Norwegian Safety Investigation Authority

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REPORT Defence 2021/02

REPORT ON SERIOUS AVIATION INCIDENT ON 11 MARCH 2020 INVOLVING A C-130J SUPER HERCULES MILITARY TRANSPORT AIRCRAFT AT MOSKEN, A ROCKY ISLAND IN VÆRØY MUNICIPALITY IN NORDLAND COUNTY

Photo: Peder Torp Mathisen/Norwegian Armed Forces

This report has been translated into English and published by the NSIA to facilitate access by international readers. As accurate as the translation might be, the original Norwegian text takes precedence as the report for reference.

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REPORT ON SERIOUS AVIATION INCIDENT

Type of aircraft:	Lockheed Martin C-130J Super Hercules military transport aircraft	
Nationality and registration:	Norwegian	
Owner:	The Norwegian State represented by the Ministry of Defence	
Operator:	The 335 Squadron, RNoAF	
Crew/aircraft commander:	Mustang 31 (MG31): Two pilots: Aircraft commander candidate – Pilot Monitoring (PM) and instructor – Pilot Flying (PF) Two loadmasters: LM1 in the cockpit and LM2 in the cargo bay	Mustang 32 (MG32): Two pilots: Pilot Monitoring (PM) and Pilot Flying (PF) Two loadmasters: LM1 in the cockpit and LM2 in the cargo bay
Passengers:	Four passengers, one of whom was seated in the cockpit when the incident occurred	One passenger in the cockpit
Incident site:	Mosken, a rocky island in Værøy municipality (67°45′1″N 12°45′3″E)	
Time of incident:	21:26 hours on Wednesday 11 March 2020	

Unless otherwise stated, all times referred to in this report are local times (UTC + 1 hour).

NOTIFICATION OF THE INCIDENT

The NSIA's investigation was initially led by the Defence Accident Investigation Board Norway (DAIBN), while it was in practice conducted by personnel from the Accident Investigation Board Norway (AIBN). When the DAIBN was closed down on 1 July 2020, that board's mandate was transferred to the AIBN. At the same time, the AIBN changed its name to the Norwegian Safety Investigation Authority (NSIA). The NSIA took over the entire investigation from 1 July 2020.

The RNoAF Flight Safety Inspector notified the DAIBN of the incident on the evening that it occurred. Based on its degree of severity, the DAIBN decided, in consultation with the AIBN, to initiate an investigation into the incident. The AIBN established contact with the RNoAF and started to collect factual information. Because of restrictions associated with the Covid-19 pandemic, interviews with the personnel involved were delayed until April 2020.

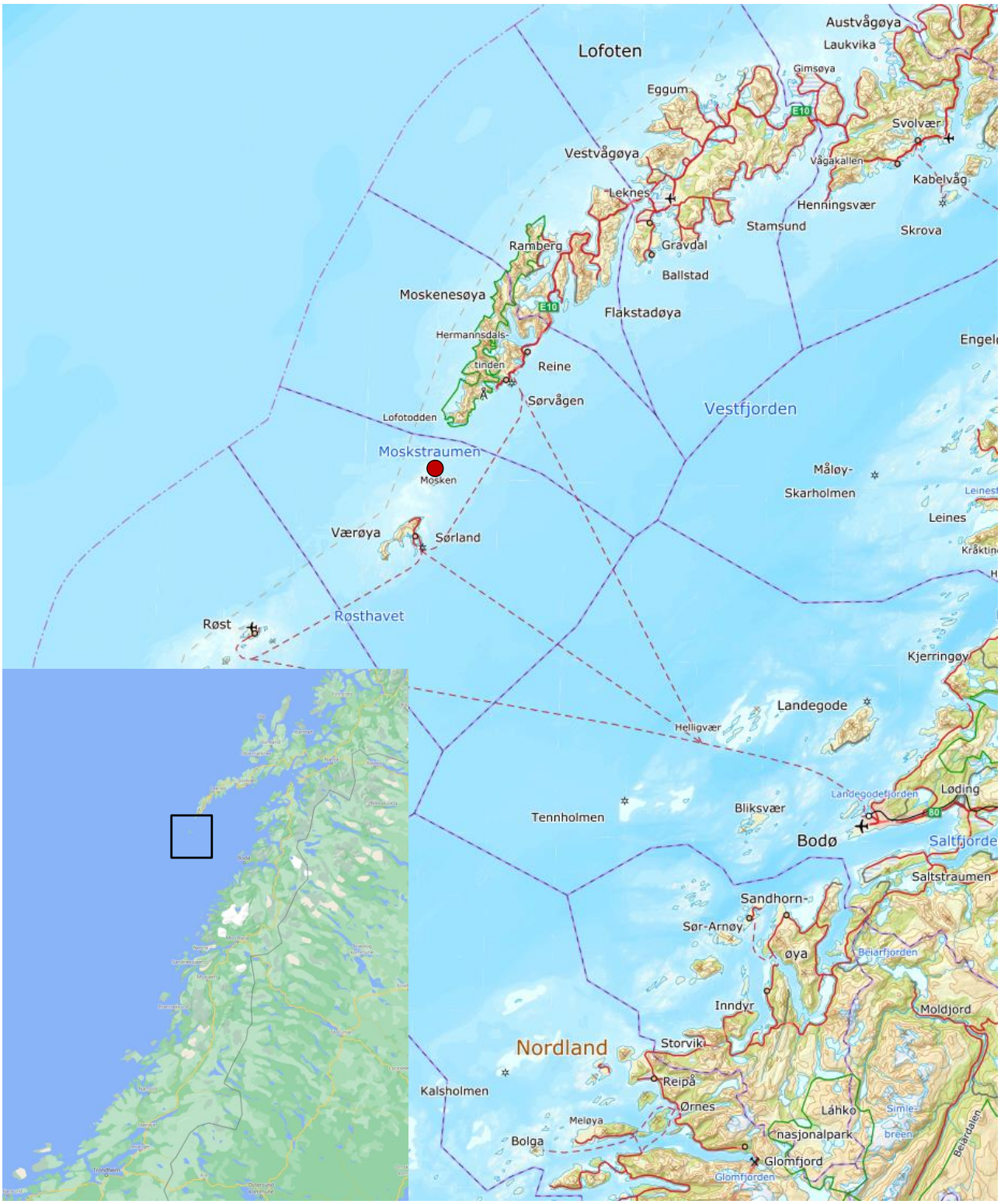

Figure 1: The incident occurred at Mosken Island in Værøy municipality in Lofoten, in Nordland county (the incident site is marked with a red dot). Map: © Norwegian Mapping Authority

SUMMARY

What happened?

At 20:26 on 11 March 2020, in connection with exercise Cold Response, a C-130J Hercules transport aircraft with eight people on board nearly crashed into the rocky island Mosken in Værøy municipality in Lofoten. A last-minute avoidance manoeuvre prevented a collision, and the aircraft cleared the terrain by 144 ft (44 metres). The aircraft was the first in a formation of two C-130J aircraft practising low-level flying with night optics under night visual conditions.

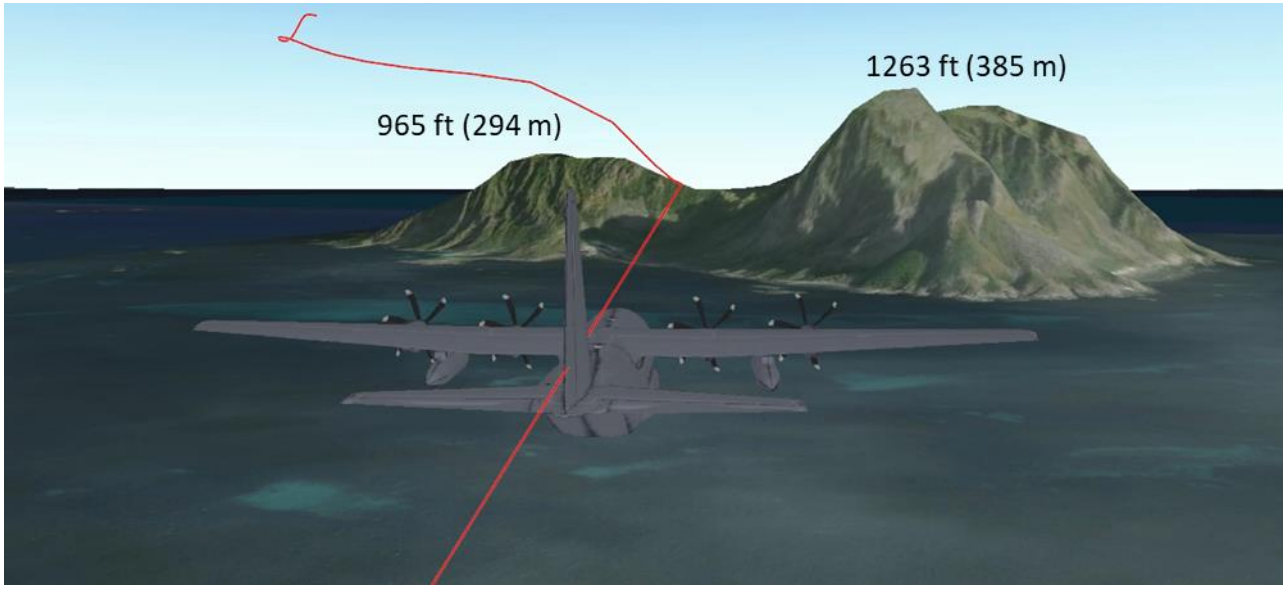

Figure 2: The aircraft cleared the terrain by 144 ft (44 metres). Source: RNoAF

Investigation findings

The NSIA has identified a number of local safety problems ('what went wrong') in all phases of the sequence of events leading up to the Hercules formation nearly crashing into the rocky island Mosken.

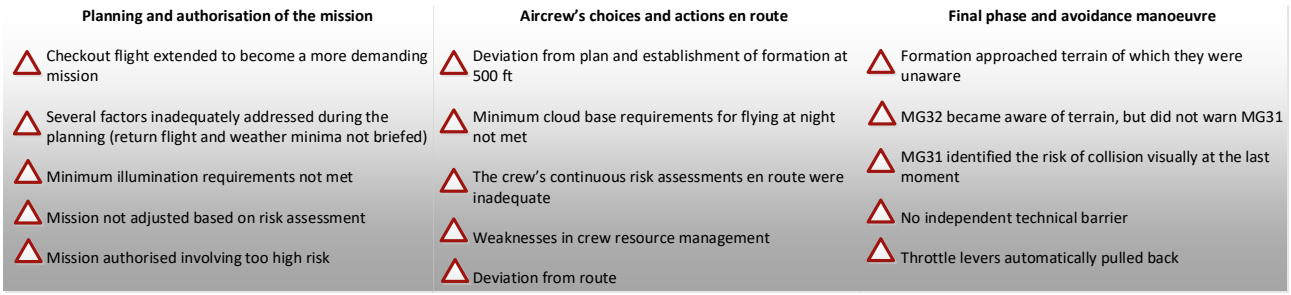

Figure 3: Local safety problems identified in the sequence of events leading up to the Hercules formation nearly crashing at Mosken. Illustration: NSIA

It was largely coincidence and the last-minute actions of the aircraft commander that prevented the loss of another RNoAF C-130J aircraft and crew[1]. Had the first aircraft in the formation initiated the manoeuvre less than one second later, the outcome would have been a catastrophic collision with the terrain.

[1] On 15 March 2012, a C-130J aircraft from the 335 squadron crashed into the Kebnekaise mountain in Sweden. All five persons on board died.

The NSIA understands the incident to have been caused by a combination of local conditions, active failures and latent weaknesses. The local conditions can be related to a combination of demanding weather and light conditions, low-level flying with night optics and commander check-out. The active failures were that the formation deviated from the planned route and weaknesses in the crew resource management (CRM). In addition, the authorised mission entailed too high a risk and was not in accordance with the regulatory framework for C-130J operations. The authorisation process thus failed to function as a safety barrier. The latent weaknesses can be linked in particular to the RNoAF's safety management, a pressure to deliver in combination with under-staffing and a high-performance culture, and inadequate supervision and follow-up. The RNoAF's management had not identified weaknesses relating to safety in the 335 squadron. Also, the RNoAF did not adequately dimension missions in relation to the available resources.

Safety recommendations

The NSIA supports the recommendations made in the RNoAF's internal investigation report on the incident and the guidelines issued by the Chief of the RNoAF. At the same time, the RNoAF should intensify its safety management work, including risk management, competence and safety culture. The NSIA also questions whether the RNoAF is capable of identifying and remedying its own systemic safety issues and believes that the investigation has identified a need for an external supervisory body.

Based on its investigation, the NSIA submits three safety recommendations:

- The Norwegian Safety Investigation Authority recommends that the Royal Norwegian Air Force review and improve its risk management processes in terms of identification of hazards, safety barriers and risk factors, as well as acceptance criteria, requirements for compensatory measures and follow-up of same.

- The Norwegian Safety Investigation Authority recommends that the Royal Norwegian Air Force conduct a survey to enable it to describe and understand the organisation's safety culture, both at command level and in operational units, as well as possible. Such a survey can establish a benchmark for subsequent safety work and efforts to improve the organisation's safety culture.

- The Norwegian Safety Investigation Authority recommends that the Ministry of Defence establish an independent overall military aviation authority (supervisory authority). This aviation authority must be allocated new resources and not be established at the expense of the Royal Norwegian Air Force's existing activities.

ABOUT THE INVESTIGATION

Purpose and method

The Norwegian Safety Investigation Authority (NSIA) is a public investigation body. The purpose of the NSIA's investigations is to elucidate matters assumed to be important to the prevention of accidents and serious incidents. It is not the NSIA's task to apportion blame or liability under criminal or civil law.

The NSIA has classified the incident as a serious aviation incident. This means that only chance prevented the incident from escalating into an accident. The purpose of this investigation has been to determine what caused the Hercules formation to come so dangerously close to Mosken Island in connection with the winter exercise Cold Response 2020 (CR20).

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

The RNoAF investigation

Based on the degree of severity of the incident and the potential for learning, the Chief of the RNoAF decided to appoint an investigation team to conduct an internal investigation of the incident. The investigation team's mandate coincided with the NSIA's mandate, namely to investigate accidents and incidents for the purpose of contributing to better safety. The RNoAF's internal investigation also used the NSIA method as its point of departure.

The report from the internal investigation was completed on 11 June 2020 and the NSIA has received a copy of the full report. The RNoAF investigation team submitted seven safety recommendations in its report, which subsequently formed the basis for concrete guidelines set out in a letter from the Chief of the RNoAF. The Chief of the RNoAF has also issued guidelines on follow-up in a further three areas. The conclusion and recommendations from the RNoAF investigation, as well as measures that have been implemented, are described in Appendix C to this report.

Focus and delimitation of the investigation

The NSIA has conducted its own independent and complete investigation of the incident. The facts and findings of the internal investigation have largely been confirmed and verified in the NSIA's investigation. On that basis, the NSIA supports the conclusion and recommendations of the RNoAF's own investigation team. Taken together, the guidelines from the Chief of the RNoAF are evidence of an organisation that is willing to address the improvement areas identified in this investigation.

In this report, the NSIA has used parts of the factual information provided in the internal RNoAF investigation report. The NSIA did not see any need to describe and discuss in detail areas that were addressed and resulted in concrete recommendations in the internal investigation report. The NSIA has instead focused on clarifying and addressing areas for improving safety in the RNoAF and Armed Forces that were given less weight in the internal investigation.

On 15 March 2012, a C-130J aircraft from the 335 squadron crashed into the Kebnekaise mountain in Sweden. All five persons on board were killed. The accident was investigated by the Swedish Accident Investigation Authority (Swedish SHK). In the present investigation, the NSIA has looked into how the findings and recommendations from the investigation into the Kebnekaise accident

[2] NSIA - Norwegian Safety Investigation Authority. See https://havarikommisjonen.no/About-us/Methodology

were followed up by the RNoAF, and whether any shortcomings in the follow-up could have had a bearing on the Mosken incident eight years later.

Sources of information
The NSIA's investigation is largely based on the following sources:

- Data from the flight recorders
- Interviews with the personnel who were directly involved in the incident, and management and flight safety personnel in the 335 squadron
- The report from the RNoAF's internal investigation of the incident and meetings with members of the RNoAF's internal investigation team
- Visits to the 335 squadron, including an observation flight with a C-130J Hercules
- Interviews with personnel from the RNoAF's higher-level management, including the Base Commander of Gardermoen Air Station, the Commander of 134 Air Wing, the RNoAF's Chief of Staff, the Chief of the Norwegian Air Operations Centre (NAOC), the Inspector and Deputy Inspector of Air Operations, the RNoAF Flight Safety Inspector and the Chief of the RNoAF
- Information received from the Armed Forces Materiel Safety Authority, the Norwegian Defence Materiel Agency's Air Systems Division, the Institute of Aviation Medicine (FMI) and Safetec
- A review of the investigation report following the Kebnekaise accident in 2012 from the Swedish Accident Investigation Authority (Swedish SHK)
- Documentation received from the RNoAF concerning follow-up of recommendations after the Kebnekaise accident
- A review of RNoAF rules and regulations, provisions and instructions and a selection of flight safety and inspection reports
- Radar data and information received from air traffic controllers in Avinor Flysikring AS

1. FACTUAL INFORMATION

1.1 History of flight[3]

1.1.1 Background to the mission

The 335 squadron participated in the winter exercise Cold Response (CR20)[4] with two C-130J transport aircraft and crew, operating from Bodø Air Base during the period from 8 to 14 March 2020. The exercise was cut short because of the Covid-19 situation and, for the 335 squadron, it was further shortened because of the incident on 11 March at Mosken in Lofoten. The squadron chose to return to its home base at Gardermoen a few days after the incident.

The air mission carried out on 11 March 2020 consisted of participating in Composite Air Operations (COMAO)[5] in an exercise area west of Lofoten. During the planning phase, the mission was extended to include a low-level flying route around Bodø. The mission was carried out as a formation flight of two aircraft: Mustang 31 (MG31) and Mustang 32 (MG32). It also served as a checkout flight for the aircraft commander candidate in MG31. MG31 was to continue the flight to transfer personnel to Evenes, while MG32 was to return to Bodø.

1.1.2 Planning

Flight planning and briefing took place in accordance with standard procedures for COMAO missions, which included a joint review of the mission for all participating aircraft and formations. An additional specific briefing was held for the two aircrews from the 335 squadron. The aircraft commander candidate had chief responsibility for the planning. He was assisted by Mission Support (MS)[6], which followed normal procedures for preparing maps and mission-related material.

The head of COMAO wanted the transport aircraft to fly at between 12,000 and 13,000 feet, but the 335 squadron expressed a wish to conduct the flight in a lower-level segment to enhance the training outcome, a wish that was granted. During the planning, it was found that the weather conditions could pose a challenge. Uncertainty was also expressed regarding the light conditions.

According to the aircrew members, there was ample time to plan the COMAO part of the flight. However, a new exercise element was introduced towards the end of the planning phase. This was a low-level flight route over the area around Bodø, to be flown using a new low-level flying concept with night vision goggles (NVG). This low-level flying concept had only recently been introduced to the squadron. NVG is described in more detail in Section 1.6.7.

Figure 4 shows the formation's planned route to the exercise area west of Lofoten and the low-flying route over the area around Bodø. MG31 was to lead the formation during the

[3] Parts of this chapter are taken from the internal investigation report (RNoAF, 2020). The NSIA has verified the sequence of events using data from the flight recorders and information obtained in interviews.
[4] Cold Response (CR) is a Norwegian-led multinational military exercise that has been held every two years since 2006.
[5] Coordinated training exercise with fighter planes and other military aircraft.
[6] Mission Support (MS) is charged with providing support for mission planning and implementation processes in the areas of intelligence, electronic warfare, operational services and navigation.

COMAO part of the mission while MG32 would lead the formation through the low-flying part. The choice of route from the exercise area west of Lofoten to the start of the low-flying route was not specifically addressed during the pre-mission planning and briefing.

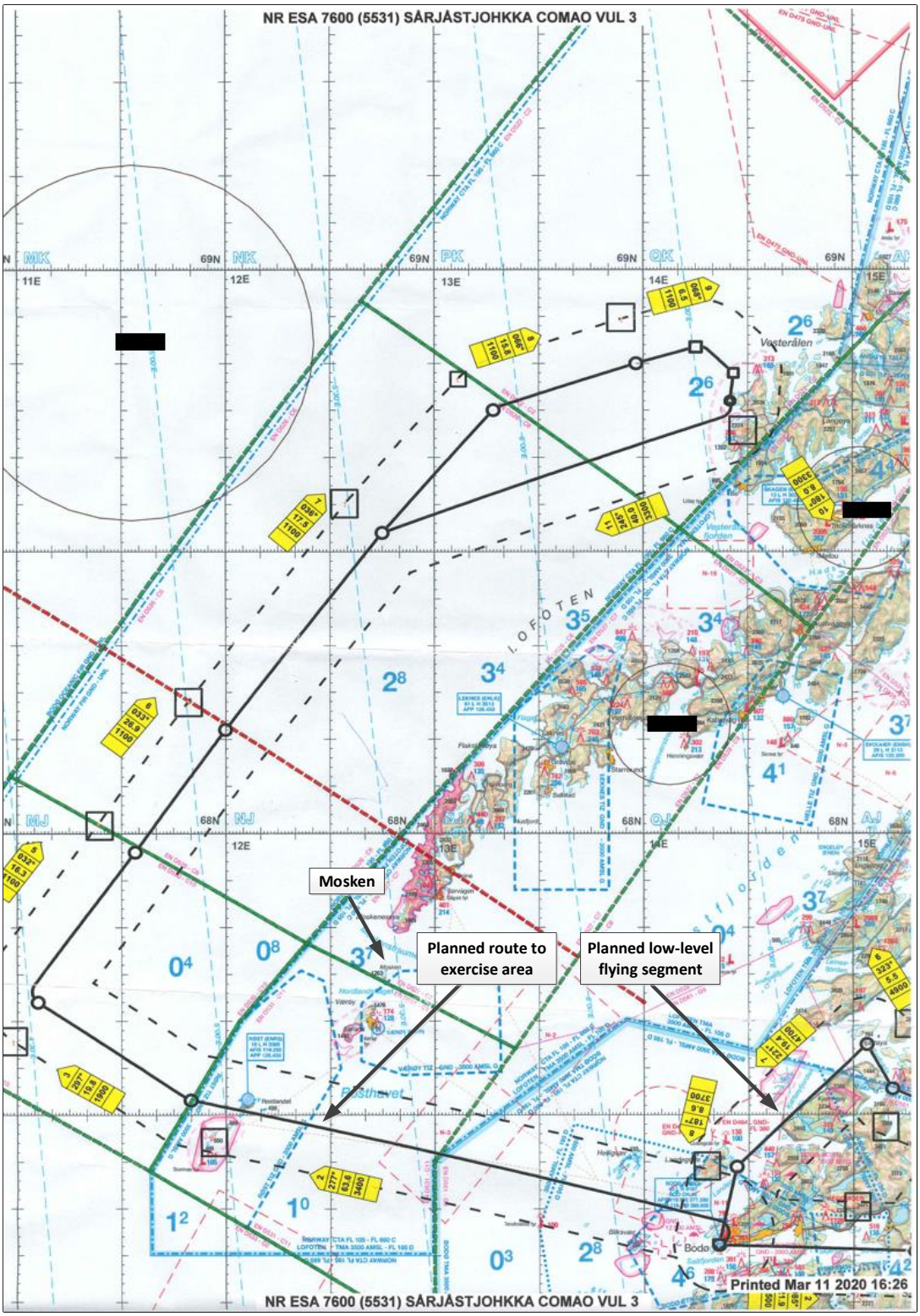

Figure 4: Planned route to the exercise area west of Lofoten and low-flying route over the planned area around Bodø (marked with a black line in the bottom right corner). Source: RNoAF

1.1.3 Authorisation

This particular mission was authorised[7] by the Supervisor of Flying (SOF), who was also the squadron's Detachment Commander – (DETCO) and the 335 squadron's Deputy Commander. In addition, SOF/DETCO attended as observer during part of the planning and pre-mission briefing.

When the mission was authorised, particular emphasis was given to a simulated drop that was to be carried out as part of the COMAO mission. The planned low-level flight route over the area around Bodø was also given a great deal of attention. Both weather and light conditions were addressed, without being assessed as hindrances to the mission. The formation was permitted to carry out the mission at flight level 110–130, if the weather and light conditions did not permit low-level flying. This alternative was discussed, but rejected because ice formation was reported at that altitude.

During the final part of the planning phase, SOF/DETCO obtained a printout of expected illumination levels in Bodø during the relevant time period from the Norwegian Meteorological Institute's meteorological service at Ørland Airport (see Figure 5).

Predicted Illumination Levels at Bodo (67.27°N 014.35°E) for 11-mar-2020 1200GMT to 12-mar-2020 1200GMT Illumination Values in Millilux

Time GMT	Clear Sky	High Cloud OVC CS	Medium Cloud OVC AS	Low Cloud OVC ST	Solid Cloud OVC NS
1700	****	****	****	****	****
1800	285.7	219.1	128.3	114.6	61.7
1900	3.2	2.5	1.4	1.3	0.7
2000	2.2	1.7	1.0	0.9	0.5
2100	9.9	7.6	4.4	4.0	2.1

Figure 5: Excerpt from the table of 'Predicted Illumination Levels at Bodø' used in connection with the authorisation of the mission. Source: RNoAF

The table in Figure 5 shows that the expected illumination levels during the flight period, in light of the weather forecast (medium/low cloud at 19–20 GMT), was below the minimum regulatory requirement of 2.2 millilux (see Section 1.18.4.2). Throughout the planning and authorisation of the mission, the attitude prevailed that the expected luminous intensity values were not absolute. The mission was therefore authorised based on a 'wait and see' approach. This entailed that the aircrews were to assess en route whether the light conditions permitted them to complete the mission, even if the minimum requirements for luminous intensity were not met as a result of low cloud cover.

