade (yellow). MOT did not show as “on” on the MSP at the conclusion of MOT. No pitch excursions were observed, and the pitch attitude did not appear abnormal for MOT.

- A fifth test was conducted to investigate intermittent failure. The fault was activated with the helicopter at about 14 kt groundspeed, with the intermittent fault activated for 1 second. No degrades were observed throughout MOT, and the MOT concluded with all modes in green (non-degrade). Only one test was performed with the intermittent fault trigger.

1.16.7 PILOT MONITORING RESEARCH BY HELIOFFSHORE

HeliOffshore is a global, safety-focused association for the offshore helicopter industry.[35] The association has members among both the helicopter operators and the energy companies as well as other businesses involved in the offshore industry. HeliOffshore has published several documents and resources for its members, and others, to increase safety.

HeliOffshore has in the period 2015–2022 conducted research[36] into pilot monitoring of flight systems in the offshore rotary wing industry. The research show that it is not uncommon for pilots (across different domains, helicopter types and countries) to prioritise other cockpit instruments than the attitude indicator (AI). The findings are irrespective of experience. Instead of the classic T-scan that is taught to pilots, see Figure 50, where the main area of focus is the AI while referencing the instruments around it (speed, altitude, heading) many pilots develop a scan pattern that does not include the attitude indicator, see Figure 51 and Figure 52.

The research indicated that this most likely is a pattern that unconsciously forms over time. Omitting the AI allows for a higher level of performance and accuracy. During normal situations the “non-AI” scan works well, but it introduces a latent safety risk. There is a risk these monitoring patterns persevere when they are not appropriate. In addition, not monitoring the AI can lead to a late identification of a potential problem or hazardous situation. The research also showed that when operating with a coupled flight director, the mode annunciations were unobserved for extensive periods of time. This highlights that mode annunciation changes can be easily missed.

The research also studied whether a direct gaze at the AI is actually needed to perceive the attitude. The research suggests that even though it is possible to gain information without a direct gaze, this is insufficient for safe flight. It was found that attitude awareness is directly correlated with time looking at AI and not time looking at instruments near the AI, such as speed indicator or altitude indicator.

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[35] https://www.helioffshore.org/
[36]https://www.helioffshore.org/resources/unexpected-events-pilot-monitoring-research-report. The research was designed and led by Dr Steve Jarvis. All research was performed by Jarvis Bagshaw Ltd, UK, for HeliOffshore

Figure 50: The green T shows the classic T-scan, focused on the attitude indicator, and referencing air speed indicator (left), altitude indicator (right) and heading (down).

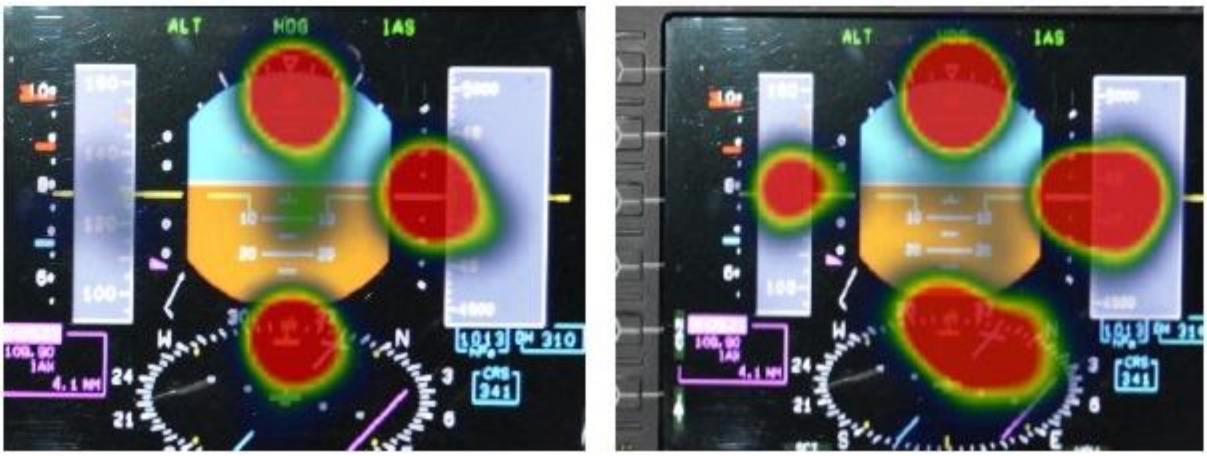

Figure 51: Two of the scanning patterns the research found. The instrument panel is from an Airbus EC225 helicopter. The circles indicate where the pilot is looking, larger circles mean more time spent looking at that area. Source: HeliOffshore/NSIA

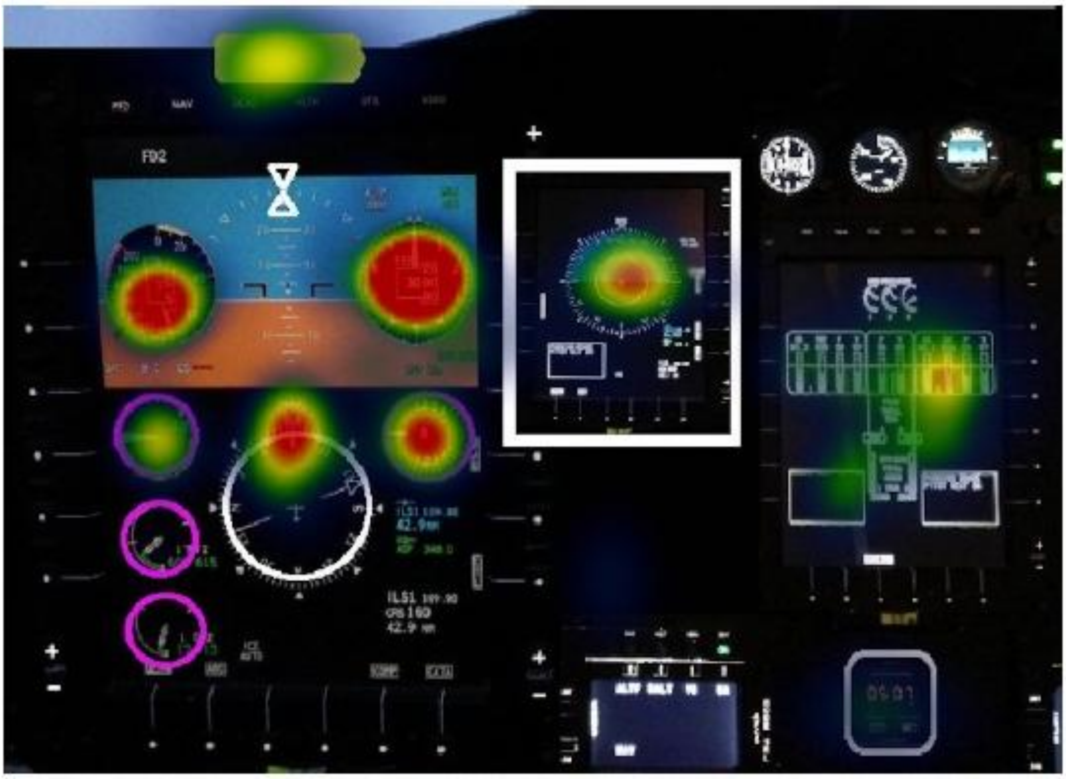

Figure 52: One extreme example of absence of AI monitoring from the research. Dwell time heat map for an 85-second period representing uncoupled flying by a PF between 450 ft and 1,200 ft. The instrument panel is from a Sikorsky S-92A. Source: HeliOffshore/NSIA

1.17 Organisational and management information

1.17.1 RELEVANT ORGANISATIONS

Below is a short introduction to the relevant organisations to this investigation and the organisational safety issues.

1.17.1.1 CAA Norway

The following is cited from the CAA Norway website[37]:

> ***The Civil Aviation Authority of Norway's main objective is to contribute to safe civil aviation in Norway.***
>
> *CAA Norway's main office is in Bodø in the northern part of Norway. We have 190 highly competent employees covering all fields of aviation. CAA Norway is an autonomous and independent administrative body responsible for ensuring safe and efficient operation of civil aviation in Norway. CAA Norway issues regulations in the field of aviation.*
>
> *CAA Norway has the responsibility to oversee and regulate all aspects of civil aviation in Norway, implementing and customising national and international legislation and regulations.*
>
> *To ensure that laws and regulations are being followed, CAA Norway oversee and supervise civil aviation operators and personnel as well as aviation facilities. We oversee and supervise commercial air transport companies, commercial drone operators, aerodromes, aircraft*

[37] *https://www.luftfartstilsynet.no/en/about-us/about-CAA Norway/*

maintenance facilities, aircraft airworthiness certificates, pilots' licences, training facilities and security, amongst other areas of civil aviation.

CAA Norway grants licences and operating permits to individuals and operators, for example to pilots, aircraft maintenance facilities and airlines.

1.17.1.2 The collaboration forum for helicopter safety on the Norwegian Continental Shelf

The following is cited from their website, translated by the NSIA[38]:

The collaboration forum for helicopter safety on the Norwegian Continental Shelf (Samarbeidsforum for helikoptersikkerhet på norsk kontinentalsokkel – SF) should be a driving force in relation to responsible authorities and actors, so that the recommendations in the sub-reports NOU 2001:21 and NOU 2002:17 "Helicopter safety on the Norwegian continental shelf" are implemented. SINTEF's helicopter safety study no. 3 (HSS-3) was presented in April 2010. SF will work on implementing the recommendations in the study. The forum will also be able to address other current issues that are important for helicopter safety and follow up with proposals for specific measures.

The recommendations are divided into four categories

1. Clarifications of responsibility of authorities, cooperation between authorities

2. Helicopters – technical and operational requirements

3. Requirements for helidecks, installations

4. Air navigation services, (air traffic services, communications, navigation and weather services)

The collaboration forum for helicopter safety on the Norwegian Continental Shelf shall work for a continuous reduction of risk when it comes to the helicopter activity on the Norwegian Continental Shelf.

The collaboration forum shall address issues that the members believe can be of importance for helicopter flight safety. If the forum finds it relevant, it shall assess the topic in more detail and propose specific mitigating measures.

1.17.1.3 Equinor ASA

Equinor ASA is a Norwegian multinational energy company with headquarters in Stavanger, Norway. Equinor has a presence in around 30 countries worldwide and employs over 23,000 people. The majority shareholder is the Norwegian State with 67%. Equinor is among the world's largest offshore operators and the largest operator on the Norwegian Continental Shelf.

[38] *https://samarbeidsforum.helikoptersikkerhet.no/ac/om-samarbeidsforumet/*

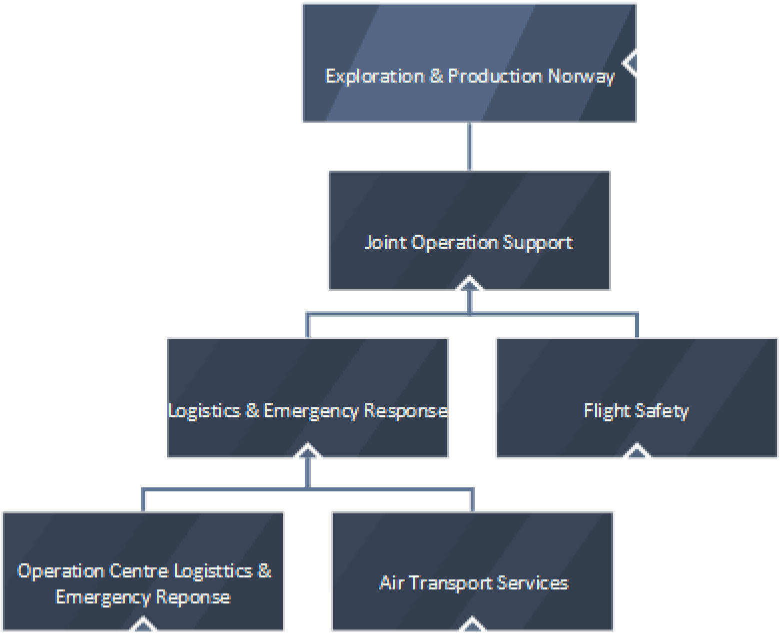

Figure 53: Highlight of relevant organisational units involved with SAR helicopter services within Exploration & Production Norway. Source: Equinor/NSIA

Flight Safety is, amongst other things, responsible for setting requirements regarding flight safety across Equinor and supervising internal compliance. Flight safety is also responsible for Equinor's technology strategy for aviation. The energy companies operating on the Norwegian Continental Shelf (NCS) have several collaborations and processes to ensure flight safety, like common audits.

Air Transport Services is the contract, resource and risk owner for air transport, including SAR helicopters. Air Transport Services has amongst other things the responsibility for portfolio management and is the requestioning unit in procurement and operator cooperation. It also has supplier follow-up responsibilities.

The SAR nurses are organisationally placed in the Functional Centre of Excellence (FCoE) which is an internal hub for specialised competences. The medical responsibility is located with the medical officer for SAR nurses in the FCoE. The manager for Health & Working Environment has personnel responsibility and Air Transport Services have the operational responsibility.

1.17.1.4 Bristow Norway AS

Norsk Helikopter AS was established at Stavanger airport Sola in 1993 as a joint venture between Andreas Ugland and Bristow Group Inc. In 2004, Norsk Helikopter became the first European operator of the Sikorsky S-92A. Andreas Ugland sold his shares and Norsk Helikopter became Bristow Norway AS in 2009, a subsidiary of Bristow Group Inc. Bristow Norway has their headquarters at Stavanger airport Sola. Bristow Norway hold Norwegian Air Operator Certificate (AOC) NO.AOC.010.

At the time of the accident Bristow Norway was serving the Norwegian oil and gas industry with a total of 30 helicopters, all S-92A. This included transport of passengers and cargo, and SAR services at the following bases:

- 4 onshore bases in Stavanger, Bergen, Florø and Hammerfest.
- 2 onshore SAR bases in Bergen and Hammerfest
- 3 SAR bases on offshore installations (Ekofisk, Johan Sverdrup and Statfjord B)

Bristow Norway also supports the Norwegian Joint Rescue Coordination Centres on SAR operations in Norway as well as in Denmark and in the UK. At the time of the accident Bristow Norway had 413 employees and flew about 220 flights per week. Annually, Bristow Norway flew about 25,000 flight hours.

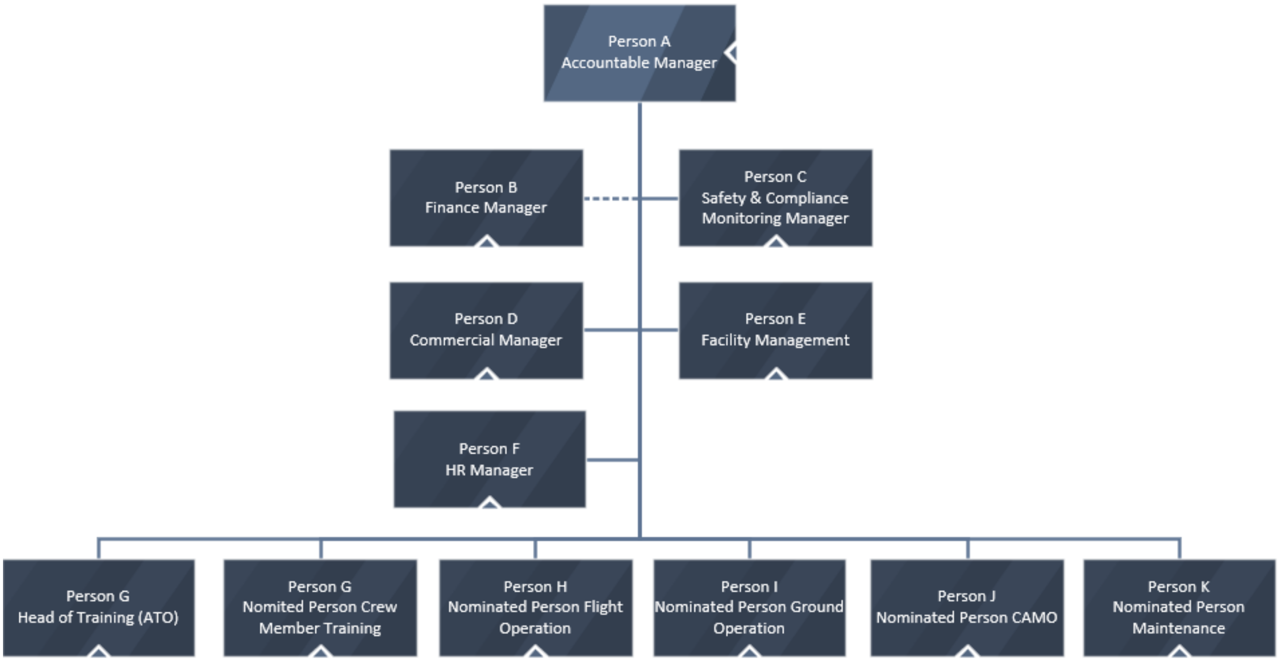

Figure 54: Top Management Organisation in Bristow Norway at the time of the accident. Person G had two roles, Head of Training (ATO) and NP crew member training. Source: Bristow Norway / NSIA

1.17.2 TENDER FOR THE SAR CONTRACTS

1.17.2.1 Introduction

In October 2021 Equinor sent out a Request for Information (RFI) as part of a tender process for a contract of helicopter services on the Mid Norway Norwegian Continental Shelf (Mid Norway NCS). The scope of this contract was crew change from Kristiansund and Brønnøysund and SAR from the Heidrun platform. The plan was to award the contract early Q2 2022 with a start date early 2023 for crew change and mid 2023 for SAR Heidrun. This RFI requested that the responses included an estimate of how much time the helicopter operators required to mobilise for the contract.

Equinor also planned to start a tender process for SAR services on the Southern Norwegian Continental Shelf (referred to further in the report as SAR South). Since there was a short timeline between the tender processes for the contracts for Mid Norway NCS and SAR South, and Bristow's RFI response to Mid Norway NCS specifically estimated 12 months to set up SAR operations on a new base, Equinor deemed it had up to date market information. It was therefore decided that it was unnecessary to issue a new RFI for this contract. Based on the RFI for the Mid Norway NCS contract, the mobilisation time for the SAR South contract was set to 12 months.

During the internal Equinor strategy process before the tender process for SAR South, they identified two serious risks. One was that Equinor might not be able deliver SAR services to Oseberg, while the other was related to mobilisation time for the company that won the contract. The first could primarily be mitigated by negotiating an extension to the current contract. The second was primarily mitigated by an efficient internal process to ensure that the company who received the contract would have 12 months available.

The enquiry for SAR South was sent to CHC Helikopter Service and Bristow Norway on 6 May 2022. The tender was for a SAR helicopter at the Johan Sverdrup oil field and the Statfjord oil and gas field, including a back-up helicopter. Further, the tender included an option for a temporary third SAR helicopter based in Bergen.[39] The tender due date was 31 May 2022. Both helicopter companies responded with a Tender Letter within the due date. The contract award was set to 30 August 2022 with a start-up date set to 1 September 2023. Bristow Norway was informed in a Letter of Intent dated 29 July 2022, that they would be awarded the contract. They could therefore start preparations one month prior to the formal contract award.

The tender submitted by Bristow Norway describes numerous topics. Bristow Norway wrote (quote from chapter 6.1.1 Personnel & Training):

> *Due to the very short timeline from award until contract start, Bristow will bring the intended backup SAR S-92 early into Norway to train SAR-crews full time.*

The tender from Bristow Norway also listed the "Ten Top Risks". Amongst them were Personnel allocation and Personnel training. CHC also identified the short timeline from contract award to contract start as a risk affecting several topics such as aircraft readiness and crew readiness.

The optional SAR service for Bergen was enacted 26 October 2022 with start-up date 1 September 2023, the same dates as for the other two SAR bases. Thus, at that date Bristow Norway became operator on Johan Sverdrup, Statfjord and Bergen.

The duration for the contracts was initially five years with an option for three one-year extensions.

1.17.2.2 Meeting with Equinor

The NSIA had a meeting with Equinor in October 2024. Key personnel involved in the tender process were present. This also involved persons with operational and technical helicopter background. During the meeting it became clear that the relatively short period from contract award to start up was decided based on feedback from Bristow Norway and CHC Helikopter Service. In their answers to the Request for Information issued by Equinor as part of the tender process for Mid Norway NCS, both companies indicated that 12 months was a minimum. The contracts for Mid Norway NCS and SAR South had different scope. A separate RFI was not issued for the SAR South contract. Equinor also stated, based on discussions with different actors and internal experiences, that they believed, in general, that the SAR services they contracted were less complex, compared to the RNoAF 330 squadron and the HEMS operator NOLAS.

Equinor saw that the biggest obstacle regarding new SAR contracts could be lack of suitable SAR helicopters. In 2024 the various models of the Airbus Super Puma were no longer accepted by Equinor, and the only realistic helicopter type was the Sikorsky S-92A. Therefore, Equinor contacted helicopter lessors to make sure that enough S-92s were available in the North Sea basin.

Due to specific requirements for helicopter operators on the Norwegian continental shelf, in reality only Bristow Norway and CHC Helikopter Service had sufficient experience to bid for the SAR contract. Equinor had a long relationship with the two companies for providing both transport of personnel and SAR services. This included audits of the operators and access to deviation reports. In addition, Equinor stated that both companies provide SAR services globally and therefore had a lot of experience. Competence and safety were therefore not a deciding factor when choosing one of the two since it was considered by Equinor that both Bristow and CHC were operators working at the same level of competence and safety. As a response to a NSIA request, Bristow Group has

[39] *To eventually be based at the Oseberg oil field but temporarily based at Bergen Airport Flesland.*

stated that each operator in the Bristow Group is individually responsible for SAR and their respective manuals. Further it was stated that due to the different operational and regulatory requirements of SAR operations within the Bristow Group, there has been limited collaborations between the different SAR operations. In 2023, Bristow Group introduced a flight standards officer whose role is to facilitate discussions and site visits between regions.

In July 2022, CHC Helikopter Service was awarded a contract for Equinor providing helicopter services for the Mid-Norway sector, including one SAR helicopter. Service vulnerability was thus a deciding factor for which company should provide SAR services in both the central and southern continental shelf in Norway. Additionally, finances became a factor when the offer for SAR South by CHC Helikopter Service was commercially less competitive. For that reason, CHC was not fully evaluated during the tender process. Further, Equinor emphasized the economic benefits of having only one operator at the two bases Johan Sverdrup and Statfjord. This meant one back-up helicopter from one operator could serve both bases.

The contracts between Equinor and Bristow Norway contained penalties if the helicopter operator failed to comply with the start-up dates. The contract included a term that Bristow would always have 12 months before penalties could incur, even if Equinor was late with awarding the contract. This also applied to the Oseberg option. During the meeting with NSIA, Equinor downplayed the likelihood of a situation arising where penalties were required. Equinor explained that they had frequent meetings with the management level in Bristow Norway. Unforeseen obstacles experienced during the run-up period were discussed during the meetings. A situation where economic penalties could be an option never appeared. The NSIA is not aware that Bristow identified any flight safety risks concerning the timeline and forwarded concerns to Equinor that the short timeline could influence flight safety negatively. The mitigating factors introduced by Bristow Norway in their tender were deemed by Equinor to reduce the risk to an acceptable level.

1.17.3 PREVIOUS TENDERS FOR SAR HELICOPTERS

The NSIA has requested information from Equinor about their five previous tenders for SAR helicopters which is provided in Table 12. Only Bristow Norway and CHC Helikopter service have provided SAR services to Equinor.