[7] By authorisation of an air mission is meant approval of pilots/aircrew for conducting an ordered air mission so that supervision, control and aviation safety are ensured, see Section 1.18.2.

No lowest permitted altitude was specified on the authorisation form. However, SOF/DETCO has stated that the formation was authorised down to 500 ft for the mission as a whole.

The crews filled in risk assessment forms for the mission (see Section 1.17.5.3), which were signed by SOF/DETCO.

1.1.4 The flight

1.1.4.1 *Introduction*

Both aircraft had two pilots and one loadmaster in the cockpit. The loadmaster occupied the third seat, a little behind and between the two pilot seats (see Figure 6). In the aircraft that led the formation (MG31), the aircraft commander and instructor (PF MG31) sat in the right-hand seat, while the aircraft commander candidate (PM MG31) sat in the left seat. In MG32, the aircraft commander (PF MG32) sat in the left seat as usual on flights other than instruction flights, while the second pilot (PM MG32) sat in the right-hand seat.

Figure 6: Photo taken from the third cockpit seat in a C-130J aircraft. The commander (PF) in the left seat and the second pilot (PM) in the right seat. Photo: NSIA

Navigation is primarily based on digital maps shown in one of four head-down displays (HDD) in the cockpit. A hard copy of the map containing information about the planned route is also brought on board. HDD is described in more detail in Section 1.6.5.

The crew on board MG31 wanted to use the night vision imaging system (NVIS) in the cockpit, but that light configuration did not adequately illuminate the head-up display

(HUD) on the left side. The MG31 crew therefore chose to use the ordinary cockpit lighting and dim it manually. On board MG32, the NVIS lighting worked as intended. NVIS is described in more detail in Section 1.6.6.

1.1.4.2 *Transit to the exercise area and execution of COMAO*

Start-up, taxiing and take-off from Bodø (ENBO) went as normal. At take-off at 18:26, the illumination was relatively good and some crew members chose to not use NVG during the first part of the trip.

It soon became clear that the weather did not permit flying in visual meteorological conditions (VMC) at the planned altitude of 1,000 ft. In order to avoid flying into the low cloud cover, the formation chose to descend to approximately 500 ft – an altitude that was maintained until the incident occurred.

The weather was characterised by low cloud cover with intermittent showers. This meant that the formation had to deviate from the planned route as it drew close to Røst, and that it had to fly south of Skomvær Lighthouse to keep flying VMC before getting back on route.

The COMAO mission was completed according to plan and the formation concluded its part of the mission on time. Meanwhile, darkness had descended and all the pilots were using NVG. PM MG31 was not happy with the performance of its NVG, and therefore took over the loadmaster's NVG at the start of the COMAO mission at around 19:19 hours.

Communication data from the cockpit voice recorder (CVR) shows that the MG31 crew commented on the weather and light conditions being demanding on several occasions in the course of the COMAO mission. PF MG31 also asked PF MG32 several times whether visibility was satisfactory and whether they were able to see the formation leader.

1.1.4.3 *Return flight from the exercise area*

After the COMAO mission was completed north-west of Værøy Island, the crew started to focus on the next part of their mission, which consisted of low-level flying over the area around Bodø. The formation was still led by MG31. Several of the pilots and the SOF/DETCO who authorised the mission have expressed that it was their understanding that the planned route to the exercise area would also be followed when returning to Bodø. The aircraft commander candidate (PM MG31) suggested on two occasions that the navigation system be programmed to reverse the route they had followed to the exercise area. The instructor (PF MG31) wanted to fly a more direct route to Bodø, however, and he eventually asked PM MG31 to enter Røst (ENRS) as the next point in the navigation system.

After the decision was taken, PM MG31 was mostly preoccupied with radio communication. He also notified PF MG31 of transferring his attention to inside the cockpit ('head down' transition).

As a natural part of concluding the COMAO mission, the formation had to obtain clearance to leave the exercise area. Such clearance was granted by the military Control and Reporting Centre (CRC) at Sørreisa (Viper). At 20:18, Viper proposed IFR

clearance[8] to flight level 150. PF MG31 first replied: '*Yes…we can just leave…split up, then*'. In response to input from PF MG32, however, clearance was instead requested to continue flying at 500 ft in accordance with the Visual Flight Rules (VFR) on the return journey to Bodø.

While waiting for clearance to leave the exercise area, the MG31 crew discussed how they would get to the planned low-flying route over the Bodø area. There was also some discussion as to whether it would be possible to complete the planned low-flying route. PM MG31 suggested IFR clearance, but the low-level flying was not cancelled when PF MG31 asked whether the original plan should simply be abandoned.

At 20:21 the formation received clearance to leave the exercise area and fly VFR at 500 ft back to Bodø. The formation continued its flight in accordance with the clearance. PF MG31 has stated that they navigated to stay clear of the Røst Traffic Information Zone (TIZ) and eventually ended up on a more easterly course towards Mosken. Figure 7 shows the route taken by the formation when leaving the exercise area and MG31's exact position at 20:21.

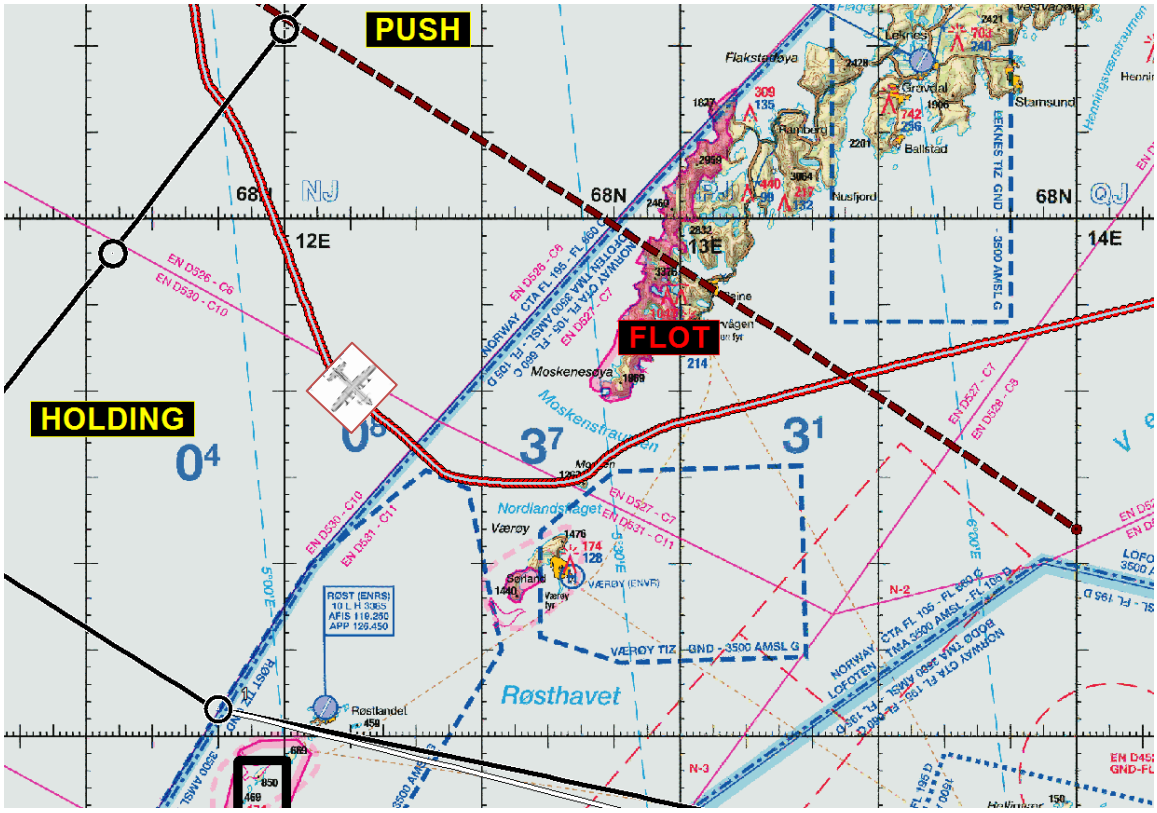

Figure 7: The formation's route when leaving the exercise area (illustrated by a red double line). The black line shows the route followed when entering the exercise area. The aircraft symbol marks MG31's exact position at 20:21. Source: RNoAF

At 20:23, PF MG31 remarked that the weather conditions were poor and that some terrain and islands were beginning to emerge up ahead. PM MG31 answered that it was dark and that visibility was poor. Immediately afterwards, PF MG32 voiced the opinion that the conditions were not good enough for completing the scheduled low-flying route at Bodø. The two aircraft crews agreed to cancel the low-flying route and instead split the formation and continue flying according to separate clearances. MG32 continued flying

[8] IFR – Instrument Flight Rules

VFR all the way to Bodø. PM MG31 started to coordinate with the air traffic service unit to get IFR clearance for the continued flight to Evenes.

Less than one minute prior to the near collision, the crews were about to complete the split-up of the formation. When PF MG31 ordered PF MG32 to split the formation, he also announced that Værøy Island was located on the right. At that time, both aircraft were still on direct course to Mosken.

According to Avinor Flysikring AS, the air traffic controllers found nothing out of the ordinary when the formation split up. MG32 was on the Bodø APP frequency, while MG31, which was heading for Evenes, switched to Norway Control. MG31 was flying at 500 ft less than 1 NM west of Mosken when it received clearance to climb to 5,000 ft. See Section 1.19.6 for more details.

After that, MG31 and MG32 conducted different manoeuvres to steer clear of Mosken. These are described in detail below.

1.1.4.4 *Mustang 31's flight passed Mosken*

PF MG31 has stated that his attention was almost entirely focused outside the cockpit during the period prior to the near collision with Mosken. PM MG31 has explained that, during the same period, much of his capacity was taken up by communication with the air traffic service unit.

At the time, the crew had selected NAV RADAR display and Monopulse Ground Map (MGM) on HDD 1 and HDD 4 in the cockpit (see Figure 15). In this configuration, the terrain in front of the aircraft is displayed, but only in black and white. This function is chosen for flights under instrument meteorological conditions (IMC) when approaching land from the open sea, among other things to be able to confirm the aircraft's position and distance from shore.

The aircraft flew about 500 ft above ground level (AGL) at a speed of 200 knots. At 20:26:02, PF MG31 banked the aircraft to the left; three seconds later he visually observed the terrain ahead through the NVG and immediately initiated an evasive manoeuvre to avoid impact with the terrain.

The manoeuvre consisted of raising the nose of the aircraft and selecting 'TAKEOFF power' (full engine power) on all four engines at the same time. Banking to the left continued during the first part of the manoeuvre. When the manoeuvre was initiated, the aircraft was flying at 544 ft AGL according to information from the radar altimeter. The speed was 198 knots. A vertical acceleration of 1,95 G was registered as the aircraft's nose was raised to an angle of 14.3°. After four seconds the aircraft had reached its maximum angle of bank (AOB) of 22° to the left. The angle of bank was then reduced towards zero degrees.

When PF MG31 moved the throttle lever to the forward position, it was moved back automatically because the auto-throttle function was still active. The engine power was reduced for about 10 seconds before PF manually deactivated the auto-throttle function and restored full engine power on all four engines.

The aircraft continued to climb as the nose angle was gradually reduced from 14.3° to 8.2°. The speed was maintained at almost 200 knots (103 m/s). Approximately

13 seconds after initiating the climb to safe height, one of the aircraft's ground collision avoidance systems (GCAS) issued warnings in the form of both Altitude and Pull-Up warnings. GCAS is described in detail in Section 1.6.3.1.

At 20:26:19, 14 seconds after the obstacle was detected, MG31 passed the northern part of Mosken with a clearance of 144 ft (44 m). It then continued to climb to the altitude of 5,000 ft for which clearance had been granted. Figure 8 shows MG 31 shortly before the near collision with Mosken and the aircraft's subsequent manoeuvres.

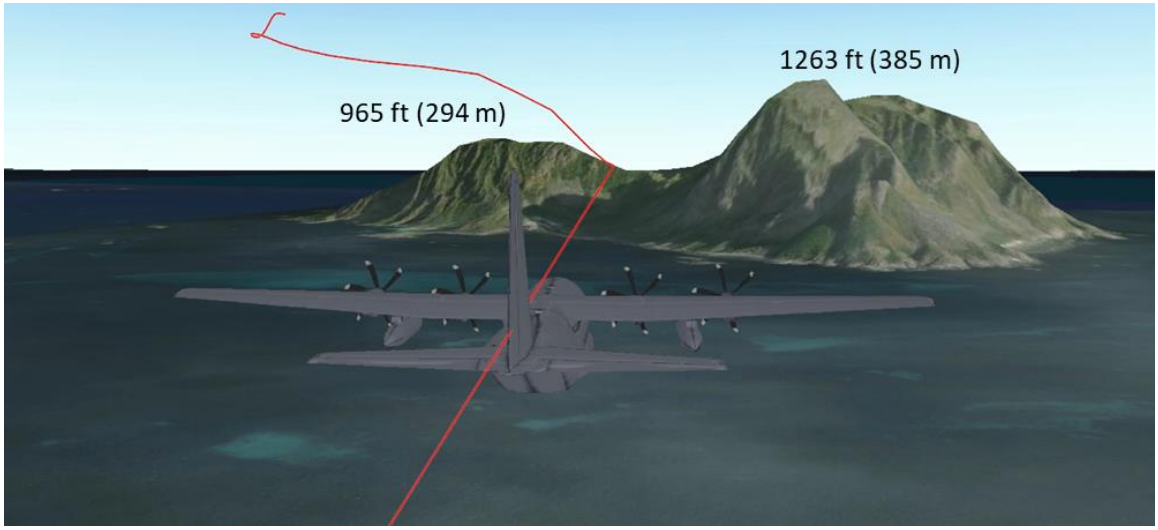

Figure 8: MG31 shortly before the near collision with Mosken. Source: RNoAF

PF MG31 has stated that he observed several small islands and skerries before spotting the terrain that was in fact Mosken directly ahead of the aircraft. According to PF MG31, the aircraft entered the cloud cover (IMC) immediately after it started to climb. PF MG31 was the only person who visually saw Mosken. Figure 9 shows MG31's ground track on passing Mosken.

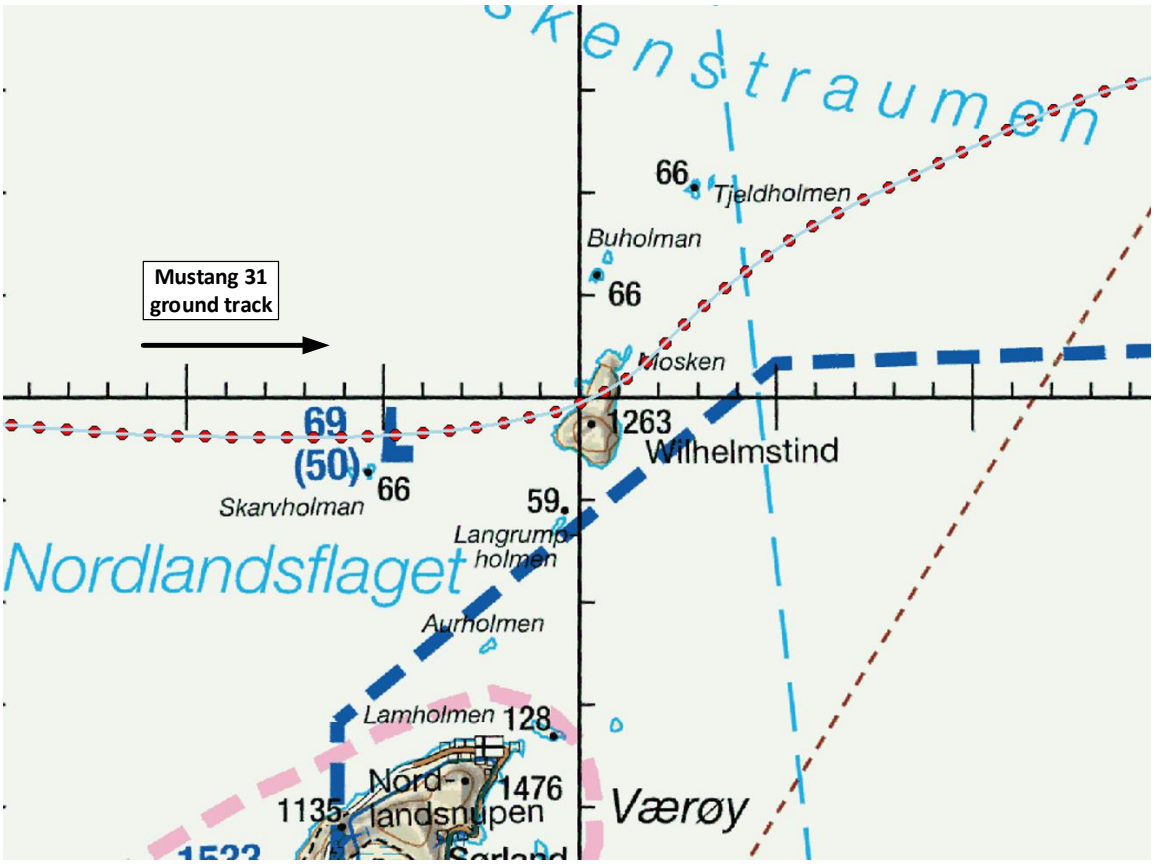

Figure 9: MG31's ground track on passing Mosken. Source: RNoAF

1.1.4.5 *Mustang 32's flight passed Mosken*

When nearing Mosken, MG32 was approximately half a nautical mile (930 m) behind and slightly to the right of MG31. PF MG32 has stated that the exterior lights on MG31 were clearly visible and that there were no challenges worth mentioning in maintaining visual contact and position in the formation.

Immediately before PF MG31 spotted Mosken visually, the MG32 crew became aware of the terrain on the digital map and weather radar. HDD 1 and HDD 4 in the cockpit had been set to the NAV RADAR function and with weather radar data displayed. The terrain was identified as the Mosken Island.

Unlike MG31, MG32 chose a horizontal avoidance manoeuvre to avoid colliding with the terrain. PF MG32 initiated a left turn towards the north. When starting to turn, the aircraft held a speed of 196 knots and was flying at 576 ft AGL. It reached its maximum angle of bank of 52.25° and 1.52 G at 20:26:09. It maintained a steady height and speed throughout the manoeuvre, which was completed in about 10 seconds.

MG32's closest proximity to Mosken in connection with the avoidance manoeuvre was approximately 1,500 m. After maintaining a northerly course for about 10 seconds, the aircraft was turned to the right and set course for Bodø. In connection with this latter turn, the lowest height was only 374 ft AGL. Figure 10 shows MG32's ground track around Mosken. Figure 11 is a photo of Mosken looking north from the island of Værøy.

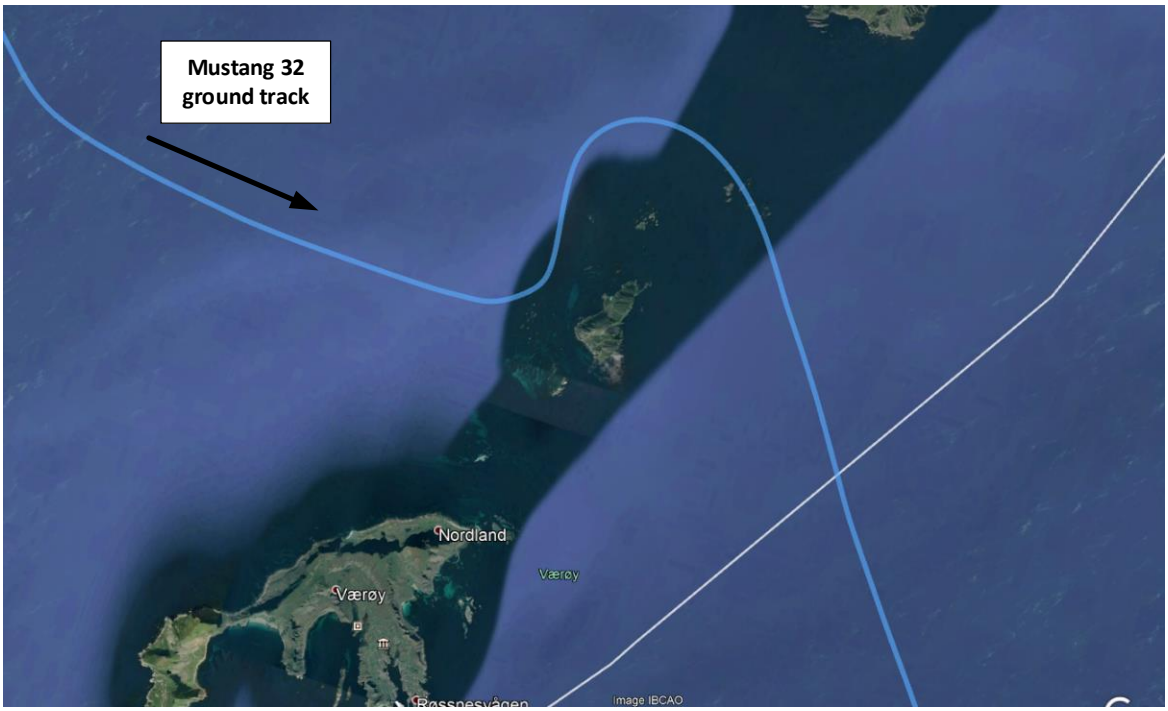

Figure 10: MG32's ground track around Mosken. Source: FDR/RNoAF

Figure 11: Mosken Island viewed from Værøy Island. Photo: Jostein Torstensen

1.1.5 Approach to the destinations Evenes and Bodø

Following the incident, MG31 continued its flight to Evenes under IFR clearance. Whether the mission should be aborted as a consequence of the incident, was not discussed. With the exception of some comments amongst themselves immediately after

the near collision with Mosken, the crew did not discuss the incident until after landing the aircraft at Evenes. From the CVR, it is clear that the mood in the cockpit was calm and controlled during the flight.

The MG31 crew did not use NVG on the remaining leg of the journey to Evenes. MG31 landed at Evenes at 20:53. MG32 continued to fly VFR at low level to Bodø, where it landed at 20:47.

After landing, the MG31 crew pulled out the fuse for the CVR to prevent the audio recording from the incident from being overwritten, before contacting SOF/DETCO to report the incident.

1.2 Personal injuries

None

1.3 Damage to aircraft

None

1.4 Other damage

None

1.5 Personnel information

1.5.1 Flight time, experience and qualifications

Table 1 shows hours of flight time and experience for the four pilots who participated in the mission. At the time of the incident, PF MG32 was considered one of the most experienced pilots in the 335 squadron, and several people have described him as an informal leader in the squadron.

According to the RNoAF investigation report, three of the four pilots were deemed to have sufficient continuity in the disciplines comprised by the mission to be qualified for the mission. Because of insufficient continuity, PF MG31 had status ‘red’ (not qualified) in the disciplines ‘Form Wing’ and ‘NVG Form Wing’. He had recently been checked out as an instructor and had therefore flown only a few instruction flights.

The qualification requirements for operational air personnel and the ‘Personnel and Qualification Status Program’ (PAQS), which is the tool used to keep an overview of the crew’s qualifications, are described in more detail in Section 1.18.5.

The SOF/DETCO who had authorised the mission was aware that the PF MG31 had status ‘red’ in the above-mentioned disciplines. This had been addressed prior to the exercise, but, based on his qualifications, it was nonetheless accepted that he would fly as an instructor. PF MG31 has told the NSIA that he felt competent to take part in the mission.

Table 1: Flight time and experience of the pilots in MG31 and MG32. Source: RNoAF

Crew member	Experience in the 335 squadron	Total hours of flight time	Last 24 hours[9]	Last 30 days	Last 90 days	Total hours on the aircraft type
MG31 aircraft commander (PF) (instructor)	10 years	3,533.6	1.9*	34.6	80.7	2,055.9
MG31 second pilot (PM) (aircraft commander candidate)	4 years	1,306.7	1.9*	15.9	42.3	1,123.7
MG32 aircraft commander (PF)	> 12 years	7,458.6	2.3*	31.9	67.4	5,175.6
MG32 second pilot (PM)	0 years	1,064.2	2.3*	20.2	52.7	82

1.5.2 Workload prior to the incident

After the incident, all crew members have completed separate forms giving details of what they had been doing during the 72 hours immediately preceding the incident. The form was completed as part of the RNoAF's medical examination and was reviewed together with an aviation doctor. The NSIA has received a summary of what the crew members reported, prepared by the aviation doctors in Bodø and at Gardermoen.

It was noted in the RNoAF report that the run-up to such a demanding mission could be described as sub-optimal. Among other things, PM MG31 and PF MG31 had high workloads prior to the incident. This is seen in conjunction with the planning of the commander checkout flight and the fact that the incident occurred during the start-up phase of the CR20 exercise. Furthermore, PF MG31 had been working in the USA immediately before the exercise and was engaged in civilian studies in addition to his full-time job in the 335 squadron.

1.6 Aircraft information

1.6.1 General information

The C-130J Hercules (see Figure 12) is a transport aircraft with four turboprop engines and is manufactured by the US company Lockheed Martin. The aircraft is an updated version of the Lockheed C-130 Hercules, with a longer fuselage, upgraded engines and avionic systems, and a more advanced flight deck where the navigator is no longer part of the aircraft crew.

[9] *All pilots had flown in a coordinated training exercise the day before the incident. It had been a daytime mission, extending slightly beyond the 24-hour period.

Figure 12: The RNoAF's C-130J Hercules. Photo: Chris Lofting

Five C-130J aircraft were procured and put into operation in the RNoAF in 2008/2009. The aircraft replaced the C-130E/H models that had been in operation since 1969. The RNoAF considers the aircraft to be highly functional, and it is used for several different types of mission.

Figure 13 shows the aircraft's external dimensions.

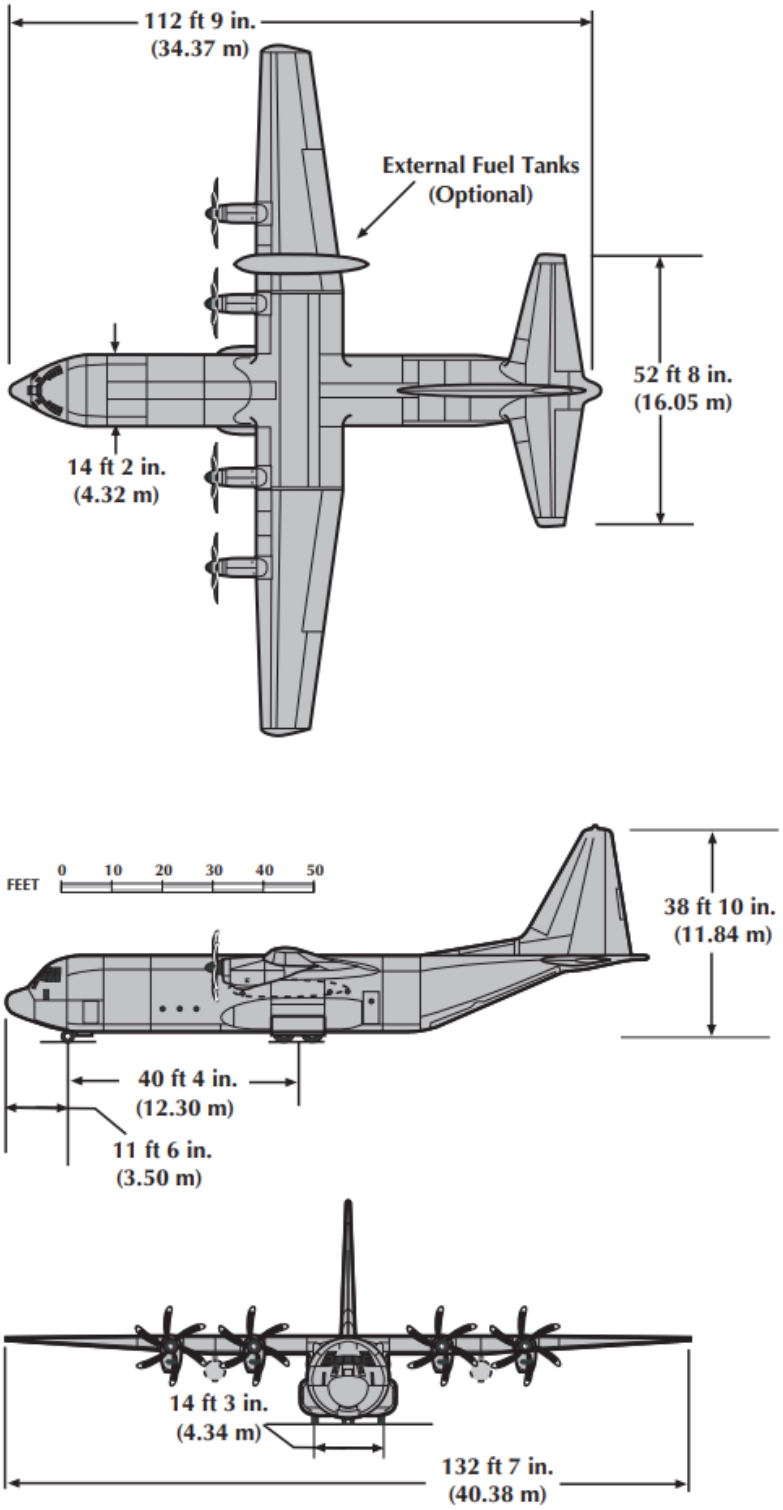

Figure 13: The C-130J Hercules – external dimensions. Source: Lockheed Martin

1.6.2 Technical status

Day-to-day maintenance of the C-130J and some of the phase inspections are carried out by the maintenance squadron of 134 Air Wing/Gardermoen Air Station. Heavy maintenance and more extensive phase inspections are normally carried out by Marshall Aerospace and Defence Group in the UK.

Neither aircraft had any outstanding remarks regarding their technical state at the time of the incident. Both aircraft were also operating within the permitted load and stability limits.

Because technical faults were not suspected, the oil and fuel were not sampled after the incident.

1.6.3 Ground collision avoidance system and terrain awareness and warning system

1.6.3.1 *Ground collision avoidance system (GCAS)*

CGAS issues audio-visual warnings in situations that can lead to collision with the terrain. Such warnings are based on real-time data about the aircraft's position, configuration, speed and altitude, but, unlike the terrain awareness and warning system (TAWS – see Section 1.6.3.2), it does not use terrain models. GCAS can warn of proximity to the ground, incorrect configuration, high sink rate or excessive angle of bank.

GCAS has different warning parameters depending on whether it is set to normal or tactical operating mode. The tactical mode is usually chosen for low-level flying, as it is better suited to the needs associated with manoeuvring at low altitudes.

Table 2 shows the criteria for GCAS warnings in the normal and tactical mode, respectively. In the tactical mode, the system will issue warnings that depend on the set minimum radar altitude on the REF/Mode panel. If the aircraft descends to below the set minimum radar altitude, GCAS will issue a continuous 'ALTITUDE, ALTITUDE' warning. If the aircraft continues to descend to below 66% of the set minimum radar altitude, GCAS will issue a continuous 'WHOOP WHOOP, PULL UP' warning.

Table 2: Criteria for GCAS warnings in normal and tactical mode. Source: RNoAF

Table 10-2. Descent Below Minimum Set Altitude Conditions.		
GCAS Mode	Flight Condition	Annunciation Altitude
Normal	Gear down	At set minimum baro altitude - "MINIMUMS, MINIMUMS"
		At set minimum radar altitude - during normal operations - "ALTITUDE, ALTITUDE" (will not be annunciated if min. baro. alt. is reached first) during CAT II operations - "MINIMUMS,MINIMUMS"
Tactical	Gear up/cycled	Below set minimum radar altitude - continuous, hushable "ALTITUDE, ALTITUDE" Below 66 percent of set minimum radar altitude - continuous, non-hushable "WHOOP WHOOP, PULL UP"
	Gear down	At set minimum radar altitude - "ALTITUDE, ALTITUDE" (once)

1.6.3.2 *Terrain awareness and warning systems (TAWS)*

TAWS issues audio-visual warnings of terrain and obstacles in situations that can lead to impact with the terrain, To achieve this, the aircraft's position, GCAS data, angle of attack, speed and altitude are combined with terrain and obstacle databases and airport information to predict potential conflict between the flight path and terrain or obstacle. Data from the database can be displayed on the head-down displays (HDD) in the cockpit, and the terrain is shown as squares of different colour according to the altitude of the aircraft in relation to the terrain. Yellow and red represent terrain or obstacles above the level at which the aircraft is flying.

The system can be set to use either the normal or the tactical database:

- The normal database corresponds to the civilian Enhanced Ground Proximity Warning System (EGPWS) with respect to data and certification, and it covers the whole world.

- The tactical database has a higher resolution (100 x 100 m), but, at the time of the incident, it did not cover areas north of 60° N and south of 56° S. Selecting the tactical database meant that no TAWS warnings or terrain data were displayed for areas north of 60° N[10]. When set to the tactical mode in areas covered by a valid tactical terrain database, TAWS will calculate warnings based on three different algorithms. When flying straight ahead, the standard look-ahead distance algorithm is used. This distance is based on the distance travelled in 5 seconds at the aircraft's current speed, plus the turn radius at 30 degrees angle of bank at the aircraft's current speed (see Figure 14).

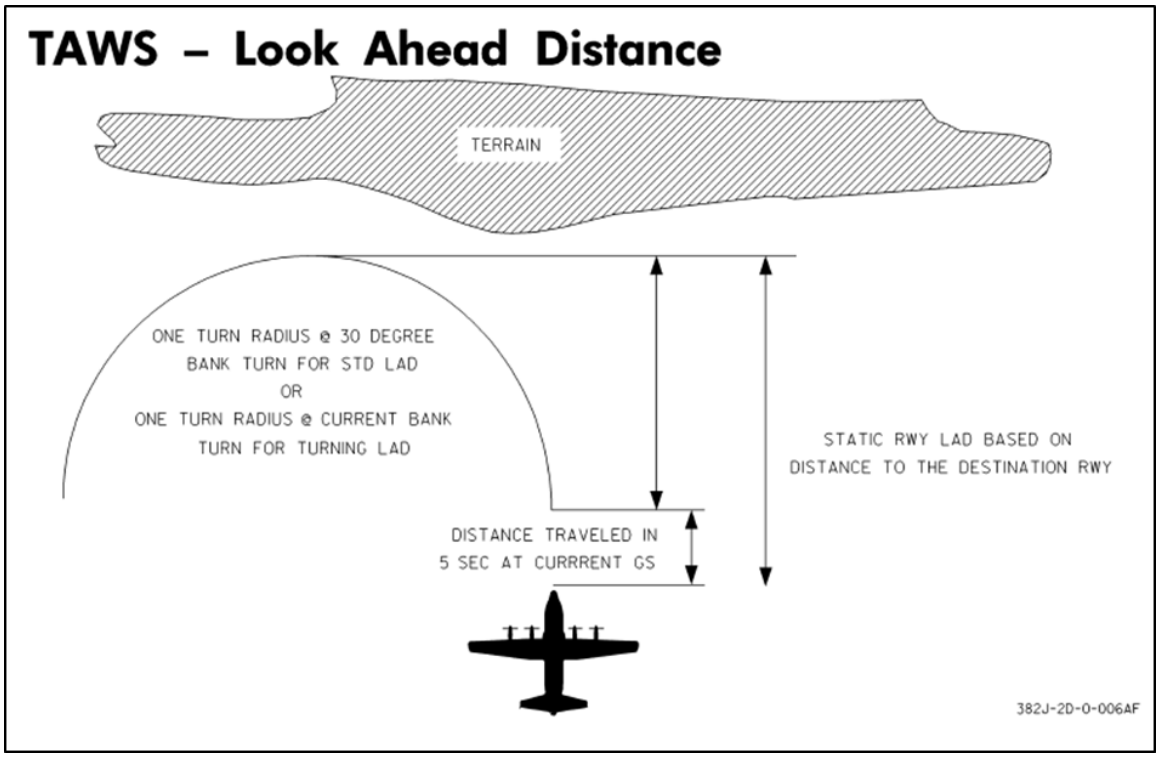

Figure 14: Figure copied from technical documentation for the C-130J. Source: RNoAF

[10] For example: The 60th parallel north passes through Nordmarka just north of central Oslo.

The safety recommendations issued following the Kebnekaise accident in 2012 included a recommendation to ensure safe use of the ground collision avoidance system. Since 2012, the RNoAF and Norwegian Defence Material Agency (NDMA) have sought to implement a tactical TAWS terrain database that also covers the area north of 60° N. Such a database was implemented in autumn 2020, after the Mosken incident. The NSIA has received a report on the process from the NDMA (see Section 1.19.4.2).

The new and updated tactical terrain database covers Mosken Island. If the system, including the updated database, had worked as intended, the crew would have been alerted approximately 1.4 NM before reaching Mosken.

In both aircraft, GCAS/TAWS were set to the tactical mode when the incident occurred. MG31 received 'ALTITUDE' and 'PULL UP' warnings (special alerts) when the aircraft passed over Mosken. The aircraft's radar altimeter was set to 400 ft on the REF/Mode panel at the time.

1.6.3.3 *Radar altimeter (RALT)*

RALT measures how high above the ground the aircraft is flying by means of radar signals and four antennae located under the aircraft belly. The C-130J is fitted with two separate radar altimeter systems. The systems measures the vertical distance to the ground below, which is presented on the primary flight display (PFD). For altitudes below 5,000 ft., RALT is also displayed on the head-up display[11] (HUD).

1.6.4 Auto-throttle function

The aircraft's autopilot includes an auto-throttle function which maintains the speed set on the REF/Mode panel. This function controls the throttle levers in the range between 'flight idle' and 'maximum continuous power'. The function cannot be guaranteed to work if the throttle levers are set to 'TAKEOFF power', as that is outside the effective range.

When the auto-throttle function is activated, a servomotor moves all four throttle levers simultaneously. The servomotor can be manually overridden, however, by moving the throttle levers without deactivating the auto-throttle function. The function is deactivated automatically if one throttle lever is moved more than six degrees from another throttle lever.

[11] HUD provides the pilots with information projected into their field of vision, so that they can look ahead and pay attention to what is happening outside the cockpit at the same time as they get relevant information from the instruments.

1.6.5 Head-down display (HDD)

The Norwegian C-130J aircraft has four head-down displays (HDD) in the cockpit (see Figure 15). The recommended set-up for HDD 1 and HDD 4 is for one of the pilots to choose TAWS display during take-off, climbing, descent and landing, while the other pilot selects NAV RADAR display. HDD 2 and HDD 3 are normally reserved for engine instruments and system status in connection with take-off and landing. During other phases of a flight, HDD 3 is used for displaying digital maps.

Figure 15: HDD 3 and HDD 4 on the right-hand side of the cockpit. HDD 3 displays a digital map while HDD 4 displays a monopulse ground map (MGM). Source: RNoAF

1.6.6 Night vision imaging system (NVIS)

NVIS is a system designed to optimise illumination in the cockpit for operations with night vision goggles (NVG). When NVIS is activated, an NVG-compatible green light will also be activated and the non-NVG-compatible white light will be deactivated. Other screens in the cockpit will be dimmed automatically to a lower luminous intensity, compatible with nigh-time operations. Such illumination reduces both reflection and light interference, and thus provides better conditions for use of NVG.

MG31 did not use NVIS lighting during the mission, because the HUD did not have sufficient luminous intensity. According to the RNoAF investigation, this was a known problem, and the NSIA has been informed that it will be remedied in connection with a future updating of the C-130J.

Pilots in the squadron, the NDMA's test pilot and the ophthalmologist at the Institute of Aviation Medicine (FMI) have told the NSIA that the absence of NVIS lighting does not normally pose any major problems during flights. One of the pilots who took part in the mission has stated that it is sometimes necessary to use one's hand to cover a panel[12] that emits too much light, to prevent reflection in the HUD.

[12] CNI-MS – Communication-navigation-identification management system

1.6.7 Night Vision Goggles (NVG)

NVG is an aid used to amplify light during operations in low-light conditions. NVG amplifies the light 5,000–10,000 times and is dependent on starlight, moonlight, artificial light and other light sources in order to function. The user is presented with a monochrome (green) image in scale 1:1. Figure 16 shows a photo of a runway seen through NVG.

Figure 16: Photo of a runway seen through NVG. Photo: RNoAF

The pilots in both aircraft and the loadmaster in the cockpit of MG32 wore NVG. The loadmaster in the cockpit of MG31 was not wearing NVG at the time of the incident. The passenger in the cockpit of MG32 used a hand-held light-enhancing monocle. Three of the NVGs used during the mission have been examined by the Norwegian Defence Logistics Organisation (NDLO), namely those worn by PF MG31, PM MG31 and PF MG32. The examination showed that the NVGs had no faults or defects that would reduce their performance or resolution.

The NVGs worn by PM and LM1 on board MG32 at the time of the incident have not been examined. Their serial numbers were not noted before they were handed in to Mission Support (MS). The NVGs were taken out and signed for at MS Gardermoen before departure for Bodø, and there was no system in place for signing for NVGs that were taken out and returned during the exercise.

As an aid, NVGs have limitations compared with human sight in daylight conditions (Parush et al, 2011). When wearing NVGs, the field of view (FOV), which is normally 114 degrees, is reduced to 40 degrees. Among other things, this means that greater head movements are required to observe the surroundings.

NVG has a negative effect on spatial orientation, cognitive capacity and situational awareness, among other things (Parush et al, 2011, pp. 257–258):

> *The NVGs' narrower-than-normal FOV requires the user to constantly scan the peripheral scene to build and maintain an accurate visual picture. Although this scanning helps the operator to maintain awareness of the environment, it may also result in physical and mental fatigue as well as spatial disorientation.*
>
> ---
>
> *FOV restriction can thus result in longer spatial task completion, less precision, and degraded cognitive maps. Greater attentional resources are needed to perform with NVGs, and as a result, higher workload can account for the degraded spatial performance.*
>
> ----
>
> *A critical limitation of operating with NVGs with a nominal 40° FOV is that it seriously degrades the ability to constantly acquire information from the environment, build up a mental picture of the immediate scene out of the NVGs' FOV, and maintain adequate SA.*

Another possible problem is that the pilots feel overconfident relating to the use of NVGs and how well they function. Technology helps, but only works well subject to human risk assessments. Studies of military helicopter pilots have also shown that stress levels tend to be higher when flying at night, particularly for those with relatively little experience (Bustamante-Sánchez & Clemente-Suárez, 2020).

1.7 Weather

1.7.1 General description

The NSIA has received an analysis of the weather situation on the day of the incident from the Norwegian Meteorological Institute (see Figure 17). A low pressure system off the coast of Helgeland produced east-northeasterly winds above the Vestfjord in the evening, with ground winds of 10–20 knots and easterly winds of 10–15 kt at an altitude of 2,000 ft. An occulated front in connection with the low-pressure area moved northwards and produced some sleet above the Vestfjord at around 20–21 hours. There were no specific visibility and cloud cover observations for the Vestfjord, but the nearby meteorological stations at Bodø (ENBO), Evenes (ENEV) and Røst (ENRS) all showed light precipitation (rain at Røst, sleet at Bodø, snow at Evenes). Cloud cover/vertical visibility above the Vestfjord was possibly as low as 600 ft.

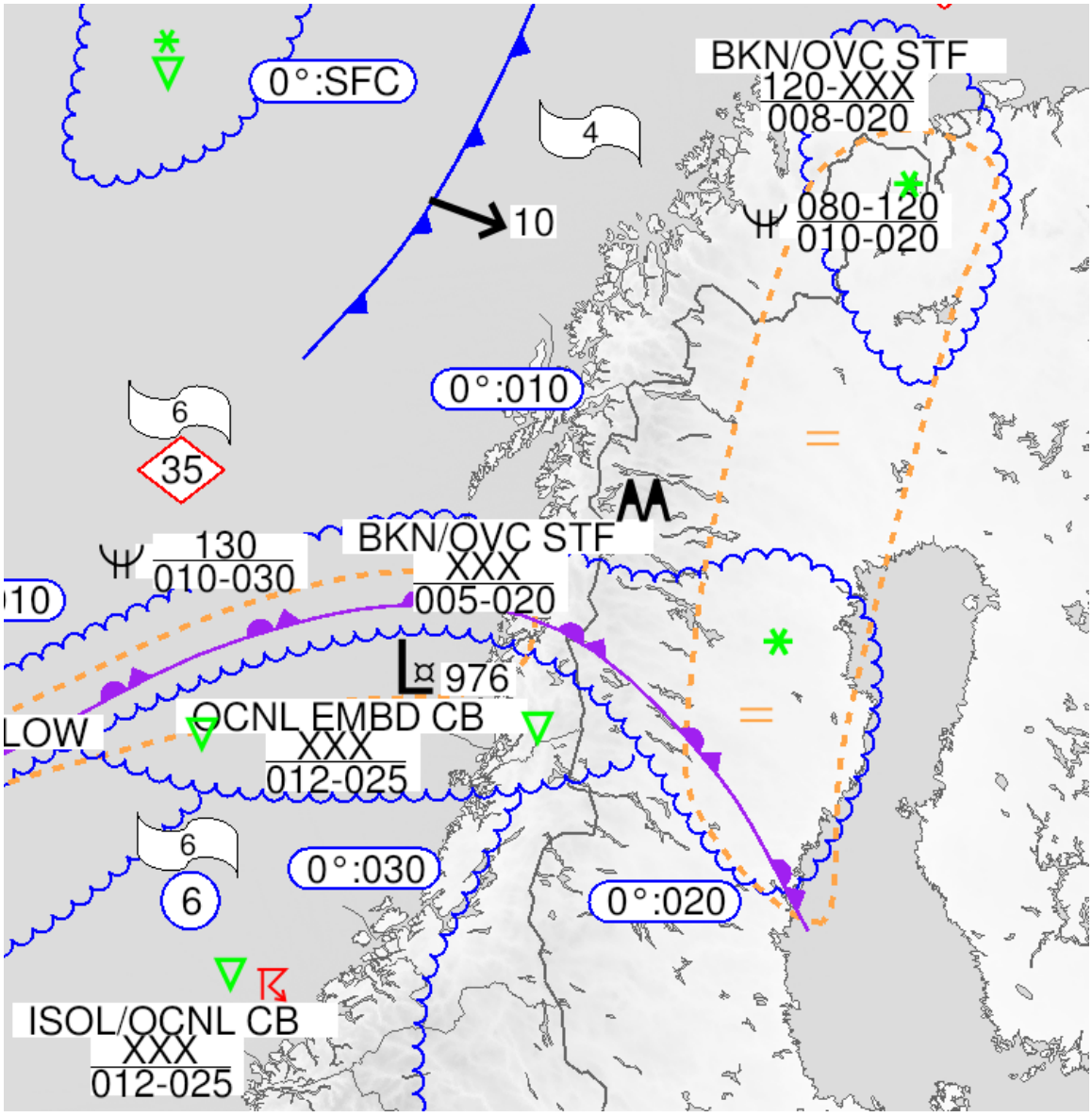

Figure 17: Significant weather chart for Northern Norway 11 March 2020, valid from 19:00. Source: The Norwegian Meteorological Institute

1.7.2 Forecast weather

The Terminal Aerodrome Forecast (TAF) for Bodø forecast easterly winds of 12 knots, visibility of more than 10 km and a light cloud cover. Showers could also be expected in the form of sleet, with a vertical visibility of 1,000 ft.

TAF ENBO:

2020-03-11T17:00:00 ENBO 111700Z 1118/1218 09012KT 9999 FEW015 SCT030 BKN070 TEMPO 1118/1212 1500 SNRA VV010 BECMG 1207/1210 36020KT TEMPO 1212/1218 36020G35KT 1200 SHSN VV008=

The TAF for Evenes forecast northerly winds of 8 knots and cloudy weather with the cloud base at 3,500 ft. Showers were also forecast, with a visibility of 2,000 m.

TAF ENEV:

2020-03-11T17:00:00 ENEV 111700Z 1118/1122 35008KT 9999 FEW015 BKN035 TEMPO 1118/1122 2000 SN VV009=

1.7.3 Weather during the relevant period

The NSIA has obtained meteorological aerodrome reports (METAR) from the airports at Røst (ENRS), Bodø (ENBO) and Evenes (ENEV). No METAR was issued by Værøy (ENVR) for the period of relevance to the incident.

The METAR issued by Røst approx. 30 minutes before the incident reported easterly/northeasterly winds of 20 knots, good visibility (more than 10 km), light rain and the cloud base at 600 ft.

METAR ENRS:

ENRS 111850Z 06020KT 9999 -RA BKN006 02/01 Q0978=

The METAR from Bodø that applied at the time of the incident reported easterly winds of 15 knot, visibility of 7 km, light precipitation in the form of sleet, some clouds at 800 ft with the cloud base at 2 500 ft. Temporary sleet showers were reported, with a visibility of 2,000 m and vertical visibility of 1,000 ft.

METAR ENBO:

ENBO 111850Z 08017KT 9999 6000E -RASN FEW008 BKN020 02/M01 Q0978 TEMPO 2000 SNRA VV010=

ENBO 111920Z 08015KT 9999 7000NE -RASN FEW008 BKN025 02/M01 Q0978 TEMPO 2000 SNRA VV010=

ENBO 111950Z 08013KT 9999 6000NE -RASN FEW010 BKN025 02/M01 Q0978 TEMPO 2000 SNRA VV010=

The METAR for Evenes at the time of the incident reported weak variable winds, 4,700 m visibility and light snow with a vertical visibility of 2,000 ft.

METAR ENEV:

ENEV 111850Z VRB02KT 5000 -SN VV015 M02/M03 Q0981 RMK WIND 1400FT 02007KT=

ENEV 111920Z VRB01KT 4700 -SN VV020 M02/M03 Q0981 RMK WIND 1400FT 01006KT=

ENEV 111950Z 22002KT 6000 -SN VV014 M02/M03 Q0981 RMK WIND 1400FT 02007KT=

1.7.4 Predicted illumination levels

The NSIA has collected information with a view to ascertaining the light conditions (illumination levels) during the period when the mission was carried out. Figure 18 indicates illumination levels under different cloud conditions (solid, low, medium, high) for Mosken during the relevant period. Figure 18 shows that the predicted illumination level at Mosken at the time of the incident was below 1 millilux for medium and low as well as solid cloud conditions.