Table 12: Details about previous tenders for SAR helicopters. Source: Equinor

Contract name	Award date	Start date	End date	Mobilisation period	Scope	Operator change
Hammerfest 1	04.07.2008	01.06.2009	31.08.2018	11 months	1 SAR & 1 Line	No
Hammerfest 2	12.09.2017	01.09.2018	31.08.2026	12 months	1 SAR & 1 Line	No
Halten/Nordland 1	11.05.2006	01.05.2007	31.01.2015	12 months	1 SAR	No
Halten/Nordland 2	19.09.2012	01.02.2015	31.08.2023	28 months	1 SAR	No
SAR/Shuttle Tampen	29.06.2007	01.03.2009	31.08.2024	20 months	2 SAR + non crewed backup	No
Mid Norway NCS	18.07.2022	01.02.2023 01.09.2023 for SAR	31.01.2028	6 months, 12 months for SAR	1 SAR + 2 Line	No
SAR South	30.08.2022 (26.10.2022 for SAR Oseberg)	01.09.2023	31.01.2028	12 months	3 SAR + non crewed backup	Yes

1.17.4 INTERVIEW WITH PERSONNEL AT BRISTOW NORWAY

To better understand the activity and organisation during the major expansion of the Bristow Norway SAR organisation in preparation for the SAR South contract, the investigation team at the NSIA interviewed several people. This includes a representative selection of pilots, other crew members, mid management level and top management level.

The interviewees drew a very different picture depending on the position they held. However, all the interviewees agreed that the available timeline when seen in connection with the expansion was short. This led to a situation with a high workload and a need for a more streamlined and intensive SAR-training, see 1.17.6.4.

The top-level management, including the Accountable Manager (AM), was aware of the time constraints. The AM explained that this was the first time there had been a 12-month timeline for such a complex contract. Further, the AM explained to the NSIA that she had full trust in her management team and valued the feedback she got from other people in management, especially the NP Flight Operations and NP Part 145 (Maintenance). Furthermore, it was the Commercial Manager that had direct contact with Equinor up until the time of contract award in August 2022. The Accountable Manager stated clearly that she was the one responsible for flight safety in Bristow Norway. It was also highlighted that she was dependent on good communication with other management personnel with key roles regarding flight safety, for example, the NP Flight Operations and the Safety & Compliance Monitoring Manager. Flight safety was not its own agenda item of the bi-weekly senior management meeting. But the AM stated that there were several other mechanisms, such as daily morning meetings, a dedicated meeting with the safety manager and the quarterly Safety Review Board. It was stated that flight safety was always a topic.

The NP Flight Operations explained to the NSIA that the period from award of a SAR contract to start-up, historically, has been about 2.5-3 years. Only contracts for passenger transport have been as short as 1 year. Management at Bristow Norway accepted the relatively short timeline for the contract this time and it was emphasised by several management personnel that Equinor is the strongest part in this relationship. He also stated during his interview that he did not expect to win the contract for SAR South but saw it as more likely for Bristow Norway to win the contract for NCS mid Norway. He told the NSIA that everyone had to “roll up their sleeves” and get the job done when they won the contract for SAR South. The NP Flight Operations stated to the NISA that he was not too pleased when the option for Oseberg was enacted, as this would put a further strain on the organisation.

Following the award of the SAR South contract, the NP Flight Operations became the project manager for the expansion. He established an organisation where the NP ATO/Crew Training and the Chief instructor SAR (during this time the Chief Instructor SAR temporarily held the role as SAR manager) were important stakeholders in addition to maintenance personnel. A Management of Change (MoC) document with 60 action points was established. A dedicated SAR school was established at Sola (see 1.17.6.4) to train the required personnel in the time available. He stated to the NSIA that they managed to be ready for start-up at the three bases with small margins. Training of personnel continued well into the contract period. A factor for the success was a high technical reliability of the helicopter dedicated for training. Due to the short summer nights in Norway, there was a challenge to get was sufficient flight training in night conditions during the last months leading up to the start-up.

When interviewing pilots and other crew members, it became clear that the perceived and experienced time pressure during the ramp-up period had caused a strain and safety concerns. Some individuals used words like *“cutting corners”* and *“breakneck speed”* to describe the situation. It was also stated by several that to not be ready for the start-up date was not an option due to the penalties in the contract. Concerns were also raised about the revised training programme and one person stated that the training program “*was cut to the bone”*. It was also expressed by personnel from different personnel groups that it was not favourable for a future career to raise critical questions. Contrary, a “can-do” attitude was appreciated by the management. It was even expressed that someone sensed a culture of fear. Several persons had expressed that the senior management disliked involvement with unions and the safety representatives[40]. Some pilots expressed lack of confidence in the NP Flight Operations. Some expressed an organisation with limited willingness to perform serious risk assessment processes.

Bristow Norway has documented a steady increase in standalone risk assessments, from 24 in 2020, 34 in 2021, 50 in 2022, 84 in 2023, 92 in 2024, to 110 in 2025. For ongoing operational activities, Bristow Norway utilizes, and have demonstrated, a comprehensive risk register as the primary tool for systematic hazard and risk management.

1.17.5 OPERATIONAL MANUALS FOR FLIGHT CREW

Bristow Norway has several manuals relevant for SAR operations and training. All these manuals give some descriptions, guidelines or procedures for SAR operations. Below is a description of the manuals and relevant excerpts.

- **Operations Manual (OM) A** is a manual issued based on EASA regulations and describes terms and conditions fundamental for the Company’s Air Operator’s Certificate (AOC). OM-A also describes the organisation and responsibilities within the organisation. The manual in

[40] The safety representative (verneombud) is an intermediary between the employer and the employees, so they can work together to create a safe workplace through health, safety and environment work (HSE). The safety representative may halt any work that poses an immediate risk to life and health. From the Norwegian Labour Inspection Authority (Arbeidstilsynet).

force at the time of the accident was revision no. 39 issued 2 February 2024. The manual describes the pilot duties in several paragraphs:

- Duties (4.5.1.3): *In flight, and with FD coupling functions engaged, the PF will monitor the aircraft and be ready to take control when necessary. …*
- Duties (4.5.1.3): *[PF shall] At all times monitor any FD coupling functions.*
- Duties (4.5.1.3): [*PM shall] Monitor flight path, navigation, power settings, procedures, aircraft systems and FD coupling functions*.
- Use of automation during normal operations (8.3.18.1.1): *PF and PM shall closely monitor achievements of the autopilot targets …*
- Use of automation during normal operations (8.3.18.1.1): *When operating with coupled modes engaged, the PF shall monitor the flight path and instruments…*
- Use of automation during normal operations (8.3.18.1.1): *When operating at low height with coupled modes engaged, PF and PM must closely monitor flight path and instruments, …*
- Scanning techniques (8.3.19.3): *An internal scan of instruments is obviously important and the balance between internal and external scanning will depend on the circumstances and flight deck workload at the time.*

In OM-A chapter 4.5.10, Bristow Norway has a summary table of which duties the PF and PM have during different phases of flight, see Figure 55.

OM-A also includes standard deviation calls in chapter 8.3.23.3. At the time of the accident Bristow Norway had not implemented a safety recommendation about a standard deviation call for pitch. This safety recommendation was issued by the NSIA in the report after the serious aviation incident on 24 February 2020 near the Maersk Invincible (XMKI) oil rig in the North Sea. Even though this report was only issued 13 days before the accident with LN-OIJ Bristow Norway had been aware of the NSIA's intent to issue a safety recommendation about a deviation call for pitch since August 2022.

- **Operations Manual (OM) A Special operations** is an appendix to OM-A. It describes the SAR operational organisational structure and procedures to be used during SAR operations. The manual in force at the time of the accident was revision no. 17 issued 22 December 2022. The manual describes pilot duties in several paragraphs:

  - Search Considerations (1.14.6): *If possible, visual contact with the target must be maintained, and the position must be saved as soon as possible.*

    The main task for the PF is to control the helicopter, and observation may be performed when the workload is low.

    The main task for the PM is observation and navigation. Mark GPS position. Write A/C heading and relative bearing to target.
  - Approach to hover *(1.21): Perform Descent and Pre SAR Ops before descending to execute a SAR operation. Perform Trans Down Check before leaving a low cruise height for an automatic transition down or a manual approach. If the intention is to perform a "pick up", the door may be opened and the hoist armed when approaching hover after the airspeed is below maximum speed for opening the door.*

    Below 600 feet at night or IMC, the PM will call rad. alt and airspeed every 100 feet. At day and VMC minimum required call is at 150 feet. Vy and Vtoss will always be called.

- Pick up – Intercom/Communications (1.24.5): The following statement is about the duties during a winching operation: *The PM will monitor cockpit instruments and pay special attention to the artificial horizon and radar altimeter. PM will immediately inform PF about any tendency to unusual attitude or variation in altitude.*
- Pick Up from the Sea or Dinghy (1.24.10): No special duties or instructions noted.

Bristow
Bristow Norway AS

Operations Manual - Part A

	COMMANDER	CO-PILOT
	Ext. & Int. Inspection	Preform Pre Start Checklist
	Check/Sign Flight Documents	**Obtain ATC Clearance**
	PF	**PM**
START UP	Monitor Start Guard controls	Start both engines
TAXI	Confirm clearance Conform to clearance Call for checks	Passenger briefing ATC clearance Monitor PF Call out/action checks A/R Update operational flight plan Call out/action checks A/R Update operational flight plan
TAKE-OFF	Confirm clearance Call for checks Conform to clearance	ATC clearance Call out/action checks A/R Monitor PM Assist with power management
SAFE ALTITUDE AND SPEED	Call for checks	Call out/action checks A/R Update operational flight plan
EN ROUTE	Call for checks Fly the a/c Brief PM on approach	Call out/action checks A/R Monitor PF Obtain destination weather Maintain operational flight plan Radio calls etc. Passenger information Flight Record, Load Sheet, Passenger Manifest, etc.
APPROACH/ LANDING/ MISSED APPROACH	Conform to ATC Call for checks	Monitor PF Call out/action checks A/R Passenger briefing
AFTER LANDING SHUTDOWN	Call for checks	Call out/action checks A/R Monitor Shutdown
	COMMANDER	CO-PILOT
AFTER SHUTDOWN	Complete/sign documents (operational flight plan, customs, traffic, etc.)	

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4 Crew Composition
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Figure 55: Screenshot from Bristow Norway's OM-A showing a summary of duties during normal operations. Source: Bristow Norway / NSIA

- **Operations Manual (OM) B** describes the operations carried out by Bristow Norway with the helicopter type S-92A. The basis for this manual is the S-92A Flight Manual. The manual in force at the time of the accident was revision no. 17 issued 4 January 2024. The OM-B is a 262-page document.
  - SAR AFCS, Crew Co-Operation (2.2.3): *All members are responsible for the monitoring of the aircraft and which of the MSP modes are in use.*

    - Crew concept and autopilot coupler functions and settings (2.2.12.12): *When coupled below 200 feet AGL, the pilot will monitor the flight controls and take action in the event of an excessive rate of descent.*

- **Operations Manual (OM) B Appendix SAR** is a manual describing the SAR operations carried out by Bristow Norway with the utility version of the S-92A. The basis for this manual is the S-92A Flight Manual. The manual in force at the time of the accident was revision no. 3 issued 15 June 2022.
    - General (1.2.1 point 3.): *When coupled below 200 feet AGL, the pilot will monitor the flight controls and take action in the event of an excessive descent rate or deviation from SAR profile.*
    - Crew concept (2.11.5): *For an approach to a ship, the SAR Captain will normally be the PM during the Trans down.*

The expanded trans down checklist can be seen in figure 56. It follows from the standard procedure that the PF initiate a checklist, the PM reads the checklist, and the PF responds as appropriate. There is no further specific guidance regarding task sharing.

2.6.31 TRANS DOWN

1. TYPE OF TRANS DOWN ________ BRIEF

APP1/APP2, ATPT, MOT or manual.

2. BUGS/HVR REF ________ SET/REVIEW

Set and confirm RA, MIN bug and Hvr RA.

3. ALTIMETERS ________ QFE A/R

For overwater operations, crosscheck Baralt and Radalt reading. Adjust altimeter setting as required to match up Baralt and Radalt (QFE).

4. AREA ________ CLEAR

Check area visually and/or by radar at night or IMC. Confirm area clear.

NOTE
APP2 and ATPT approaches should be made into the wind whenever possible. The MOT approach will align the aircraft with the FMS calculated wind at the time the approach is initiated. However, the pilot should verify FMS wind direction prior to the approach. The aircraft must be flown at a steady speed above 50 KIAS for a minimum of 1 minute before the FMS can accurately calculate wind vector. Monitor wind direction and speed during the descent. If a substantial change in wind direction is encountered during the descent, consider maneuvering the aircraft into a more favourable condition.

SAR Circuit:

5. CABIN ________ READY

This item is only to be performed during a SAR circuit. Ready mean the WO confirm the cabin checklist is complete and cabin is ready for the mission to be carried out.

CHECKLIST COMPLETED

Figure 56: Bristow Norway's expanded trans down checklist. Source: Bristow Norway / NSIA

As part of this investigation the NSIA has asked another helicopter operator for their SAR procedures. This operator's trans down procedure has a clear task sharing, see Figure 57.

14.6.1.3 **Transition**

Established at 500 feet, the PM will adjust the RADAR controls, and verify that there are no obstacles in the planned approach path.

It may become necessary to adjust the planned approach path, using HDG mode to stay clear of any obstacles and adjust for a moving RP (ship in transit).

Adjust the missed approach plan in relation to obstacles.

Transition check:

1. **Compass .... As required**
   a. Select DG if the RP is a large vessel or rig, due to magnetic interference
2. **Landing gear .... Down**
3. **Bugs .... Min 20**
4. **Final track .... SAFE / into wind**
   a. Verify no obstacles are within 0.75 nm and approximately into wind

Procedure calls before selecting APP modes

Flight condition	PF	PM	Remarks
On final		**"Heading for missed approach xxx"**	
	"Missed approach on xxx checked"		

Established on final at 500 feet:

a. Verify that the approach path is clear of obstacles, and into wind

b. Verify that the missed approach sector is clear

c. Select **APP1**

d. Adjust IAS to give 80 knots groundspeed

e. At 1.5 nm from RP, select **APP2**

f. Monitor closely the transition to hover

g. PF shall:

- **i.** Guard the controls
- **ii.** Check and call mode changes of the FMA
- **iii.** Monitor pitch, roll, yaw, airspeed, and heading to ensure limitations are not exceeded
- **iv.** Call **"Power increase"** when approaching hover
- **v.** When established and trimmed as required in hover, call out for hover checklist

h. PM shall:

- **i.** Check and respond to the PF's call-out of mode changes on the FMA
- **ii.** Adjust and monitor the radar until it is assured that there are no obstructions in the descent and missed approach sector
- **iii.** Advise the PF of obstructions in the radar sector
- **iv.** Monitor aircraft instruments, in particular RADALT, VS, and AS during the descent. When approaching hover, anticipate and monitor TQ increase.
- **v.** Call every 100 feet from 500 feet down to 100 feet above, then 50 feet above H.HT
- **vi.** Call **"50 feet above"** (H.HT)
- **vii.** Call visual with sea
- **viii.** Call visual with target
- **ix.** Remain on instruments as soon as the PF declares visual
- **x.** Call **"APP 1 and APP 2 complete"**

Figure 57: Example of another trans down procedure. Source: Helicopter operator / NSIA

The procedure in Figure 57 has the following note regarding MOT:

> ***Transition using MOT***
>
> *When executing a visual or an electronic search, the MOT function of the autopilot will be used in conditions of night / DVE.*
>
> *It is assumed that the SARA descent / approach check has been done prior to the visual / electronic search start.*
>
> *a. Fly visually or electronically on top of the RP / target*
> *b. Select MOT on MCP when on top of RP / target*
> *c. Perform transition check*
> *d. Continue as for the coupled transition procedure, omitting the APP 1 and APP 2 selection, as this will be performed automatically in MOT mode*

- **Operations Manual (OM) D.** The OM-D describes the organisation, responsibilities and qualifications for the training department within Bristow Norway. It also contains all training and checking programs and syllabi for all crew training, including for SAR. The manual in force at the time of the accident was revision no. 18 issued 28 November 2022.
- **Rotorcraft Flight Manual (RFM) for S-92A.** The RFM is provided by Sikorsky and approved by the FAA. The complete RFM is subject to revisions, but for time critical changes there is a system for temporary revisions. The manual in force at the time of the accident was revision no. 8 issued 2 May 2012. The RFM also includes a number of FAA approved supplements describing various systems that can be installed in the helicopter and the operation of these.
- **SAR pilot ground school training manual.** The manual is provided by Bristow Norway and emphasizes the description of different AFCS SAR modes. It also describes different emergency procedures and has chapters for limitations and performance. The manual is for training purposes only.
- **SAR training manual tailored for each individual SAR helicopter.** The manual describes in detail the SAR equipment installed in the helicopter. It richly illustrates different units, where it is installed, how to operate it and how it works.
- **Rescue Technical Operation Manual (ROM).** The ROM is considered to be an appendix to OM-A, Special Operations Manual. ROM prescribes procedures, standards, instructions and capabilities pertinent to all phases of Bristow Norway Rescue Operations. The manual is written in Norwegian.
- **Redningsteknisk Utstyrsmanual (RUM).** The RUM describes policy, guidance and technical information related to configuration, maintenance and inspection of main components of Bristow Norway aviation SAR equipment. The manual dictates policy and procedural guidance for users within the Bristow Norway SAR community. The RUM is written in Norwegian language.

1.17.6 BRISTOW NORWAY’S SAR TRAINING

1.17.6.1 Training programme for flight crew

The NP Crew Training is responsible for issuing, amending and revising the training manual (OM-D) including the training programme (see person G in Figure 54). The Norwegian CAA approves changes to training programmes and syllabi. Since SAR is nationally regulated, there is no common European specification of what a SAR training programme should include.

Senior Management has explained to the NSIA that they had identified that Bristow Norways's SAR training programmes were outdated. During the winter and spring of 2022, they had therefore started a revision process. A revised training programme for the initial training of SAR captains, SAR hoist operators and rescuemen was sent to the Norwegian CAA for consultation during the autumn of 2022. A formal application for approval of the training programme was sent 3 November 2022, and the revision was approved 7 November 2022. An application for a revised training programme for SAR co-pilots was sent to the CAA Norway on 16 February 2023 which was approved 24 February 2023.

Some Bristow Norway managers have stated that the old training programme was unsuited for training a large number of flight crew in a short period of time. One of the essential tasks stated in the Management of Change document was to obtain approval for revision of the training programme from the Norwegian CAA. The due date for this approval was set to 1 October 2022

At the same time during the autumn of 2022 a full revision of the OM-D was ongoing and almost complete. New EASA requirements for the structure of OM-D had an entry into force 30 October 2022, which would require significant changes. Hence, OM-D revision no. 18 was sent to the Norwegian CAA for approval 15 November 2022 and included a statement that OM-D, revision no. 18 did not include the newly approved SAR training programmes, and that the NP Crew Training immediately would start on OM-D, revision no. 19 with the new training programme incorporated. The OM-D revision no. 19 was approved by the Norwegian CAA 30 March 2024, one month after the accident. Between the approval dates of the individual training programmes and the approval date of OM-D revision 19 the training programmes were implemented through Operations Information Circulars in accordance with OM-A.

OM-D revision 17 was the valid version for flight crew training when Bristow Norway was awarded the contract for SAR South in August 2022.

1.17.6.2 SAR co-pilot course

The following is cited from OM-A Special operations chapter 1.3.2:

> *To qualify as Co-pilot in limited SAR operations the pilot must:*
>
> • *Have at least 200 hrs on type.*
> • *Have completed a limited SAR course, according to OM part D.*
> • *Satisfy the recency requirements laid down in OM part D.*
>
> *To qualify as a Co-pilot in AWSAR operations the pilot must in addition to the requirements above:*
>
> • *Have completed an AWSAR Co-pilot training course.*

The NSIA has compared the OM-D revision 17 (rev. 17) training programme and the OM-D revision 19 (rev. 19) training programmes. Before the candidate for co-pilot can start the flight training programme, they must complete a 26-hour ground school.

The rev. 17 initial training programme consisted of 15 sorties, including two night-sorties in a SAR helicopter. Eight of these 15 sorties could be replaced with five sorties (of which 2 were night sorties) flown in a suitable flight simulator. The two night-sorties could not be replaced. Following the initial programme the line training[41] programme consisted of 10 flights including five night-sorties. When the candidate had completed both the initial and line training programmes and

[41] Line training is flight training in normal operations with a qualified line training captain. According to ICAO, line training is crucial in order to consolidate practical skills in actual operations.

passed a Line Check they were released for line duty. No nominal flight hours were set for the rev. 17 program.

The rev. 19 initial training programme consisted of 16 sorties including three night-sorties. Six sorties were flown in a suitable simulator with all three night-sorties conducted in the simulator. After the accident, Bristow Norway has made night flying in a helicopter a mandatory part of the training programme for co-pilots. Several of these simulator sorties were flown with two co-pilots in training as they are intended to mainly train a procedure. Following the initial programme the line training programme consisted of two flights. The two line-training flights should preferably be completed as night sorties, but this was not essential. The flight hours of the rev. 19 program were nominally set to 27 flight hours of which 12 were in a simulator.

The main difference between rev. 17 and rev.19 is the reduction of the line training programme, and more of the training being completed in a flight simulator.

1.17.6.3 SAR Captain course

The following is cited from OM-A Special operations chapter 1.3.1:

> *To qualify as SAR Commander, a pilot must:*
>
> • *Have at least three years' experience as a pilot in a SAR organisation*
> • *Have at least 3,000 hrs on helicopters, of which 1500 hours on relevant helicopter types.*
> • *Have at least 500 hours as Pilot in Command.*
> • *Have at least 200 hrs on type;*
> • *Have completed a limited SAR course, according to OM part D.*
> • *Satisfy the recency requirements laid down in OM part D.*
>
> *To qualify as a Commander in AWSAR operations a pilot must in addition to the requirements above:*
>
> • *Have completed an AWSAR Commander training course.*

The NSIA has compared the OM-D revision 17 (rev. 17) training programme and revision OM-D revision 19 (rev. 19) training programmes. 20 hours of theoretical lessons are given in parallel to the flight training programme.

The rev. 17 initial training programme consisted of 12 sorties including two night-sorties. Following the initial programme, the line training programme consisted of minimum 15 sorties, including five night-sorties. When the candidate had completed both the initial and line training programmes and passed a Line Check they were released for line duty.

The rev. 19 training programme consisted of 15 sorties, five of which had to be night-sorties. Sortie 1–6 had to be with a SAR instructor, while 7–15 could be performed with a SAR line-training captain. There was no defined line training.

The main difference between rev. 17 and rev. 19 is the restructuring of the initial training programme and the removal of line training. Due to the hoist being located on the right-hand side of the helicopter, the commander is most often the pilot flying during hoist operations. For that reason, it was deemed challenging to train a sufficient number of SAR captains. The training program therefore had a focus on basic handling skills.

1.17.6.4 Bristow Norway's SAR School

The scope of the contract with the option for Oseberg activated meant that Bristow needed 19 SAR pilots, 12 hoist operators and 11 rescuemen for the contract. Documentation the NSIA has received show that the number of crew trained during the mobilisation period were:

- Commanders: 6 started, 5 completed
- Co-pilots: 14 started and completed
- Rescuemen: 11 started and completed
- Hoist operators: 8 started, 7 completed

Due to the short timeline from contract award to contract start and the number of people required to be trained for the expansion, Bristow Norway elected to bring one of the SAR helicopters designated for the SAR South contract to Norway early to establish a "SAR School" at Sola. It was not feasible to train the required personnel at the operational SAR bases. During this process they drew upon experience from other periods where high-intensity training was required. Most of the new SAR crew members (captains, co-pilots, hoist operators and rescuemen) were trained at this "SAR school". LN-OIJ was the aircraft used by the "SAR school" and flew two sorties almost every day.

In interviews conducted by the NSIA with personnel at Bristow Norway, see section 1.17.4, various opinions about the "SAR school" have emerged. Almost everybody believe it was a very efficient way of training the required personnel in a short period of time, but there is a difference in opinion about the level of quality. Some have stated that being removed from an operational SAR base during training is detrimental to the general level of understanding of SAR operations. It has been flagged that this is especially true for SAR co-pilots, and several SAR co-pilots interviewed by the NSIA have stated that they felt their training was rushed and that there was not enough time to get them to the level they would expect. Some interviewees have also stated that due to time constraints they did not get to repeat an exercise if desired. Since a single sortie included several crew members to be trained, there were also instances where desired repetition of training items was dropped since there was simply not enough time to complete everything for everyone. The NSIA has not seen documentation that any of the pilots trained during the mobilisation have expressed that they felt they did not get enough training.