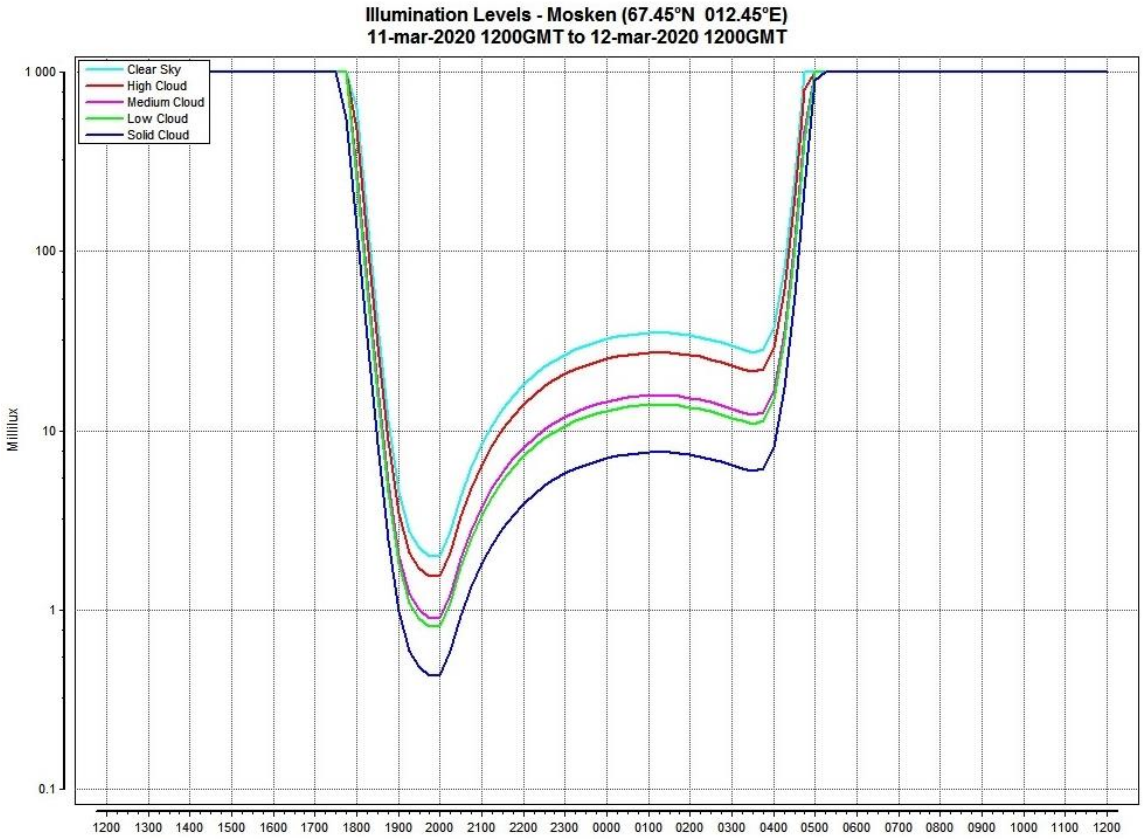

Figure 18: Illumination levels at Mosken during the relevant period. The incident occurred at 19:26 GMT. Source: The Norwegian Meteorological Institute

1.8 Aids to navigation

The digital map is the primary basis for navigation when flying at low levels. It must therefore be available on one of the HDD displays at all times. In addition, the NAV RADAR display can be set to either monopulse ground mapping (MGM) or to the weather radar function to display the terrain ahead.

Several crew members have told the NSIA that they looked at the displays (HDDs) in the cockpit several times before passing Mosken, but without detecting the island. The internal RNoAF investigation report describes several factors that can help to explain this, such as the luminous intensity set on the HDD that displayed the digital map, screen size, the size of the island, cursor position, and other and more prominent map symbols showing traffic information zones (TIZ), geographical boundaries etc.

1.9 Communications

MG31 and MG32 maintained communication between the two aircraft throughout the formation mission. The formation also communicated with different parts of the civilian air traffic service in Avinor Flysikring AS and with the military Control and Reporting Centre (CRC) at Sørreisa (Viper)[13], while they were operating in the exercise area. No radio communication problems were reported.

1.10 Aerodrome information

Not relevant.

1.11 Flight recorders

The RNoAF's C-130J aircraft are equipped with a cockpit voice recorder (CVR) with 120 minutes' storage time and a digital flight data recorder (DFDR) with 25 hours' storage capacity. The system stores navigation data and a number of parameters from the aircraft systems. After the incident, both aircraft's CVR recordings were secured. The DFDR data were downloaded at Gardermoen and analysed by the RNoAF investigation team supported by Lockheed Martin.

The C-130J is also equipped with a removable memory module (RMM), a data storage system used for maintenance purposes. Stored data from different system are used to assess aircraft status and to analyse, for example, engine data. The data are stored on a memory module (RMM card) that can be removed from the aircraft. Data from both aircraft involved were downloaded at Gardermoen after the incident.

Most fighter planes have built-in systems that store position data etc. that can be downloaded and played back during debriefings. In the case of aircraft without such capacity, it is possible to place a portable GPS tracker on board. On this particular mission, both C-130J planes carried a portable GPS tracker. According to the user manual, these trackers have a position accuracy of < 3 m and are updated at frequencies of 1-5 Hz.

[13] CRC Sørreisa (Viper) is reports to 131 Air Wing. See https://www.forsvaret.no/om-forsvaret/tjenestesteder/sorreisa (Downloaded 23 March 2020)

The air mission was carried out with support from CRC Sørreisa (Viper). Recorded radio communication and radar images have been made available to the NSIA and are part of the total data volume on which the investigation was based. The recorded radar images correspond to what was recorded by the GPS trackers and DFDR and RMM.

1.12 Wreckage and impact information

Not relevant.

1.13 Medical factors

The Institute of Aviation Medicine has confirmed that all crew members held a valid medical certificate when the incident occurred. Blood samples were taken from all members of both aircraft crews after the incident and sent for forensic toxicology analysis. They all tested negative for alcohol and other intoxicating substances. All the pilots have stated that they felt in sound mental and physical health, and that they had slept as normal (6–9 hours) prior to the incident.

1.14 Fire

Not relevant.

1.15 Survival aspects

Not relevant.

1.16 Tests and research

On the NSIA's request, the Institute of Aviation Medicine carried out ophthalmological assessments of the aircraft personnel involved. The following is reproduced from the overall assessment by the Institute's ophthalmologist:

> *All the personnel I examined held approved medical certificates with approved eyesight/ eye status. None of them were required to wear corrective eyeglasses while flying. During my re-examinations, all were found to have better uncorrected visual acuity than required; two of them even had extraordinarily good visual acuity (2.0 binocular). One of the pilots (Pilot Flying on aircraft 2) would by today's standards have been required to carry reading glasses (VNL).*
>
> *Pilot Flying aircraft 2 had the mildest form of myopia (-0.25), which, without glasses, would cause slightly reduced night vision with glare, but which is normalised with glasses. His night vision without glare was normal, however. Apart from this, all were found to have normal night vision when tested with Optec 6500 under mesopic conditions (3 cd/M2) with/without glare and under photopic conditions (885 cd/M2).*
>
> *All wore NVG and stated that they had normal dark adaptation. The light environment in the cockpit appears to be sub-optimal, however, in that NVIS lighting is intentionally deselected because it also dims the HUD display. Furthermore, light from the CNI-MU* [Communication/navigation/ identification management unit] *is perceived as distracting and a source of glare. Light sources used by pilot monitoring can also distract the pilot flying.*

When asked by the NSIA about pilots' contrast vision and whether there was a need for regular examinations, the Institute of Aviation Medicine gave the following answer :

> *For civil aviation a requirement was introduced in 2019 for assessment of mesopic contrast sensitivity in connection with first-time examination (AMC1 MED.B.070.b.9). This was not implemented in practice because of a lack of standardisation of examination methods and the absence of standard thresholds.*
>
> *Current practice at FMI consists of routine night vision tests of all pilots who are to be trained to fly F-35 aircraft, personnel who have undergone refractive* [eyesight correction] *surgery, and others where indications in ophthalmological examinations give reason to suspect reduced night vision/contrast sensitivity.*
>
> *At FMI, no F-35 pilots have been found to have unacceptable night vision since testing started in 2016. Today, there are also very few incidents of refractive surgery causing reduced night vision. Most of these diseases of the eye usually occur after the age of retirement from the RNoAF. We have seen that uncorrected refractive errors can have a negative effect on mesopic contrast sensitivity, but air force personnel are selected subject to relatively strict eyesight requirements, and regular health checks ensure that they should have good eyesight.*
>
> *Because of the limitations of current night vision examinations and the low probability of finding reduced night vision in aircraft personnel with approved medical certificates, routine testing of aircraft personnel is not recommended.*

1.17 Organisational and management information

1.17.1 Organisation of the defence sector

The Armed Forces is the largest agency under the Norwegian Ministry of Defence. Other subordinate agencies are the Norwegian Defence Research Establishment (FFI), the Norwegian Defence Estates Agency (NDEA) and the Norwegian Defence Material Agency (NDMA)[14] (see Figure 19). The Chief of Defence governs the Armed Forces through the Defence Staff and activity plan, on the one hand, and through the head of the Armed Forces' Joint Head Quarters (NJHQ) and operational plans, on the other.

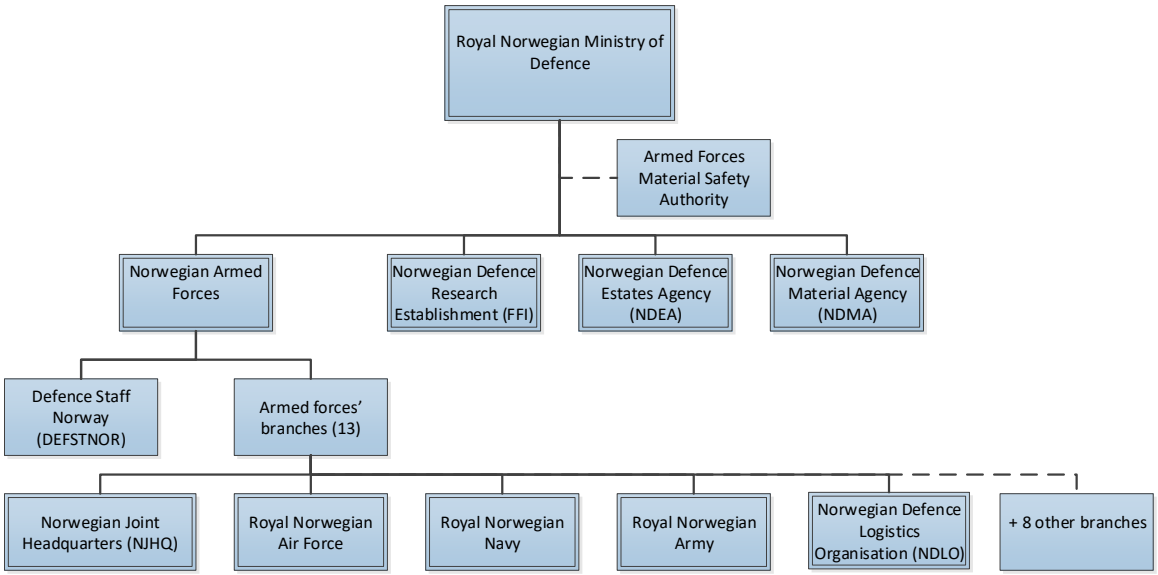

Figure 19: Organisation of the defence sector. Illustration: NSIA

The chiefs of the different branches of the Armed Forces are responsible for building defence capacity in the form of operational units that can be deployed on national and international missions[15] by the NJHQ. The various operational units in the Armed Forces are therefore being trained continuously and exercises are at the core of the Armed Forces' activities. The most comprehensive exercises are led by the NJHQ, including the Cold Response (CR) winter exercise that takes place in Norway every two years.

NDMA's Air Systems Division is responsible for evaluating, ordering, purchasing and managing the Armed Forces' aircraft. The Air Systems Division is the competent authority for approving and monitoring the airworthiness of all military aircraft[16].

The Armed Forces Materiel Safety Authority is charged with ensuring that the defence sector comply with applicable rules for materiel safety[17]. Under the current instructions from the Ministry of Defence, the head of the Materiel Safety Authority is also responsible for supervising the airworthiness of military aircraft. In addition, the Material

[14] When the Norwegian Defence Material Agency (NDMA) was established on 1 January 2016, the new agency took over most of the tasks of the Norwegian Defence Logistics Organisation (NDLO).
[15] See https://www.forsvaret.no/om-forsvaret/tjenestesteder/-- (Downloaded 17 March 2021)
[16] See https://www.forsvaret.no/om-forsvaret/-/ (Downloaded 17 March 2021)
[17] See https://www.regjeringen.no/no/dep/fd/organisering-og-ledelse/avdelinger/forsvarets-materielltilsyn/id2485407/ (Downloaded 17 March 2021)

Safety Authority is responsible for following up those parts of the NSIA's reports and any safety recommendations that concern materiel safety.

1.17.2 Organisation and Management of the Royal Norwegian Air Force (RNoAF)

The RNoAF is operator of the C-130J Hercules aircraft. The RNoAF is led by the Chief of the RNoAF[18], to whom the Chief of Defence has delegated the powers of military aviation authority.

The Chief of the RNoAF has overall charge of the RNoAF through a management level[19] consisting of the RNoAF Staff, the Norwegian Air Operations Centre (NAOC) and the Air Operations Inspectorate (LOI) (see Figure 20). The Flight Safety Inspectorate also has a direct line to the Chief of the RNoAF in matters relating to safety and security.

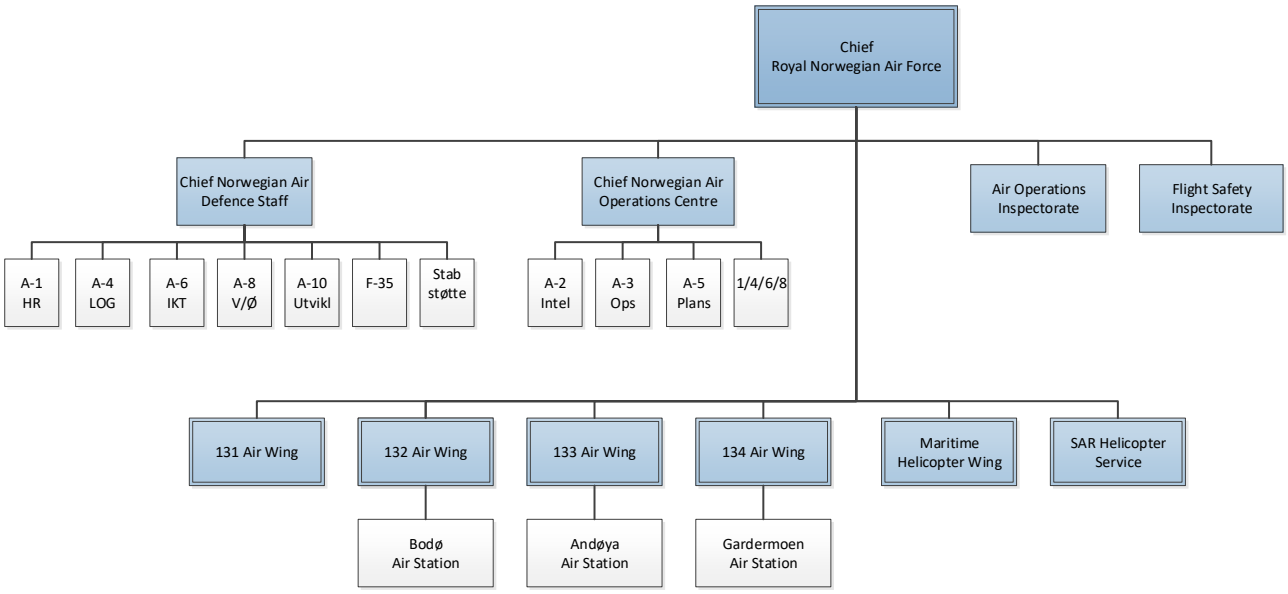

Figure 20: Organisation chart of the RNoAF[20]. Illustration: RNoAF

The RNoAF Staff coordinates the Air Force's main processes, including the planning, management, operation and development of operational capabilities. The RNoAF Staff administers the RNoAF's allocated resources: personnel, materiel, infrastructure and funds. The Chief of Staff is Deputy Chief of the RNoAF.

The National Air Operations Centre (NAOC) plans, coordinates and leads defence capacity building activities and air operations on behalf of the Chief of the RNoAF in the NJHQ's assigned area of responsibility.

The Air Operations Inspectorate (LOI) is the RNoAF's military aviation authority, with regulatory and supervisory powers. The Inspector of Air Operations also exercises military aviation authority on behalf of the Chief of the RNoAF, except military airworthiness authority which is vested in the NDMA Aviation Systems Division through an agreement with the Chief of the RNoAF as the military aviation authority. Hence the Air Operations Inspectorate is both technical and supervisory authority in the RNoAF.

[18] Formerly Inspector General of the RNoAF (*Generalinspektøren for Luftforsvaret – GIL*).
[19] Later in this report, this level is referred to as the 'central level'.
[20] The current organisation of the RNoAF entered into force in August 2018.

The Flight Safety Inspectorate is independent of the operational units, and responsible for flight and ground safety in the RNoAF. The Flight Safety Inspector advises the Chief of the RNoAF on matters to do with flight and ground safety.

The air wings/stations are the RNoAF's operational units and are under the command of air wing commanders, the maritime helicopter wing commander and the military search and rescue service commander, which report directly to the Chief of the RNoAF.

1.17.3 The 335 Squadron of 134 Air Wing

1.17.3.1 *Management and organisation*

The 335 squadron is the RNoAF's transport aircraft squadron and operated four C-130J Hercules aircraft at the time of the incident. The 335 squadron reports to 134 Air Wing at Gardermoen Air Station[21].

The Commander and staff unit for 134 Air Wing are based at Rygge. The Base Commander and staff unit for Gardermoen Air Station are based at Gardermoen. The Commander of 134 Air Wing is Air Wing Commander for the operational units at Rygge and Gardermoen. The Commander of 134 Air Wing is also Air Base Commander at Rygge military air base and Gardermoen military air base Rygge Air Base is formally approved by the Military Aviation Authority. Rygge Air Base is exempt from the requirements for an airport licence and technical-operational approval that apply to civilian airports.

The 335 squadron management comprises seven persons, including the squadron commander and deputy commander. The squadron management is part of the squadron's operational personnel and participates in exercises and international operations.

1.17.3.2 *Mission portfolio*

According to the RNoAF investigation report, the mission portfolio of the 335 squadron's C-130J aircraft is described and the requirements defined in operational plans. In order to be able to solve the missions assigned under the Air Operations Directive (AOD), the squadron personnel must participate in annual exercises.

The mission portfolio of the C-130J aircraft have several features in common with the US method of utilising operational capacities. At the same time, Norwegian C-130J aircraft are also used to support Norwegian special forces, the Norwegian Armed Forces Joint Medical Services and civilian emergency response operations. Among other things, the 335 squadron is used to provide tactical transport support for the purpose of asserting sovereignty, exercising authority, handling incidents and disasters and participating in the collective defence of Norway and NATO. In addition, the squadron is required to engage in defence capacity building, which means that about half of the total number of flying hours must be devoted to developing readiness through training and exercises.

The 335 squadron is regularly involved in international operations and is used for strategic transport to destinations such as Western Africa and the Middle East. Such missions entail that personnel are absent from the squadron, both during the

[21] The 134 Air Wing was formally established on 1 August 2018. Squadrons 335 and 717 were previously under the control of the now closed down 135 Air Wing at Gardermoen.

implementation phase and afterwards. Since the C-130J aircraft were phased in, the squadron has been deployed to destinations like Afghanistan (2012–13), Sierra Leone (Grit Rock 2015), Niger (Flintlock 2018) and Mali (NORTAD[22] I in 2016 and NORTAD II in 2019). Since autumn 2016, the squadron has also carried out regular missions to support Norwegian forces in Iraq.

The new low-level flying concept based on the use of night optics was developed as a result of a need identified by the 335 squadron. On its own initiative, the squadron contacted the Air Operations Inspectorate to establish a regulatory framework for the concept. The further work on the concept is described in Section 1.17.5.1.

1.17.3.3 *Life in the 335 squadron*

The pilots who were interviewed by the NSIA described the squadron as having varied missions and offering a dynamic and hectic everyday life. They also told the NSIA that they mostly find this satisfying. The pilots are issued with two-week work schedules. Some ad hoc missions come in addition to the scheduled work, which means that they have to make changes, plan and carry out missions at short notice. These missions are not generally complicated in tactical terms, but they can nonetheless be complex and consist of multiple elements. To some extent, the pilots felt that heavy workloads and time pressure meant that they were not always given enough time to solve missions or to take account of unforeseen events and changes en route.

It emerged from the interviews that flexibility is a highly valued quality within the squadron. The pilots said they felt highly motivated to deliver on and complete missions. The pilots interviewed by the NSIA have described how every mission is used as an opportunity to practise and maintain their qualifications in accordance with PAQS. According to some individual members of the 335 squadron: *'we are expected to do everything, but we never become good at anything'*. It also emerged that the pilots feel there is a certain expectation that they will accept missions, including during holidays/when taking time off in lieu. The 335 squadron does not normally have any formal emergency response duties, but it is known for accepting missions voluntarily at short notice.

The squadron has relatively few common arenas for coordination, standardisation and exchange of experience. Air missions entail absence, both in connection with the actual mission and afterwards, as a result of rescheduled working hours and time off in lieu. Hence, long periods can transpire between the times that the personnel come together. According to the RNoAF investigation report, this has been described as an aviation safety challenge in several reports on aviation safety. Reference is made to the fact that few common arenas limit the possibility of being a learning organisation. It also emerged that the pilots felt they had little time for administrative tasks and for developing and maintaining discipline knowledge, for example by reading civilian and military regulations for operations with C-130J aircraft.

Furthermore, the pilots perceived the regulatory framework for C-130J operations as relatively complex, at the same time as it was sometimes necessary to operate in the regulatory grey zone or even breach the rules in order to solve a mission. With reference to the strong inherent drive to solve missions, the RNoAF investigation report cites

[22] NORTAD – Norwegian Tactical Airlift Detachment.

examples of rules and regulations that are sometimes construed and stretched for the purpose of completing missions. An example from Cold Response 2020 concerns unauthorised low-level flying along unplanned flight routes. Another example referred to is that the unit sometimes deviates from the VFR requirements (cloud base) that regulate flying in controlled air space during daytime operations from Gardermoen.

The RNoAF investigation uses the term 'pressure culture' to describe this assertive, mission-focused and solution-oriented culture that can result in excessive risk-taking. The Commander of 135 Air Wing[23] at the time of the Kebnekaise accident has told the NSIA that he was probably part of the 'pressure culture' described by the RNoAF investigation team. His assignment was to improve and rationalise the 335 squadron's performance using the new J model aircraft that the RNoAF had procured and put into operation in 2008/2009.

The NSIA has also been told that the 335 squadron has generally attached importance to crew rotation whereby 'everybody is required to fly with everybody else'. The pilots interviewed by the NSIA have stated that the squadron personnel get along well. They also say that they have great confidence in each other and feel that they are given room and opportunity for raising any concerns they may have. They claim that it is acceptable to say 'stop' if you believe that safety is being compromised or if you do not feel fit for flight.

1.17.3.4 *Dimensioning of missions in relation to resources*

All RNoAF personnel interviewed by the NSIA have described the 335 squadron as a resource in great demand capable of carrying out a broad range of transport and logistics missions. The RNoAF's management level (the Chief of the RNoAF, NAOC, the Air Operations Inspectorate, Flight Safety Inspectorate, RNoAF Staff) as well as 134 Air Wing management had for some time been aware of the 335 squadron' high rate of delivery and work pressure in relation to the squadron's resources.

Several informants have voiced the opinion that there has been a general shortage of manpower, including pilots, in the RNoAF in latter years, and that not enough C-130J pilots have been trained. In 2019 the Chief of the RNoAF decided to increase the number of squadron crew, but there is still a shortage of pilots and loadmasters.

The NAOC has also informed the NSIA that have cooperated with the squadron in an effort to adapt the scope and number of missions. In the NAOC's experience, however, the squadron has never refused to take on a mission. According to the squadron and air wing management, they have regularly reported on the high work pressure, without this having resulted in any reduction in the types and number of missions. Sometimes the 335 squadron has also been assigned tasks directly, without these being routed through the NAOC or air wing level as they should.

The NSIA has contacted the NJHQ requesting further information about the 335 squadron's mission portfolio and how the 335 squadron's missions are planned. The NJHQ's answers are cited in Appendix D.

[23] The 135 Air Wing was the RNoAF's operational unit at Gardermoen Air Station and included the 335 squadron.

1.17.4 Safety management system and flight safety in the RNoAF

1.17.4.1 *Requirements, roles and responsibilities*

The Directive on requirements for a safety management system in the Armed Forces (*Direktiv Krav til sikkerhetsstyring i Forsvaret*, 2010) contains general provisions on safety management and attention to safety in the Armed Forces. Safety management in the RNoAF is specifically addressed in *Bestemmelse om sikkerhetsstyring i Luftforsvaret* (BFL 010-1, 1 July 2017).

The RNoAF has adopted the principle of 'mission first, people and safety always'. According to Section 1.4 of the Regulation on military aviation (*Bestemmelser for Militær Luftfart* – BML) of 1 June 2017, the concept of 'just culture' is also '*an established culture in the Armed Forces whereby crew members inform of own mistakes and incidents with a view to learning from each other for the purpose of improving flight safety'*.