The NP Flight Operations and people from the SAR management stated that it could be demanding to become a SAR captain. The hoist was located on the R/H side of the helicopter, and for that reason the pilot in the R/H seat had to manoeuvre the helicopter during demanding hoist operations. It was thus necessary to practice a lot together with a hoist operator. In addition, the NSIA got an impression from several different people that the co-pilot, due to the nature of SAR operations, more often was the PM. The PM role includes more flight administration like communication, and monitoring of various systems.

1.17.6.5 Unusual Attitude Recovery and emergency training

As part of every Operator Proficiency Check (OPC) Bristow Norway's pilots train scenarios that cover unusual attitude and recovery as well as different emergencies. This is outlined in OM-A rev 39 section 5.3.13.11. Bristow Norway have six different OPCs that pilots cycle through. Depending on the OPC, there are several different scenarios that train unusual attitude recovery, but always a minimum of one. The OPC has a validity of six months, and if a new OPC is completed within the last three months of the validity period the new validity period is 6 calendar months from the original expiry date. As stated in chapter 1.5 the co-pilot completed an OPC in January 2024 and the commander completed an OPC five days before the accident.

OM-A rev 39 section 8.4.5.13, see Figure 58, states the Bristow Norway procedure for unusual attitude recovery during approach.

The FAA Instrument Flying Handbook[42] has the following to say about unusual attitude recovery:

> *To recover from an unusual attitude, a pilot should correct bank-and-pitch attitude and adjust power as necessary. All components are changed almost simultaneously, with little lead of one over the other. A pilot must be able to perform this task with and without the attitude indicator.*

8.4.5.13 Unusual Attitude Recovery during Approach

If the flight path and/or flight parameters have deviated significantly from the normally accepted tolerances during approach, especially when close to the surface, the unusual attitude recovery process should be used rather than the normal go-around procedure. The procedure for unusual attitude recovery to a climb is summarised below:

- De-couple upper modes;
- Roll wings level, centralize the slip ball; and simultaneously
- Apply maximum continuous power; and
- If IAS greater than V_Y, adjust attitude to climb at V_Y; or
- If IAS below V_Y, adjust attitude to achieve V_Y; and
- Maintain the climb until safe altitude

Figure 58: Screenshot from Bristow Norway's OM-A regarding unusual attitude recovery. Source: Bristow Norway / NSIA

1.17.7 QUESTIONNAIRE TO BRISTOW NORWAY SAR PILOTS

The NSIA created a questionnaire and sent it to pilots who were registered as SAR pilots in the period between 1 January 2022 and 1 March 2024. This was done to gather information about the mobilisation period after Bristow Norway won the SAR South contract. The questionnaire was sent out to 52 people and the NSIA received 32 responses, which is 61.5%[43]. The questionnaire was open for responses from 25 October 2024 to 8 November 2024.

The questionnaire focused on training and allocation of duties in the cockpit as well as some organisational aspects. The most important findings are summarised below.

The NSIA asked the pilots if they felt they got adequate time for training and practice. The difference being that training is acquiring new knowledge, while practice is applying and getting experience (for example through line training).

[42] https://www.faa.gov/sites/faa.gov/files/regulations_policies/handbooks_manuals/aviation/FAA-H-8083-15B.pdf

[43] *It is important to highlight that even if the percentage (61.5%) of responses is relatively high, the low number of actual responses (N=32) means that the answers can only be used qualitatively. They should therefore not be used as a sole indication but must be used in combination with other information.*

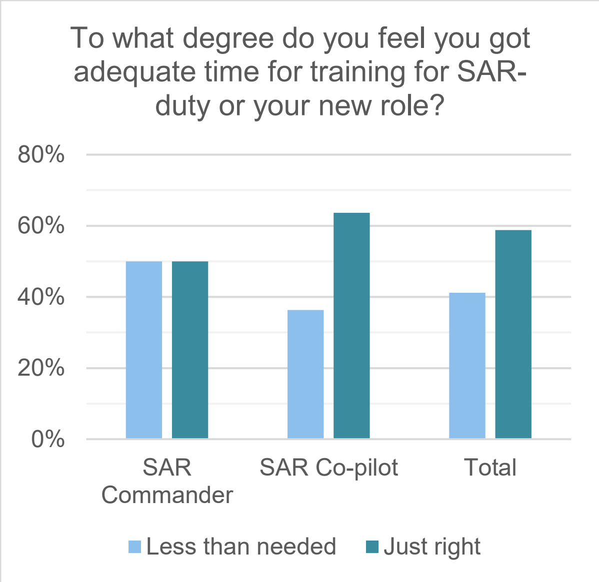

Figure 59: Answers to the question "To what degree do you feel you got adequate time for training for SAR-duty or your new role?". Source: NSIA

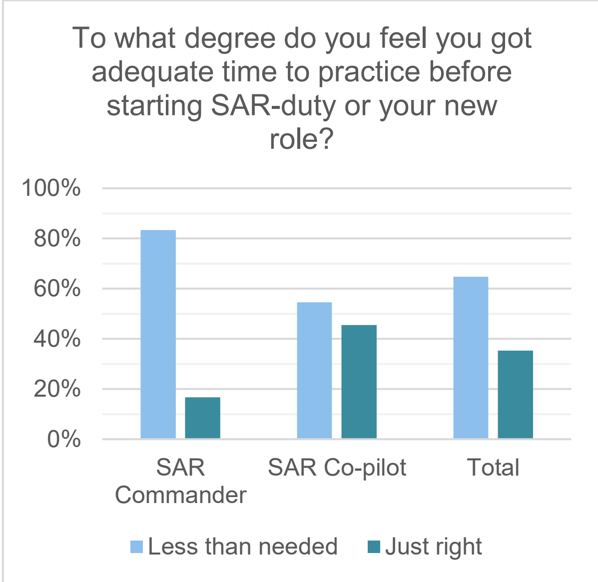

Figure 60: Answers to the question "To what degree do you feel you got adequate time to practice before starting SAR-duty or your new role?" Source: NSIA

The graphs depicted in Figure 59 and Figure 60 shows the answers from those trained to become SAR commanders, SAR co-pilots and a total comprising both. It was possible to indicate if the time was less than needed, more than needed or just right. None of the participants indicated that there was more time than needed. A majority believed that there was enough time for formal training, but not enough for practice.

The regulations that make aviation one of the safest transport systems despite its complexity, also have the unfortunate consequences that operational manuals might be difficult to navigate for pilots. The NSIA asked the pilots how easy they found it to locate the correct procedures in the operational manuals and if they found the procedures ambiguous or unambiguous. The results can be seen in Figure 61 and Figure 62. The answers are split into groups depending on whether the responder: remained in the same role in the SAR organisation; changed role within the SAR organisation; or if the responder was transferred from line flying. There is an almost equal number of pilots who find the SAR procedures unambiguous (22%) as ambiguous (25%), but the overall majority find them neutral (53%).

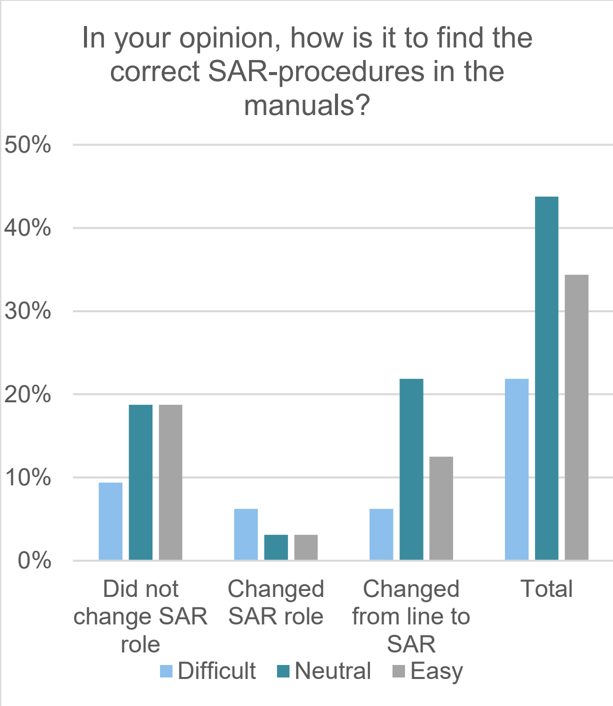

Figure 61: Answers to the question "In your opinion, how is it to find the correct SAR-procedures in the manuals?" Source: NSIA

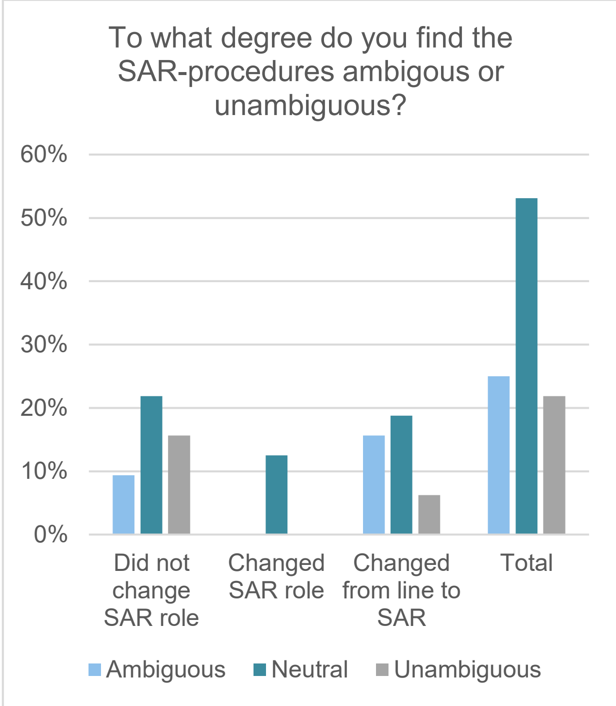

Figure 62: Answers to the question "To what degree do you find the SAR-procedures ambigous or unambiguous?" Source: NSIA

The NSIA also asked the pilots how they found sharing of experience between experienced SAR pilots and the new pilots being trained. The results are seen in Figure 63 but the majority (81%) of respondents stated that there was no organised experience sharing, much less than desired, or less than desired.

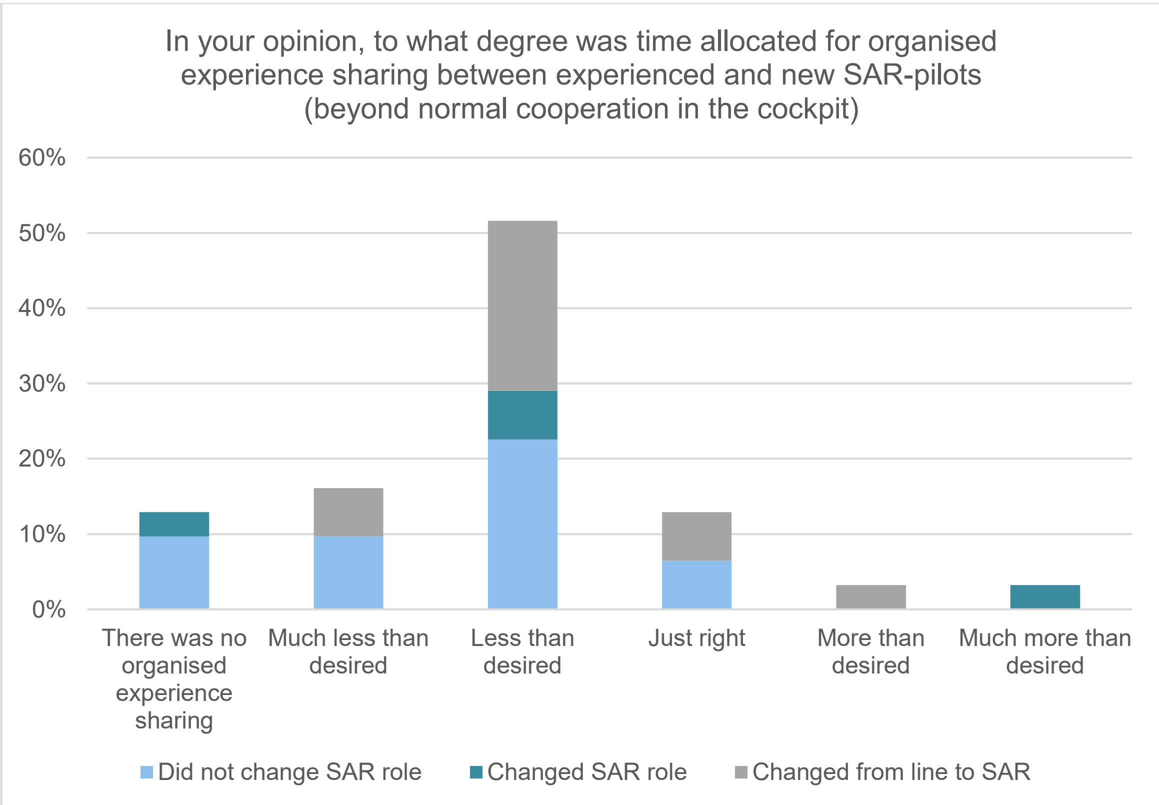

Figure 63: Answers to the question "In your opinion, to what degree was time allocated for organised experience sharing between experienced and new SAR pilots (beyond normal cooperation in the cockpit)" Source: NSIA

The NSIA was also interested in asking the pilot corps for their perception of responsibilities during an automatic trans down using MOT (in theory the same responsibilities apply to any automatic trans down). It is important to recognise that it is very difficult to formulate a concise question that rules out any ambiguity as there are several scenarios and situations that would influence the answer. It is noted that there is a diversity in the answers, which indicate that clear communication and clarification of duties is important.

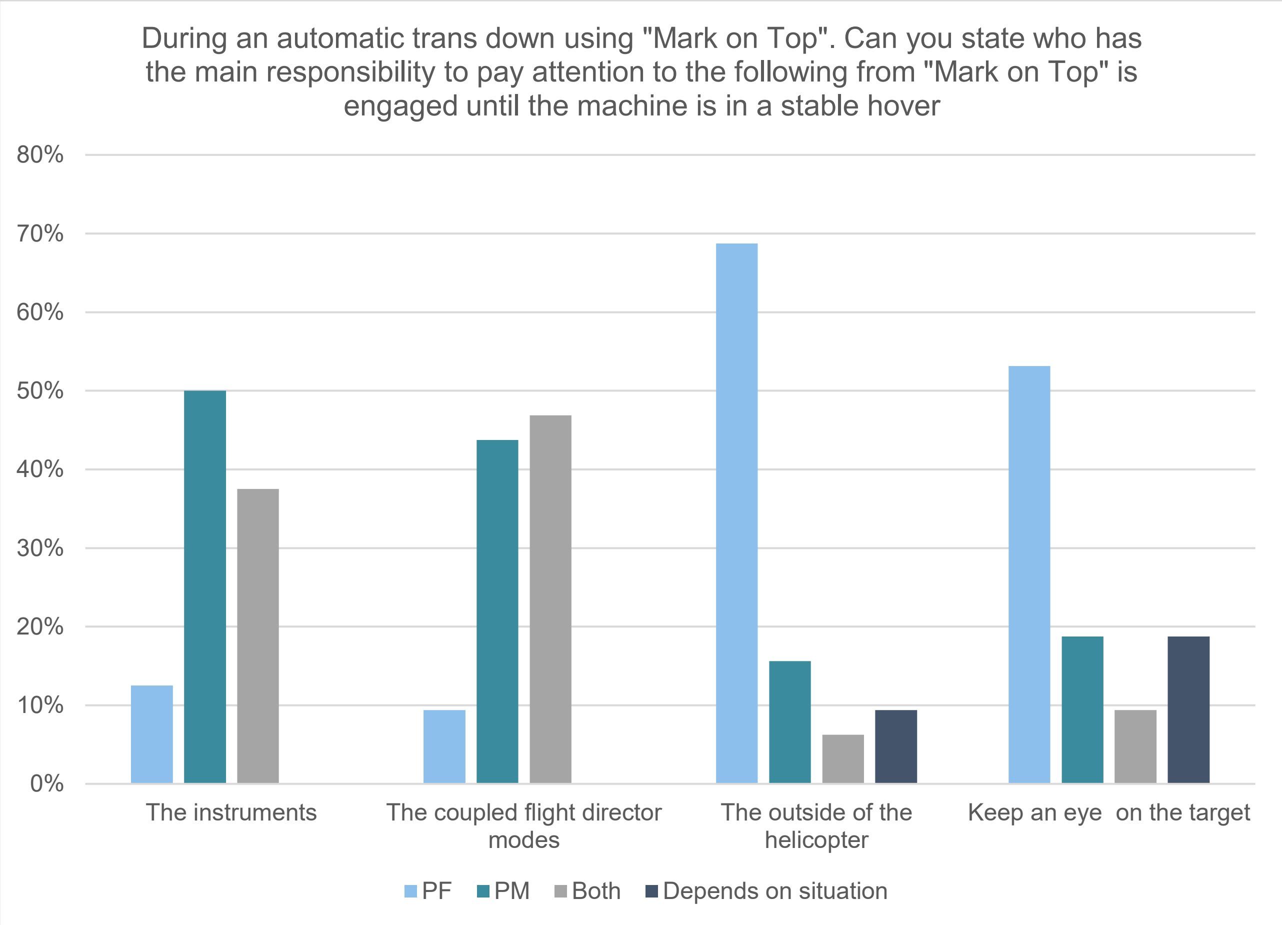

Figure 64: Answer to the question "During an automatic trans down using "Mark on Top". Can you state who has the main responsibility to pay attention to the following from "Mark on Top" is engaged until the machine is in a stable hover" Source: NSIA

Finally, to see if it was possible to gather data about the safety culture the NSIA asked how easy the pilot corps thought it was to raise questions to different management personnel that might be viewed as controversial. The answers showed that the majority found it either neutral or easy to raise controversial questions. There was also a significant minority (25–30%) that found it difficult to raise questions to some managers.

1.17.8 AUDITS OF BRISTOW NORWAY BY CAA NORWAY

1.17.8.1 Introduction

The NSIA has requested reports from all audits performed by CAA Norway on Bristow Norway in the period from 2021 until the time of the accident. This includes audits of the management, the operational department, the technical department as well as the handling of Health, Environment and Safety within the company. Several audits have no findings. It must be stated that findings during an audit is normal. If a finding is detected during an audit, there is a documented procedure to correct the finding with reference to EASA OPS ORO.GEN.150 and EASA OPS ARO.GEN.350 (d).

Based on EASA OPS ARO.GEN.350 (b) the CAA Norway describes level 1 as *"Deviations from regulations that threaten flight safety"* and based on EASA OPS ARO.GEN.350 (c) the CAA Norway describes level 2 as: *"Deviations from regulations that might threaten flight safety."*

Below is a description of audits that the NSIA find relevant. All audit reports are originally in Norwegian and have been translated by the NSIA.

1.17.8.2 Audit of Bristow Norway in May 2021

The CAA Norway performed a general audit of Bristow Norway at its headquarters at Sola 26–27 May 2021. Parts of the summary are quoted below:

> *Over a period of just over two years, the company has changed several Nominated Postholders in the management (4). This appears to be a combination of heavy work pressure over time, aftereffects following a dismissal case last year and COVID-19. A new compliance/safety manager has been hired but not yet joined the company. An acceptance interview with CAA Norway is expected in late summer this year. It's a heavy work pressure in the organisation.*
>
> *(…)*
>
> *The company's use of Management of Change (MoC) is maturing slowly, perhaps too slowly. The company received a level 3 non-conformance in 2020 regarding use of this tool. Implementation and progress appear to be modest. It still appears that the Safety/compliance department to some extent must "run after" AM/NP's and remind them to use this. Safety/compliance can facilitate but the regulations assume that this originates with the AM/NPs.*

During the audit, the CAA Norway found seven non-conformances.

The NSIA would like to mention the following level 2 non-conformances:

- *It appears that tools for implementing MoC are not being used to the full. The company received a level 3 finding for limited use of MoC processes at the last head office audit. Lessons learned can be a way of collecting experiences so that these are not lost. Regulation reference: EASA Part OPS ORO.GEN.200.a) (3)*
- *The company has established KPI/SPI [Key Performance Indicator / Safety Performance Indicator] in its safety work. It is difficult to distinguish between commercial and safety-related KPIs. KPIs are useful, but not in safety work. The company has a limited number of SPIs and these do not measure values in an early phase. Regulation reference: EASA Part OPS ORO.GEN.200.a) (3)*
- *The safety/compliance department within the operational department appears to be understaffed. Regulation reference: EASA Part OPS ORO.AOC.135*
- *Criteria for measures/procedures in relation to risk acceptance are poorly described. Regulation refence: EASA Part OPS ORO.GEN.200.a) (3)*

1.17.8.3 Audit of Training and FSTD department in October 2022

The CAA Norway performed an audit of the Flight Simulation Training Devices (FSTD)/Training department at Sola 4–5 October 2022. The CAA Norway did not include a summary but found two non-conformances during the audit.

The NSIA would like to mention the following level 2 non-conformance:

According to the company's "Focus Document" for OPC, session no. 3 will be carried out in night conditions. This session was carried out in daytime conditions. Only one of four trips carried out under night conditions is not satisfactory to meet the requirement for operations under night conditions. Regulation Reference: EASA Part OPS SPA.HOFO.170

1.17.8.4 Audit of Training and FSTD department in July 2023

The CAA Norway performed an audit of the FSTD/Training department at Sola 19–20 September 2023. The summary is quoted below:

The inspector was well received by instructors and PC/OPC candidates. The instructor appeared to be knowledgeable in both operational and technical fields and facilitated PC/OPC in an educationally good way. He was skilled in operating the simulator. After finishing the PC/OPC, the inspector had a professional conversation with the instructor and NPCT[44].

No non-conformances were found.

1.17.8.5 Audit of the management system in September 2023

The CAA Norway performed an audit of the management system 5–6 September 2023. Parts of the summary is quoted below:

The company started up 3 new secondary bases for offshore-stationed SAR-helicopters at the turn of August/September 2023.

Staffing and equipping these bases have created the need for checking out much new personnel of different categories related to this part of the company's operations, development of operational, technical and administrative documentation and routines, while the company's other operations must be in accordance with the contractual obligations with the company's customers. Such a process involves not only the transfer and checking out of personnel already employed in the company, but also the hiring and checking out of new employees to cover the internal transfers. This means that the company has not only had to take personnel who are to be checked out, out of daily commercial production, but also the instructors who carry out the checking out of both permanent employees and new employees.

A demanding situation that mostly belongs to the past. However, the company now has a number of employees who are new to their roles, both in the new SAR-contracts and in the form of new employees. This requires particular attention from the company's management in the short and medium term.

During the audit, the CAA Norway found three non-conformances.

The NSIA would like to mention the following level 2 non-conformance:

The company's monitoring of safety performance using SPI does not seem optimal. There are no defined target figures or limit values to trigger measures for many of the SPIs. Regulation reference: EASA Part OPS ORO.GEN.200

[44] *Nominated Postholder Crew Training*

1.17.9 BRISTOW NORWAY'S MANAGEMENT OF CHANGE DURING SAR SOUTH MOBILISATION

The NSIA has reviewed Bristow Norway's Management of Change process during the SAR south mobilisation. The following is cited from Bristow Norway's Management System Manual:

> *Management of change (MoC) is a system or process for managing risk associated with the introduction of change within the organisation or to the company. Communicating those changes effectively, what, how, when and progressed through to completion within an agreed timescale. Such changes may include operational, organisational and infrastructure.*
>
> *MoC is a documented proactive process to manage safety risks related to a change by identifying external and internal factors that may have an adverse effect on safety and operation. It makes use of existing hazard identification, risk assessment and mitigation processes.*
>
> *Significant or complex changes within the business may require detailed planning and project management whereas minor changes may simply require procedural updates and communication regardless of nature all such changes require to be effectively controlled. Significant changes are those which have a notable impact on the operation and can be considered outside the scope of day-to-day business as usual practices.*
>
> *Significant changes shall follow a documented MoC process by use of a defined template.*

The NSIA has received the MoC document Bristow Norway used during the mobilisation. There are no indications of any specific flight safety risks being identified or mitigated in relation to the SAR South mobilisation. The MoC document mainly details operational items that need to be completed to ensure readiness at contract start-up.