The safety management system in the RNoAF is a management level responsibility. The Chief of Staff and Deputy Chief of the RNoAF are delegated responsibility for the overall safety management system and for ensuring that it is maintained in accordance with applicable rules and regulations. The air wing commander is responsible for implementing safety requirements in own organisation.

Bestemmelse for fly- og bakketrygging of 1 January 2020 defines roles, responsibility and authority relating to flight and ground safety [24] in the RNoAF. The air wing commander shall facilitate safe operational activities in own air wing, and establish a local flight and ground safety organisation in accordance with the regulations (*Reglement for fly- og bakketrygging*) of 1 January 2020. Accordingly, a local flight safety organisation had been set up at Gardermoen Air Station, led by a senior flight safety advisor; see Section 1.17.4.4 for further details.

Local flight and ground safety organisations report to the Flight Safety Inspectorate, which is the RNoAF's central flight and ground safety organisation. The flight and ground safety organisation shall not be in charge of the safety management system, but shall, by virtue of its advisory function, provide management at all levels with support and advise on matters with a bearing on flight and ground safety.

1.17.4.2 *Safety initiatives by the RNoAF management*

In January 2020 (before the Mosken incident) the RNoAF management decided to appoint a working group to report on how the RNoAF Staff could put in place a new framework for overall safety management. This is described in greater detail in Section 1.19.2.3. The background to the project was that implementation of a safety management system (following the introduction of BFL 010-1) in the RNoAF had not yielded the desired results.

In 2017/18, the Chief of the RNoAF launched the project 'Heart medicine' (*Hjertemedisin*) consisting of various initiatives intended to improve the balance in the operational leadership of the RNoAF's squadrons and ground-based air defence units

[24] By 'flight and ground safety' is meant all systematic work to identify risk factors associated with flight and ground operations that can cause incidents and accidents, and advising on how the risk can be reduced.

(batteries). The project was initiated based on the recognition that *'Over time, the combination of persistently high delivery levels and limited resources have contributed to what is perceived to be an imbalance between the requirements for operational leadership and supervision, on the one hand, and required administrative tasks, on the other'.*

The RNoAF management has also communicated, through several channels, the importance of balancing the level of ambition against available resources. According to the RNoAF, this has been the primary focus of the annual mission dialogue with the Chief of Defence and the air wing commanders. It has also been the main focus in the continuous planning and coordination of air force operations and defence capacity building through the NAOC, and it is reflected in various classified orders/products. Furthermore, the RNoAF states that the need for such balancing is regularly communicated to leaders and employees through emails, management meetings, flight and ground safety reports and seminars.

It has also been communicated[25] that management will support those in command of operational units if they find themselves in situations where it is necessary to say stop, not on a general basis, but based on a specific risk assessment. At the same time, they are expected to take necessary action locally in addition to requesting necessary support.

According to the RNoAF investigation report, the RNoAF management has also communicated the importance of the willingness to deliver displayed by operational units, and of management at all levels being aware of this willingness. The Chief of the RNoAF has also communicated the importance of maintaining sufficient focus on vigilance and supervision.

The following quote is taken from the Chief of the RNoAF's cover letter to the Flight Safety Inspectors report No 3/2017:

> *Squadron culture, the willingness to deliver and the professional identity of an operational unit are largely characterised by personnel who want to carry out the missions they are assigned. These are important characteristics in the RNoAF, but can at the same time constitute a risk.*
>
> *(...)*
>
> *All our operational deliveries are in high demand. Together with local commanders, the RNoAF management must therefore focus on measures to balance tasks and resources in an optimum manner within the given framework. We shall never compromise on safety and protection, however.*
>
> *(...)*
>
> *The final safety barrier before a mission is implemented, is the power of authorisation, and I must rely on this power being exercised in a way that ensures that the authorisation of every single air mission constitutes a real safety barrier for our activities.*

[25] Most recently in connection with the Chief of the RNoAF's talk at the RNoAF seminar on flight and ground safety in January 2021.

1.17.4.3 *The Flight Safety Inspectorate's status reports and overview of recommendations*

The Flight Safety Inspectorate submits status reports[26] to the Chief of the RNoAF on the basis of internal inspections and visits to the air wings/squadrons, collected information and input from the air wings. The reports describe the level of flight and ground safety and related challenges in the units. The Flight Safety Inspectorate may also submit recommendations to the Chief of the RNoAF if there are challenges that cannot be solved at the operational unit level.

Because the RNoAF did not have a well-functioning internal system for following up recommendations, the Flight Safety Inspectorate chose, in 2015, to prepare its own overview of all recommendations that had been submitted in internal investigation reports. The overview was enclosed as appendix 2 to its status report. Some parts of the RNoAF management have subsequently introduced the Remedy RIO ORS system for internal control and follow-up.

The Flight Safety Inspectorate has stated that recommendations can remain open for a long time, particularly those that concern more than one operational unit and require coordination. Because of the range and variety of the RNoAF's activities, the Flight Safety Inspectorate has not weighted or ranked the recommendations. The NSIA has received a copy of the Flight Safety Inspectorate's overview of recommendations.

1.17.4.4 *Flight safety at Gardermoen Air Station*

The local air safety organisation at Gardermoen Air Station was led by an experienced senior flight safety advisor with operational experience of the C-130J. The Senior Flight Safety Advisor also participated in the CR20 exercise. A dedicated air safety advisor had also been appointed for the 335 squadron.

The Senior Flight Safety Advisor and the Base Commander at Gardermoen Air Station have stated that they met regularly. The Senior Flight Safety Advisor also participated in meetings of the management group at Gardermoen and was involved in the planning of exercises and operations. No fixed forum had been established for meetings between the Senior Flight Safety Advisor and the Commander of 134 Air Wing. Flight safety meetings were held at Gardermoen twice a year and were attended by the Commander of 134 Air Wing. Beyond that, there was little contact between the Senior Flight Safety Advisor and Air Wing Commander.

According to the RNoAF investigation report, the Senior Flight Safety Advisor and squadron's flight safety advisor were both involved in case processing and follow-up of incident reports in the RNoAF's reporting system for incidents and accidents (Remedy FOB). They had also been important contributors to the risk assessment work at Gardermoen Air Station.

The Senior Flight Safety Advisor has told the NSIA that he spent much time on risk assessments relating to the 335 squadron, including in connection with mission planning. The NSIA has received documentation of the involvement of both the Senior Flight Safety Advisor and the squadron's flight safety advisor in the planning and evaluation of the first exercise undertaken by the 335 squadron in connection with the new low-level

[26] Four-monthly reports up until this was changed to biannual reports with effect from 1 January 2020; see *Reglement for fly- og bakketrygging*.

flying concept. The Senior Flight Safety Advisor also prepared the squadron's risk assessment for CR20 (see Section 1.17.5.2).

The Senior Flight Safety Advisor stated that he had been extensively involved in flight safety discussions relating to the 335 squadron and, in practice, acted as advisor to the squadron commander. This applied to a lesser extent in relation to the 717 squadron, which is also based at Gardermoen. The 717 squadron is smaller and has more generic missions.

The Senior Flight Safety Advisor stated that the 335 squadron had limited case processing capacity, and that it was therefore necessary to see incidents and risk assessment through to the end to ensure implementation. It had also resulted in a significant backlog and failure to meet deadlines. The Senior Flight Safety Adviser described the combination of a lot of good work in advance and an inability to follow up in practise as a classic challenge. The Senior Flight Safety Advisor expressed a wish to promote methodical operational flight safety work, but lacked the requisite time, resources and systems to do so.

The Commander of 134 Air Wing and the Base Commander at Gardermoen Air Station told the NSIA that, prior to the CR20 exercise, their greatest concern was for the safely level in the 717 squadron. The Base Commander Gardermoen Air Station therefore participated in CR20 together with the 717 squadron.

1.17.4.5 *Requirement for risk assessment*

The following is stated in Section 6.5 of *Bestemmelse om sikkerhetsstyring i Luftforsvaret* (BFL 010-1, 2017):

> *If an operational unit does not have sufficient resources, the activities of that unit must be adapted to the resource situation so that an acceptable level of safety can be maintained. Resources to ensure safety in connection with new activities or the allocation of new materiel shall be surveyed and set aside before implementing new activities or making use of the new materiel.*

Both Section 2.6.6 of *Bestemmelser for militær luftfart* (BML) and Section 6.6 of *Bestemmelse om sikkerhetsstyring i Luftforsvaret* (BFL 010-1, 2017) contain requirements for conducting risk assessments. Section 6.6. of BFL 010-1 also refers to a procedure for risk assessment in the Armed Forces, prepared on the basis of the operational risk management (ORM) process described in the Armed Forces safety regulations for land-based activities (UD 2-1 *Forsvarets sikkerhetsbestemmelser for landmilitær virksomhet*). Figure 21 shows the five steps of the ORM process.

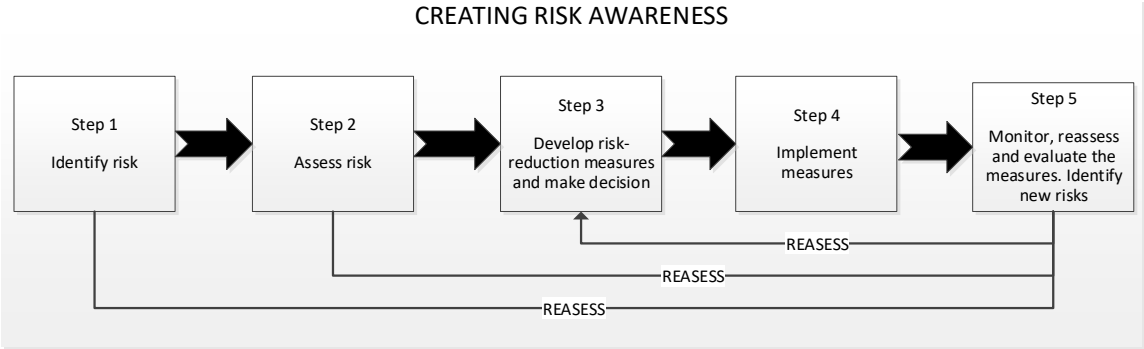

Figure 21: Operational risk management (ORM) process in the Armed Forces. Source: UD 2-1 Forsvarets sikkerhetsbestemmelser for landmilitær virksomhet (the Armed Forces, 2020, p. 34)

A procedure for risk assessment in the RNoAF from 2014 (*Prosedyre for Risikovurdering i Luftforsvaret*) is also applicable, but it is not mentioned in BFL 010-01. In connection with several supervisory activities of the air wings and RNoAF management conducted after 2014, the Armed Forces Materiel Safety Authority has investigated how the procedure is used, and it has pointed out in several reports that the procedure is little known and used. According to the Materiel Safety Authority, the procedure does not describe a systematic process for implementing, assessing, deciding and evaluating risk-reduction measures.

According to BFL 010-01, a systematic and documented risk assessment shall be conducted prior to any mission entailing a real risk of loss or injury, and the assessment shall be used as a decision-support tool in the planning of operations. Risk assessments shall also be conducted in connection with activities of a more permanent nature, such as the introduction of new materiel, development of new education programmes etc.

According to BFL 010-1, the unit commanders shall ensure that the ORM provisions in UD 2-1 and the Armed Forces' procedure for risk assessment are known and complied with in their respective units. According to *Bestemmelse for fly- og bakketrygging*, the air wing commander and Chief of NAOC shall ensure that all air and ground-based operations are planned and risk-assessed. The Inspector of Air Operations shall ensure that air and ground-based operations are carried out in accordance with the regulations.

According to the RNOAF investigation report, risk assessments at the organisational level are normally linked to major changes, such as the procurement and commissioning of new systems or arms/equipment, change of concepts, dispensations, regulatory amendments and similar. The RNoAF investigation team goes on to describe how formal risk assessments have not necessarily been part of the basis for decision-making in connection with changes, but that recently, there has been a shift towards requiring written risk assessments before decisions are made.

The RNoAF investigation report goes on to describe that the approach to risk handling at the local air operations level is twofold. Risk assessments are carried out of all the 335 squadron's air missions, entailing, among other things, that the crew is required to complete a risk assessment form before the mission may be authorised. The Senior Flight Safety Advisor has prepared guidelines for use of the form, and these guidelines have been made available to the unit's personnel. In addition, all exercises, deployments etc. are risk assessed in accordance with the guidelines in BML and BFL 010-1.

1.17.5 Relevant risk assessments prior to the incident

1.17.5.1 *Risk assessment of the new low-level flying concept*

The Air Operations Inspectorate did not conduct any independent risk assessment when adjusting and preparing rules for the new concept for low-level flying in the dark. The NSIA has received a copy of a risk assessment prepared by the squadron's flight safety advisor prior to the first exercise conducted by the 335 squadron to test the new concept for low-level flying in the dark.

On completion of the exercise, the Senior Flight Safety Advisor prepared an experience report containing a number of recommendations for further implementation of the concept. Based on these recommendations, a new low-level flying exercise was conducted with the aid of night-vision goggles (NVG) under poorer light conditions than those that prevailed during the first exercise. This latter exercise was not evaluated or translated into concrete guidance before the 335 squadron's participation in CR20.

1.17.5.2 *The 335 squadron's risk assessment of Cold Response 2020*

In preparation for the exercise, the squadron conducted its own risk assessment, dated 17 February 2020. The risk assessment was conducted on the orders of the Commander of 134 Air Wing, and prepared under the leadership of the Senior Flight Safety Officer (see Figure 22). The risk assessment was enclosed as an appendix to the 335 squadron's exercise orders for CR20. The risk assessment listed a number of main activities[27] that were planned for the exercise, with identification of associated risks, causes and proposals for risk-reduction measures.

Hovedaktivitet:	Fare:	Årsak:	K :(1)	S:(2)	R:(3)	Tiltak:	A,F : (4)	K:	S:	R:	Merknad:
	Kollisjon terreng	Overgang IFR til VFR i ukjente områder ingen TAWS database nord av 60 grader nord	5	2	10	Sette av nok tid til route study med DETCO. Planlegg for at været ikke tillater lavflyging.	DETCO/ PIC, ved autorisering	5	1	5	Repeter VFR minima i forkant av øvelsen

Hovedaktivitet:	Fare:	Årsak:	K :(1)	S:(2)	R:(3)	Tiltak:	A,F : (4)	K:	S:	R:	Merknad:
NVG OPERASJONER	Kollisjon terreng	Lav lysintensitet, vanskelig å se konturer	5	2	10	Konservativ tilnærming til modified contour og valg av rute ved lav lysintensitet, grundig route study med DETCO og om mulig rekognosering i dagslys	DETCO/ PIC, ved autorisering	5	1	5	
	Kollisjon hinder	Vanskelig å se hinder på NVG, utdaterte kart, mangelfull CHUM, mangelfull hinderbelysning	5	3	15	Rekognosering av ruta i dagslys, stick diagram med hinder	PIC/ MS, før NVG low level	5	1	5	Restrisiko (R) er 10 (gul) dersom ruta ikke er rekognosert (ukjent operasjonsområde)

Figure 22: Excerpt from the 335 squadron's risk assessment relating to CR20, addressing the main activities of low-level flying and NVG operations. Source: the 335 Squadron

Figure 22 shows that the risk assessment relating to CR20 identified the risk associated with low-level flying and NVG operations of colliding with the terrain, including the uncertainty relating to applicable rules for low-level flying at night (VFR minima). DETCO was assigned the task of clarifying VFR minima before the exercise as described

[27] For example, mission planning, COMAO and NVG operations.

in the risk assessment, but this had not been done by the time CR20 started. Nor was any daylight reconnaissance flight of the route conducted prior to the mission.

1.17.5.3 *The 335 squadron's risk assessment of the air mission in question*

According to Section 6.2.1 of *Ordrebok for Lufttjeneste*, the aircraft commander is responsible for ensuring that risk assessments are conducted. Two forms shall be completed. One form lists the status of each member of crew with respect to hours of sleep/rest and various factors such as family problems, stress at work and, if applicable, pressure to complete the mission. Points are awarded in each area, and if the total exceeds a certain level, consideration must be given to putting measures into place.

The second form to be completed concerns the actual mission. It addresses multiple factors relating to prevailing weather conditions, the crew members' continuity as regards the disciplines covered by the mission, mission complexity, conditions at the destination and an overall assessment of threats. If the risk values exceed a certain limit, authorisation is required from the squadron commander or deputy commander. The NSIA has received copies of the forms that were completed by the MG31 and MG32 crews prior to the mission in question. The risk values on both forms are below the threshold for requiring such authorisation.

The NSIA has been informed through interviews that the aggregate risk-level values on forms for pre-mission risk assessment are often high. It is also clear from the RNoAF investigation report that risk assessments are sometimes seen by the squadron as an awareness-raising tool, without any systematic process being established for implementing, assessing, deciding on and evaluating risk-reduction measures. This also emerged from the interviews conducted by the NSIA.

1.17.6 Crew resource management (CRM) in the RNoAF

1.17.6.1 *General information*

CRM is described *inter alia* by the US Air Force (Martinussen & Hunter, 2008, p. 155):

> *Crew Resource Management entails effective use of all available resources — people, weapon systems, facilities, equipment and environment, by individuals or crews to safely and efficiently accomplish an assigned mission or task.*

CRM includes elements such as getting along with other crew members, knowing when and how to assert one's self effectively in critical situations, and maintaining situational awareness[28].

The European Aviation Safety Association (EASA, 2017) states the following about CRM training:

> *Crew Resource Management (CRM) training encompasses a wide range of knowledge, skills and attitudes including automation management, monitoring and intervention, resilience development, surprise and startle effect management, safety culture and cultural differences; together with all the human dimensions which each of these areas entails.*
>
> *CRM can be defined as a management system, which makes optimum use of all available resources (equipment, procedures and people) to promote safety and enhance the efficiency of flight operations.*
>
> *CRM training improves the cognitive and interpersonal skills needed to manage the flight. (…)*

1.17.6.2 *CRM training in the RNoAF*

The RNoAF has not established a formal CRM training programme. According to the RNoAF investigation report, the failure to establish such a programme has also been addressed in previous internal reports, most recently in connection with a serious incident involving a Sea King SAR helicopter on 17 May 2018. In the report, the investigation team recommended that the RNoAF address the need to establish systematic and structured CRM training programmes for its squadrons. On that basis, the Inspector of Air Operations was requested to implement a standardised CRM training programme in the RNoAF's operational air squadrons, but this had not been followed up by the Air Operations Inspectorate at the time of the incident at Mosken.

1.17.6.3 *CRM in the 335 squadron*

The 335 squadron is required to participate in CRM training in connection with both ground training and simulator training in the USA.

[28] Situational awareness (SA) is defined as follows: Situational awareness is the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and a projection of their status in the near future (Endsley 1995, p. 36).

The importance of effective CRM is discussed in C130J Hercules Standard Operating Procedures (SOP) (121-50B), published/approved by the Air Operations Inspectorate (2019):

> *The high level of automation on the C-130J gives aircrew a variety of ways to obtain flight information and execute mission tasks. It also presents them with challenges for managing information, monitoring systems and operations and verifying task accomplishment. If not properly managed, such variability can lead to loss of situational awareness, increased workload, crew error and conflict.*
>
> *Standardized procedures and effective Crew Resource Management (CRM) enhances mission safety and effectiveness by:*
>
> *a) Creating an environment for predictable execution methods that allows crew to quickly recognize deviations requiring corrective action.*
>
> *b) Prioritizing crew actions during periods of high workload.*
>
> *c) Ensuring "Closed-Loop" Communication: Crewmember to Crewmember and Crewmember to Automation.*
>
> *d) Reducing crew workload.*

Pilot Flying (PF) shall fly the aircraft and, during formation flights, maintain communication with the other aircraft (SOP Section 2.1). Pilot Monitoring (PM) shall address tactical and administrative elements and has greater responsibility for sensors in the aircraft, including for monitoring the map, planning and plotting data, 'leg brief'[29] and communication with the air traffic service. PF shall always look out of the aircraft, and PM shall alert of 'heads down' if he/she intends to spend a significant amount of time on tasks that require shifting attention away from monitoring the flight (SOP Section 2.4).

Closed-loop (mostly verbal) communication between the pilots was prescribed in checklists. When the aircrew includes an aircraft commander candidate, it is standard practice for this person to make all decisions as long as it does not compromise safety. In the case under consideration, this was also explicitly stated during the pre-mission briefing with the crew, according to SOF/DETCO.

The loadmasters were not deemed to be part of the operational aircrew on the C-130J and were not required to be seated in the cockpit. It is nonetheless clear from interviews that the loadmasters, depending on their level of experience, supported the C-130J pilots, among other things by alerting of 'two pilots heads down', keeping an eye on the map and picking up on elements from the radio communication (SOP Section 2.10).

1.17.6.4 *Safetec study of the 335 squadron in 2014*

In 2014[30] Safetec conducted a study of CRM in the 335 squadron commissioned by the Air Operations Inspectorate on behalf of the RNoAF. The study was a follow-up measure after the Kebnekaise accident. The squadron wanted such a study, and it had the support of both the Air Operations Inspectorate and the former Inspector General of the RNoAF.

[29] The 'leg brief' shall contain information about the next route segment (altitudes, obstructions, airspace etc.)
[30] The start-up meeting for the study was held on 14 October 2013. The report was completed on 20 May 2014.

Safetec interviewed selected 335 squadron personnel. Safetec observers were also present during the planning and execution of flights. The study showed that CRM practice in the 335 squadron was generally good. There was little variance between the aircrews, and their behaviour on board was largely in line with good CRM practice. At the same time, Safetec proposed 14 measures to further enhance CRM in the squadron.

Through its interviews and observations, Safetec had also formed the impression that this was an organisation that clearly needed improvements over and above what the aircrew members could influence or handle through good CRM. Safetec had observed several underlying factors that they deemed to be unfortunate for flight safety,

including in the following areas:

- Lack of clarity in regulatory framework and procedures
- Standardisation work
- Operational support
- Working hours arrangements
- The system for following up qualifications (PAQS) and training

Safetec summed up these finding as follows in its report:

> *Given the choice of improving CRM or the factors we have drawn attention to above, there is little doubt that improving the framework conditions would have a greater effect on risk levels.*

Safetec has informed the NSIA that after the report was submitted and presented to the Air Operations Inspectorate and Inspector General of the RNoAF on 24 April 2014, and on the 335 squadron's ground day[31], it received no request for further follow-up or questions about the study findings. The study indicated to Safetec that the framework for the squadron's activities had not been fully defined. The organisation had not been adequately prepared for taking on a new aircraft system and the pilots were not sufficiently familiar with the system. They also felt that the 335 squadron consisted of a number of skilled personnel, but that the resource, regulatory and procedural framework had not been adapted to the squadron's activities.

According to the RNoAF[32], the Air Operations Inspectorate and 335 squadron reviewed Safetec's recommendations together and concluded which of them were relevant and how they were to be followed up. The NSIA has not received any concrete documentation of such follow-up having taken place or of how the recommendations were addressed going forward.

[31] Workday without flights.
[32] Letter of 14 September 2018 from the RNoAF to the Defence Staff on follow-up of measures after the Kebnekaise accident (*Oppfølging av tiltak i Luftforsvaret – Kebnekaiseulykken*).

1.18 Regulatory framework and supervisory activities

1.18.1 List of overriding rules and regulation for the C-130J

Figure 23 shows the hierarchy of civilian and military rules and regulations for C-130J operations. Regulations relating to flying at night, weather and light conditions (illumination) and qualifications (checkout programme) are of particular relevance to the incident at Mosken.

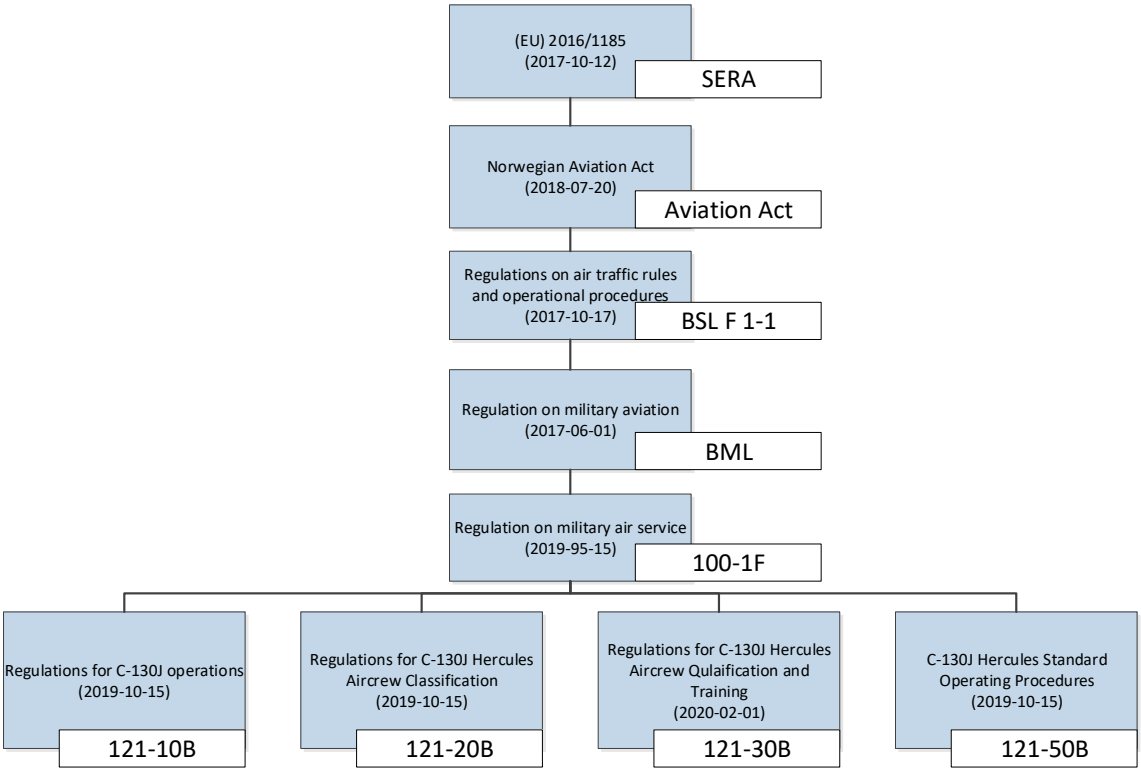

Figure 23: Simplified hierarchy of civilian and military rules and regulations for C-130J operations. Illustration: RNoAF

In addition to the rules and regulations listed in Figure 23, the following provisions relating to the safety management system and flight safety are also of relevance to the incident:

- Directive on requirements for safety management in the Armed Forces (*Direktiv – Krav til sikkerhetsstyring i Forsvaret*, 2010)
- The Armed Forces' safety rules and regulations for land-based activities (UD 2-1 *Forsvarets sikkerhetsbestemmelser for landmilitær virksomhet*), 2020
- Regulation on safety management in the RNoAF (BFL 010-1 *Bestemmelse om sikkerhetsstyring i Luftforsvaret*), 1 July 2017
- Regulation relating to flight and ground safety (*Bestemmelse for fly- og bakketrygging)*,1 January 2020
- Rules and regulations relating to flight and ground safety (*Reglement for fly- og bakketrygging)*,1 January 2020

1.18.2 Authority to issue orders and powers of authorisation in the RNoAF

Authority to issue orders and powers of authorisation are described in Sections 2.4.1 and 2.5.1 of BML. By authority to issue orders is meant the power to order air missions with the Armed Forces' aircraft. By authorisation of an air mission is meant approval of pilots/aircrew for conducting an ordered air mission so that supervision, control and flight safety are ensured.

In principle, all military air missions in the Armed Forces under Norwegian operational command shall be ordered by the Chief of NAOC. All operational air unit commanders (air wing/air base commanders and squadron commanders) in the RNoAF are delegated the authority to issue orders within given limits as described in Section 2.4.6 (including 'Air missions that form part of approved training programmes for defence capacity building'), that permit making changes to air tasking orders (ATO) issued by the Chief of NAOC.

Authorisation of air missions is an important formal safety barrier intended to assure the quality of mission planning and execution within a safe and acceptable framework. The power to authorise flights is delegated to the operational line organisation for the purpose of ensuring the best possible flight safety and supervision. The Inspector of Air Operations normally delegates powers of authorisation to the commanders of the respective air wings, who are in turn responsible for further delegation within their units. The Commander of the 335 squadron has been delegated powers of authorisation for that squadron's flying missions.

Air missions shall be authorised by a person with powers of authorisation who, in principle, does not participate in the mission. In connection with the mission being considered here, the 335 squadron's deputy commander had powers of authorisation by virtue of being the detachment commander (DETCO), as described in the 335 squadron's authorisation instructions.

Among other things, the authorisation instructions state that formation flying with C-130J aircraft and low-level flying shall be authorised by the 335 squadron's deputy commander or a higher-ranking officer. The instructions also contain a checklist for authorisation of air missions, including the following checkpoints: weather and light conditions[33], airfield status, aircraft performance, condition and equipment, the aircrew's qualifications[34], experience and status, transport mission, drop, NVG and low-level flying.

1.18.3 Development of rules and regulations for the C-130J

The RNoAF investigation report stated that the pilots in the 335 squadron had completed conversion to the J version of the C-130 aircraft in the USA. To start with, the 335 squadron adopted US procedures, operational patterns, limitations and, in the absence of Norwegian provisions on operations with C-130J, largely also US rules and regulations. For several years after the procurement of these aircraft, the squadron relied mostly on US publications and rules and regulations, even though they had not necessarily been

[33] For flying at night, this includes a check of NVG and illumination data.
[34] Including ORM status, and a check of PAQS and of whether all aircrew have the requisite qualifications and continuity.

adapted to conditions in Norway and sometimes contained requirements that came into conflict with other Norwegian rules and regulations.

In 2015, the rules and regulations for the C-130J were extensively revised, a process that entailed, among other things, that US publications were largely replaced by Norwegian rules and regulations. According to the Air Operations Inspectorate, there are still gaps and deficiencies in Norwegian rules and regulations relating to the C-130J. The Air Operations Inspectorate has also pointed out that, over time, this has probably affected the squadron's respect for and compliance with applicable regulations.

1.18.4 Requirements for flights under visual conditions

1.18.4.1 *General requirements for VFR flying at night (with or without NVG)*

The following is quoted from the RNoAF investigation report:

> *The investigation found a deficiency in existing rules and regulations in that they do not specify what requirements apply to flight visibility and distance to clouds in connection with C-130J operations. The investigation also showed that the personnel involved were not aware of the dispensation from the requirements in BSL F 1-1/SERA section 5. Nor did the personnel have sufficient knowledge about the original requirements in BSL F 1-1/SERA section 5, in particular those relating to minimum cloud height for flying in the dark.*

The dispensations referred to in the quote were granted in a letter from the Air Operations Inspectorate of 2 February 2018, exempting the C-130J from the requirements set out in the Regulations of 14 December 2016 No 1578 on rules of the air and operational procedures (BSL F 1-1), which should have been described in BML.

BSL F 1-1 describes Standardised European Rules of the Air (SERA)[35] and includes special provisions for Norway. BSL F 1-1 was adopted in pursuance of Section 9- of the Norwegian Aviation Act, and applies to both civilian and military aviation. According to BSL F 1-1 Section 14, the minimum altitude (1,000 ft) for VFR flying at night, as described in SERA 5005(c), may be reduced subject to a minimum visibility of 10 km, minimum cloud height of 2,000 ft, and given clearance to clouds and visibility of the ground/terrain below.

On the mission in question, which was flown at 500 ft, the cloud base was at times only just above 600 ft.

1.18.4.2 *Requirements for VFR flying at night using NVG*

The following is quoted from Section 8.4 of the regulations for operations with C130J Hercules (*Reglement for operasjoner med C-130J Hercules*, 121-10B), which defines requirements for the adjusted low-level flying concept that had been introduced in the 335 squadron:

[35] Regulation 923/2012 - Common Rules of the Air and Operational Provisions Regarding Services and Procedures in Air Navigation has been implemented in Norwegian law, and is referred to as the Standardised European Rules of the Air (SERA).

> ***8.4 VFR night flying with NVG***
>
> *VFR flying using NVG is permitted in both controlled and uncontrolled airspace. The following restrictions apply to VFR flying at night using NVG when navigating by visual reference to the terrain:*
>
> *a) The minimum height is 500 feet AGL.*
>
> *b) The illumination must be 2.2 millilux (mLux) or higher.*
>
> *c) The route must be planned in advance and not pass over densely populated areas.*
>
> *d) The light conditions must be such that the contours of the terrain can be clearly seen through NVG.*
>
> *Only the deputy commander or a higher-ranking authorisation authority may approve VFR night flying with NVG below 1,000 feet AGL. Such missions may be authorised by a pilot who has been delegated powers of authorisation.*

The following is quoted from the RNoAF investigation report:

> *The investigation has shown that the regulatory minimum illumination requirements (2.2 mLux) were not met. In consultation with SOF, the crews chose a 'wait and see' approach whereby an assessment would be made of whether the light conditions were good enough en route during the mission. The aircrews had neither the possibility of measuring illumination in the area where they were operating, nor of verifying that the contours of the terrain were sufficiently visible to pass Mosken at close proximity.*

1.18.4.3 *Requirements when deviating from a pre-planned route*

The following is quoted from the RNoAF investigation report:

> *BML and 121-10B Annex X sets out specific requirements relating to deviation from a pre-planned route for low-level VFR flying (with or without NVG). It permits deviating from a pre-planned route provided that the requirements of BML (4.17.7 and 4.17.8) and 121-10B Annex X (5.4.3) are complied with. These requirements were not complied with at the time when the formation initiated a more direct route from the exercise area to Bodø.*

The decision to deviate from the route could have been taken in accordance with the rules and regulations, had the formation initiated a route abort and climbed to a safe height.

1.18.5 Requirements for aircrew qualifications

The qualification requirements for operational C-130J air personnel are regulated by several sets of rules and regulations[36]. The tools used by the RNoAF to keep an overview of aircrew qualifications include the Personnel and Qualification Status Program (PAQS). PAQS is intended to provide squadron commanders and management with a better basis

[36] 121-20B Regulations for C-130J Hercules Aircrew Classification (2019-10-15) and 121-30B Regulations for C-130J Hercules Aircrew Qualification and Training (2019-10-15).

for planning exercises and training activities, in addition to providing an overview of current personnel status in relation to regulatory requirements.

When a person is qualified in a given discipline, this is indicated by the colour green in PAQS. The 'currency period' is six months for disciplines that can be carried out in daylight and ten months for disciplines that must be carried out at night. A person with status 'orange' (not current) in a given discipline may perform that discipline without an instructor, but, at the same time, a thorough theoretical review of the discipline is required before any mission is authorised. If given status 'red' (not qualified), the discipline shall be performed in the presence of an instructor. The squadron commander may grant dispensation from the requirement for an instructor.

1.18.6 Military aviation authority

The Armed Forces are exempt from civil aviation legislation, with the exception of the provisions set out in the Act of 11 June 1993 No 101 relating to Aviation (the Aviation Act, most recently amended 1 July 2020), Part II on military aviation. The provisions that apply include those set out in BSL F 1-1. The Chief of the RNoAF is delegated military aviation authority by the Chief of Defence; see Section 1 of the Regulations of 13 February 2015 No 123 relating to military aviation authority.

The military aviation authority takes the place of the civil aviation authority (the Civil Aviation Authority) in the enforcement and administration of those provisions of the Aviation Act that apply to military aviation. The military aviation authority may issue further regulations to implement and complement the rules on military aviation provided for in Part II of the Aviation Act.

The Chief of the RNoAF has issued *Bestemmelser for Militær Luftfart* (BML). BML regulates the powers of the military aviation authority and lays down special rules for military aviation, supplements and provides for exemptions from civil aviation regulations and clarifies authority and responsibility.

Hence the military aviation authority is not distinct from the operator of military aircraft; the RNoAF fills both functions. The Chief of the RNoAF has issued instructions that delegate the exercise of military aviation authority to the Inspector of Air Operations, however, with the exception of military airworthiness authority, which is exercised by the NDMA Air Systems Division under an agreement with the RNoAF as the military aviation authority.

The Head of the NDMA Air Systems Division has issued military airworthiness rules in *Reglement for militær luftdyktighet* (RML) . RML provides legal authority for the introduction of a joint European framework for regulation and control of airworthiness entitled European Military Airworthiness Requirements (EMAR) that is currently taking place. EMAR is administered by the airworthiness authority and stipulates airworthiness requirements for military aircraft.

Hence the airworthiness authority is not distinct from the NDMA, the authority responsible for both procurement and ownership management of military aircraft. The Head of the Air Systems Division has established and assigned staff to a department referred to as the Norwegian Military Airworthiness Authority and delegated the exercise of airworthiness authority to the head of that department.

1.18.7 The RNoAF's supervision and follow-up of the 335 squadron

According to a draft handbook for supervision by the Air Operations Inspectorate (*Utkast til håndbok for tilsyn ved LOI*, 2018) the Air Operations Inspectorate's primary task is to support and facilitate safe training, exercises and operations in peacetime and situations of crisis and war by Norwegian and allied military air systems. Regular supervisory activities are intended to ensure that applicable regulations, including BML, are complied with and work as intended. Supervision by the Air Operations Inspectorate is also intended to provide a basis for evaluation of rules and regulations and, if applicable, for input to amendment proposals (experience learning). The Air Operations Inspectorate's supervisory activities comprise audits, inspections and verifications at the RNoAF's air wings/stations and schools.

The Air Operations Inspectorate's office for multi-engine and flight instruction aircraft is responsible for technical inspection and supervision relating to the C-130J. The office is required to have one field officer per aircraft type, but the position of field officer for tactical transport aircraft has not been held by a pilot with C-130J competence since 2018. The 335 squadron was one of four operational air units for which the Air Operations Inspectorate lacked personnel with competence relating to the aircraft type at the time of the incident.

The following overview of evaluation and supervision activities is based on, *inter alia*, the RNoAF investigation report:

- The most recent ordinary inspection of the 335 squadron took place in January 2012. The inspection was led by the Air Operations Inspectorate and included participants from the Flight Safety Inspectorate and the Institute of Aviation Medicine, among others.

- Inspection of Tactical Airlift Detachment (TAD) in Afghanistan in October 2012, and of Norwegian Tactical Airlift Detachment (NORTAD) in Mali in May 2016. Both inspections were led by NJHQ, with support from the Flight Safety Inspectorate and Institute of Aviation Medicine.

- In connection with the pre-preparations for NORTAD II, the Air Operations Inspectorate and Flight Safety inspectorate conducted a supervisory activity (observation) of the squadron in March 2019. The Air Operations inspectorate prepared an observation report from the preparations, and a verification report of the NORTAD II deployment.

- In 2019, the Air Operations Inspectorate's planned inspection of the 335 squadron was cancelled, among other things because the Inspectorate was unable to provide a C-130J guest pilot. In addition, the Inspectorate considered that it had a good understanding of status and how flying operations were conducted based on the reports from 2019 and cooperation with the 335 squadron on the revision of C-130J publications.

- In addition to participating in inspections under the auspices of the Air Operations Inspectorate and NJHQ, the Flight Safety Inspectorate has paid several visits to the 335 squadron during the period 2012–2020.

Other than the above, no internal audits or inspections of the 335 squadron had been carried out by 134 Air Wing or the RNoAF management to verify compliance with rules and regulations and governing documents. Nor had the NAOC conducted any tactical evaluation (TACEVAL/NATEVAL) of the 335 squadron to verify that the unit was capable of solving defined missions in accordance with applicable operational rules and regulations.

1.18.8 Supervision by the Armed Forces Material Safety Authority

1.18.8.1 *General information*

The Armed Forces Materiel Safety Authority is limited to auditing equipment and arms in the defence sector, and has access to all the Ministry of Defence's subordinate agencies. The scope of the Authority's activities is limited to areas where the defence sector is exempted or assigned independent responsibility by law or regulation. In practice, this means that the Authority is a supervisory authority for materiel safety in areas where other government supervisory bodies have no authority. The Materiel Safety Authority comprises a staff of 11 persons, and has a dedicated advisory group on airworthiness in military aviation. The Authority conducts supervisory activities in the form of system inspections, verifications, advice and certification, and by issuing orders and conducting follow-up activities.

1.18.8.2 *The Armed Forces Materiel Safety Authority's supervision of the RNoAF and 134 Air Wing at Gardermoen*

According to information received from the Material Safety Authority, it has conducted four supervisory activities at Gardermoen since 2012: two relating to aircraft maintenance and two relating to ground equipment. Two of these activities were of the verification type, meaning that they were more in the nature of confirmation of individual factors than system inspections. None of the Authority's findings were significant in relation to the incident under consideration, and the Authority had not considered aspects relating to TAWS.

In addition, the Authority conducted an audit in 2019 involving the whole RNoAF and the NDMA Air Systems Division, including Gardermoen. The audit addressed the handling of incidents and nonconformities in military aviation. Four nonconformities and ten observations were reported to the RNoAF management. The Materiel Safety Authority also conducted a supervisory activity in relation to the RNoAF management in 2016, after which it reported five nonconformities and six observations, relating to, among other things, how the RNoAF management followed up operation and maintenance of aircraft at all its operational bases, including Gardermoen.

According to the Material Safety Authority, there are currently no nonconformities pertaining to the 134 Air Wing, including the 335 squadron, that remain outstanding.

1.18.8.3 *The Armed Forces Materiel Safety Authority's assessment of materiel safety culture*

According to information from the Materiel Safety Authority, it has evaluated the materiel safety culture of the operational units under its supervision since 2011. Such evaluation is carried out by the inspection team based on observations and concrete questions posed during the inspection. The evaluations are used by the Authority so as to be able to better understand and provide guidance to the operational units. The

Authority's remit only cover materiel safety, and not other areas of safety, but since operation and maintenance of military aircraft are carried out by the individual air wings, it considers it reasonable to assume that the performance values also give some indication of conditions in other areas of safety.

The Authority's assessment of materiel safety culture addresses five main categories: flexible, informed, fair, learning and reporting cultures[37]. According to the Authority, the performance indicators have improved year on year, and then flattened out. The most prominent feature is how low the defence sector's operational units, including RNoAF units, score on learning culture. According to the Materiel Safety Authority, this has been a weak point since they started to measure cultural aspects in 2011, and it appears that there is still some way to go before the organisation achieves sufficient maturity for a good learning culture.

1.18.9 Military aviation authorities in other countries

Several countries have an independent, overall (supervising both operations and airworthiness) military aviation authority that is distinct from the military aircraft operator, including Australia, France, Germany, Hungary, the Netherlands, Sweden and the UK. The Materiel Safety Authority has also informed the NSIA that more countries are seeking to establish an independent, overall military aviation authority.

The UK Military Aviation Authority[38] was established in 2010 as a consequence of 'The Nimrod Review – An independent review into the broader issues surrounding the loss of the RAF Nimrod MR2 Aircraft XV230 in Afghanistan in 2006'[39], which recommended a radical review of the UK rules and regulations for military airworthiness.

1.18.10 The Ministry of Defence's work on supervisory schemes for the defence sector

1.18.10.1 *Supervision and development of rules and regulations for the defence sector's ships*

The working group on ship safety and security was tasked by the Ministry of Defence with reviewing how future supervision and regulatory developments relating to ship safety and security should be organised in the defence sector. The situation at present is that no special supervisory authority has been appointed and no detailed rules relating to supervision of defence sector ships have been adopted.

The working group has assessed three different supervision models based on the following criteria: independence, regulatory competence, competence in supervisory methods including safety management systems, defence sector competence, clearly defined roles, safeguarding the Armed Forces' operative capabilities, the need to protect information, establishment of safety barriers– robust organisation, resource optimisation and effective supervision.

Based on its discussion, the working group has recommended that supervision be carried out by a separate entity organised as a department of the Norwegian Maritime Authority

[37] These categories are in line with the safety culture elements described by Reason (1997) in *Managing the risks of organisational accidents*.

[38] https://www.gov.uk/government/organisations/military-aviation-authority/about (Downloaded 17 March 2021) https://www.gov.uk/government/publications/the-nimrod-review (Downloaded 17 March 2021). The Nimrod XV230 was lost on a routine mission over Afghanistan when she suffered a catastrophic mid-air fire, leading to the total loss of the aircraft and the death of all 14 service personnel on board.

(NMA), and that the entity be supplemented with military technical and operative expertise. The Ministry of Defence will be the competent authority and governing agency for the unit.

1.18.10.2 *Study relating to overall supervision in the defence sector*

The Ministry of Defence has initiated a study to consider overall supervision of the defence sector in all areas of regulation where the sector is exempted or subject to special rules and regulations, including military aviation and naval activities. In that connection, consideration is being given to areas of regulation in which a supervisory scheme would be appropriate, and to how consistent and overall supervision can be optimally ensured in these areas. The work is divided between a phase in which the principles are established and a phase of applying the principles to the individual areas of regulation. In this work, account is taken of the recommendations of the working group that reported on ship safety and security, and the recommendations are considered in conjunction with the results of that report. The work had not been completed at the time of publishing this report.

1.19 Other information

1.19.1 Excerpts from the RNoAF investigation report

1.19.1.1 *The RNoAF investigation team's conclusions*

The following is quoted from the RNoAF investigation report:

> *Squadron culture, the willingness to deliver and the professional identity of operational units are largely characterised by personnel who want to solve the missions they are assigned. This description also applies to the 335 squadron, insofar as the unit offers capabilities that are in high demand and is an accessible resource. At times, this results in a very high pace of operation and a mission portfolio that challenges the ability to conduct operations safely.*
>
> *The investigation has shown that the incident at Mosken could have been avoided had the executing unit, local management and RNoAF's management more fully recognised the inherent drive and the heightened risk associated with being mission-focused and solution-orientated. In this case, this drive does not need to be reinforced through praise and recognition, but must rather be regulated through increased focus on risk assessment and risk management at all levels. Precise rules and regulations, knowledge of the rules and regulations and rigorous ORM are considered important tools. In this report, the investigation team has claimed that the unit could itself have prevented the incident, had the aforementioned tools to a greater extent been used and translated into practical action. This should not be understood as a responsibility carried by the operational unit alone, however.*
>
> *The RNoAF management had on several occasions given voice to and described measures addressing the balancing of the relationship 'Mission first – People and Safety Always'. In the investigation team's opinion, the measures described are robust and can be very effective. However, this will require that the RNoAF's organisation as a whole becomes better at translating the adopted measures into practical action. The organisation must also be adequately dimensioned and staffed with personnel with the requisite competence. When combined with a continuous focus on translating risk-reduction measures into practical action, the above will, in the investigation team's opinion, do much to prevent the recurrence of similar incidents in future. The near collision with Mosken on 11 March 2020 is an indication that the RNoAF as an organisation still has potential for improvement in this area.*

1.19.1.2 *The RNoAF investigation team's recommendations*

The RNoAF investigation team submitted seven recommendations intended to help the addressee to remedy circumstances that may have facilitated the incident. Implementation of these recommendations will reduce the risk of recurrence of similar incidents. The addressees are responsible for ensuring that the recommendations are assessed by and, if relevant, implemented at appropriate levels in the organisation.

Six of the team's recommendations were addressed to the RNoAF. The final recommendation was addressed to the NDMA.

***Recommendation No 1 Mission portfolio**:*

The investigation team recommends that the RNoAF management carry out an overall evaluation of the C-130J mission portfolio.

***Recommendation No 2 Competence management**:*

The investigation ream recommends that the RNoAF management assign necessary advisory air operations competence to levels above the 335 squadron to exercise authority and management and supervisory responsibilities. Corresponding measures should be considered for other operational air squadrons.

***Recommendation No 3 Supervision and evaluation**:*

The investigation team recommends that the RNoAF management conduct an assessment of whether existing procedures for follow-up and control of the 335 squadron are sufficient to maintain safe dimensioning of advisory, operational and control functions.

***Recommendation No 4 Rules and regulations**:*

The investigation ream recommends that the Air Operations Inspectorate review and clarify the requirements for low-level VFR flying in the dark, with and without NVG.

***Recommendation No 5 Pressure culture**:*

The investigation team recommends that the 335 squadron evaluate and clarify the degree to which the pressure culture affects the safety level in the unit, and that, based on such an evaluation, appropriate measures be implemented to ensure safety.

***Recommendation No 6 Joint arenas**:*

The recommendation team recommends that the RNoAF management take steps to ensure that the 335 squadron is provided with the requisites for focusing on learning and continuous improvement.

***Recommendation No 7 Change of procedure**:*

The investigation team recommends that the NDMA Air Systems Division consider whether disengagement of the auto-throttle should be addressed as part of the procedure in the aircraft manual for GCAS/TAWS PULL UP Alert Recovery.

All the RNoAF investigation team's recommendations, including the grounds for the recommendations and the status of implemented measures, are described in Appendix C.

1.19.2 Implemented measures

1.19.2.1 *The 335 Squadron*

On 16 March 2020, the commander of squadron 335 announced the following to the squadron via Red Marker 20-06:

> *After the incident in connection with CR20, we will not conduct low level operations with NVG in the 335 squadron. This limitation shall apply until the investigation team has completed its report.*
>
> *NVG operations/training other than at low level will continue as usual.*

1.19.2.2 *The Chief of the RNoAF's guidelines relating to the investigation team's report and recommendations*

In a letter of 1 July 2020, Chief of the RNoAF has commented on and issued guidelines relating to the RNoAF investigation report. In order to ensure that the recommendations are followed up, the Chief of the RNoAF has assigned tasks and responsibilities with deadlines for ensuring that necessary measures are implemented. In addition, the Chief of the RNoAF has issued guidelines to follow up three other areas for improvement identified in connection with the RNoAF investigation. They are:

- The project for operational balance and consistent learning culture in the RNoAF
- Crew resource management (CRM)
- Terrain awareness and warning systems (TAWS)

All the guidelines from the Chief of the RNoAF are available in Appendix C.

1.19.2.3 *Project for an overall safety management system*

In January 2020 (before the Mosken incident) the RNoAF management decided to appoint a working group to report on how the RNoAF Staff could implement a new framework for overall safety management.

The work was based an acknowledgement of the level of safety management in the RNoAF being unsatisfactory. The purpose was to study how the RNoAF management could put in place a new framework for a safety management system, including good and expedient processes. It was also an explicit ambition that the safety management system should contribute to simpler and better safety management for managers through clarification, simplification and more efficient use of resources (see also Appendix C).

The working group distributed a draft report for internal consultation in the RNoAF in autumn 2020, and the report was presented to the Chief of the RNoAF on 20 January 2021. The report was completed on 19 February 2021.

The report includes a description of the present situation and challenges in the RNoAF's safety work. It goes on to discuss the RNoAF going forward to 2040, management and control of safety, roles, responsibilities and authority, and safety management from a competence perspective.

The report recommends that the RNoAF Staff submit more requirements/needs to the Defence Staff, including that the RNoAF initiate a process to establish an independent military aviation authority that is not part of the RNoAF.