The minutes from the Safety Review Board held in quarter two of 2023, agenda item 17 "*Safety Action Plan"* contained following item: *"Risk Assessments for inexperienced SAR crews".* Bristow Norway has not been able to retrieve this risk assessment.

1.18 Additional information

1.18.1 REGULATORY REQUIREMENTS REGARDING EMERGENCY FLOTATION SYSTEM AND LIFE RAFTS

Operators in Europe are required to follow the regulations set out by the European Commission and any additional national regulation. The EU Basic Regulation is not applicable for SAR operations, and they are therefore nationally regulated. Products used in aviation must also be certified according to Certification Specifications (CS). As technology advances and knowledge increases both operational regulations and Certification Specifications are updated. Not all new requirements are given a retroactive effect.

EASA published *Commission Regulation (EU) 2015/640 of 23 April 2015 on additional airworthiness specifications for a given type of operations and amending Regulation (EU) No 965/2012*[45] in 2015 which introduced Part-26. Part-26 is one way of making safety improvements

[45] *Adopted into Norwegian law by forskrift 18. juni 2015 nr. 719 om ytterligere luftdyktighetsspesifikasjoner for luftfartsselskaper, Part 26*

apply retroactively and has been expanded several times since 2015. For this investigation the amendment in 2022 with Regulation (EU) 2022/1254[46] is relevant.

Norway is a European Economic Area (EEA) member. This means that before new EU regulations are adopted into Norwegian law, there is a process to validate if they should be part of the EEA-agreement. If the process concludes that the regulation is not part of the EAA-agreement, Norway can still adopt it as a national regulation. This is the case regarding *Commission Regulation (EU) 2016/1199 of 22 July 2016* which added subpart K *Helicopter Offshore Operations (HOFO)* to the air operations regulation *Commission Regulation (EU) No 965/2012 of 5 October 2012 (965/2012)*[47].

The regulation regarding civilian state aircraft, *forskrift 26. mai. 2020 nr. 1076 om sivil statsluftfart med offentligrettslig formal mv.,* which regulates SAR operations makes the HOFO and Part-26 regulation applicable to Norwegian civil SAR operations.

On 22 February 2023 regulation (EU) 2022/1254 amending Part-26 with heightened requirements for helicopter occupant survivability was adopted into Norwegian law.[48] Among other items the amendment made some of the ditching requirements introduced in "*CS-29 Large Rotorcraft – Amendment 5*" applicable retroactively.

The new requirements in Part-26 had a staged application date. Depending on the complexity of the changes, they have an application date of 9 August 2023, 9 August 2024, 9 August 2025 or 9 August 2026.

1.18.1.1 Emergency Flotation system

Early in the investigation it became apparent that the EFS did not deploy automatically. It was quickly established that this was due to loss of both generators. Thereby also removing power from the DC PRI Bus which powers automatic deployment, see section 1.6.5. As the main rotor hit the sea, the generator power was lost, and automatic deployment was therefore not possible. Sikorsky has stated in the RFM (in section 17.0 FLOAT DITCHING in Part I, Section III – Emergency Procedures) that the EFS is intended to function in a controlled emergency water landing (ditching) situation. The same section also states that the pilot must manually deploy the floats. The commander of LN-OIJ was knocked unconscious and therefore did not have the opportunity to manually deploy the floats.

Among other requirements regarding EFS, Part-26 "*26.435 Automatic deployment of an emergency flotation system (b)"* require that operators of large helicopters that are certified for ditching, such as the S-92A, "*…shall ensure that if an emergency flotation system is installed and is stowed during flight, then it shall automatically deploy as a result of entry into water and shall not rely on any pilot action during flight".* This is intended to keep the helicopter floating so that the occupants can evacuate the helicopter and this requirement has an entry into force on 9 August 2026.

The commander of LN-OIJ has stated that the thought of deploying the EFS manually did not cross his mind, as they were armed, and he thought they would deploy automatically. He was also knocked unconscious and woke up when the water was reaching his face.

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[46] Commission Implementing Regulation (EU) 2022/1254 of 19 July 2022 amending Regulation (EU) 2015/640 as regards the introduction of new additional airworthiness requirements.

[47] Adopted into Norwegian law by forskrift 7. august 2013 nr. 956 om luftfartsoperasjoner § 1a.

[48] (EU) 2022/1254 was adopted into Norwegian law on 22 February 2023 by amending forskrift 18. juni 2015 nr. 719 om ytterligere luftdyktighetsspesifikasjoner for luftfartsselskaper, Part 26.

1.18.1.2 Redesign of Automatic EFS logic

After the accident the NSIA reached out to both EASA and Sikorsky about the issue of the EFS not being deployed. It was established why the EFS did not deploy. As described in section 1.18.1.1 the regulatory requirements regarding EFS were updated in 2022 but not in force at the time of the accident. Due to the forthcoming regulatory changes, the NSIA elected to allow the involved parties to find solutions to fulfil the new requirements. No immediate safety recommendation was therefore issued.

The NSIA was made aware in early 2025 that EASA was prepared to issue an Airworthiness Directive[49] regarding the EFS automatic deployment logic. After further discussions between EASA, FAA and Sikorsky, the NSIA was informed in May 2025 that Sikorsky was redesigning the logic for EFS deployment. This redesign is intended to eliminate the issue of the EFS not deploying when the RPM of the main rotor drops so low that the generator power disappears. The redesign and retrofit target date is the Part-26 deadline of August 2026. The Flight manual direction to the pilot will not be changed. Pilots will still be directed to deploy the floats once water landing is executed.

1.18.1.3 Life rafts

The amendment to Part-26 from 2022 also includes heightened safety requirements regarding life rafts. During the investigation it became clear that several of the crew members considered for a short while to swim back to the capsized helicopter to release the life rafts. This was deemed impossible, since the handle to release the life rafts was on top of the sponson, which is submerged when the helicopter capsizes. In addition, the helicopter fuel was mixed in the water close to the helicopter.

The life raft installation is identical on both SAR helicopters and normal transport helicopters.

Part-26 *26.420 Emergency equipment for flight over water (c):*

> *Operators of large helicopters that are required by point SPA.HOFO.165(d) of Annex V to Regulation (EU) No 965/2012 to have one or more life rafts installed, shall ensure that the life raft(s):*
>
> *(1) is (are) remotely deployable, with the means to deploy the life raft(s), located within easy reach of the flight crew, the occupants of the passenger cabin and any survivors in the water, with the helicopter in an upright floating or capsized position;*
>
> *(2) can be reliably deployed with the helicopter in any reasonably foreseeable floating attitude, including capsize, and in the substantiated sea conditions for capsize resistance.*

Article 26.420 had an entry into force on 9 August 2024 and was thus not applicable at the time of the accident. Based on the accident and the information gathered, the NSIA contacted EASA to get their opinion if the manual deployment of the life rafts were located within easy reach for survivors in the sea with the helicopter capsized. The EASA stated that they had no information that the S-92A was compliant with the relevant Part-26 requirements. It was highlighted that this just meant that compliance was not demonstrated, not that the helicopter was non-compliant.

[49] A document issued or adopted by EASA which mandates actions to be performed on an aircraft to restore an acceptable level of safety, when evidence shows that the safety level of this aircraft may otherwise be compromised.

Based on the above the CAA Norway had to issue a set of article 71.1 Exemptions[50] from the Basic Regulation, (EU) 2018/1139 on the 4th of December 2024 on all S-92As flying in Norway. These exemptions cover the life rafts requirements, but not other requirements and should therefore be updated for completeness. These exemptions gave the operators a deadline until 3 August 2025 to find a solution and be compliant. The mitigating actions are further discussed in 1.18.1.4.

1.18.1.4 Redesign of manual deployment of life rafts

As described in 1.18.1.3 the regulatory requirements regarding life rafts were updated in 2022. After the NSIA highlighted the issue of the life raft deployment to the CAA Norway, EASA and Sikorsky held several meetings to further understand the situation. The handling of this issue was transferred over to the CAA Norway.

In May 2025 EASA confirmed that Sikorsky had contracted the design organisation HeliOne to design a solution with a second Life Raft deployment handle on the underside of the sponson. EASA also confirmed that the solution would make the S-92A compliant with Part-26 paragraph 26.420 (c). A certification application had been received, and the certification process was progressing well. A Supplemental Type certificate (STC No.: 10089003) was granted on 9 January 2026, and the modification is now approved and available.

1.18.2 ADDITIONAL AIRWORTHINESS SPECIFICATIONS – EASA PART-26 (REGULATION (EU) 2015/640)

The investigation brought to light that before the accident the CAA Norway did not verify that the operators were in compliance with requirements set out in regulation (EU) 2022/1254 for the S-92A Norwegian fleet. These requirements introduced, among others, heightened safety requirements for life raft deployment. Hence, to allow continued operation, it was necessary for CAA Norway to issue exemptions from the Basic Regulation, as discussed in 1.18.1.3.

In July 2022 CAA Norway sent out information to the operators in Norway about the forthcoming regulatory change and reminding operators to ensure compliance. The operators then asked Sikorsky if they were compliant with relevant Part 26 changes, to which Sikorsky responded that the operators were. This was further confirmed in an “All Operators Letter” (CCS-92-AOL-24-0008) sent out in June 2024.

Article 1 of Regulation (EU) 2015/640 clearly states the scope of the regulation:

> *1. This Regulation lays down common additional airworthiness specifications related to the continuing airworthiness and safety improvements of aircraft.*
>
> *2. This Regulation applies to:*
>
> *(a) operators of:*
>
> *(i) aircraft registered in a Member State;*

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[50] *A member state can issue an exemption to the requirements laid in chapter III of the basic regulation based on an evaluation of several criteria. Such an exemption has a maximum time of eight months. After eight months EASA shall assess and within three months send a recommendation regarding the outcome of that assessment to the EU commission. The EU commission shall decide if the exemption conditions are met or not.*

(ii) aircraft registered in a third country and used by an operator for which a Member State ensures oversight;

(b) holders of a type-certificate, restricted type-certificate, supplemental type-certificate or a change and repair design approval approved by the Agency in accordance with Commission Regulation (EU) No 748/2012 (1) or deemed to have been issued in accordance with Article 3 of that Regulation;

(c) the applicants for a type-certificate or a restricted type-certificate for a turbine-powered large aeroplane, for which the application was submitted before 1 January 2019 and who are issued with the certificate after 26 August 2020 when specified in Annex I (Part-26).

Article 1 has had its current wording since 26 February 2021.

In Part-26 paragraph 26.10 it is also clearly stated that operators show their compliance to their national authority while type certificate holders show their compliance to EASA. EASA has stated that major changes are to be substantiated via Application for Major Design Change. Operators may accomplish this through application for EASA STC.

1.18.3 NIGHT VISION GOGGLES

There were night vision goggles (NVG) aboard LN-OIJ, but they were not intended for the flight crew. They were intended to be used by the rear cabin crew members in a search situation, in accordance with the Equinor contract. During the tender process for SAR South Bristow Norway recommended to Equinor that the whole crew should have NVG. Flying with NVG require, amongst other things, extra training and this was not part of the scope of the SAR south contract. The only Bristow Norway SAR base that operates with NVGs for the flight crew is the Hammerfest-base. There has been some debate on whether NVG could have aided the flight crew by giving them the horizon as a visual reference.

NVG work by amplifying already existing light. Therefore, there must be some light present for the NVG to work. The crew of SAVER50 used NVG and NSIA asked the commander of SAVER50 how they experienced the use of NVG on the night of the accident. The response was that in this specific situation NVG did not make much difference since there was so little natural light due to the overcast weather. Therefore, it was not possible to see the horizon even with NVG, and the crew relied heavily on the helicopter flight instruments.

1.18.4 COCKPIT IMAGE RECORDING

Currently there is no regulatory requirement to fit aircraft with a Cockpit Image Recorder (CIR). CVRs and FDRs provide accident investigators with invaluable data to understand accidents to prevent recurrence. Several accident investigations (for example Air France 447[51], UPS Airlines flight 6[52], CHC Scotia flight 23R[53]) have highlighted a need for CIRs to complement already installed recording devices like FDRs and CVRs. Several recommendations have been issued on this topic; a selection is found in Table 13.

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[51] https://bea.aero/fileadmin/documents/docspa/2009/f-cp090601.en/pdf/f-cp090601.en.pdf
[52] https://www.faa.gov/sites/faa.gov/files/2022-11/UPS6_Accident_Report.pdf
[53] https://assets.publishing.service.gov.uk/media/56e7eaeaed915d0379000023/AAR_1-2016_G-WNSB.pdf

Table 13: Summary of some safety recommendations issued regarding CIR. Source: NSIA

SR identifier	Issuer	Addressee	Issued date and Status
A-15-008	NTSB (USA)	FAA	22 January 2015 – Open
2016-014	AAIB (UK)	EASA	17 March 2016 – Open
2015-036	AAIB (UK)	EASA	19 October 2015 – Closed
FRAN-2011-026	BEA (France)	ICAO	29 July 2011 – Closed

The latest edition of ICAO Annex 13 (Thirteenth edition) has the following definition of a flight recorder: "*Any type of recorder installed in the aircraft for the purpose of complementing accident/incident investigation.*" Annex 13, in standard 5.12, also explicitly state that CVR recordings and CIR recordings are protected and should not be used for other purposes than accident investigation and prevention nor disclosed to the public. Further, Standard 5.12.2 of Annex 13 states that protected records should only be used when pertinent for the analysis of the accident or incident, and the minimum extent possible should be used.

The International Association of Oil & Gas Producers (IOGP)[54] has issued numerous publications. These cover many different topics and one such topic is aviation safety. Report 690 – *Offshore Helicopter Recommended Practices* (OHRP) is one of the documents and the description below is quoted from IOGP:

> *Report 690 – Offshore Helicopter Recommended Practices (OHRP), and its component documents provide recommended practices that will assist in the safe, effective, and efficient management of offshore commercial helicopter transport operations. The document reflects industry best practices, developed in collaboration between Oil and Gas Companies, Aviation Industry Associations, and Helicopter Operators. Adopting the Offshore OHRP will provide the framework for effective management of a key material risk to the safety of offshore personnel.*

The fifth module of the report, *IOGP Report 690-5: Helicopter and Equipment,* has a recommendation that a cockpit camera is fitted with the purpose of "*Preventing recurrence of accidents or incidents and supporting accident and incident investigations.*"

Airbus Helicopters have since 2013 installed the Appareo Vision 1000 as standard on several of its helicopters. The Appareo Vision 1000 is a Class C[55] Airborne Image Recorders and not a crash protected device. The Appareo Vision 1000 has aided the NSIA in several accident investigations. Two notable examples are the accident with the Airbus Helicopters AS350 B3, LN-OSY[56], in June 2014 and the accident with the Airbus Helicopters MBB-BK117 D-2, LN-OOS, in November 2021[57]. In these accidents the images recorded by the Appareo Vision 1000 completed the picture and allowed the investigations to move forward more quickly and provide clearer answers. Sikorsky offers a Cockpit Image Recording system under Top Kit Option 33792-54647.

1.18.5 EXEMPTIONS FROM HUET TRAINING DURING REFRESHER TRAINING

During this investigation the NSIA became aware that a number of the passengers flying offshore do not complete Helicopter Underwater Emergency Training during their mandatory 4-yearly basic

[54] *https://www.iogp.org/about-us/*
[55] *An ICAO Annex 6 recognised lightweight airborne image recorder that captures the instruments and control panels.*
[56] *https://nsia.no/Aviation/Aviation/Published-reports/2015-08-eng*
[57] *https://nsia.no/Aviation/Aviation/Published-reports/2022-10*

safety course refresher training. This accident has shown the importance of training for a safe and rapid evacuation. The NSIA expects the organisations involved to ensure that this does not constitute a safety concern.

1.18.6 HELIOFFSHORE'S CONTRACTING PRINCIPLES FOR OFFSHORE AVIATION

In July 2025 HeliOffshore published new contracting principles for offshore aviation. These were developed jointly with the Offshore Energies UK[58]. Cited from the HeliOffshore website[59]:

> *The principles are designed to support sustainable practices across the aviation supply chain, enabling the sector to invest confidently in its people, products, and services and support continuous improvement in safety performance.*
>
> *The principles were developed based on existing work started by OEUK to describe what good procurement practice and service delivery looks like in the energy industry supply chain.*
>
> *By encouraging greater alignment between commercial terms and long-term safety goals for the sector, HeliOffshore's Contracting Principles aim to foster resilience, innovation, and high operational standards. This collaborative approach reflects a shared commitment to building a more sustainable and safer future for offshore aviation.*

1.18.7 IMPLEMENTED MEASURES

Both Equinor and Bristow have conducted investigations into the accident. Both have identified several safety improvements.

Equinor identified 29 different actions and have stated to the NSIA that all have been closed.

Bristow identified 23 different actions and have stated to the NSIA that 16 have been completed, while seven are still being followed up.

Below is a summary of some of the implemented measures the different stakeholders have enacted after the accident, and which are mentioned elsewhere in this report:

[58] *Offshore Energy UK is the leading trade association for the UK offshore energy industry, a not for profit membership organisation with a history stretching back five decades*
[59] *https://www.helioffshore.org/resources/contracting-principles*

- Bristow Norway no longer uses the lanyard without a quick release mechanism.
- Bristow Norway has revised their procedures, and the SAR nurse shall be seated in their primary seat, secured with a four-point harness during the trans down phase.
- The JRCC, Equinor, Bristow Norway and CHC Helikopter Service began work to ensure the civil SAR helicopters were registered so that they are visible in the same way as the national SAR helicopters are.
- The JRCC now has access to ADS-B so that aircraft with an ADS-B transponder can be shown with real-time position information in the systems the JRCC use.
- Bristow Norway crew utilizes the actual equipment they use when flying during training.
- All Equinor SAR nurses now complete training annually together with the helicopter operator and crew, if the operator conducts yearly training. If the helicopter operator does not provide annual training, the SAR nurse completes the standard training course separately, without the rest of the crew. They also train using the same equipment that is utilized during flights.
- Bristow Norway has made night flying in a helicopter a mandatory part of the training programme for co-pilots.
- Bristow Norway has chosen to start the APU during low level SAR operations to increase the likelihood that the EFS would deploy in a similar situation.
- Bristow Norway has implemented a dedicated SAR safety brief that covers key safety aspects before, during and after flight. The SAR safety brief has a 90-day currency requirement which is tracked.
- Bristow Norway has started to develop a dedicated in-brief that is to be conducted when a crew goes on duty that also cover safety aspects.
- Bristow Norway has combined their normal and SAR OPC to give SAR crews more opportunity to practice together as a crew.

1.19 Useful or effective investigation techniques

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

2. Analysis

2. Analysis

2.1 Introduction

The main purpose of the analysis is to explain what happened, how it happened and provide the NSIAs opinion's as to which contributing[60] factors influenced why it happened. This includes the NSIA recommendations as to how it is possible to reduce the likelihood of a similar occurrence, improve flight safety in general and identify lessons to be learned.

Figure 65 is a simplified presentation of the structure of the NSIA analysis. In addition, survival aspects are analysed in 2.5. The analysis is based on the factual information provided in part 1 of this report.

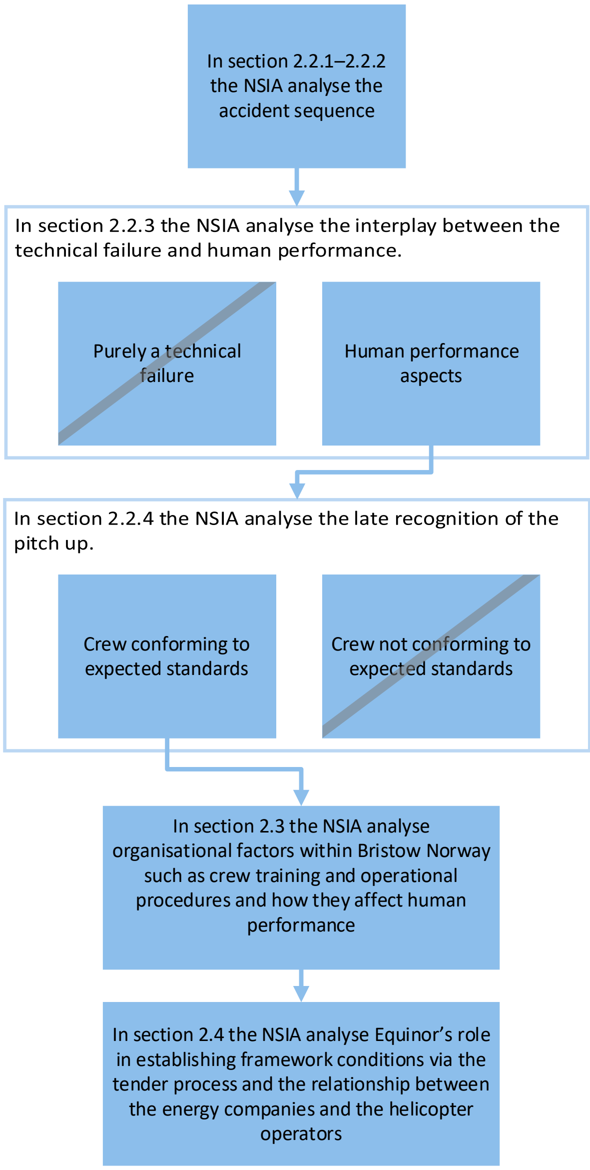

Figure 65: Simplified presentation of the structure of the NSIA analysis. The grey lines are aspects the NSIA has analysed but where nothing has been found warranting further analysis. Illustration: NSIA

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[60] Definition from the NSIA method: Contributing factors are actions, omissions, events and conditions, or a combination thereof, which, if eliminated, avoided or absent, would have prevented or reduced the probability of the accident or incident occurring, or would have mitigated the severity of the adverse consequences of the accident or incident. These are factors that have not necessarily had a clear cause-and-effect relationship, but that are considered to have increased the risk (for example fatigue/exhaustion, pressure to get the job done, unclear work descriptions etc.).

2.2 Course of events

2.2.1 PRE-FLIGHT PREPARATIONS AND THE FLIGHT UP TO ENGAGEMENT OF THE MOT

Based on the available information, the NSIA believes that the crew was well rested and conducted a normal and thorough briefing before the flight. There was a detailed plan on how the training flight was to be conducted. This report focusses on the details from when the Automatic Flight Control System (AFCS) mode "Mark on Top" (MOT) was engaged. The flight can be described as normal until shortly before the accident. The Cockpit Voice Recorder (CVR) indicates good Cockpit Resource Management (CRM) and a sound working environment with good cooperation between all crew members.

Furthermore, the NSIA concludes that the daily inspection and the pre-departure inspection were performed thoroughly and without any significant findings.

2.2.2 THE ACCIDENT SEQUENCE

After engaging the AFCS mode MOT at 200 ft, the helicopter started a right-hand turn to align into the wind. During the turn the crew completed the necessary checklists and configured the helicopter for low level operations. The standard procedure is that these checklists should be completed before engaging the MOT. The entire MOT took 4 minutes and 34 seconds from it was engaged to the helicopter crashed into the sea. The checklists were completed 2 minutes and 35 seconds before the final descent began. The NSIA do not see any connection between the "non-standard" run-up to the retrieval of the beacon and the accident. There was nothing unusual during the initial part of the trans down. The CVR indicate a normal workload in the cockpit. All crew members can be heard discussing various essential tasks. For comparison, another helicopter operator allows the transition checklist to be completed after MOT is engaged.

After aligning into the wind, the helicopter began the descent from 200 ft towards 150 ft and the deceleration from 80 kt to end up in a hover. During this period the crew complete their tasks according to Bristow Norway's SOPs. For example, the co-pilot arms the EFS when the helicopter airspeed is below 80 kt. He also sets the rescue hoist to "all" so that the hoist-operator can control the hoist and instructs the cabin crew to have the doors closed until the helicopter is in position. The MOT is normally finished when the helicopter transitions to Position Hold mode. This did not occur since the airspeed requirements for Position Hold was never met.

The following analysis will set the time of the Flight Director pitch axis degrade as T=0:

- T-28 s: The commander states that they will overfly the beacon. Several people the NSIA have interviewed state that this is a normal occurrence. The MOT only stores a position, and an object in the sea can drift, or the engagement of the MOT can be a bit inaccurate making it necessary to adjust position once MOT is complete. The commander is very clearly heard saying that they will let the helicopter finish the MOT and then back up to reach the beacon.
- T-21 s: Confirmation from both the commander and the co-pilot that they are overflying the beacon.
- T-9 s: The co-pilot states that approach is coupled. At this point the pitch attitude was approximately 8° nose up, the ground speed was 24 kt and the radar altitude was 200 ft.
- T-2 s: The pitch-rate of the helicopter became positive (i.e. increasing nose up) and stays positive for the next 10 seconds. The recorded data show that the initial pitch-up rate was accompanied by a slight aft FCC commanded movement of the cyclic stick.
- T=0 s: The pitch channel of the AFCS was flagged as degraded. The AFCS was indicating that something was interfering with the FD's ability to fully control the aircraft's pitch attitude. The

sampling rate of the pitch degrade is one second. During this second when the degrade appeared the pitch attitude increased from 10° to 11.2°. As discussed in 1.6.4.3 this would limit the control authority of the AFCS. Possible explanations for this degrade are discussed in 2.2.3.

- T+2 s: The AFCS collective axis switched to RadAlt-mode and the co-pilot stated that RadAlt is coupled. This could have been checked on both the MSP and the FD announcement bar on top of the PFD. At this point the pitch attitude of the helicopter was approximately 14–15° nose up and increasing. Based on interviews The NSIA believes that the pitch attitude at this time would not be seen as abnormal. The crew would expect the helicopter to pitch up in this phase of the flight.
- T+4 s: The helicopter reached ~17° nose up pitch attitude. The main rotor wake tail impingement effect increased in magnitude and provided an additional pitch-up moment, see 1.16.2.2. To overcome this, the cyclic needs to be moved further forward to counter the pitch-up movement, compared to when there is no main rotor wake tail impingement.
- T+5 s: The helicopter groundspeed was zero and the helicopter started to accelerate rearwards. The helicopter pitch attitude was 19°.
- T+8 s: The commander realised that something was wrong, as he calls "*Hey, the nose is coming up really…*" and pushes the cyclic forward. At this time the pitch attitude was 27°
- T+10 s: The commander called "*GOING AROUND, GOING AROUND, GOING AROUND*" and initiated a go-around by pulling the collective to increase the lift. The helicopter pitch attitude was at this point 30° nose up. Further, the helicopter was at 135 ft radar altitude and travelling rearwards at a speed of 19 kt. Based on the GenHel analysis, see 1.16.2.3, it was concluded that the aircraft entered VRS when it reached ~30° nose up and the accident became unrecoverable. The use of collective to increase dual engine torque to 200% did not arrest the descent or recover the aircraft.
- T+13 s: The last accurate information was recorded by the FDR and HUMS. The helicopter was registered as 15 ft above the sea and travelling rearwards with a groundspeed of 40 kt. The pitch attitude of the helicopter was 11.7° nose up and the registered bank angle was 17.6° to the left. The NSIA believes that the helicopter impacted the sea in this attitude and that the ramp door at the rear of the helicopter was knocked in due to impact with the water. The actuators to the ramp were also knocked loose. When the helicopter was recovered all the left windows on the helicopter were missing. The NSIA knows that the co-pilot removed the emergency exit on his left side to evacuate the helicopter. Based on the recorded information, the hydro deformation on the aft left side of the fuselage, and the missing rear part of the left sponson the NSIA believes that the helicopter impacted the water with a left bank and with the tail first. Several windows on the left-hand side were most likely pushed in due to the forces at impact.

2.2.3 THE PITCH-UP MANOEUVRE

2.2.3.1 Introduction

The NSIA has investigated thoroughly what could have caused the helicopter to pitch up excessively. The helicopter aerodynamics, as described in 1.16.2 is an important factor. As the helicopter pitches up and the rotor wake impinges on the tail, more control input is needed to pitch the helicopter down. If this motion is not countered the helicopter will continue to pitch up. As can be seen in the FDR data, see Figure 21, the cyclic moved slightly aft, and is then almost stationary for six seconds before moving forward. The refined GenHel model confirm that the cyclic position recorded will result in the recorded pitch attitude. It is evident that for some reason the FD was not able to move the cyclic forward and arrest the pitch motion even though it was commanded to do so by the Flight Control Computers (FCC). Based on the available information, there are two scenarios that seem plausible to explain why the FD could not arrest the pitch up motion:

- Interference with the mechanical flight controls – Any restriction of the cyclic stick during the final part of the MOT would lead to the pitch up seen.
- Failure of the pitch trim actuator – The fault found on the motor driver card of the pitch trim actuator can explain the pitch up.

2.2.3.2 Interference with the mechanical flight controls

If the cyclic is restricted and cannot move freely in the pitch axis, this could lead to the stick forces building and the FD pitch degrade seen. The NSIA has explored three main theories as to what could have restricted the cyclic:

Mechanical restriction
One of the first things the NSIA did after the helicopter was salvaged was to test the mechanical flight controls. They operated smoothly without restriction in all axes, except the collective. It was quickly established that the reason the collective was restricted was due to the honeycomb of the ceiling of the cabin collapsing, most likely due to water pressure, and restricting the control. No evidence has been found of a mechanical restriction of the pitch axis.

Foreign object
No foreign object has been found after the accident and if an object was present before the accident, it must have been dislodged afterwards. In addition, the pilot in command who grabbed the controls has not mentioned any restriction or trouble with moving the controls. The NSIA has no information to support that a foreign object was present before the accident.

Pilot interference
Intentional or unintentional interaction with the controls could have caused the pitch up. In addition to the failure of the pitch trim actuator, this is the other main theory that the NSIA has explored. It is impossible from the recorded data alone to conclude whether either of the pilots have interacted with the controls while the FD was controlling the helicopter. It is therefore important to have a complete view of all the information available. In the discussion below the NSIA will present the available data and explore how it fits.

The recorded flight data shows that the cyclic did not move forward even though the FCC commanded the trim actuator, and in extension the cyclic stick, to drive forward. Looking at the timings, the NSIA believes that the first aft movement of the cyclic is normal, and very similar motion is seen in the recorded data from the uneventful MOT done on the 11 February 2024, see Figure 24. So, the question then becomes; did either of the pilots hold the cyclic and constrict its movement? To try and understand this it is important to ask the question, for what reason would either pilot restrain the cyclic? The most obvious answer is that as they reached the beacon and saw that they would overfly it, they wanted to arrest the motion. This explanation does not make sense considering the CVR recording and statements from the pilots themselves and Bristow Norway’s training department.

The statements from the training department will be addressed first. They have told the NSIA that they instruct Bristow Norway’s pilots not to interfere when the CFD is engaged. For example, while conducting a MOT the pilots are instructed to let the automation finish before they interfere with the controls. All the pilots the NSIA have talked with during this investigation confirm this. This has also been stated very clearly by the crew of LN-OIJ. The CVR recordings back this up. The commander clearly states that they will overfly the beacon and that they will let the helicopter finish the manoeuvre before backing up to the beacon. The NSIA find it extremely unlikely that a crew trained to not interfere during a MOT, states on the CVR that they will not interfere, and state the same again in interviews with the NISA immediately after the accident, have interfered with the controls. The commander who was the pilot flying, has also explained to the NSIA how he normally guards the controls when flying with the CFD engaged. The NSIA has no reason to question his statements and sees it as unlikely that the pilot flying restricted the controls.

If the pilot flying most likely did not interfere with the controls, then is it possible that the pilot monitoring for some reason restricted the controls? The only reason the pilot monitoring should be on the controls is if he realised that the helicopter was in an unusual situation, and he takes control to intervene. The CVR recordings indicate that his focus was on the tasks at hand and confirm that in the seconds leading up to the accident he was reviewing the instruments. There are no indications that the pilot monitoring interfered with the controls.

The final item to be discussed is if either pilots clothing restricted the movement of the cyclic or if it is possible to place your feet in such a way that they block the controls. The cockpit in the S-92A is relatively spacious and the NSIA sees it as unlikely clothing should interfere with the cyclic without the crew realising. During the investigation it has been mentioned that if either pilot uses thick boots with heavy soles, it is possible to place your feet in such a way that the cyclic is blocked. The NSIA has no evidence to support this and sees it as unlikely in this case.

2.2.3.3 Failure of the pitch trim actuator

The NSIA, together with Sikorsky, Collins and the NTSB has spent considerable time to understand if and how the fault found in the pitch trim actuator would affect the helicopter, and if it contributed to the accident.

Before moving on with the analysis the NSIA would like to state that the accident does not fit a trim hardover as described in section 1.6.4.2. The recorded data does not show a gradual aft cyclic stick movement that could explain the pitch up. In addition, the commander has stated that the situation did not feel like a trim hardover as practiced during simulator sessions.

The pitch trim actuators were sent to Collins Aerospace in Vermont and examined. During the examination it was determined that at least one electrical component on one of the circuit cards in the pitch trim actuator had failed, see 1.16.5. The SIL testing, see 1.16.6, also showed that the actuator reported error messages indicating that it was not moving as fast as it should be, which means that the pitch trim actuator would give a slower response. The SIL testing also indicated that the failure was intermittent. The first SIL trial with the circuit card from LN-OIJ progressed as normal without fault. It was only during the second trial that the failure appeared and continued to be present for the remainder of the trials.

The testing at Collins found that the pitch trim actuator exhibited two erratic behaviours:

1. The pitch trim actuator would report its own position erroneously to the FCCs; the testing indicates that the actuator would under-report its position.
2. The spring deflection signal was found to be zero, when it should be equal and opposite to the trim position signal. This would lead to the FCCs reading a stick force, even when the spring is not deflected. When the registered stick force increases to 3% this activates the FD pitch degrade and the colour of the pitch axis on the mode annunciator bar on the primary flight display would change from green to amber.

Based on the available data, the NSIA believes that the failure occurred shortly before the recorded stick force started to increase. In the recorded data, the stick force is zero before starting to increase in a linear fashion, see Figure 21. LN-OIJ was at this time at a low altitude and low airspeed and consequently in a situation with small safety margins. Looking at the SIL data from the trial where the failure occurred mid-flight, a similar picture is seen, with the stick force increasing in a linear fashion, see Figure 49. The question then becomes how the failure would influence the AFCS and the helicopter.

As discussed in 1.6.4.3, when the pitch degrade signal is activated the integral command in the command loop is held. This means that from that point forward the FCCs can only command a pitch attitude of 10.635 ± 5° and a trim position of approximately ± 8%, since the trim position was around zero when the failure occurred. There were several instances in the SIL-testing where the helicopter was not able to slow down as programmed during a MOT. This was determined to be due to insufficient control authority to command the correct nose-up attitude because of an initial nose-down attitude when the failure occurred. The NSIA believes that the opposite happened in the accident; that the FCCs were not able to command a large enough nose-down attitude due to an initial nose-up attitude.

The lack of control authority by the FCC is only part of the issue. It is important to remember that the pitch trim actuator is not moving as fast as expected and that it wrongly reports its own position to the FCCs. All these factors combined in a real-world scenario will be difficult to simulate and predict.

No abnormal pitch attitudes were seen in the SIL, but the SIL has not been corrected with the correct main rotor wake impingement data. This means that the SIL is incapable of modelling the helicopter motion accurately, and therefore is not able to simulate the control system accurately in this situation.

The NSIA also sees it as highly unlikely that, out of thousands of electronic components on 10 of 12 circuit cards (two were damaged and not tested), the only one that fails is the one that would give rise to symptoms like those seen in the accident flight. To further back-up this, both FCCs were also subject to the same conditions, and data from both was downloaded without issue. Thus, the NSIA do not believe that the failure of the electronic component is due to water and the pressure at 220 m depth.

Even though considerable time and effort have gone into analysing the available data, it has not been possible to recreate the accident flight path in a simulator. It is possible that additional factors contributed to the accident helicopter's high pitch attitude and the inability of the FCCs to level the helicopter at the end of the MOT, but evidence of those factors may not have been possible to retrieve.

Based on all available evidence the NSIA concludes that it is likely the failure of the pitch trim actuator was present before the crash and that LN-OIJ did not automatically arrest its pitch up due to the failure in the pitch trim actuator. The pitching moment created by the main rotor wake tail impingement was larger than the FCCs were able to counteract.

The NSIA believes the fault could occur without warning and that this kind of electronic component fault cannot be caught by a maintenance programme. It is therefore common that a built-in self-test is completed after start-up. This self-test is part of the daily inspection of the helicopter before flight. If the self-test had reported an error, the crew would not have taken off. The pitch trim actuator did not pass the PFBIT during the SIL testing, and it is therefore likely that the component failed after the last built-in-self-test was performed.

It is important to state that even if the CFD is engaged and the autopilot system controls the helicopter, the crew can always override the CFD and take control of the helicopter. The pitch trim actuator is a non-redundant component, and it is very important that the crews flying the S-92A are conscious of this fact. Why the crew did not recognise the abnormal pitch attitude earlier is further discussed in 2.2.4.

During the investigation Sikorsky stated that when MOT is engaged the helicopter should normally not exceed 12–13° nose up attitude and never go above 20°. This information was not stated in the Rotorcraft Flight Manual Supplement describing SAR modes but could aid S-92A helicopter crews to recognise anomalous AFCS behaviour. The NSIA therefore issued an immediate safety recommendation on 6 August 2024.

As a response, Sikorsky issued an "All Pilots Letter" on 6 August and updated the S-92A RFM on 17 December 2024 so this information is now included. This safety recommendation has been acted upon and is now closed.

2.2.4 WHY TWO PILOTS DID NOT RECOGNISE THE UNUSUAL PITCH INCREASE EARLIER

According to interviews with the flight crew and CVR recordings, the helicopter initially pitched up and slowed down as expected. The co-pilot stated *"Approach coupled",* followed 10 sec. later with the words: *"Radalt coupled"* and *"It should level out".* This indicates that his attention mainly was towards the AFCS Mode Selector panel or the FD mode annunciator field on the upper part of the Primary Flight Display. Based on the FDR, at this time the pitch channel should have shifted from green to amber to indicate a degraded channel.

The NSIA holds the opinion that the colour change of coupled flight director channels is not an "attention getter". In a dynamic environment, where several items compete for the pilots' attention a subtle colour change is easily missed. The NSIA experience from the observation flight backs this up. This is further supported by the research conducted by HeliOffshore. It is also important to remember that seeing a degraded CFD channel is something the crews experience on a regular basis during normal SAR operations. During hoisting it is standard procedure to engage the CFD and then work against it to position the helicopter. This will also lead to a degraded CFD with corresponding colour change, and there is a risk that this desensitises the pilots.

The helicopter pitched up from the nominal 10–12° nose up to a maximum of 30° nose up in about nine seconds. The helicopter most likely became uncontrollable at an attitude of about 25° nose up in this situation. The first indication of something unusual was the pitch trim degrade annunciation. At that time the pitch attitude of the helicopter was between 10° and 11.2°. Information the NSIA has received as part of this investigation indicates that flight crews had experienced pitch attitudes between 15° and 18° and this was not perceived as unusual. From this it can be estimated that the crew had between three and six seconds to recognise that the helicopter pitch attitude had become unusual and to act.

The flight crew could not remember exactly when they realised that something was unusual. By the time the situation was recognised, the helicopter had entered vortex ring state and would be very difficult to recover from at a low altitude. The NSIA believe it would be difficult for the crew to recognise that a vortex ring state situation was developing.

The question then becomes why two experienced pilots did not recognise the unusual pitch attitude in time to react. They descended to 200 ft before engaging the MOT, a decision that altered the MOT slightly, but did not rush the situation. The CVR recordings gives an impression of calmness, professionalism and a good working relation between the two. The commander clearly expressed a trust in the helicopter's ability to stop as expected, although a distance past the beacon. While the pilots' statements and CVR recording suggest that they were paying full attention to the tasks, it is likely that the pilots were not actively monitoring the AI during a critical portion of the MOT.

To prevent the accident the pitch increase had to be recognised and the correct action taken. Three to six seconds is not a long time. The NSIA believes that it was a wise decision by the commander to cross-check the standby attitude indicator when he realised that something was off, even though this consumed time in a critical situation. Reactions taken without due considerations may also create dangerous situations.[61] This illustrates that parts of the three to six second window could have been taken up by legitimate tasks.

A closer look at the company procedures might illustrate some uncertainty as to who is meant to do what during a critical portion of the MOT (see chapter 1.17.5). The operational manuals describe the flight crew tasks and responsibilities differently in various chapters. *"The pilot flying shall monitor the flight path and instruments"* according to one chapter in OM-A. The same duties must be shared according to another chapter in the same manual: *"PF and PM must closely monitor flight path and instruments."* and *"An internal scan of instruments is obviously important and the balance between internal and external scanning will depend on the circumstances and flight deck workload at the time."*. The NSIA understands that it is difficult to fully describe all tasks in a stringent manner, given the variability of a SAR operation and need for flexibility.

Both interviews and the questionnaire sent by the NSIA to SAR crew in Bristow Norway supports a somewhat different view as to who is responsible for what during different phases of the flight. In the questionnaire a majority of respondents answered that it was the task of the pilot monitoring to monitor the instruments (50%) during MOT, but 12.5% saw it as the task for the pilot flying. A large percentage (37.5%) answered that the task of monitoring instruments could be the responsibility of both flight crew members.

Both flight crew members were highly experienced S-92A pilots. However, they had recently changed roles and responsibility. The line captain becoming a SAR co-pilot and the SAR co-pilot becoming a SAR captain. For that reason, both had to learn new procedures and duties, while other procedures and duties had to be un-learned. It is especially challenging to unlearn behaviours. It takes time to become familiar in a new role with a set of responsibilities, and to override all the instincts and memory items you have acquired in a similar role during a different flight operation. The more room for interpretation there is, the longer this process takes. Having clear procedures and sufficient time for training and practice will therefore be an important factor during this process.

Bristow Norway has stated that ideally, they wanted to pair experienced captains with new co-pilots and new captains with experienced co-pilots. This was somewhat challenging due to the large number of personnel to be trained, and because Bristow Norway's other SAR contracts were with other energy companies, the possibility to move people around was limited. Bristow did try to pair as many new co-pilots as possible with experienced captains, but some were paired with less experienced captains.

The research by HeliOffshore discussed in 1.16.7 indicates that instrument monitoring is something the entire offshore rotary wing community should work to improve. The research has found that a significant number of pilots do not actually look at the attitude indicator or use this when flying. They rely on other flight instruments, since the underlying stability augmentation system of modern helicopters maintains correct attitude. One quote stated to the NSIA as part of this investigation is *"Everyone keeps talking about monitoring, but nobody actually teaches us how to do it properly"*. In addition, it is important that procedures must be clear and that tasks must be

[61] *Accident in the arctic north of Sweden to a Canadair CRJ 200 aircraft (SE-DUX), 8 January 2016, https://shk.se/engelska/the-swedish-accident-investigation-authority/search-investigation/aviation/2023-11-20-accident-in-the-arctic-north-of-sweden-to-a-canadair-crj-200-aircraft-se-dux*

clearly designated, especially in a critical situation such as a pick-up from sea, when the helicopter is at a low altitude and in a hover.

The NSIA believes that the flight crew experienced a low probability event. The component in the pitch trim actuator failed during a critical phase of flight with hardly any external visual references. It is also important to remember that the helicopter was supposed to pitch up, so the pitch up itself was not abnormal. It is the extent of the pitch up that is abnormal. The NSIA believes that this made it more difficult for the crew to realise that something was wrong and perform corrective actions. Only an active monitoring of the attitude indicator during the critical phase could alert the crew of what was going on. Ambiguous procedures in Operation Manuals and the training regime during the mobilisation for the SAR South contract can be factors that explain why the increasing pitch attitude was detected too late.

It must also be added that several pilots at Bristow Norway in general described the S-92A AFCS as somewhat slow and imprecise, especially when compared to the Airbus Helicopter Super Puma, but also that it was dependable. Therefore, it was not expected that the AFCS should start to pitch up beyond acceptable limits. Additionally, Sikorsky had not given any information about acceptable limits and what attitudes could be expected during AFCS trans down. As a result of the NSIA Safety Recommendation 2024/10T issued with the preliminary report on 12 August 2024, Sikorsky has updated the S-92A Rotorcraft Flight Manual with the AFCS limitations.

The NSIA has no indications that during the accident the crew did not conform to the standard set by Bristow Norway. The commander passed his Operators Proficiency Check (OPC) 23 February 2024, five days before accident. Similarly, the co-pilot passed his OPC 19 January 2024. This leads the NSIA to look further into human performance aspects, which is explored in chapter 2.3.

2.2.5 NIGHT VISION GOGGLES

Night Vision Goggles (NVG) can provide crews with better safety margins, since it can aid them in establishing a visual reference in situations where they normally would have none. NVG also have some limitations, e.g. they limit the wearer's field of view significantly. Therefore, NVG requires extra training to ensure continued safe operation. It might also be necessary to make adjustments in the cockpit to enable the use of NVG.

In general, the NSIA believe that NVG is a good tool, which can significantly enhance safety margins, given sufficient training. Even though statements from the crew of SAVER50 indicate that NVG gave limited support in this specific circumstance, it cannot be ruled out that NVG could have aided the flight crew of LN-OIJ to notice the pitch up manoeuvre earlier. Even so, operations like the accident flight can safely be conducted without NVG and based on information that it was not possible to see the horizon even with NVG, the NSIA does not analyse this further.

2.2.6 COCKPIT IMAGE RECORDINGS

Even though the NSIA has had good audio recordings from the CVR and recorded flight data from three different sources (FDR, HUMS, FCC) it has been impossible to unambiguously determine what happened with LN-OIJ. Cockpit Image Recording would have been a great supplement to the already recorded data. Crucially, a CIR would have given the NSIA an image of the cockpit and the controls. This might have aided the NSIA in determining if there were any interference with the controls or not.

In accident investigations, investigators are often faced with the issue of having an abundance of data that are not necessarily unambiguous or straightforward to corroborate. In this accident investigation there are two mutually exclusive scenarios that might explain why LN-OIJ did not complete the MOT as expected:

- The pilots interfered with the controls (either consciously or unconsciously) and that AFCS worked as intended.
- The pitch trim actuator failed, leading to errant behaviour of the AFCS.

As stated in the discussion above, the NSIA concludes that the second scenario is the most likely. A CIR might have added information that could confirm or exclude either scenario. Additionally, a CIR would have provided insight into the condition of the flight displays and indications, as well as flight crew actions and where the flight crew's attention was during the end of the MOT. Due to the ambiguity of the data, the NSIA, NTSB and Sikorsky have had to spend considerable time trying to corroborate information. The NSIA sees it as likely that a CIR would have sped up this investigation and provided more conclusive evidence.

There should be no technical barriers of requiring CIRs on aircraft used for commercial operations, especially those used for passenger transport. As intended in ICAO Annex 13, CIRs should solely be installed for the purpose of accident or incident investigation and prevention. The NSIA is aware that there is a resistance from pilot unions to install CIRs due to privacy concerns. Current regulations afford protection of sensitive information, for example cockpit voice and image recordings. Such information shall be included in a report only when relevant to the analysis of the accident or serious incident. In the NSIA's experience, images from the cockpit are likely to support a pilot's statement.

The NSIA reiterate safety recommendations issued by other safety investigation agencies to ICAO, FAA and EASA to mandate the installation of cockpit image recorders for accident and incident investigation and prevention on aircraft used for commercial operations.