The report also addresses several recommendations to the Chief of the RNoAF in five main areas. A selection of these recommendations are quoted below:

- Framework: The RNoAF should introduce a quality system based on ISO 9001:2015. The framework for safety management should be in accordance with ICAO's Safety Management System (SMS[40]) template. Restructuring of discipline/safety areas for the RNoAF.
  BFL 010-1 should become the overall regulation for safety work, to which other regulations are linked.

- Digitalisation: The RNoAF should procure/develop an up-to-date ICT safety management system. Remedy should be completely phased out.

- Competence: Competence in overall safety management in the RNoAF should be strengthened, including competence in methods, quality management and safety management systems.

- Management, control and coordination: The safety management system should be integrated with corporate governance through the development of a safety policy, safety objectives and management parameters.

- Organisational structure: A new safety and security department should be established as part of the RNoAF management by bringing together all advisors on safety management systems, flight safety, HSE and security. The safety and security department should be assigned responsibility for both the overall safety management system and the quality system. The grounds for this include the need for an overall approach, uniform methods and a competence environment.

The report also discusses safety culture and recommends that the RNoAF conduct safety culture surveys at least every two years, along the same lines as the Navy[41].

The Chief of the RNoAF has commissioned seven sub-studies based on the report from the working group (see Appendix C).

[40] The RNoAF is not regulated by civil aviation legislation and is therefore not subject to the requirements for a safety management system defined there. *'A safety management system (SMS) describes a systematic process comprising an administrative structure, management, safety policy and procedures for risk control. SMS shall be used to identify safety risks, ensure continuous measurement and assessment of safety levels, as well as to seek continuous improvement of SMS and ensure corrective actions to maintain the desired safety level.'* (The Civil Aviation Authority Norway, 2017, p. 16)

[41] DNV GL carried out a survey of the safety culture in the Fleet and Navy on assignment for the Norwegian Defence Logistics Organisation (NDLO) in connection with the internal investigation of the accident on 8 November 2018 involving HNoMS 'Helge Ingstad'.

1.19.3 Other incidents involving the C-130J

According to the RNoAF investigation report, seven other incidents involving C-130J aircraft have been subject to extensive investigation by the RNoAF since the aircraft type was phased in in 2008/2009.

Table 3: Incidents involving C-130J aircraft that have been subject to investigation by the RNoAF. Source: RNoAF

Date	Title	Location
6 March 2009	Tailstrike	Kvernberget
15 March 2012	Controlled flight into terrain (CFIT)	Kebnekaise
11 October 2013	Landing short	Grafenwohr
7 March 2014	Smoke development in the cabin during application of the brakes	Bardufoss
13 April 2015	Flight Controls	In the air (Værnes)
27 April 2015	Hot brakes and wheel-area fire	Rena
10 January 2017	Tailstrike	Ørland

The RNoAF investigation team's review of the seven investigation reports addressing incidents involving the C-130J, shows that five of them are largely linked to human factors. The incidents of 7 March 2014 and 13 April 2015 were largely caused by technical factors. Several of the reports point out that the regulatory framework for C-130J operations is unclear. The absence of joint arenas for transfer of experience/learning is also mentioned, which can be partly explained by personnel not being present on account of extensive operational activity followed by time off in lieu. Another common feature appears to be linked to a lack of knowledge about the aircraft, aircraft systems and limitations. A (too) large mission portfolio is also mentioned in several of the reports.

The RNoAF investigation team's review of the safety recommendations in the seven investigation reports shows that all recommendations addressed to 134 Air Wing and the 335 squadron have either been closed or are about to be closed. At the central level, some recommendations remain open, particularly relating to procurement and orders not placed by the RNoAF.

1.19.4 The Kebnekaise accident on 15 March 2012

1.19.4.1 *The investigation report*

On 15 March 2012, in connection with Cold Response 2012, a C-130J aircraft collided with the Kebnekaise mountain in Sweden (see Figure 24). Five people died. The accident was investigated by the Swedish Accident Investigation Authority (Swedish SHK). NORKOM, a delegation from the NJHQ, assisted the Swedish SHK in the investigation. Representatives of the Accident Investigation Board Norway[42] also participated in the early phase of the investigation and at the scene of the accident. The Swedish SHK's report was published on 2 October 2013[43].

[42] Now replaced by the Norwegian Safety Investigation Authority (NSIA).
[43] Swedish Accident Investigation Authority (2013): Accident involving a Royal Norwegian Air Force aircraft of type C-130 with call sign HAZE 01, on 15 March 2012 at Kebnekaise, Norrbotten county, Sweden. Final Report RM 2013:02: English version available at https://www.havkom.se/assets/reports/English/RM-2013_02_e.pdf (Downloaded 21 June 2021).

Figure 24: Photo of Kebnekaise. The photo was taken in the direction of flight at the same height as the point of impact (marked). Photo: Swedish Accident Investigation Authority, 2013

The mission was to fly a transport flight under IFR to Kiruna in Sweden to pick up Norwegian military personnel and materiel and fly them back to Evenes. On the flight operations side, the investigation found shortcomings in the RNoAF's procedures for planning and following up air missions. In combination with what was probably a high level of confidence in air traffic control, this meant that the crew did not realise that the clearance received from the control tower in Kiruna entailed an altitude that did not allow for adequate terrain separation (Swedish SHK, 2013).

The investigation report went on to point out the following relating to the RNoAF (Swedish SHK, 2013):

- Lack of clarity in the system documentation and training may have resulted in possible gaps in the crew's knowledge of the ground collision avoidance system (GCAS/TAWS). Together with weaknesses in the system design, this can explain why the crew chose to use TAWS Tactical despite the fact that the system's terrain map database did not cover areas north of 60° N.

- A large number of references and cross-references in the regulatory framework for C-130J operations made it demanding for individual aircrew members to maintain the requisite level of knowledge to meet the strict requirements for flight safety and tactical performance that apply during flights.

- The 335 squadron phased out the previous Hercules model (C-130H) and started using the C-130J as from January 2009. The minimum aircrew on the C-130H comprised two pilots, one navigator and one engineer. The Swedish SHK did not find any documentation explaining how the duties that had previously been performed by the navigator were transferred to the new crew configuration, and was therefore unable to rule out a potential system weakness.

1.19.4.2 *Safety recommendations from the Swedish SHK*

As a consequence of the investigation, the Swedish Accident Investigation Authority issued the following recommendations to the RNoAF (Swedish SHK, 2013):

- *Ensure that procedures are used that prevent aircraft from being flown below the minimum safe altitude or flight level en route in IFR flight. (RM 2013: 02 R1)*
- *Ensure that flight crew knowledge and routines means that the system for ground collision avoidance is used in a safe manner. (RM 2013: 02 R2)*
- *Further examine whether, and where necessary take measures to ensure that, the current crew configuration on the C130J attends to all aspects of the safe implementation of planning and flight. (RM 2013: 02 R3)*
- *Develop clear rules, manuals and procedures, which make it easier for flight crews to conduct safe air operations. (RM 2013: 02 R4)*

1.19.4.3 *Recommendations from NORKOM*

In connection with the submission of its final report to the Norwegian Armed Forces/NJHQ, NORKOM made a further three recommendations to the RNoAF (dated 23 October 2013):

- *The RNoAF is recommended to conduct operative testing and evaluation (OT&E) when it phases in new structural elements (planes, helicopters, unmanned aerial systems). Adapted rules and regulations must be established at the same time.*
- *It is recommended that the RNoAF evaluate its training system for air operations.*
- *It is recommended that the RNoAF evaluate its management structure in order to ensure that military aviation authority is exercised in full compliance with the Aviation Act and the Regulation on military aviation ('Bestemmelser for Militær Luftfart').*

1.19.4.4 *Letters and recommendations from the NJHQ*

A letter dated 26 February 2014 from the Chief of the NJHQ to the Chief of Defence, with copies to the Defence Staff and Inspector General of the Air Force, contained further comments on factors that were not discussed in any detail in the Swedish SHK report. The Chief of the NJHQ acted in the capacity of Norwegian military investigation authority. The letter points out that the Defence Staff is expected to follow up by assigning concrete tasks to subordinate units.

The Chief of the NJHQ submits four own recommendations:

> *a) That the C-130J aircrew concept be evaluated.*
>
> *b) That the RNoAF provide an account of its planning procedures, CRM procedures and training programmes (including ground training programme and simulator training) for the 335 squadron.*
>
> *c) That the RNoAF review the scope of authority of the flight safety organisation with a view to making adjustments based on the information that emerges from the investigation (including in connection with the procurement of materiel).*
>
> *d) That the RNoAF review military/civilian rules and regulations together with the Civil Aviation Authority in order to identify any ambiguities with reference to minimum altitudes as discussed in the report.*

It is clear from the Chief of the NJHQ's letter that the C-130J was phased in by the RNoAF as an urgent procurement. OT&E, which would probably have entailed evaluation and possibly adaptation of operational procedures, work procedures and technical solutions, was not carried out when the aircraft were phased in. The letter also refers to the 335 squadron's mission portfolio having increased as had the complexity of many of the missions. The Chief of the NJHQ considered that the removal of the navigator and engineer when transitioning to the C-130J, may have affected safely levels on board the aircraft.

1.19.4.5 *Follow-up of safety recommendations/recommendations after Kebnekaise*

The NSIA has received detailed documentation from the RNoAF of how the recommendations issued after the Kebnekaise accident were followed up. The documentation is collated in Appendix B.

The document review showed that, in February 2014, the RNoAF reported on measures that had been implemented or that it planned to implement as a consequence of the recommendations from the Swedish SHK and NORKOM. The planned measures included an observation study of CRM in the 335 squadron. Based on the RNoAF's response, the Swedish SHK considered that all the recommendations had been met, with the exception of R1 on *'procedures ... that prevent aircraft from being flown below the minimum safe altitude or flight level en route in IFR flight*'. The RNoAF responded by including '*minimum safe flight level'* as a separate point on the checklist for authorisation, and thus considered recommendation R1 to have been addressed. All recommendations from the Swedish SHK and NORKOM were therefore deemed to have been closed by the RNoAF on 11 September 2014.

With respect to the recommendations from the Chief of the NJHQ , the document review showed that the Defence Staff had not followed them up by assigning concrete tasks to subordinate units, including the RNoAF, as originally requested by the investigation authority. Near the end of 2017, the RNoAF realised that the Defence Staff had not assigned concrete tasks to follow up the recommendations from the Chief of the NJHQ. Some time later, the Defence Staff assigned the RNoAF the task of '*reviewing and confirming that factors identified by the NJHQ in connection with the accident at Kebnekaise in 2012 have been considered, and that any necessary measures have been implemented'*. The RNoAF replied to the Defence Staff and reported on the measures that

had been implemented and confirmed that the Chief of the NJHQ's recommendations of 14 September 2018 were closed.

1.19.5 Report from the NDMA Air Systems Division regarding the tactical TAWS database

The NSIA has received a report from the NDMA Air Systems Division on the process of procuring a tactical TAWS database covering more of Norwegian territory:

> *Background*
>
> *After learning about the Kebnekaise accident, several nations (not just Norway) agreed to join forces through the existing C-130J JUG (Joint User Group) with a view to improving the tactical TAWS database to cover the whole world, including areas where there had previously been 'gaps' in the terrain database. (…)*
>
> *Briefly told, Lockheed was assigned the job of improving TAWS Tactical.*

According to the NDMA Air Systems Division, the work of updating the tactical TAWS database originates as far back as before 2010. There were also a number of activities in this are after the Kebnekaise accident and up until June 2020, when an updated tactical TAWS database was ready.

The test pilot at Air Systems Division has also informed the NSIA about the following regarding use of tactical TAWS:

Information about tactical TAWS

Use of tactical TAWS is described in the flight manual CSTO NO1C-130J-1 and is also commented on in the NDMA's comments on the RNoAF investigation report. The most important feature of tactical TAWS is that it is meant for tactical flights under VFR. There are no civil [aviation] requirements for certification of this part of TAWS, which was developed according to requirements specifications from the US Air Force.

It is a weakness of the system (even given world-wide coverage and higher-resolution terrain data) that it can issue too many warnings, which might be more distracting than helpful, and that the crews may therefore choose to turn off the system for that reason. As described in the flight manual, the system is designed for 'rolling terrain' and not for 'mountainous' terrain. This has also been commented on by the NDMA.

Hence, when TAWS is set to Tactical (as opposed to Normal), two extra functions become available: TERRAIN INHIBIT and POP-UP INHIBIT. TERRAIN INHIBIT means that no terrain warnings are issued (the obstacles (ex master) warnings continue to be issued) if the function is chosen. POP-UP INHIBIT means that when this function is selected, the TAWS system will not take over HDD 3 in the cockpit to display TAWS warnings.

The NDMA recommended following up the recommendation from the Kebnekaise report that the RNoAF must ensure safe use of the ground collision avoidance system: 'Ensure that flight crew knowledge and routines means that the system for ground collision avoidance is used in a safe manner'. Even though the tactical TAWS database now has worldwide coverage, it is not a given thing that the crews have set up the system to issue warnings during tactical low-level flying. Full coverage is of little use if routines/procedures are not established to ensure safe use. The RNoAF has supported the NDMA's recommendations/comments on the report.

1.19.6 Statement from Avinor Flysikring AS

The NSIA asked Avinor Flysikring AS to give an account of whether it would have been possible for the air traffic controller to detect the situation that was about to arise when the formation approached Mosken at 500 ft. MG31 had switched frequency to Norway CTR, while MG32 remained on Bodø APP.

According to Avinor Flysikring AS, it is normal procedure in such cases to verify position in order to identify the aircraft before issuing clearance for safe IFR altitude. The air traffic services do not have local knowledge of all terrains and altitudes and cannot, therefore, take account of the terrain for flights under VFR or in transition to IFR.

The normal set-up at Norway CTR during the period when the incident occurred, would be for sectors 25 and 26 (Bodø and Kirkenes) to be grouped together, whereby the radar range scale in NATCON[44] would be approximately 160 NM. It is possible to include map overlays showing the Norwegian coastline, but this is not a requirement. Two types of geographical maps ('GEO maps') showing the Norwegian coastline can be displayed in NATCON. The choice is between a high-resolution and a low-resolution map. Mosken is visible on the high-resolution map, but not on the low-resolution map. With a range of 160 NM, it is almost impossible to spot Mosken on the map. It is not known which of

[44] NATCON – Norwegian Air Traffic Control System

these maps, if any, was displayed at the time of the incident. When there are many VFR flights, for example in summer, most air traffic controllers have GEO maps displayed on their screens to keep an extra eye on things.

At the time of the incident, military activity outside Lofoten was about to be concluded and many F-16 aircraft were returning to Bodø, at the same time as there were other, civilian aircraft in the area. Bodø APP is located in the same air traffic control room as Norway ACC Bodø. Bodø APP operates with a radar range of between 50 and 70 NM in NATCON and is required to have high-resolution GEO maps displayed at all times.

1.19.7 Rollover accident with AW101-612 SAR helicopter on 24 November 2017 at Sola Air Base

In 2017, an AW101-612 SAR helicopter rolled over during start-up. The helicopter was the first of its type that Norway had taken delivery of and was operated by the RNoAF's OT&E AW101 department. The following is quoted from the English summary of the investigation report published by the former Defence Accident Investigation Board Norway (DAIBN, 2019, p. 5):

> *Over time, ambitious timelines in the project for acquisition of new rescue helicopters, combined with delays in the development of the helicopter, had created a situation of persistent time pressure for all parties involved. (...) The constant demand for progress, negatively affected quality assurance in various parts of the organisation, and contributed to elevated and unidentified operational risk.*

OT&E AW101 did not belong to an air wing, but was a department reporting directly to the Inspector of Air Operations, who was thus authorised to issue orders to the head of OT&E. *'The Inspector of Air Operations was in other words both operator and charged with exercising independent supervision.'* (DAIBN, 2019, p. 49)

The report goes on to describe how the time pressure was directly linked to the OT&E management (DAIBN, 2019, p. 49):

> *It is always difficult to say stop for a person who is directly involved in the operational delivery. The pressure experienced by the OT&E organisation was regularly reported to the RNoAF's management, without this resulting in any changes to the process.*

It emerged from the chapter on implemented measures that several changes had been made to the OT&E AW101 organisation after the incident, both within the department and as regards the position of the department in the RNoAF organisation. In latter years the RNoAF has also put targeted efforts into improving its management and control structure and internal processes, focusing on division of responsibility and lines of command. Among other things, the Air Operations Inspectorate has sharper focus on exercising its powers as competent authority.

1.20 Useful and efficient investigation methods

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

2. ANALYSIS

2.1 Introduction

2.1.1 Decision to initiate an investigation

The NSIA deems this to be a serious incident because it was only chance that prevented it from becoming an accident. Once the aircraft commander had conducted the avoidance manoeuvre to avoid collision with Mosken, there were no more safety barriers. Apparent similarities with the Kebnekaise accident eight years before also constituted weighty grounds for investigating the present incident.

2.1.2 Theoretical perspective and conceptual approach

The NSIA sees the near collision as a typical organisational incident, in which 'active failures' on the part of the aircraft crew cannot alone explain why the incident occurred. As recognised in modern safety theory and visualised in Reason's Swiss cheese model[45], latent conditions in complex systems can exist for many years before circumstances align with local conditions and active failures to penetrate the defences against accidents.

Safety has to do with a complex interaction of technical, human, organisational and environmental factors. Organisations must always handle different goals simultaneously, with limited resources available. The RNoAF faces the challenge of balancing the need for training and readiness for combat, without compromising safety. Furthermore, those at the 'sharp' end (operating personnel) and those at the 'blunt' end (management), have different understand the situation from different perspectives.

Rasmussen's adaptation model[46] describes how working under pressure from efficiency and other performance goals can cause a practical drift in behaviour, so that safety margins are gradually reduced. Accidents can happen if the limit for acceptable risk is exceeded (see Figure 25).

[45] Reason, J (1997): *Managing the risks of organisational accidents*. Ashgate Alderslot.
[46] Rasmussen, J (1997): *Risk Management in a Dynamic Society: A Modelling Problem*. Safety Science Vol. 27, No. 2/3, pp. 183-213, 1997.

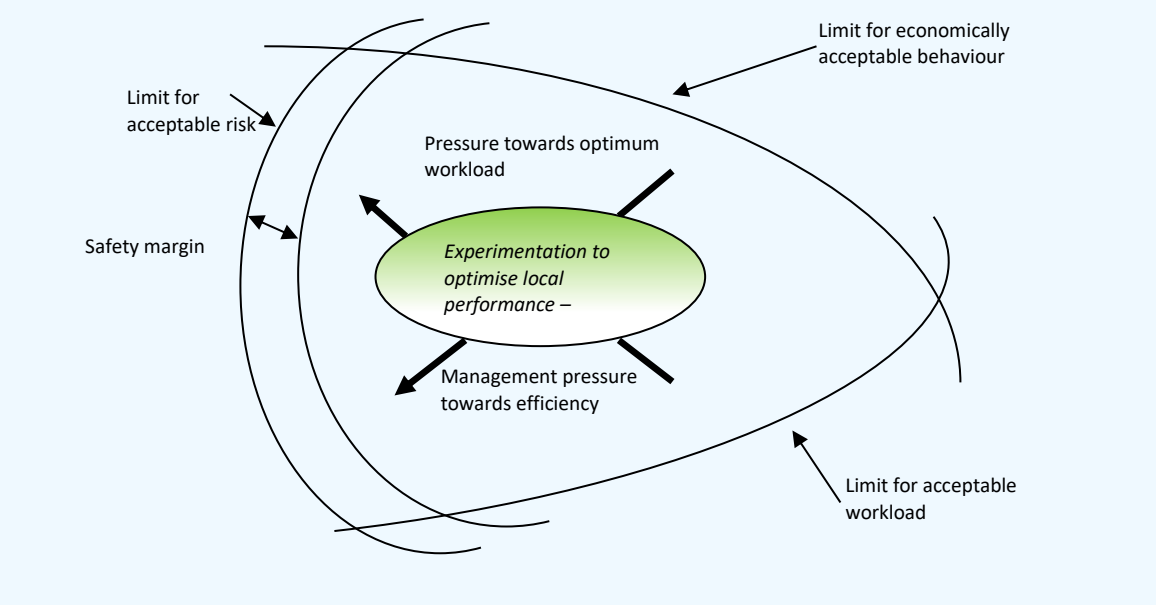

Figure 25: Rasmussen's adaptation model. As a consequence of pressure towards efficiency and other performance goals, behaviour will drift towards the boundary for acceptable risk. Illustration: Adapted by NSIA, based on Rasmussen (1997)

Safety management comprises all the activities, practices and management functions established by an organisation for the purpose of controlling sources of risk and avoiding undesirable incidents. Examples include defining safety goals, allocating resources for safety measures, ensuring that personnel with safety-critical tasks have the requisite competence, and establishing decision-making processes for the implementation of measures. Safety management consists of structural elements (e.g. technology, procedures and rules) as well as cultural elements (e.g. everyday work practices and attitudes). Hence, safety management covers both formal and informal practices (Albrechtsen et al, 2015).

The purpose of an organisation's safety management is to maintain an acceptable risk margin (see Figure 25). It is largely a matter of vigilance in relation to risk, of ensuring that the system boundaries are known and perceptible, and that there is counter-pressure that favours safe actions (Tinmannsvik, 2017).

According to Reason (1997), an essential characteristic of a good safety culture is an informed culture. In the absence of accidents, collecting the right types of data is the best way to maintain people's awareness of risk and to make good decisions. An effective, overall safety management system can help in this respect. The basis for all safety management systems is the systematic assessment of safety performance in the past (investigations, reporting), present (supervision, audits, inspections) and future (risk analyses). The principle of continuous improvement is also fundamental to a safety management system.

Figure 26 shows that the organisation's safety management system is part of its safety management and constitutes a major part of the structural element of its safety management. Risk control and barrier control are key elements of a safety management system. In that connection, risk assessments are an important tool in determining what risks/hazards should be handled as a matter of priority and what barriers are necessary to reduce risk to an acceptable level (Albrechtsen et al., 2015).

Figure 26: Safety management, safety management system, risk and barrier control. Illustration: Albrechtsen et al., 2015

2.1.3 Methods, structure and delimitation

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

The sequence of events, from departing Bodø until approaching Evenes and Bodø, was mapped using CVR/DFDR records and interviews, and the sequence was presented in a STEP[47] diagram. By means of interviews and documentation, the NSIA has also mapped how the mission was planned and what took place in the pre-mission briefing.

The local safety problems ('what went wrong') in the sequence of events were then identified. In the NSIA method, local safety problems are defined as where 1) the sequence of events could have been changed or interrupted, 2) the sequence of events involved a loss of control/poor control, and 3) the sequence of events deviated from safe or expected functions.

The NSIA's assessment of the sequence of events, local safety problems and operational, human and technical factors by which they are affected are described in more detail in the incident analysis in Section 2.2. This part of the NSIA's analysis largely concurs with the findings made in the RNoAF investigation.

In turn, the incident analysis serves as a point of departure for the barrier analysis described in Section 2.3, which looks more closely at the effectiveness and integrity of

[47] STEP– Sequentially timed events plotting.

the barriers in the system. That section discusses the barriers that had been established and the operational and technical factors that affected them, and, where applicable, why the barriers failed.

The analysis then proceeds from the operational and technical level to a more general analysis of possible underlying causal factors. This includes an analysis of operational factors such as defective barriers, CRM and risk control at squadron level (blue in Figure 27), as well as the RNoAF's organisation and safety management (dark green in Figure 27). It also includes a review of recommendations and advice issued in connection with previous incidents, including follow-up after the Kebnekaise accident.

Based on the causal analysis, the NSIA has described systematic safety problems[48] and areas for improving safety. On this point too, the NSIA's investigation has largely confirmed and verified the findings of the RNoAF investigation. Hence, the NSIA saw no need to describe and discuss in detail those factors that were addressed and subject to concrete recommendations in the internal investigation report. Areas covered by the recommendations of the RNoAF investigation team and the Chief of the RNoAF's own recommendations are shown in Figure 27.

The NSIA has put special emphasis on identifying and examining areas where safety can be improved that were not addressed in any great detail in the RNoAF investigation and that can provide additional safety benefits for the RNoAF and the defence sector.

On that basis, the analysis will look more closely at the following factors:

- Section 2.4 Crew resource management (CRM) in the mission under consideration, and the RNoAF's history relating to CRM
- Section 2.5 Risk control and dimensioning – risk assessments prior to the mission under consideration and the RNoAF's dimensioning of missions in relation to resources
- Section 2.7 Safety culture – The NSIA's observations of cultural features of the 335 squadron, discussion of the pressure to deliver in a performance culture, as well as some general considerations
- Section 2.8 The Kebnekaise accident – comparison and follow-up
- Section 2.9 Safety management system and safety management – safety management system and organisation and overall assessment of the RNoAF's safety management
- Section 2.10 Supervision and follow-up – evaluation of the RNoAF's internal supervision and control mechanisms, as well as military aviation authority

[48] Systemic safety problems are properties and processes in organisations and systems that have contributed, or have the potential to contribute, to an accident. They are factors that an organisation or public authority have partial or full control of and responsibility for, and that will probably persist and increase the risk of accidents in future unless they are dealt with. Systemic safety problems are therefore the investigative findings that offer the greatest potential for improving safety.