2.3 The effect of procedures and training on human performance

2.3.1 INTRODUCTION

As detailed in 2.2.3.3 the NSIA holds the opinion that the failure of the pitch trim actuator played an important role in the accident. However, as the pitch trim actuator was a non-redundant component the flight crew is assumed to be the redundancy. As discussed in chapter 2.2.4 the late recognition of the unusual pitch attitude contributed to this accident occurring. The NSIA has tried to understand how this could happen and has analysed contributing factors (see footnote 60 for definition). As part of understanding human performance, the NSIA has looked into Bristow's procedures and training for SAR crew.

2.3.2 EXTENSIVE OPERATIONAL MANUALS AND AMBIGUOUS PROCEDURES

The following discussion will look into Bristow Norway's operational manuals and procedures, in particular how task sharing in the cockpit is defined. In the NSIA's view an ambiguous[62] task sharing does not facilitate good CRM. Further, it might be more difficult to standardize instruction as well as the operation in general.

Bristow Norway has defined its crew concept in OM-A chapter 4.5. The overall duties of the PF and the PM are defined there. In essence, they state that the PF shall fly the aircraft, and focus on flight path management, while the PM shall assist the PF and be ready to take over. However, other manuals and procedures provide different guidance and responsibilities to the crew, see chapter

[62] *Having or expressing more than one possible meaning.*

1.17.5. The main issue is that the NSIA see no clear definition of who should have their eyes inside the cockpit and who can afford to also look outside the cockpit. Furthermore, based on interview and the questionnaire sent out to SAR pilots, there is not a consensus to this within the SAR pilot corps. The NSIA highlights the following examples:

- OM-A:
    - *In flight, and with FD coupling functions engaged, the PF will monitor the aircraft and be ready to take control when necessary. …*
    - [*PM shall] Monitor flight path, navigation, power settings, procedures, aircraft systems and FD coupling functions*.
- OM-B:
    - *All members are responsible for the monitoring of the aircraft and which of the MSP modes are in use.*
    - *"When coupled below 200 feet AGL, the pilot [The NSIA assume "the pilot" is meant to be the PF] will monitor the flight controls and take action in the event of an excessive rate of descent.*

From the above examples both have the same responsibility. There is no clear task sharing in Bristow Norway's trans down procedure, see Figure 56, unlike other examples the NSIA has seen as part of this investigation, see Figure 57. The NSIA see it as crucial for flight safety that high-risk operations have procedures with a clear task sharing defined.

The investigation has found that in this case the only way to timely, and with certainty, determine that something was wrong was to actively monitor the attitude indicator. Even though it is clearly defined that the PF shall monitor the flight path, this is not the same as paying full attention to the attitude indicator only. Looking at all the duties for both the PF and the PM, they need to divide their attention among several different systems and displays in the cockpit such as the flight mode annunciator bar on top the primary flight display. Scanning technique is therefore obviously important. The research by HeliOffshore indicates that pilots might not actually use the scanning technique they think they do. It is therefore important to recognise that operator design of their procedures will influence how they are interpreted.

The NSIA see no clear definition of task sharing in the Bristow Norway trans down procedure. This might allow for individual interpretation, and different understanding. This is supported by the responses to the questionnaire sent out to the Bristow Norway SAR pilot corps. Some SAR co-pilots the NSIA has interviewed also indicate that different SAR commanders want things done in a certain way and that they adapt depending on who they are flying with. Some variation in an operation will always be present and is natural. It is therefore important to recognize and mitigate the hazard that both pilots believe that a certain task is the other pilot's primary responsibility. This increases the chance that something can be missed. In this accident it cannot be ruled out that, for a few seconds, both pilots were looking out the window to keep an eye on the beacon.

Individual interpretation is particularly hazardous in a high-workload environment with reduced safety margins. The NSIA believes that it is particularly important that written procedures are concise, unambiguous and with a clear distribution of tasks. Writing SOPs and operational manuals require several considerations to be balanced. A SAR mission goes through several different phases, and the tasks and priorities change accordingly. In "*OM-A Special Operation*" it is stated that during a search the main task for the pilot monitoring is "*observation and navigation."*. One possible situation that might arise is that the outside observation focus during a search continues into a trans down. If there also is an understanding that the PF is mainly responsible for monitoring flight path and instruments, the PM might focus on maintaining visual contact with the target at the expense of instrument monitoring. During interviews with the SAR pilot corps, the NSIA has seen different understanding as to who can keep an eye of the target. Having clear guidance simplifies the workload and allows for unambiguous workload sharing during the different phases.

The NSIA see that clear workload sharing has been defined for line operations, see Figure 55. The NSIA understands that it can be challenging to write strict procedures for a dynamic SAR operation. Nevertheless, it is important to minimise the risk that the crucial tasks are not designated properly. One possible way to minimise this risk is that the crew actively state workload sharing before a critical phase of the operation is begun. During this investigation the NSIA has seen examples of procedures by other operators where the task sharing, and priority, is more clearly defined. To the NSIA it appears that Bristow Norway had not managed to extract the full potential of their two-pilot concept for SAR operations.

Following the accident Bristow Norway has updated its operational manuals with a clearer description of task sharing during approaches, which includes trans downs. Because of this safety action the NSIA does not issue a Safety Recommendation about operational manuals

2.3.3 BRISTOW NORWAY'S SAR TRAINING

2.3.3.1 Introduction

Bristow Norway had revised their SAR training programmes shortly before the tender process for SAR South. Several managers the NSIA has interviewed has stated that they saw it as challenging to train the required amount of personnel for the SAR South contract in the time available with the old training programme. Based on available data, they recognized that their training was extensive and not necessarily efficient. The NSIA recognize Bristow Norway's need to find a more time-efficient way to train the large number of personnel needed within a limited time frame.

During the winter and spring of 2022, Bristow Norway initiated a process to revise the training programmes. At the same time as this revision was ongoing Equinor had first issued a tender for SAR services for Mid Norway NCS and informed that the SAR South tender would be issued in the near future. The revised training programme for SAR captains was approved by CAA Norway on 7 November 2022. The revised training programme for SAR co-pilots was approved 24 February 2023.

A comparison of training programme rev. 17 and rev. 19 is provided in 1.17.6.2 and 1.17.6.3.

The NSIA finds that a combination of factors related to training during the mobilisation for SAR South might be undesirable. Bristow Norway's training regime for the SAR South contract was markedly different from the previous way of training. The NSIA finds it likely that these changes manifested themselves in a greater variation amongst the pilots in the understanding of the nature of SAR operations.

2.3.3.2 Bristow Norway's training regime for the SAR South contract

A formal training programme provides the theory and basics of how to conduct a safe operation, while the experience required to increase safety margins must be gained elsewhere. This can for example be gained through mission relevant practice in a helicopter or in a simulator if the Line

Oriented Flight Training (LOFT)[63] principle is followed. The questionnaire the NSIA sent out to pilots underpins the fact that several of the newly trained pilots felt that there was to little practice before they started to fly operations. For example, one SAR co-pilot have highlighted that they were lucky to get valuable additional experience since they were scheduled to fly with a line training captain after starting to fly SAR operations.

Simulator training is a great tool to teach and practice procedures. It is a very efficient way to standardise an operation. It is also a good method to gain experience with abnormal situations and emergencies in a safe way. However, a simulator will always have a set of limitations, some of these might be well known and other less so. A simulator is always programmed, and this is one source of limitations. Even though it can mimic the real world to a substantial degree; there will always be nuances that can't be represented. This investigation has found that the simulator used by Bristow Norway could not model the aerodynamics of the situation that arose with LN-OIJ. The simulator would therefore not model the behaviour of this edge case of the MOT accurately.

Because a simulator will never be able to exactly capture reality, an appropriate balance between flight training in a helicopter and a simulator must be found. This is not necessarily straightforward. It is important to experience how the procedures and helicopter behaves outside of the simulator limitations, but within the helicopter limitations. How the simulator is used is also important. There is a difference if the simulator is mainly used as a procedure trainer or as a mission trainer. Based on documentation received, NSIA finds that Bristow Norway used it for both.

The co-pilot received over 50% of his training in a simulator. For an airline transport licence around 25–30% are allowed by regulation to be in a simulator. When it comes to getting training for a specific type of complex aircraft, called a type rating, this can be done entirely in a simulator. But then there are regulatory requirements for line training. Line training can mission relevant practice, if structured as such. For SAR operations, which by their nature are irregular operations, special care must be taken to ensure that mission relevant practice is provided.

Another way to look at line training, or other forms of mission relevant practice, is a controlled way of phasing personnel into the operation. The NSIA see this as essential in a specialised high-risk operation, such as SAR. This is especially true for SAR co-pilots that have no previous SAR experience. Another example of a controlled way of phasing in new personnel can be pairing inexperienced personnel with experienced personnel. Bristow tried to do this, but the major expansion of personnel provided a challenge. Both the commander and the co-pilot, as well as the hoist operator of LN-OIJ were newly transferred to SAR as part of the SAR South mobilisation.

To train the required personnel, Bristow Norway established a SAR school at Sola. During this process they drew upon experience from periods where high-intensity training was required and most of the personnel trained for the SAR South contract were trained at this SAR school. Previously, training of new SAR personnel had happened at one of the operational SAR bases. Being removed from the operational SAR bases reduced the candidates' possibility to learn from the experience of operational SAR crews conducting daily operations. This is especially true for the co-pilots. In the questionnaire sent out to the pilots 78% of respondents stated that they felt that the experience sharing was less than they desired.

The NSIA has interviewed pilots who trained at the SAR school which have stated that they experienced that there were training items they would like to have repeated or done to a greater extent to gain a deeper understanding, but that this was not possible. The large number of personnel being trained simultaneously within a tight time frame, restricted training possibilities. A

[63] LOFT refers to aircrew training which involves a full mission simulation of situations which are representative of line operations, with special emphasis on situations which involve communications, management and leadership. In short, LOFT means realistic, "real-time", full mission training.

single sortie sometimes trained both flight crew and rear crew, and there were times where the training items of one crew member affected the time available for other crew member's training.

The questionnaire sent out to SAR pilots indicate that during the mobilisation period the level of practice was less than desired. However, this might be seen as a self-correcting problem. As crews fly more and more, they gather experience. It is therefore reason to believe that the risk will go down over time. The main issue with this is that if this process is not formalised which can lead to greater variety in how the operation is performed and greater variability in the execution of missions by pilots who have apparently received the same training.

The fact that 81% of respondents to the questionnaire stated that there was no organised experience sharing or less than desired is a clear indication that experience sharing is seen as a benefit. A good way to learn from an organisational memory is to talk about how and why things are done in a certain way. This allows for new perspectives, but it also takes time. Before the SAR South contract this was partially achieved with the training being done at the operational bases. This was not the case during the mobilisation period for the SAR South contract due to the large number of personnel, 39 in total, being trained and the establishment of the SAR school.

During the interviews the NSIA had with key personnel at Bristow Norway the NSIA got the impression that the SAR co-pilot largely was synonymous with the PM role. This is because both the commander's seat and hoist are located on the right-hand side, and the commander is therefore most often the pilot flying during hoisting operations. In turn this might have influenced the training regime, and a focus on getting the SAR commanders and hoist operators ready. Interviews and the questionnaire sent out to SAR pilots (see 1.17.4 and 1.17.7) indicates that several pilots trained for the SAR South contract felt less prepared than desired. The NSIA has seen no documentation that these concerns were raised during the mobilisation process, while several individuals have stated that they did so. A natural question is then why no evidence of these objections are recorded. There could be numerous reasons for this. The NSIA is concerned about the statements that it was not seen as beneficial to be critical. This indicates challenges with the safety culture and can lead to a situation where individuals don't want concerns to be recorded.

As the competent authority the CAA Norway was involved in the revision and approval of the training programme. The process and dialogue with the CAA Norway leading up to the approval gave Bristow Norway confidence in their training. The NSIA has seen no evidence of a risk assessment of the new training regime. Based on this investigation the NSIA believes that the CAA Norway focused on the training syllabus and did not to see the full picture of the training regime, especially the disconnect from the inherent variation on an operational SAR base and a reduction of mission relevant practice. Further, the training regime resulted in the removal of much of the structured transfer of experience that could be achieved by training on an operational base.

2.3.4 SUMMARY OF HUMAN PERFORMANCE ASPECTS

The NSIA has analysed several latent conditions and organisational factors that in conjunction affected human performance and can provide some answers as to the late recognition of the abnormal pitch attitude.

Both flight crew members were relatively inexperienced in their respective roles as SAR commander and SAR co-pilot within the Bristow Norway SAR system. The NSIA is of the opinion that Bristow Norway's training regime during the mobilisation period for the SAR South contract combined with ambiguous procedures that lack a clear task sharing might have increased the variation in the understanding of the nature of SAR operations amongst the pilots. In extension this can have increased the variation in the execution of mission.

Based on this investigation, the NSIA believe that the crew was faced with a low probability event when the pitch trim actuator failed. It is not unlikely that expectation bias influenced the crew based on their training and experience. The helicopter pitched up as they expected, they were part of an organisation were pitch attitudes between 15° and 18° were not seen as uncommon and they were trained and instructed to monitor the flight director, but not to interfere. The crew also had limited experience with MOT in a real-life scenario. All these factors can have contributed to late awareness that something was abnormal.

The NSIA has no indication that the crew of LN-OIJ differed significantly from other pilots that had received the same training. There is no indication that they did not conform to the standards set by Bristow Norway and accepted by the CAA Norway.

Based on this investigation the NSIA holds the opinion that in the rush to get ready for the contract start date Bristow Norway did not manage to effectively extract the full potential of their two-pilot concept. Neither did they use the learning possibilities provided by the serious incident in 2020.

2.4 The tender process for SAR Services

2.4.1 INTRODUCTION

To understand all aspects of the accident with LN-OIJ it is necessary to look at the 2022–2023 process that led to Bristow Norway becoming the operator of three SAR bases. It is important to analyse how the tender process affected Bristow Norway and if it influenced the latent conditions described in 2.3.4.

The NSIA know that the energy companies regularly perform common audits of the helicopter operators. The energy companies' audit activity will have challenges identifying the latent conditions the NSIA has found.

At the time of the tender process there were two large helicopter operators serving the oil and gas industry on the Norwegian continental shelf, these being CHC Helikopter Service and Bristow Norway. Both operators had for a long time competed for, and were dependent on receiving, contracts from the energy companies operating on the Norwegian continental shelf and therefore had experience with tender processes.

The time from this contract award to start-up date was 12 months. This timeline was established by Equinor based on the request for information they sent out in relation to another contract of a different scope. Equinor had identified that there was a risk that they might not be able to deliver SAR services to Oseberg. To mitigate this, they could negotiate an extension to the current contract held by CHC Helikopter Service. Equinor also saw a risk with high probability related to mobilisation time. This was to be mitigated by an efficient internal process to ensure that the company who received the contract would have at least a 12-month mobilisation period.

Bristow Norway believed that the time available for mobilising the bases was marginal at best. In their reply to the tender, CHC Helikopter Service also expressed that the time available was tight. Equinor explained to the NSIA that Bristow Norway accepted a minimum timeline of 12 months. Additionally, Equinor emphasized that they throughout the entire tender process, and subsequent mobilisation period, had a good dialogue with Bristow Norway. In the meeting with the NSIA, see 1.17.2.2, Equinor downplayed the probability of them using penalties if the schedule could not be met, precisely because of the short timeline from contract award to contract start.

The NSIA hold the opinion that during the tender process for SAR South, Equinor focused primarily on mitigating risks that could affect the start-up date since flight safety risks were deemed to be mitigated to a reasonable level. The NSIA see several aspects of tender processes that require awareness so that they don't negatively affect flight safety.

2.4.2 POWER IMBALANCE

In a tender process, a power imbalance can easily develop in the relationship between the issuing company (offeror) and tenderer. The winner of this SAR contract would increase business and potentially avoid reducing activity. A contract with a scope of three SAR bases could provide stability and predictable income to a helicopter operator, even if parts of the contract had a shorter length.

A power imbalance between the offeror and the tenderer can have negative consequences when it comes to complex safety critical organisations such as in aviation. A situation can arise where a tenderer does not want to communicate potential challenges that they see they can handle internally. This to avoid creating doubt about the ability to fulfil the contract. The offeror must account for the fact that they often will be the strong part in the relationship and ensure that the imbalance of power does not lead to negative consequences. Based on this investigation and dialogue with Equinor, the NSIA holds the opinion that Equinor had not sufficiently reflected on the power imbalance during the tender process in question.

The NSIA has not seen evidence that flight safety risks were concealed in this case. However, in general, the NSIA holds the opinion that the offeror must be proactive and create an atmosphere where an honest and open dialogue of flight safety can be conducted.

2.4.3 THE DIFFICULTY OF STIPULATING SAFETY MARGINS IN A CONTRACT

During the dialogue with different managers at Equinor, the NSIA got a clear impression that safety was fundamentally viewed as being at an acceptable level due to regulatory approvals and audits, as well as audits performed by the energy companies. In addition, Equinor had several processes to ensure flight safety. However, the NSIA got the impression that there was not enough of a conscious consideration of the actual level of flight safety during the tender process. Flight safety was not explicitly stated in the "Instructions to Tenderer" that Equinor sent out. Financial aspects were emphasised. A lot of emphasis was put on the fact that Equinor had a long-standing relationship with Bristow Norway as a contractor and that they had a close dialogue with the management at Bristow Norway. This included access to occurrence reports. It was further emphasised that Bristow Norway was part of a global and experienced organisation. Equinor highlighted that Bristow Norway had all the necessary approvals, for example a Norwegian Air Operator Certificate, and fulfilled all requirements for conducting a SAR operation in the North Sea. The NSIA holds the opinion that Equinor overestimated the importance of Bristow Norway being part of the Bristow Group Inc. and the support they possibly could receive from other Bristow Group Inc. SAR operations. The NSIA got a clear impression that Equinor had a lot of confidence in Bristow Norway's ability to conduct the operation safely.

The NSIA has reviewed the tender documents and believe that the tender process had deficiencies regarding requirements related to safety, competence and training. Equinor had not sufficiently identified, and therefore mitigated, the issue that the combination of a short timeline and a change of operator could lead to unreasonable pressure relating to training of personnel. In their tender Equinor had asked the helicopter operators to list their "Top ten risks". Both Bristow and CHC Helikopter Service had individually listed half of their "Top ten risks" to be related to the short timeline. The NSIA has not seen documented concrete mitigating actions regarding this by Equinor. On the other hand, Equinor was worried about the availability of suitable helicopters and took active measures regarding this.

The NSIA recognize that it is challenging to evaluate different safety cultures and safety margins during a tender process. This makes it easy to refer to approvals and regulations. However, regulations only prescribe a minimum of requirements and will to a lesser extent reflect different operators' safety margins. Compliance is not necessarily enough to ensure safety. However, it is wrong to believe that safety culture, competence and safety margins can be specified in detail during a tender process. This leads to a situation that a tenderer almost automatically fulfils all the formal requirements. It must be recognised that short timelines and a "threat" of penalties is a mechanism that can encourage corners to be cut, consciously or unconsciously. It is also a risk that there is not room or time to properly assess the risks and uncover hazards, which reduces the resilience of an organisation. In general, the NSIA holds the opinion that it is important to ensure that a mobilisation timeline is sufficient to conduct a proper safety focused Management of Change process. The NSIA has not found documentation supporting that Equinor gave these aspects due consideration during the tender process for SAR South.

The time from contract award to contract start was just 12 months. The option for the third SAR base (Bergen/Oseberg) was enacted only 10 months before contract start. After the tender process has started with a defined scope and start-up date it would be very difficult for the tenderers to influence the time schedule. Offerors should endeavour to plan to ensure that time pressures during a tender process do not become a factor that negatively influences flight safety.

The short timeline put a lot of time pressures on Bristow Norway. Several managers at Bristow Norway expressed that the time schedule was very tight for such a complex contract with such a large scope, but they still believed they would succeed. The investigation indicates that Bristow Norway did not thoroughly reflect on the impact the expansion of their SAR operation would have on their organisation and if it could flight safety. An example of this is that the NSIA has not seen evidence of an effectively applied safety focused Management of Change process.

Previous tender processes by Equinor had more lenient schedules to establish a SAR base (see 1.17.3) and did not involve a change of operator. Several people at Bristow Norway have expressed to the NSIA that the time pressures caused strain on the organisation. It was expected that all employees "rolled up their sleeves" and put in the necessary work to achieve the goal. Critical questions were not appreciated, and it was expressed that some areas *"were cut to the bone"*. The manager of flight operations believed that one critical factor for the success of the project was the fact that the dedicated training helicopter had a high technical reliability. Further, he recognised that the complexity increased when the option for Bergen/Oseberg was enacted. This provided more strain on the organisation in an already challenging situation. The NSIA believe this indicates that they did not properly reflect on how this would affect the organisation before the contract was accepted.

The NSIA investigation has found several indicators that Bristow Norway might have overextended to be ready at the three SAR bases before the startup date:

- The SAR co-pilots had limited opportunity to practice SAR operations in a helicopter during night conditions.
- A factor for the success was a high technical reliability of the helicopter dedicated for training. Based on the dates for completion of training, there were small margins.
- Both flight crew members on the accident flight were relatively inexperienced in their respective roles when they started duty. This was also true when the accident occurred. The major expansion of the SAR organisation made it challenging to schedule experienced and newly trained captains and co-pilots on the same duty roster.
- Several people have stated to the NSIA that the fast pace during the preparations to take over the SAR bases caused strain in the organisation.

The NSIA holds the opinion that if care is not taken, tender processes can be a mechanism that increases strain on an organisation and reduces safety margins. On the other hand, when handled properly, tender processes can also be used as a tool to increase both effectivity and safety margins. The NSIA got the impression that Equinor had not fully reflected upon these potential impacts. The NSIA is aware that, in general, there can be a large variation in scope and complexity of different tender processes. Equinor has stated, based on discussions with different actors and internal experiences, that they believed that the SAR services they contracted were less complex. The NSIA holds the opinion that the scope of the contract should have triggered Equinor to issue a Request for Information to gather information about any unforeseen risks. In their reply to the tender, both CHC Helikopter Service and Bristow Norway clearly state that the short timeline is a risk. The NSIA see no evidence that Equinor used this information to reassess if this risk could affect flight safety.

2.4.4 STRAIN IN AN ORGANISATION

Winning or losing contracts can lead to large organisational changes. For that reason, aviation companies are mandated to have a documented Management of Change (MoC) process. Even though it is from a few years ago, the report after the CAA Norway audit in May 2021, might be a good indicator that it can be difficult to extract the full potential of the MoC tool (see 1.17.8.2). The NSIA does not believe that procedures alone can handle all the challenges a helicopter operator must deal with during a period of change, especially involving SAR contracts.

Typical generic challenges can be:

- Procurement of suitable helicopters and phasing in any eventual new helicopter types.
- Procurement and modification of SAR equipment for new helicopters.
- Changes and scaling of a maintenance organisation.
- Training of individuals and complete SAR crews.
- Training new line pilots, if internal recruitment to SAR results in a need to hire external pilots.
- Establishing base infrastructure and integration of IT-systems.
- Procurement and tailoring of emergency equipment and personal equipment.
- The company’s Safety & Compliance department can end up overloaded if extra resources are not allocated.

During a major process of change, it can be difficult to identify new and unforeseen elements and hence be difficult to implement measures to reduce any eventual threats from these elements. Information gathered during this investigation indicates that the short timeline affected the MoC process. Based on the investigation, the NSIA holds the opinion that it can be very challenging to control all safety critical elements during such a complex and large process. It is therefore important that top level management take active ownership of MoC and continue to systematically assess potential hazards and risks during the MoC process. An added challenge is that the organisation also must contend with day-to-day operations.

The NSIA has found evidence of organisational strain in Bristow Norway. Differing views on how to run a company are normal and is to be expected, but it becomes serious when several employees have expressed that time pressures and the major expansion of the SAR organisation could challenge flight safety.

Several people the NSIA has interviewed, from different levels of Bristow Norway, state that these concerns were only expressed orally, and it has therefore not been possible for the NSIA to find written documentation. Even so, the number of persons from different parts of the organisation, who independently and of their own volition have expressed this concern, makes the NSIA believe that there is some truth to these statements. However, it is important to state that all personnel have a duty to speak up when it comes to flight safety. The NSIA knows that this can be extremely challenging, especially when faced with commercial pressures or fear of negative consequences. The management in an organisation therefore has a particular responsibility to ensure that there are open and proper non-punitive channels for people to voice their concern. This is in line with the intention of the EASA regulations that require nominated postholders for safety critical functions.

Bristow Norway has presented several flight safety processes with reference to their Management System Manual. The NSIA is of the opinion that Bristow Norway has a mature safety management system. However, the NSIA has found that there is room for improvement regarding MoC. The NSIA has got the impression that a short timeline gave little room for reflections regarding how flight safety was influenced by the major change. It is important to do a holistic, honest and thorough risk assessment of the totality of changes. The NSIA has not found evidence that this has been done in this case by Bristow Norway and that they relied on their existing risk assessment processes.

The CAA Norway noted in an audit in September 2023 that Bristow Norway's "*monitoring of safety performance using SPI does not seem optimal. There are no defined target figures or limit values to trigger measures for many of the SPIs."*. The CAA Norway has also noted that Bristow Norway's use of management of change could be improved. The CAA Norway was well aware of the large expansion of Bristow Norway's SAR operation. They also approved the new training regime.

There is no evidence that the CAA Norway acted on this information by for example asking for Bristow Norway's MoC risk assessments to review them and provide guidance.

2.4.5 FREQUENCY OF MAJOR CHANGES

As mentioned in the chapter above, losing or winning a contract will lead to changes. These changes can prove challenging for any organisation. The fact that changes can lead to risks related to safety is known. MoC is implemented as a requirement to handle these challenges in the best possible way. The changes can require resources that under stable operating conditions otherwise could have been used for continuous flight safety work.

Longer contract periods will reduce the number of periods with change and might therefore contribute to increased flight safety. The NSIA believes that for an operation as complex as SAR, frequent contractual changes, especially if they involve a change of operator or helicopter type is a significant risk that must be accounted for and mitigated. With reference to the discussion about mobilisation time, frequent tender processes can also lead to pressure on an offeror, which can lead to difficulties with balancing workload, properly assessing risk and conduct a thorough safety focused MoC process.

2.4.6 SAFETY RECOMMENDATION TO THE COLLABORATION FORUM FOR HELICOPTER SAFETY ON THE NORWEGIAN CONTINENTAL SHELF

Based on the discussion in chapter 2.4, the NSIA see several challenges regarding tender processes offshore, especially when it comes to SAR services. It is the NSIA's view that tender processes easily can become a mechanism that puts pressure on, and has the potential to reduce, safety margins. This applies to both the tender process itself, but also the duration of the contracts and consequently how often the tender processes are carried out.

The NSIA hold the opinion that during the tender process for SAR South, Equinor focused primarily on mitigating risks that could affect the start-up date since flight safety risks were deemed to be mitigated to a reasonable level. Equinor expected that Bristow Norway would inform them if flight safety became at risk. The NSIA has no indication that Bristow Norway viewed flight safety as being affected during the mobilisation period for SAR South.

Based on this investigation the NSIA believes that the tender process for SAR South and the short timeline was one factor that caused strain within Bristow Norway, affected safety margins and possibly set up an environment where there was an increased risk of an accident.

It is important to ensure that tender processes leading to major changes provide involved organisations with enough time and resources so that they can perform thorough risk assessments of the changes. This is the intention of MoC. The NSIA has not been able to find information that this was the case regarding the SAR South contract.

The NSIA emphasises the importance that all parties are aware of possible negative consequences and implement measures to minimise the risk that this affects flight safety during a tender process.

The NSIA issue one safety recommendation to the CAA Norway as the leader of the collaboration forum for helicopter safety on the Norwegian Continental Shelf regarding tender processes.

2.5 Survival aspects

2.5.1 INTRODUCTION

The NSIA has evaluated several topics regarding survival aspects after the accident with LN-OIJ. Several factors regarding personal equipment, evacuation, the period waiting for rescue and the rescue operation is discussed in the following chapter. This also includes emergency training and helicopter equipment.

The NSIA also discuss why five people survived and why the SAR nurse perished. The analysis identifies challenges that arise when a helicopter crashes in the sea, and what can be done to increase the chances of survival.

2.5.2 THE EVACUATION

The five survivors have all explained that the accident occurred suddenly and unexpectedly. The cabin was almost immediately filled with water and there was no time for preparation before the water was rushing in. The investigation has found that four out of five survivors used Emergency Breathing System (EBS). EBS was critical for two of the survivors and the NSIA firmly believes that the fact that the crew was equipped with CAT-A EBS, which can be deployed under water, was one critical factor for the success of the evacuation and that more lives were not lost.

Those who were seated and restrained using their seat belts did not have any issue releasing themselves. The two restrained by a monkey-strap or lanyard had to use time and energy to release themselves. This was especially true for the rescueman on re-training who struggled to free himself. The NSIA therefore believe that it is important that restraints are appropriate and have a standardised quick release mechanism. It is also important to train on freeing oneself from restraints in different situations. In addition, the equipment used during flight and helicopter underwater escape training should be identical. Following the accident, both Equinor and Bristow Norway have implemented measures to further improve emergency training.

The explanation from the survivors varies regarding the function of HEELS-lights and emergency lighting. This includes if the lighting worked, if it was helpful and for how long it was lit. Three of the survivors have stated that the HEELS-lights worked. The HEELS-light aided two of these during the evacuation. The explanation of the senior rescueman indicated that the cabin emergency lighting worked for a short period of time. The cabin emergency lighting is not designed to function under water as opposed to HEELS.

The helicopter hit the sea and rolled to the left. Based on the survivors' accounts the helicopter rolled over onto its back shortly after impacting the water. This, combined with the rushing water and darkness, led to most of them having difficulties orienting themselves and escaping. None of the survivors saw anyone else until they had evacuated to the surface. Relevant and frequent training is exclusively positive. However, based on the investigation and the explanation of the survivors the NSIA does hold the opinion that their emergency evacuation training had been insufficient.

It is not certain what happened to the SAR nurse. According to the post-mortem examination she had large amounts of fluid in her lungs and injuries to her forehead. In addition, she had no signs of bruising around her hips that could be expected from the use of seatbelts. Other crewmembers restrained with seatbelts had bruising resulting from the use of these. The NSIA therefore believe she was unrestrained in the cabin when the helicopter hit the sea. If she was in her seat and restrained with her seatbelts, she must have been conscious for long enough to release herself. Bristow Norway has after the accident implemented measure to ensure that the SAR nurses on board their helicopters are secured during trans down.

The water in the lungs and the injuries to her forehead might indicate that she lost consciousness when the helicopter hit the sea, and that she remained in the cabin for a period of time. The presence of significant fluid in the lungs can indicate reduced consciousness before drowning. If she had been conscious even minor amounts of water would most likely cause laryngospasm[64] and coughing reflexes which would have led to less fluid in the lungs. The NSIA has not found marks to her helmet, and her equipment and clothing show no evidence of factors that may result in fatal injury. As the helicopter sank it is possible that water rushing through the windows and the ramp door carried the SAR nurse out of the helicopter, so she surfaced even though she was unconscious. The fact that she was later found floating face down, without an inflated life jacket further strengthens the theory that she never regained consciousness after the accident. The NSIA has no indication that there was anything wrong with her equipment or that it was unsuitable.

The accident with LN-OIJ occurred suddenly and unexpectedly. None of the crew members therefore had time for any preparation. The NSIA believes the crew was subject to an accident few had seen as a possible scenario. The fact that all the survivors managed to evacuate the helicopter must therefore be a combination of extensive experience, good training, good equipment and chance.

2.5.3 THE PERIOD WAITING FOR RESCUE

The survivors ended up in a hostile environment and a precarious situation. They had to survive floating in the North Sea without a life-raft waiting to be rescued in the pitch black and submerged in cold water. The NSIA believe that prior to the accident few had considered that a low energy accident would evolve into such a lethal and life-threatening situation as the crew experienced.

A review of the information provided by the survivors show that the cold water had been the most problematic and life-threatening factor after the evacuation. The cold water affected the physical state of the survivors, led to a reduced cognitive and physical function and after a while life

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[64] Laryngospasm is an uncontrolled or involuntary muscular contraction of the vocal folds.

threatening cardiac arrest for one person. Several factors influenced the degree of heat loss and cooling. The water ingress, choice of base layer under the survival suit and individual predisposition to heat loss were the most significant factors. Regarding the base layer there is a balance to be struck between keeping warm in an emergency and being able to do the work as required during normal operation. Wool-based materials have the advantage that provide warmth even when wet, even so one of persons who got the coldest wore two layers of wool. In addition, two of the survivors removed their helmet and one lost his helmet. After the survivors ended up in the water with inflated life jackets, it became impossible to put on the hood stored in a pocket of their survival suit. An uncovered head kept wet by cold water will lead to a large heat loss. In addition, several of the survivors experienced varying degrees of water leakage into their survival suit, primarily due to a need to bend over or wiggle during the evacuation. Even small amounts of water can have a significant impact on heat loss, depending on the water temperature and any clothing under the survival suit. Based on the explanation given by the survivors the NSIA still believe that the survival suits worked as expected.

The cold water also reduced the hands' ability to function and therefore affected other conditions during the period waiting in the sea. Two persons did not wear gloves, one wore neoprene gloves, one fabric work gloves and one person only had one fabric glove. The consequences of cold fingers manifested early with a marked reduction in fine motor skills. Some had trouble activating their PLB, some experienced difficulties connecting the buddy lines and several were hesitant to remove equipment from pockets. The accident shows that extremely cold fingers will quickly cause problems with all tasks requiring precision and dexterity.

Several survivors have stated that they had issues with activating their PLB. Seen in relation to extremely cold fingers and the use of gloves, especially relatively thick neoprene gloves which are the only suitable gloves, the NSIA see it as very unfortunate that the two buttons for operating the PLB are small, have almost no tactile feel and are close together. It is not desirable to activate the self-test function in an emergency. This button should therefore not be placed close to the activation button. This problem is amplified in the dark since the unit also do not have any lights, other than a small green LED to signal activation.

Several of the survivors have stated that they both lacked and missed good sources of light. The light on the life jackets was too weak and positioned where it impeded their night vision. On the other hand, the strobe light was blinking and both lights where therefore not suitable as a light source for working.

The survivors waited in the sea without a life raft for one hour before being rescued. It was dark, the wind speed was about 33–35 kt, the air temperature was 6 °C, the sea temperature was 5 °C and the wave height was about 3–4 metres with some larger waves. Under these conditions, the condition of three of the survivors became critical. The conditions on the 28 February 2024 were not atypical, considering that the accident occurred in the North Sea during winter. The fact that the outcome of the accident was not worse can be attributed to the fact that another SAR helicopter already was airborne, had a strong tailwind and arrived at the accident site relatively quickly. In addition, the crew of LN-OIJ were well trained in evacuation and the rescuemen had experience working in cold water. The NSIA also believe that the actions of the senior rescueman and hoist operator were a factor for the survival of the co-pilot and the commander.

The problems the survivors faced which are described in this report should form a decent basis for a review for possible learning points for operators flying similar missions.

SAR operations are nationally regulated. The NSIA therefore issues a safety recommendation to the CAA Norway to evaluate if the current requirements for personal emergency equipment for SAR crews are satisfactory and harmonised. The NSIA also issues one safety recommendation to HeliOffshore to investigate the possibility of international guidelines.

2.5.4 THE RESCUE OPERATION

2.5.4.1 Introduction

The NSIA firmly believes that the rescue operation was efficient and that the five survivors were picked up in time and provided medical treatment so that no further loss of life occurred. One decisive factor for the efficiency of the rescue operation was early warning and good position data from the ELT and PLBs.

Shortly after the accident, numerous questions were raised as to whether it would have been possible to save the SAR nurse if a different prioritisation of SAR helicopters had been made. However, this is not the case. The investigation indicate that the SAR nurse drowned shortly after the accident, and resuscitation would not have been possible.

Even though the rescue operation was efficient, there is often potential for improvement. In the following chapter, some aspects that the NSIA believe could be improved are analysed.

2.5.4.2 Overview of resources and access to real time information

At the time of the accident the, JRCC did not have a complete overview of real-time position of all available resources. Equinor’s SAR resources were only presented statically, without real-time position, to the rescue coordinators. The JRCC-S has also explained that they saw it as easier and quicker to mobilise the national SAR resources. The NSIA believes this contributed to potentially important resources not being mobilised in parallel. The NSIA holds the opinion that it was unfortunate that the organisation with the overall responsibility for all SAR services did not have a complete and updated picture of where potential resources were located.

The NSIA knows that after the accident with LN-OIJ the JRCC, the energy companies, Bristow Norway and CHC Helikopter Service began implementation of measures to ensure that the civil SAR resources also are available in the Shared Resource Information Repository. These measures have now been implemented. This means that the status of the civil SAR resources is available in the Shared Resource Information Repository and that their real time position is displayed. The JRCC has also been granted access to ADS-B data such that the position of aircraft with an ADS-B transponder on board is also shown in real-time.

Due to this implemented Safety Action, the NSIA does not issue a safety recommendation about access to real time information.

2.5.4.3 Scramble of resources

The NSIA has looked closely at the situation at 1948 hrs when the JRCC-S started to mobilise resources, and has looked in detail at the four closest airborne resources with hoisting capabilities:

- SAVER50 was airborne on a training mission west of Sola.

- RESCUE8 was on the ground in Florø with a 15-minute readiness.
- NORSAR9 was airborne in the Tampen-area to conduct hoist training with a tanker. The hoisting had not yet started.
- NORSAR4 was on the ground at the offshore platform Johan Sverdrup with a 20-minute readiness.

The NSIA has estimated arrival times in different situations to illustrate how dynamic a rescue operation is. It is difficult to ascertain with certainty how long the flight time would have been. However, a good estimation is to take the actual flight times and adjust them, assuming the same wind conditions. The arrival times can then be found by estimating the ground speed of helicopters that are coming from the same direction since they would have comparable wind conditions. For example, the NSIA has estimated that NORSAR4 and SAVER50 would have similar ground speeds. Then that ground speed is multiplied with distance to estimate arrival time. If a helicopter is on the ground, a scramble time has been allotted for both NORSAR4 and NORSAR9 this has been set to 10–20 minutes, while for SAVER50 it has been set to 10–15 minutes.

SAVER50
Distance: 82 NM
Ground speed: 154 kt
- Actual arrival time: 2021 hrs
- If parallel scramble: 2021 hrs
- If on ground at Sola: 2030–2035

RESCUE8
Distance: 77 NM
Ground speed: 83 kt
- Actual arrival time: 2104 hrs
- If parallel scramble: 2101 hrs

NORSAR9
Distance: 88 NM
Ground speed: 103 kt
- Actual arrival time: NIL
- If parallel scramble: 2039 hrs
- If on ground at Statfjord B: 2108–2118

NORSAR4
Distance: 113 NM
Ground speed: 154 kt
- Actual arrival time: NIL
- If parallel scramble: 2042–2052 hr

Based on the estimations above SAVER50 would always be the first rescue helicopter to arrive. Interestingly both NORSAR9 and NORSAR4 could have arrive before RESCUE8, but this information was not available to the JRCC-S.

In retrospect, it is clear that it would not have been possible to save the SAR nurse’s life. However, the situation the crew members from LN-OIJ found themselves in was not known when the JRCC-S started to mobilise resources. The fact that one person was floating face down in the water without any life signs was first known when SAVER50 arrived at the accident site.

Around 2000 hrs, after both SAVER50 and RESCUE8 were scrambled, the air ambulance service west offered to help. The JRCC-S accepted without question and wanted the air ambulance to use search lights and NVGs to look for survivors. The air ambulance helicopters were not optimally equipped to operate over open water at night, nor did they have hoisting capabilities. The NSIA believe this illustrates the importance that the JRCC has a conscious awareness of the capabilities of scrambled resources compared to the risks involved.

Time is critical during a rescue operation. This investigation has found that it was most likely just minutes away from this accident having more than one fatality. Therefore, it is important that the JRCC has a clear opinion of the response time of different helicopters. A helicopter that is closer in physical distance can be further away in time due to wind conditions. An estimation of arrival time is currently based on individual JRCC rescue coordinators’ experience and is just one of many factors when determining which resource should be mobilised.

The NSIA issue a safety recommendation to the JRCC about a digital estimation of arrival times for helicopters.

2.5.4.4 Communication

The JRCC-S knew that SAVER50 was airborne on a training mission and had real-time access to their position data. The JRCC-S tried to mobilise SAVER50 in four different ways:

- Via *Nødnett*. SAVER50 was outside the coverage area and could not hear the call. The NSIA believe it is important that both the JRCC and the crews operating national SAR helicopters are aware of the coverage area of *Nødnett* and ensure that alternative methods of communication are available, if necessary, when the helicopters are out on training missions.
- Via satellite communications. After the accident it became clear that problems with aircraft wiring affected the reliability of the satellite communications system. The RNoAF 330 squadron has explained that these wires are replaced as part of the maintenance programme.
- Maritime VHF channel 16. The crew of SAVER50 did not hear the call from the Coastal Radio since the volume of both maritime radios had been erroneously turned down while they conducted hoisting operations.
- Air traffic service VHF. The JRCC-S established communications with SAVER50 at 1953 hrs, about four minutes after the first attempt.

The slight delay in establishing communication ended up having minimal consequences. However, SAVER50 could have had slightly better time margins during the rescue operation. The accident illustrates the importance that both SAR helicopters and the JRCC always ensure that communication is possible and that the time margins during a rescue operation can be small.

2.5.5 RELEVANT HELICOPTER SURIVAL EQUIPMENT

2.5.5.1 Emergency Flotation System

LN-OIJ was fitted with an Emergency Flotation System that did not deploy during the accident. It was quickly established that this was due to the automatic deployment logic. For automatic deployment, both generator power from the MGB and battery power was required. When the main rotor blades hit the sea, generator power was lost, and consequently automatic deployment was not possible. Manual deployment only requires battery power and was thus available. The investigation has found that the information about the limitations of the EFS was available to pilots, but this was not at the forefront of their minds. In the chaotic situation that arose the crew concentrated on evacuation and survival.

Amongst other reasons, but also as a mitigating action, Bristow Norway has chosen to start the APU during low level SAR operations to ensure that the EFS would deploy in a similar situation.

The NSIA believes that if the EFS had deployed it would have increased safety margins and survivability. A helicopter floating upright, or capsized, could have acted as a safe haven for the survivors while waiting for rescue. In addition, a floating helicopter could have increased the possibility of releasing life rafts.

Throughout the investigation the NSIA has had a continuous dialogue with both Sikorsky and EASA regarding automatic deployment of the EFS. Because of this dialogue and because of the new requirements in EASA Part-26, the NSIA did not issue an immediate safety recommendation.

Sikorsky is in the process of altering the EFS auto float deployment logic to comply with the forthcoming EASA Part-26 regulations. Because of this Safety Action the NSIA does not issue a safety recommendation on this topic.

2.5.5.2 Manual life raft deployment

The investigation found that several of the crew members contemplated swimming back to the capsized helicopter to release one of the life rafts. When the helicopter capsized, the manual deployment handle was submerged at a depth of around half a metre. The survivors quickly dismissed the idea of swimming over to the helicopter and locate the handle as impossible with the helicopter rolling in the waves, fuel in the water, darkness, and the extra buoyancy provided by the life vests. The survivors therefore had to remain in the sea without a life raft while awaiting rescue.

The new requirements for life raft deployment set forth in EASA Part-26, entered into force on 9 August 2024, require that life rafts *"is (are) remotely deployable, with the means to deploy the life raft(s), located within easy reach of the flight crew, the occupants of the passenger cabin and any* ***survivors in the water, with the helicopter in an upright floating or capsized position****"* (emphasis added). This will increase the possibility of survivors being able to deploy life rafts.

After a dialogue with the NSIA and EASA, Sikorsky supported the design organisation Heli-One to develop a Supplemental Type Certificate for enhanced accessibility of the manual deployment handle of the life-rafts. This STC (STC No.: 10089003) was approved on 9 January 2026. Because of this Safety Action, the NSIA does not issue a safety recommendation on this topic.

2.5.5.3 EASA's Part-26 regulations

With reference to section 1.18.1.3, it was necessary for CAA Norway to issue exemptions from the Basic Regulation to keep the Norwegian S-92A fleet operational in December 2024. The investigation had brought to light that the S-92A did not fulfil the requirements set out in regulation (EU) 2022/1254 which updated Part-26 and introduced, among others, heightened safety requirements for life raft deployment.

Part-26 is one way of making safety improvements apply retroactively. The NSIA agrees with the regulatory intention that some retroactive safety requirements are operation dependent. On the other hand, this also presents some challenges. Some of these requirements might be impossible for an operator to implement on their own without the aid of the type certificate holder or a design organisation. In this specific case a modification of the S-92A is required, which must also be approved by EASA.

A question the NSIA has investigated is how the situation where exemptions were required arose. The operators asked the manufacturer if they were compliant and received an affirmative response that they were compliant. It is then understandable that the operators did not take any further action. As far as the NSIA has found, the assessment by the manufacturer supporting the claim that the operators were compliant was wrong. It is the national aviation authority, in this case the CAA Norway, that is responsible to verify through audits the compliance of the operators. In this case the CAA Norway informed all the operators that the new requirements were being implemented and that they had to ensure compliance. Except from the information sent to the operators in July 2022, see 1.18.2, the NSIA has not seen evidence that the CAA Norway provided further guidance, or verified how the operators were compliant. The investigation has not found any information to indicate that EASA investigated how Sikorsky were to show compliance with the new regulatory requirements.

The investigation after the accident has highlighted one pitfall of how Part-26 is implemented, which requires the proactive involvement of all parties. The NSIA expects all actors within the European aviation system, being authorities, manufacturers or operators to be aware of this regulatory framework.

As part of the external consultation process EASA acknowledged the need and benefit for all affected stakeholders to increase the visibility and awareness on Part-26 requirements and deadlines. To achieve this, EASA took several actions, summarised hereafter:

- On 1 April 2025, an information on the latest changes to Part-26 was included in the Design & certification newsletter (5th edition – March 2025). https://www.easa.europa.eu/en/newsroom-and-events/news/design-certification-newsletter-202501
- On 5 May 2025, a communication on understanding Part-26 was published in the EASA Air Operations Community network. https://www.easa.europa.eu/community/topics/understanding-part-26
- On 20–21 May 2025 during the EASA Member States' Air Operations Technical Body (Air OPS TeB) Meeting 2025-01, an information on the latest changes to Part-26 was presented, and an exchange on implementation issues occurred. EASA also shared a draft document providing an oversight of the Part-26 mandates deadlines (in view of future publication, see also last bullet below).
- EASA regularly issues consolidated publications designated as 'Easy Access Rules' (EAR) to facilitate stakeholders access to regulatory materials (free download). Regarding Part-26/CS-26, on 8 October 2025 EASA published an updated version that consolidates all the previous amendments to Regulation (EU) 2015/640 (Annex I Part-26) and CS-26 Issue 5. https://www.easa.europa.eu/en/document-library/easy-access-rules/easy-access-rules-additional-airworthiness-specifications-2
- In addition, EASA plans to publish a database that would allow stakeholders to filter the applicable Part-26 requirements per date, type of operations, type of aircraft, etc. The aim is to help operators, design approval holders, and competent authorities to be better aware of and better anticipate the coming compliance deadlines.

The NSIA issue one safety recommendation to EASA regarding the accessibility of Part-26.

3. Conclusion

3. Conclusion

3.1 Main conclusion

LN-OIJ suffered a loss of control and impacted the sea. The helicopter was almost immediately filled with water. The NSIA believe that the fact that five people survived must be attributed to a combination of training, experience, skill, good fortune and an effective rescue operation. There were several contributing factors to the accident. These are factors that have not necessarily had a clear cause-and-effect relationship, but that are considered to have increased the risk (see footnote 60 for full definition).

Based on all available evidence the NSIA concludes that it is likely that the failure of the pitch trim actuator was present before the crash. The crew therefore experienced a technical fault in a critical phase of flight. The failure of the pitch trim actuator influenced the pitch motion of the helicopter and failed to arrest the expected pitch-up manoeuvre. This was not recognised by the crew in the three to six second window the NSIA believes the situation could be identified as abnormal and theoretically corrected. The NSIA has no indication that the crew of LN-OIJ differed significantly from other pilots that had received the same training during the SAR South mobilisation. There is no indication that they did not conform to the standards set by Bristow Norway and accepted by the CAA Norway.

The NSIA finds that Bristow Norway’s training regime during the mobilisation period for the SAR South contract combined with ambiguous procedures that lack a clear task sharing affected human performance. This might have increased the variation amongst the pilots in the understanding of the nature of SAR operations and in the execution of the mission. This might have led to an increased risk of undesirable occurrences. The NSIA holds the opinion that the training regime during the mobilisation gave the crew limited mission relevant practice before flying real-life operations and limited learning exchanges between experienced crews and crew in training. Even though both crewmembers were highly experienced S-92A pilots, both were new in their respective SAR roles for Bristow Norway.

The NSIA also finds that Equinor did not fully appreciate the complexity of changing operators as part of their tender process for SAR services. In their reply to the tender, both CHC Helikopter Service and Bristow Norway clearly stated that the short timeline was a risk. The NSIA has seen no evidence that Equinor used this information to reassess if this risk could affect flight safety. Because of the compressed timeline and the scope of the contract, the NSIA holds the opinion that Equinor inadvertently put undue pressure on the bidding companies. In the interest of flight safety, the offshore energy companies, as the dominant part in a contractual relationship, have a responsibility to fully appreciate and explore the situation they are putting helicopter operators in during a tender process. It is important to ensure that a mobilisation timeline is sufficient to conduct a proper safety focused Management of Change process. In addition, there is no evidence that the CAA Norway used available information to aid Bristow Norway with the MoC process by for example asking for Bristow Norway’s MoC risk assessments to review them and provide guidance. The NSIA has not seen evidence that flight safety risks were concealed in this case. However, in general, the NSIA holds the opinion that all involved parties must be proactive and create an atmosphere where an honest and open dialogue of flight safety can be conducted.

3.2 Investigation findings

3.2.1 GENERAL

A. Both the commander and the co-pilot possessed all necessary licenses and qualifications. All regular routines were followed on the day of the accident.

B. The actual flight was a re-training flight for a rescueman who had been on sick leave.

C. The flight was scheduled as a VFR round-trip flight from Bergen.

D. There were six people on board, two cockpit crew members, the rescueman under re-training, an instructor/senior rescueman, a hoist operator, and a SAR nurse.

E. At around 1720 hrs the crew had a thorough pre-flight brief.

F. The plan for the flight was to first drop a training beacon that simulates an emergency position-indicating radio beacon (EPIRB), then do hoist training with a ship and finally search for and retrieve the training beacon.

G. Before the flight the hoist operator signed for a pre-departure inspection at 1730 hrs and the commander signed for acceptance of the helicopter at 1810 hrs.

H. There were no relevant Minimum Equipment List (MEL) items recorded in the Aircraft Technical Log (ATL) or relevant Deferred Defect List (DDL) items.

I. The NSIA has briefly reviewed the maintenance documentation. No maintenance irregularities have been observed during this review.

J. LN-OIJ, with call sign NORSAR6, departed Bergen Airport Flesland at 1824 hrs.

K. The flight took place during an overcast night, with no moon- or starlight.

3.2.2 THE ACCIDENT SEQUENCE

A. The flight was uneventful until the helicopter approached the hover position with the intention to retrieve the training beacon using the “Mark on Top” (MOT) function of the Automatic Flight Control System (AFCS).

B. After engaging the AFCS mode MOT the helicopter started a right-hand turn. When it had aligned into the wind it then descended from 200 ft towards 150 ft above the sea. There was nothing unusual during the initial part of the trans down.

C. The CVR indicate a normal workload in the cockpit. All crew members can be heard discussing various essential tasks.

D. The commander recognised and stated that they would overfly the beacon. The crew stated that they would let the automation finish without interference.

E. The helicopter started to pitch up to slow down for a hover over the MOT position.

F. According to FDR data a pitch degrade was likely annunciated on the PFD. However, this was never identified by the flight crew.

G. The commander has explained to the NSIA that he did not touch the flight controls until he realized that something was seriously wrong.

H. The pitch-up manoeuvre was never arrested and continued past the nominal 10–12° nose up at a rate of about 2° per second until the maximum nose up attitude of 30° was reached.

I. The excessive pitch-up manoeuvre was not timely recognised and corrected during the three to six second window the NSIA believes the situation theoretically could be acted on by the flight crew.

J. The commander recognised the high nose attitude and pushed the cyclic forward. He then called “GOING AROUND, GOING AROUND, GOING AROUND” and initiated a go-around by pulling the collective to increase the lift, but the helicopter had a trajectory which made recovery impossible before it hit the sea.

K. Recorded data indicates that the helicopter impacted the sea travelling rearwards with a speed of 40 kt, with a nose up attitude of 11.7° and a bank angle of 17.6° to the left.

L. The ramp door and the windows on the left-hand side were pushed in due to the impact with the water.

3.2.3 TECHNICAL INVESTIGATIONS OF FLIGHT CONTROL SYSTEMS

A. The helicopter was salvaged from a depth of 220 m on Saturday 2 March at 0510 hrs, three days after the accident.

B. The flight controls were tested shortly after retrieval. They operated smoothly without restriction in all axes, except the collective. It was established that the reason the collective was restricted was due to the honeycomb of the ceiling of the cabin having collapsed.

C. The combined Flight Data & Cockpit Voice Recorder and HUMS data memory card were transported to the Air Accident Investigation Branch in the United Kingdom with subsequent successful data extraction.

D. The flight control computers were transported to the manufacturer Collins Aerospace in Phoenix, Arizona, USA for a successful data extraction.

E. The pitch SAS/boost servo was shipped to Parker Aerospace in Irvine, California, USA and tested with the NTSB present. No functional anomalies were observed during hydraulic bench tests that would preclude SAS and boost function.

F. All four (pitch, roll, yaw, collective) trim actuators were shipped to Collins Aerospace in Vergennes, Vermont, USA for examination.

G. During the examination it was determined that at least one electrical component on one of the circuit cards in the pitch trim actuator had failed.

H. The testing at Collins found that due to the component failure the pitch trim actuator exhibited two erratic behaviours. Firstly, the pitch trim actuator would report its own position erroneously to the FCCs. Secondly, the trim actuator would report a stick force, even when no stick force should be detected.

I. Based on all available evidence the NSIA firmly concludes that it is likely that the failure of the pitch trim actuator occurred shortly before the stick force started to increase in the recorded data and that LN-OIJ did not automatically arrest its pitch-up due to this failure.

J. The failure of the pitch trim actuator did not appear during any previous flights or maintenance based on available information.

3.2.4 OPERATIONAL FACTORS

A. The flight crew did not get any obvious warnings about the trim actuator failure.

B. The NSIA believes that the absence of direct attention to the pitch attitude during a three to six second window was a factor that allowed the helicopter to enter vortex ring state.

C. The helicopter entered vortex ring state at a low altitude which would most likely be very difficult to recover from.

D. Research by HeliOffshore has found that a significant number of pilots rely on other flight instruments than the attitude indicator since the underlying stability augmentation systems of modern helicopters maintains correct attitude. This indicates that monitoring is something the entire offshore rotary wing community should work to improve.

E. The two pilots had recently changed roles and responsibilities. The line captain becoming a SAR co-pilot and the SAR co-pilot becoming a SAR captain. It is especially challenging to unlearn behaviours. It takes time to become familiar in a new role with a new set of responsibilities, and to override all the instincts and memory items you have acquired in a similar role during a different flight operation.

F. The NSIA holds the opinion that the flight crew were presented with a highly unusual situation when the component in the pitch trim actuator failed during a critical phase of flight and in a situation where the crew had hardly any external visual references.

G. The NSIA holds the opinion that the training regime during the mobilisation for the SAR South contract gave the crew limited mission relevant practice before flying real-life operations and limited learning exchanges between experienced crews and crew in training.

H. The NSIA is of the opinion that Bristow Norway's training regime during the mobilisation period for the SAR South contract combined with ambiguous procedures that lack a clear task sharing might have increased the variation in the understanding of the nature of SAR operations amongst the pilots. In extension this can have increased the variation in the execution of mission. This might have led to an increased risk of undesirable occurrences.

I. The NSIA has no indication that the crew of LN-OIJ differed significantly from other pilots that had received the same training. There is no indication that they did not conform to the standards set by Bristow Norway and accepted by the CAA Norway.

3.2.5 THE TENDER PROCESS FOR SAR SERVICES

A. Bristow Norway was informed by Equinor in a Letter of Intent dated 29 July 2022, that they would be awarded the contract. They could therefore start preparations one month prior to the formal contract award.

B. The investigation has found that this was the first time that 12 months from contract award to start up was the deadline for such a large contract that also included a change of operator.

C. The NSIA holds the opinion that 12 months from contract award to start up is marginal considering the scope of the contract.

D. The NSIA got a clear impression that Equinor, during the tender process, viewed flight safety as being at an acceptable level within both Bristow Norway and CHC Helikopter Service due to, among other things, regulatory approvals and audits.

E. Based on this investigation and dialogue with Equinor, the NSIA holds the opinion that Equinor had not sufficiently reflected on any power imbalance during the tender process.

F. In their reply to the tender, both CHC Helikopter Service and Bristow Norway clearly stated that the short timeline is a risk. The NSIA see no evidence that Equinor used this information to reassess if this risk could affect flight safety.

G. Several people at Bristow Norway have expressed to the NSIA that the time pressure caused a strain on the organisation.

H. The NSIA holds the opinion that during the tender process for SAR South, the involved organisations focused primarily on mitigating risks that could affect the start-up.

I. It is important that tender processes leading to major changes ensure that the involved organisations are provided with enough time and resources to perform a safety focused Management of Change process that includes risk assessments of the change itself.

J. The NSIA has seen no evidence that the CAA Norway used available information to aid Bristow Norway with the MoC process by for example asking for Bristow Norway's MoC risk assessments to review them and provide guidance.

3.2.6 SURVIVAL ASPECTS

A. The accident happened abruptly and unexpectedly.

B. The cabin was filled with water within a very short timeframe.

C. The helicopter's Emergency Flotation System did not deploy automatically. This was due to the main rotor hitting the sea and the subsequent loss of the required AC power for automatic deployment.

D. Manual activation was available, but the crew did not manually deploy the floats as they were knocked unconscious for a short time after the impact and then focussed on exiting the aircraft

E. The helicopter rolled over and became inverted after a short period. This in combination with the water and darkness made orientation difficult.

F. When the helicopter rolled over the handles for manual deployment of the life rafts were submerged and became inaccessible.

G. Sikorsky has initiated work change both the automatic deployment logic for the emergency flotation system and access to manual deployment of the life rafts.

H. Based on crew statements the cabin emergency lights functioned for just a short period. The cabin emergency lighting is not designed to function under water.

I. The Helicopter Emergency Egress Lighting System was beneficial for one crew member during the evacuation.

J. At least two crew members believed that they survived because they had compressed air emergency breathing system.

K. The NSIA believe the SAR nurse was unrestrained in the cabin when the helicopter hit the sea.

L. The NSIA sees it as likely that the SAR nurse lost consciousness when the helicopter crashed and she subsequently drowned.

M. The helicopter sank after a short period of time.

N. Several of the crew members have expressed difficulties in activating their Personal Locator Beacon due to cold fingers, non-tactile buttons and lack of a good light source.

O. Except for the Personal Locator Beacon, personal emergency equipment performed adequately under the extreme conditions.

P. While waiting for rescue it was dark, the wind speed about 33–35 kt, the air temperature was 6 °C, the sea temperature was 5 °C and the wave height was about 3–4 metres with some larger waves.

Q. The survivors waited in the sea without a life raft for 45 minutes before being rescued.

R. The cold water has been the most problematic and life-threatening factor after the evacuation.

S. The NSIA firmly believes that the rescue operation was efficient, and this contributed to the five survivors being picked up and pre-hospital medical treatment started in time so that no further loss of life occurred.

T. One decisive factor for the efficiency of the rescue operation was early warning and good position data from the ELT and PLBs.

U. At the time of the accident the JRCC did not have a complete overview of real-time position of all available resources. This has now been remedied.

4. Safety recommendations

4. Safety recommendations

The Norwegian Safety Investigation Authority issues the following safety recommendations[65]:

Safety Recommendation Aviation No. 2026/05T

On 28 February 2024 LN-OIJ suffered a loss of control and crashed into the North Sea west of Sotra, Norway during a training mission. The investigation into the accident has had a lot of data available. Even though the NSIA has had good audio recordings from the Cockpit Voice Recorder and recorded flight data from three different sources it has been impossible to unambiguously determine what happened. Cockpit Image Recorder (CIR) data would have been a useful supplement to the already recorded data. Crucially a CIR would have given the NSIA an image of the cockpit and handling of the controls. Several recommendations have already been issued by other safety investigation authorities regarding this topic. The NSIA still find it necessary to use this opportunity to reiterate a safety recommendation.

The Norwegian Safety Investigation Authority recommends that ICAO expedite its work to make cockpit image recordings mandatory for all newly built aircraft used for commercial air transport.

Safety Recommendation Aviation No. 2026/06T

On 28 February 2024 LN-OIJ suffered a loss of control and crashed into the North Sea west of Sotra, Norway during a training mission. The investigation into the accident has had a lot of data available. Even though the NSIA has had good audio recordings from the Cockpit Voice Recorder and recorded flight data from three different sources it has been impossible to unambiguously determine what happened. Cockpit Image Recorder (CIR) data would have been a useful supplement to the already recorded data. Crucially a CIR would have given the NSIA an image of the cockpit and handling of the controls. Several recommendations have already been issued by other safety investigation authorities regarding this topic. The NSIA still find it necessary to use this opportunity to reiterate a safety recommendation.

The Norwegian Safety Investigation Authority recommends that the Federal Aviation Administration expedite its work with the National Transportation Safety Board ‘s recommendation A-15-008 to require that all newly manufactured aircraft operated under Title 14 Code of Federal Regulations (CFR) Part 121 or 135 are required to have a cockpit voice recorder and a flight data recorder also be equipped with a crash-protected cockpit image recording system compliant with Technical Standard Order TSO-C176a, “Cockpit Image Recorder Equipment,” or equivalent.

[65] 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 § 8.

Safety Recommendation Aviation No. 2026/07T

On 28 February 2024 LN-OIJ suffered a loss of control and crashed into the North Sea west of Sotra, Norway during a training mission. The investigation into the accident has had a lot of data available. Even though the NSIA has had good audio recordings from the Cockpit Voice Recorder and recorded flight data from three different sources it has been impossible to unambiguously determine what happened. Cockpit Image Recorder (CIR) data would have been a useful supplement to the already recorded data. Crucially a CIR would have given the NSIA an image of the cockpit and handling of the controls. Several recommendations have already been issued by other safety investigation authorities regarding this topic. The NSIA still find it necessary to use this opportunity to reiterate a safety recommendation.

The Norwegian Safety Investigation Authority recommends that the European Aviation Safety Agency work with the Federal Aviation Administration to timely implement the National Transportation Safety Boards's recommendation A-15-008 to ensure harmonised rules.

Safety Recommendation Aviation No. 2026/08T

On 28 February 2024 LN-OIJ suffered a loss of control and crashed into the North Sea west of Sotra, Norway during a training mission after excessive pitch up attitude. Six months prior to the accident, Bristow Norway became the operator of three new SAR bases, including the one at Bergen airport, Flesland. This major expansion was the result of a tender process with a short time period between contract award and contract start. This led to a strain on the organisation to be able to train the required personnel and to make the necessary equipment ready.

The Norwegian Safety Investigation Authority recommends that CAA Norway, in its role as leader of the *Samarbeidsforum for helikoptersikkerhet på norsk kontinentalsokkel* initiate work to establish guidelines for tender processes, particularly when it comes to Search and Rescue, including but not limited to the timeframe between contract award and contract start.

Safety Recommendation Aviation No. 2026/09T

On 28 February 2024 LN-OIJ suffered a loss of control and crashed into the North Sea west of Sotra, Norway during a training mission after excessive pitch up attitude. After the accident the crew on board had to survive in the sea for about 45 minutes before being rescued. During their time in the sea, they experienced several difficulties with their personal emergency equipment. For example it was difficult to activate the personal locator beacons with cold fingers in the darkness due to a lack of tactile buttons. SAR operations are nationally regulated.

The Norwegian Safety Investigation Authority recommends that CAA Norway use the findings in this report to evaluate if the current requirements for personal emergency equipment for SAR crews are sufficient and ensure harmonisation.

Safety Recommendation Aviation No. 2026/10T

On 28 February 2024 LN-OIJ suffered a loss of control and crashed into the North Sea west of Sotra, Norway during a training mission after excessive pitch up attitude. After the accident the crew on board had to survive in the sea for about 45 minutes before being rescued. During their time in the sea, they experienced several difficulties with their personal emergency equipment. For example it was difficult to activate the personal locator beacons with cold fingers in the darkness due to a lack of tactile buttons. SAR operations are nationally regulated and there is no international standardisation.

The Norwegian Safety Investigation Authority recommends that HeliOffshore start work to investigate the possibilities of creating guidelines regarding personal emergency equipment for SAR crews.

Safety Recommendation Aviation No. 2026/11T

On 28 February 2024 LN-OIJ suffered a loss of control and crashed into the North Sea west of Sotra, Norway during a training mission after excessive pitch up attitude. After the accident the crew on board had to survive in the sea for about 45 minutes before being rescued. Time is a critical resource during a rescue operation. The digital tools the rescue coordinators use today do not estimate arrival times that account for weather conditions, such as wind. An estimate of arrival time is done manually by the rescue coordinators based on experience and is one of several considerations that must be balanced when scrambling resources.

The Norwegian Safety Investigation Authority recommends that the Joint Rescue Coordination Centre expand their digital tools to include an estimation of arrival times for resources which factor-in weather conditions as an additional decision support tool.

Safety Recommendation Aviation No. 2026/12T

On 28 February 2024 LN-OIJ suffered a loss of control and crashed into the North Sea west of Sotra, Norway during a training mission after excessive pitch up attitude. After the accident the crew on board had to survive in the sea for about 45 minutes before being rescued. Over the course of the investigation, it was found that new airworthiness requirements, applicable to helicopters operating over water and introduced in an amendment to EASA Part-26, had not been implemented nor were planned to be. This was due to a misunderstanding regarding the way to show and verify compliance. The CAA Norway therefore issued a set of exemptions to keep the Norwegian S-92A fleet operational.

The Norwegian Safety Investigation Authority recommends that the European Aviation Safety Agency make the retroactive design changes required by Part-26 more accessible to operators and provide guidance as to the obligations.

Norwegian Safety Investigation Authority
Lillestrøm, 25 February 2026

Abbreviations

Abbreviations

ADS-B	Automatic Dependent Surveillance-Broadcast
AFCS	Automatic Flight Control System
AIRMET	Airmen's Meteorological Information – a concise description of weather phenomena that may affect aircraft safety that are occurring or may occur (forecast) along an air route.
AI	Attitude Indicator
AIS	Automatic Identification System
ALT	Altitude
AM	Accountable Manager
AMLCD	Active-Matrix Liquid Crystal Display
AMS	Avionics Management System
AOC	Air Operator Certificate
AOL	All Operators Letter
AP	Autopilot
APP	Approach
ATC	Air Traffic Control
ATO	Approved Training Organisation
ATP	Acceptance Test Procedure
ATS	Air Traffic Servies
ATPL(H)	Airline Transport Pilot Licence (Helicopter)
ATPT	Approach to Point
ATT	Attitude Hold
BEA	Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile
CAA Norway	Civil Aviation Authority Norway
CFD	Coupled Flight Director
CIR	Cockpit Image Recorder
CS	Certification Specifications
CVFDR	Combined voice and flight data recorder

CVR	Cockpit Voice Recorder
DC	Direct Current
DCU	Data Concentrator Unit
DDL	Deferred Defects List
DP	Dynamic Positioning
DI	Daily Inspection
EASA	European Aviation Safety Agency
EBS	Emergency Breathing System
EEA	European Economic Area
EFS	Emergency Flotation System
ELT	Emergency Locator Transmitter
ENBR	Bergen airport, Flesland
EPIRB	Emergency Position-indicating Radio Beacon
ERP	Emergency Response Plan
FAA	Federal Aviation Administration
FBL	Light (feeble) turbulence
FCC	Flight Control Computer
FCoE	Functional Centre of Excellence
FD	Flight Director
FDR	Flight Data Recorder
FRR	Shared Resource Information Repository – *Felles RessursRegister*
FSTD	Flight Simulating Training Device
GPS	Global Positioning System
HDG	Heading
HEELS	Helicopter Emergency Egress Lighting System
HEMS	Helicopter Emergency Medical Service
HOFO	Helicopter Offshore Operations
HOV	Hover

HUMS	Health and Usage Monitoring System
IAS	Indicated Airspeed
ICAO	International Civil Aviation Organisation
IOGP	The International Association of Oil & Gas Producers
IR(H)ME	Instrument Rating (Helicopter) Multi Engine
JAA	Joint Aviation Authority
JRCC	Joint Rescue Coordination Centre
JRCC-S	Joint Rescue Coordination Centre – South
KIAS	Knots Indicated Airspeed
KPI	Key Performance Indicator
LED	Light Emitting Diode
MEL	Minimum Equipment List
MMEL	Master Minimum Equipment List
METAR	Meteorological Aerodrome Report
MFD	Multi-function Display
MGB	Main Gearbox
MoC	Management of Change
MOD	Moderate turbulence
MOT	Mark on Top
MR	Main Rotor
MSP	Mode Select Panel
NCS	Norwegian Continental Shelf
NM	Nautical miles
NOLAS	Norwegian Air Ambulance As
NP	Nominated Postholder
NSIA	Norwegian Safety Investigation Authority
NTSB	National Transportation Safety Board
NVG	Night Vision Goggles

OHRP	Offshore Helicopter Recommended Practices
OM-A	Operational Manual Part A – General
OM-B	Operational Manual Part B – Aircraft Operating Matters
OM-D	Operational Manual Part D – Training
OPC	Operator’s Proficiency Check
OSD	Operational Suitability Data
PC	Proficiency Check
PCB	Printed Circuit Board
PF	Pilot Flying
PFBIT	Pre-Flight Built-in Test
PFD	Primary Flight Display
PHLD	Position Hold
PLB	Personal Locator Beacon
PM	Pilot Monitoring
PVI	Pilot Vehicle Interface
RADALT	Radio altitude
RFI	Request for Information
RFM	Rotorcraft Flight Manual
RNoAF	Royal Norwegian Airforce
ROM	Rescue Technical Manual – *Redningsteknisk Operasjons Manual*
ROV	Remotely Operated Vehicle
RUM	Rescue Technical Equipment Manual – *RedningsUtstyr Manual*
RVDT	Rotary Variable Differential Transformer
SAR	Search and Resuce
SAS	Stability Augmentation System
SATCOM	Satellite communication
SF	Collaboration forum for helicopter safety on the Norwegian Continental Shelf – *Samarbeidsforum for helikoptersikkerhet på norsk kontinentalsokkel*

SIGMET	Significant Meteorological Information – a severe weather advisory that contains meteorological information concerning the safety of all aircraft.
SIL	Systems Integrations Lab
SPI	Safety Performance Indicator
SR	Safety Recommendation
TEM	Threat and Error Management
TR	Tail Rotor
TR(H)	Type Rating (Helicopter)
ULB	Underwater Locator Beacon
USA	United States of America
UTC	Coordinated Universal Time
VHF	Very High Frequency
VFR	Visual Flight Rules
VNL	Valid only with correction for defective near vision
VRS	Vortex Ring State
QNH	The pressure set on the subscale of the altimeter so that the instrument indicates its height above sea level.
WMO	World Meteorological Organisation
WS	Wind Shear