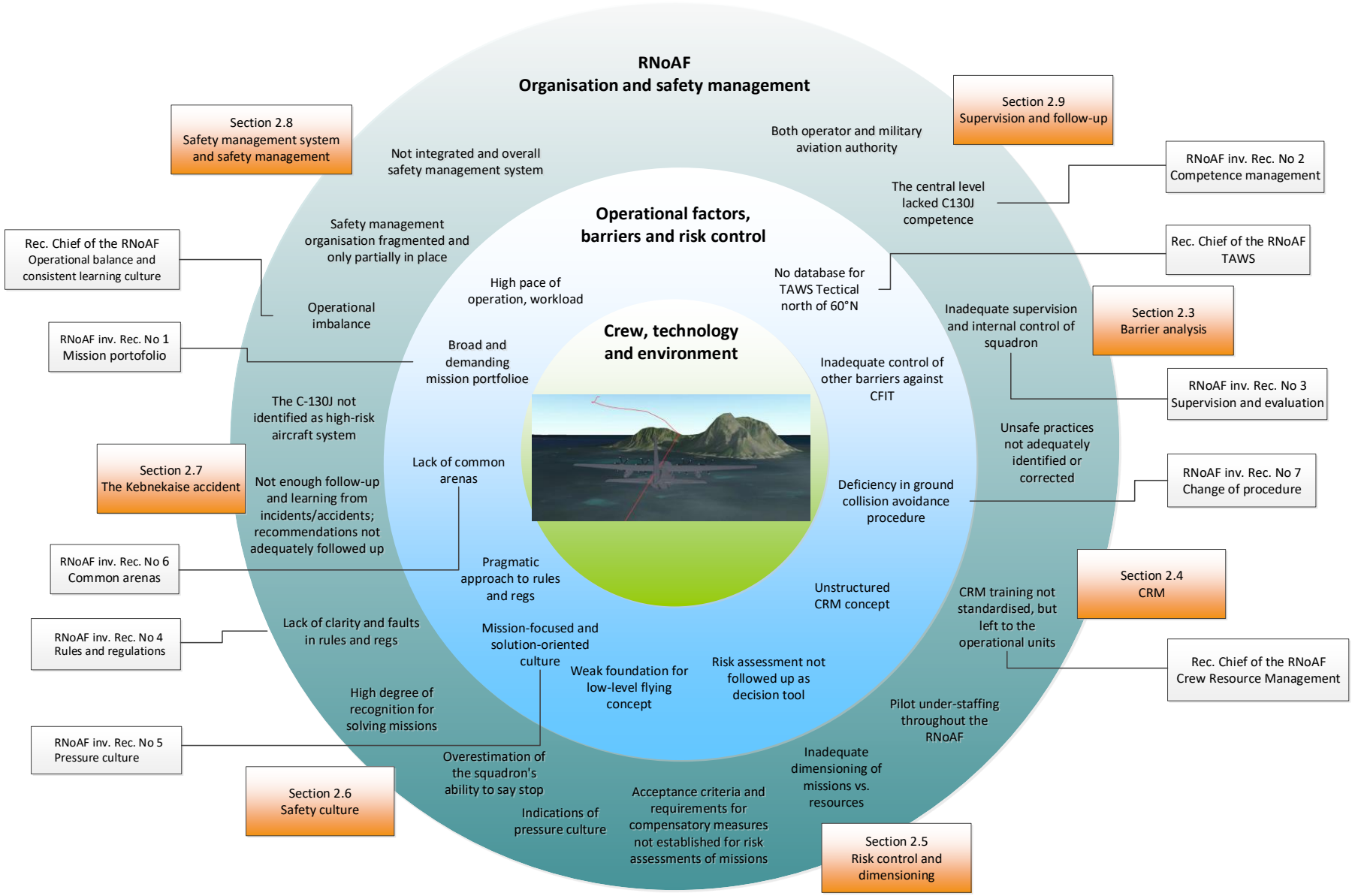

Figure 27: Organisational and systemic factors of relevance to the Mosken incident. The main sections of the analysis (highlighted in orange) and areas covered by the RNoAF investigation. Illustration: NSIA

2.2 Incident analysis

2.2.1 Introduction

The NSIA has identified a number of local safety problems in the sequence of events that almost caused the Hercules formation to crash into the rocky island of Mosken. In the following, the NSIA will address the safety problems that emerged in the different phases of the sequence of events. This applies to the planning phase, the aircrew's choices and actions en route, and the final phase of the flight and the avoidance manoeuvre.

2.2.2 Planning and authorisation

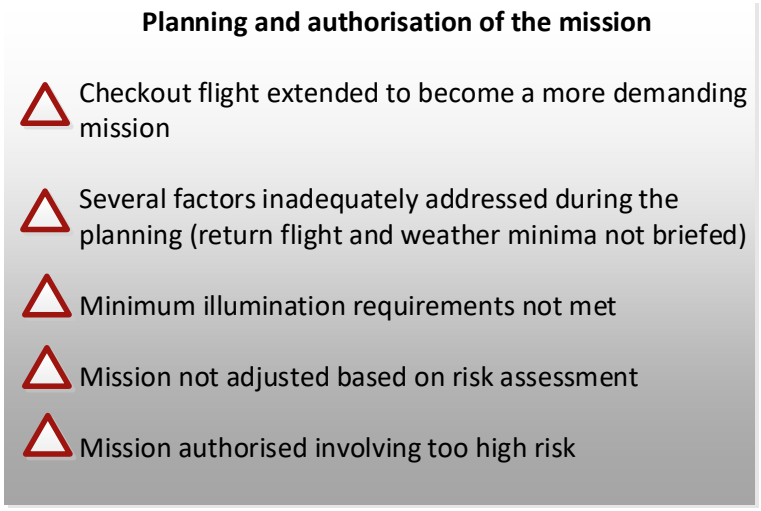

Figure 28: Safety problems △ relating to planning and authorisation. Illustration: NSIA

Figure 28 shows the local safety problems ('what went wrong') that were identified relating to the planning and authorisation of the mission. During the planning, the commander checkout flight was extended from participation in COMAO to become a more demanding mission. It was extended to include a low-level flying route around Bodø in accordance with the new low-level flying concept with NVG. In addition, MG31 would fly on to Evenes to drop off technical personnel once the low-level flying part had been completed. The decision to include the low-level flying part left less time to plan each individual element. It was also pointed out in the RNoAF investigation that this increased the complexity of the mission to an extent whereby the sum total of exercise elements challenged and probably exceeded what the personnel had the ability and resources to execute safely.

Furthermore, the investigation has shown that there was a general tendency in the squadron environment to include as many exercise elements as possible on each trip. Among other things, the SOF/DETCO found it expedient to include more exercise elements in the mission for the purpose of exposing the aircraft commander candidate to a wider range of disciplines under the supervision of an instructor. As described above, there is a strong motivation to conduct exercises on all missions in the portfolio with a view to ensuring maximum readiness for solving the missions the unit is assigned. This approach also contributes to formally qualifying more aircrew members as they gain 'green' status in the Personnel and Qualification Status Program (PAQS). During the CR20 exercise, it was convenient to add practice in the use of the recently introduced low-level flying concept. The concept had not been fully developed.

The planning focused on the simulated drop in connection with the COMAO part of the mission, in addition to the low-level flying route around Bodø. No review or briefing was conducted relating to the return trip from the exercise area. This was one reason why the formation ended up flying an unplanned route when returning from the exercise area.

Furthermore, while necessary information about weather, visibility and illumination was available, the minimum requirements for flying VFR in the dark were not addressed during the planning. This had to do with inadequate preparation for the exercise as regards the regulations for VFR flying at night, as a consequence of which the aircrews and SOF/DETCO did not know enough about the regulatory framework governing such flying.

A related aspect of the planning and authorisation that had a major impact on the mission was the forecast illumination level, which was below the minimum requirement of 2.2 millilux. This was pointed out in the course of the briefing, but the mission was authorised nonetheless, based on a 'wait and see' approach, and, as a consequence, both aircraft flew into conditions in which low-level flying with NVG was not safe. The pilots have stated that they had a clear view of the contours at Røst and Lofoten, but that the light may have come from light sources on the ground. This may have given them a false sense of security.

All in all, the NSIA believes that the mission that was authorised was complex and entailed a high level of risk. Authorisation as a safety barrier is discussed further in Section 2.3.2. Furthermore, the mission was neither adjusted nor changed on the basis of the risk assessment forms completed by the crews. This will be discussed in more detail in Section 2.6.2.

2.2.3 The aircrew's choices and actions en route

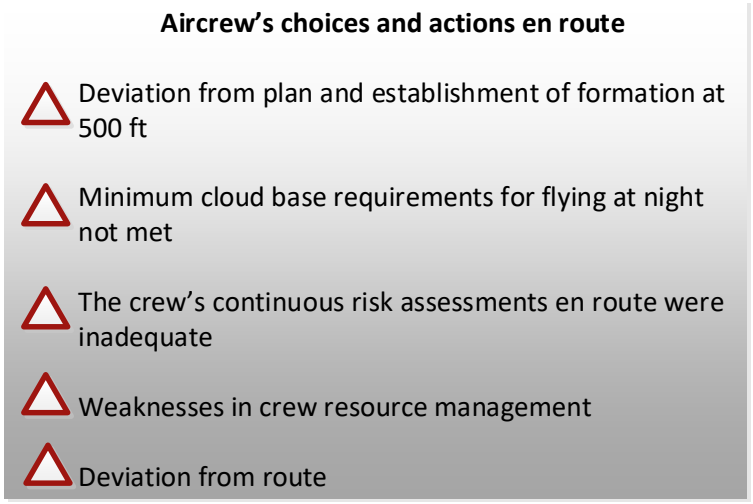

Figure 29: Safety problems △ relating to the crew's choices and actions en route. Illustration: NSIA

Figure 29 shows identified safety problems relating to the crew's choices and actions en route. Soon after departure, the formation deviated from the original plan as the weather conditions did not permit flying at 1,000 ft AGL. According to the SOF/DETCO, the formation was authorised down to 500 ft AGL throughout the mission. The aircrew therefore quickly adopted an altitude of 500 to go clear of the low cloud cover and

maintained that altitude up until the time of the incident. This contributed to MG31, especially, almost colliding with Mosken. It also meant that the formation did not meet the minimum requirements relating to cloud base at night set out in BSL F 1-1. Minimum requirements for flying below 1,000 ft are flight visibility of 10 km and a cloud ceiling of 2,000 ft. This had little practical impact in the present case, but was nonetheless not in accordance with the regulations. Had the formation observed the regulations, it could not have flown at 500 ft, but would have had to climb out of the clouds and followed the backup plan, which was to fly at 12,000–13,000 ft.

The most serious safety problem that occurred before the near collision with Mosken was when the crew chose to take a new and more direct route towards Bodø without also climbing to a safe altitude. The new route had neither been planned in advance, nor was it authorised. It was in breach of established rules whereby the planned route would be followed, and eventually resulted in the course being set accidentally to collide with Mosken. The safety barrier that a pre-planned route entails is discussed further in Section 2.3.3. As mentioned above, the formation had no generally agreed plan for this leg of the flight, as the plan for returning from the exercise area had not been briefed. A false feeling of security when flying over the open sea probably also contributed significantly to the perception that it was acceptable to change the route.

As a whole, the analysis of the sequence of events shows that the continuous risk assessments undertaken by the aircrews did not adequately identify and make corrections for risks en route. The increased risk to which the formation was exposed on changing its route was not identified, assessed or communicated by the crews.

After leaving the exercise area, the formation was given the option by CRC Sørreisa (Viper) to climb to safe IFR altitude. This offer was rejected based on input from the MG32 commander, because it was practical to continue flying under VFR as they were subsequently to conduct a low-level flying exercise around Bodø. The NSIA has also noted that the pilots discussed the challenging weather and light conditions between themselves on several occasions. Even so, they failed to recognise how these conditions would affect the formation’s ability to navigate safely under VFR in the dark.

The NSIA considers the choices made by the crews to be partially related to what was described in the RNoAF investigation as a certain degree of overconfidence and self-assurance. It is also an indication of the 335 squadron’s strong motivation for training on all missions in the portfolio. These cultural aspects are discussed further in Section 2.7.2. The choices were also related to the aircrews’ perception of there being little risk involved in low-level flying with NVG over the open sea, and to the fact that NVG operations tend to lower people’s mental capacity and hence also their situational awareness. Nor can it be ruled out that a high workload during the run-up to the mission may have affected choices and actions en route.

The NSIA has found several weaknesses relating to CRM, and this is discussed further in Section 2.4. CRM in the first aircraft in the formation (MG31) was inadequate during the final phase of the flight before the near collision with Mosken. There were also clear weaknesses in the communication between the two aircraft during the final phase before the formation split up.

2.2.4 The final phase of the flight and the avoidance manoeuvre

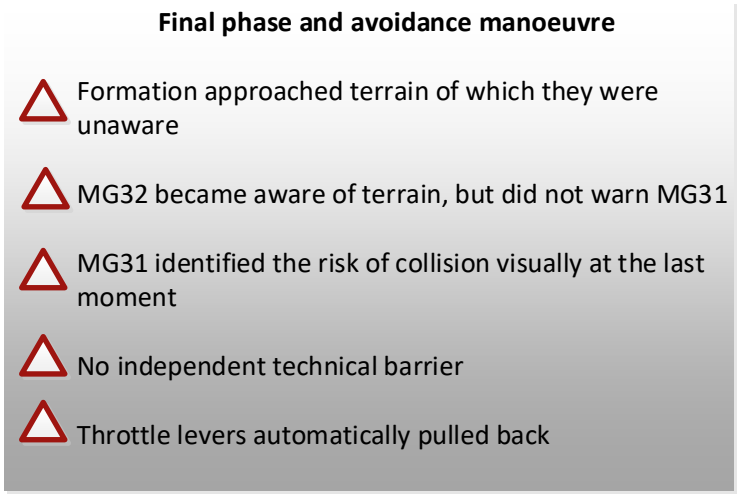

Figure 30: Safety problems △ relating to the final phase and avoidance manoeuvre. Illustration: NSIA

Figure 30 shows identified safety problems relating to the final phase of the sequence of events and the avoidance manoeuvre. When they eventually realised that the weather and light conditions were not adequate, the aircrews decided to cancel the low-level flying sequence at Bodø and the two aircraft started the process of separating the formation. This happened three minutes before the near collision, when the aircraft were 10 NM west of Mosken. At that point in time, the formation was unaware of the terrain they were approaching.

PM MG31 started to coordinate with the air traffic service in order to obtain necessary clearance, which largely occupied the crew's attention up until they nearly collided with Mosken. During this phase, the PF MG31's attention was mostly focussed outside the cockpit. Less than one minute prior to the near collision, the formation split-up was about to be completed. Neither the PM nor the PF in MG31 had identified Mosken by means of navigational aids in the cockpit, and both aircraft were on course to collide with the island.

The use of navigational aids is discussed further in Section 2.3.4. Whether it would have been possible for the air traffic service to warn the formation of the danger of collision with the terrain is discussed further in Section 2.3.8.

MG31 was very close to Mosken when PF realised that they were on course to collide. The Mosken Island consists of two mountain peaks of 1,263 ft (385 m) and 965 ft (294 m), respectively, of which the southernmost peak is the highest. MG31 crossed the island near the northernmost peak of Mosken. The aircraft's lowest registered height AGL was 144 ft (44 m). The aircraft's speed at the time was just over 200 kt (100 m/s). Had the same manoeuvre been initiated less than one second later, the outcome would have been a catastrophic collision with the terrain. This illustrates how serious the incident was.

The NSIA agrees with the RNoAF investigation team that the timing of the formation split-up gave MG32 a wider margin to the terrain. MG32 could have ended up in much the same situation as MG31 had the decision to split the formation been delayed by less than one minute. On the other hand, the formation split-up meant that PM MG31 had to

devote much of his capacity to radio communication at the expense of paying attention to the navigational aids in the cockpit.

The MG32 crew became aware of the terrain via the digital map and the weather radar as the formation was splitting up, approximately 30 seconds before MG31 carried out its avoidance manoeuvre. MG32 chose a horizontal avoidance manoeuvre around Mosken. The shortest distance between MG32 and Mosken was approximately 0.8 NM. The MG32 crew did not warn the MG31 crew of the terrain, which would have been a natural thing to do had their situational awareness been better. Mental capacity and spacial orientation are reduced when flying with NVG, particularly under marginal conditions. It also took the MG32 crew a while to initiate and complete their avoidance manoeuvre, and to process and understand what was actually about to happen.

The aircrews received no warnings of the possible danger of collision from the aircraft systems. This had to do with the fact that, when set to tactical mode, the TAWS system did not issue terrain warnings north of 60° N. This is described in greater detail in Section 2.3.6. Approximately 13 seconds after initiating the climb to safe altitude, the MG31 crew received a GCAS warning.

When PF MG31 initiated the manoeuvre to avoid collision with Mosken, the auto-throttle function was not deactivated until PF MG31 manually pushed the lever all the way forward and initiated full engine power. The throttle levers were thus automatically pulled back, whereby engine power was reduced until PF MG31, shortly afterwards, realised what had happened and remedied the situation. In addition, the aircraft nose was lowered a few degrees a little later in the climb.

The NSIA has not analysed the data relating to this manoeuvre in detail, but the failure to disengage the auto-throttle function brought MG31 closer to the terrain than it would have been had the procedure been optimally performed. The aircraft’s procedure for ground collision avoidance is discussed in more detail as a safety barrier in Section 2.3.7. The NISIA would like to add that, given the conditions of marginal visibility, darkness, low cloud cover and suddenly appearing terrain, PF MG31 did well in implementing an avoidance manoeuvre that prevented collision with Mosken.

2.3 Barrier analysis

2.3.1 Introduction

The following definition[49] of barrier is used here:

> *Technical, operational or organisational measures or functions for the purpose of, separately or together, identifying conditions that can lead to faults, hazard or accident situations, prevent a specific sequence of events from occurring or escalating, influence a sequence of events to take an intended course, or limit harmful effects and/or loss.*

Concerning the controlled flight into terrain (CFIT) in the near collision with Mosken, the following are relevant barriers that might have prevented or interrupted the sequence of events:

Safety barriers against collision with terrain

- Risk assessment of the mission
- Authorisation of the mission
- Crew resource management (CRM)
- Compliance with pre-planned/reconnaissance route
- Use of navigational aids
- Visual ground references through sufficient illumination
- Warnings from the aircraft's ground collision avoidance system
- Procedure for ground collision avoidance manoeuvre
- Air traffic control service

This section goes on to address the effectiveness and integrity of these barriers, including their functioning or failure in relation to the present incident. The NSIA has chosen to address CRM separately in Section 2.4, because of its importance in relation to all parts of the flight. Risk assessments will also be further discussed in a separate Section 2.6.2.

2.3.2 Authorisation

Authorisation constitutes the final safety barrier before a mission is initiated. The power of authorisation is delegated down the line from the Chief of the RNoAF, via the Inspector of Air Operations and Air Wing Commander to the head of the operational unit, where the Squadron Commander, Supervisor of Flying (SOF) or individual aircraft commander has the power to authorise air missions.

[49] Definition developed by the NSIA.

The 335 squadron's authorisation instructions list relevant elements to be reviewed in connection with authorisation; in the present case, however, several of these elements not were sufficiently addressed, and the authorisation barrier failed.

In the NSIA's opinion, the SOF/DETCO authorised a mission that was complex and entailed a high level of risk. Like the aircrews, he lacked sufficient knowledge of the regulations relating to weather minima. Furthermore, the mission was authorised by SOF/DETCO subject to a 'wait and see' approach, even though the light conditions did not meet the minimum illumination requirement. In the NSIA's assessment, SOF/DETCO lacked sufficient awareness of the use of risk assessments as a decision tool in the authorisation process. As part of the planning, separate risk assessments were conducted for each aircrew and for the mission as a whole, without this leading to any changes.

Hence the authorisation barrier did not work as intended in connection with this incident. Overall, the NSIA believes that authorisation is a control mechanism that has the potential to identify and close safety gaps before a mission is initiated. However, the integrity of this barrier will depend on cultural aspects in the squadron, among other things. This is discussed further in Section 2.7.

2.3.3 Pre-planned route

For low-level flying under VFR, it is a requirement to follow a pre-planned and authorised flight route. This is intended to ensure that the pilots are aware of where the aircraft is flying at all times and are prepared for en-route obstacles and terrain in every segment of the flight. According to BML, an aircraft that deviates from its route must initiate route abort and climb to a safe altitude.

When leaving the exercise area, the formation deviated from the route taken to the exercise area in order to fly a more direct route to Bodø. As mentioned above, it was the understanding of several crew members that the route to the exercise area should be reversed when flying back to Bodø, but this had not been planned or included in the briefing. When the formation deviated from the route, PM MG31 lost out on the possibility of conducting a 'leg brief', a brief that should contain information about the next route segment (altitudes, obstacles, airspace etc.). This contributed to Mosken not being spotted on the map before the near collision.

2.3.4 Aids to navigation

Information about Mosken, and the obstacles its peaks represented, was available to both aircrews via several navigational aids in the cockpit. Meticulous visual scanning of the available navigational aids could thus have prevented the near collision with Mosken at an earlier point in time.

Several crew members have told the NSIA and the RNoAF investigation team that they looked at the screens (HDD) in the cockpit several times before the near collision with Mosken, but without detecting the island. The RNoAF investigation team points out that several factors can help to explain this, including luminous intensity on the HDD, screen size, the size of the island, cursor position, and other and more prominent map symbols showing traffic information zones (TIZ), geographical boundaries etc.

Furthermore, in the decisive phase of the sequence of events, it appears that the attention of PF in MG31 was mostly focused outside the cockpit and on flying the aircraft, while PM in MG31 was preoccupied with external communication and obtaining clearance. The crews did not have enough capacity left to ensure safe navigation. The NSIA therefore considers that MG31, the aircraft that headed the formation, breached the safety barrier represented by the navigational aids in the cockpit. This was a consequence of lack of attention to the 'navigate' part of the 'Aviate-Navigate-Communicate' doctrine.

2.3.5 Visual ground references and sufficient illumination

A safety barrier had been established relating to the new low-level flying concept with NVG in the form of minimum requirements for illumination to ensure visual ground references. The minimum requirement is no guarantee of sufficient light, however, and the crew must therefore always verify that the terrain contours can be clearly observed through the NVG.

The predicted illumination level for the period during which the mission was to be carried out was below the minimum regulatory requirement. The mission was nonetheless authorised subject to a 'wait and see' approach, entailing that the aircrews would decide en route whether the light conditions permitted the mission to be completed. The aircrews had no possibility of measuring illumination in the area en route, however. As mentioned above, the pilots may have gained a false sense of security that the illumination was sufficient from observing the contours of the terrain at Røst and Lofoten, although that illumination may have been from light sources on the ground.

The examinations conducted by the Institute of Aviation Medicine showed that the pilots had satisfactory night vision. All crew members wore NVG and stated that they had normal dark adaptation. The Institute of Aviation Medicine has also concluded that regular control of night vision in accordance with the current practice for F-35 pilots is not required for C-130J pilots. The NSIA assumes that the pilots in MG31 had satisfactory night vision and that poor eyesight was not a contributing factor. What may have affected their night vision, however, was the failure to use NVIS lighting in the cockpit. Since the NVIS did not function in an optimum manner, distracting light sources may have been present. The known shortcomings of the NVIS were not emphasised in the 335 squadron's risk assessments, however.

In the NSIA's view, the prevalence of the 'wait and see' approach, even though illumination was below the minimum requirement, must be considered in light of the new low-level flying concept not having been fully developed and internalised. Those involved appear to have interpreted the regulations to mean that it was sufficient if the crew felt that they had visual ground references en route, even if the illumination requirement was not met. This was therefore in breach of the safety barrier that required visual ground references and sufficient illumination.

2.3.6 Ground collision avoidance system (GCAS/TAWS)

The crew did not receive any TAWS warnings or terrain data on the HDD during the flight in question. The tactical database used by GCAS/TAWS in connection with low-level manoeuvring, lacked coverage north of 60° N at the time of the incident. It would not have been possible to complete the COMAO mission and the planned low-level flying sequence with the system in normal mode, as it would have resulted in a number of

false warnings. Hence, there was no independent technical barrier that could have warned the aircrew of Mosken. The NSIA found, as did the RNoAF investigation team, that the aircrews were aware of the system's limitations in the area where they operated, so that they did not rely on warnings from the ground collision avoidance system to ensure a safe flight.

The NSIA has received a report from the Head of the NDMA Air Systems Division showing that the RNoAF and NDMA have worked on procuring a terrain database with extended coverage to include the area north of 60° N since 2012. It seems clear to the NSIA that the reason why it has taken so long to update the tactical database must be ascribed to external factors outside the control of the RNoAF and NDMA.

Had an updated terrain database been available, and the system worked and been operated as intended, the crew would have been alerted approximately 1.4 NM before reaching Mosken.

2.3.7 Procedure for ground collision avoidance manoeuvre

A final safety barrier to avoid collision, would be last-minute detection of the terrain by the crew and implementation of a ground collision avoidance manoeuvre to climb to safe altitude AGL.

The aircraft manual from Lockheed Martin contains a procedure for GCAS/TAWS PULL UP Alert Recovery. This procedure is to be followed during any phase of the flight in the event that there is a risk of colliding with the terrain. The procedure does not address disengagement of the auto-throttle function. The RNoAF investigation team has submitted a recommendation to the NDMA to revise the procedure.

2.3.8 Air traffic control service

The investigation has shown that MG31 called Norway CTR less than one minute before the near collision. At that point in time, Norway CTR had not set up the radar screen to enable identification of small geographical points such as the Mosken Island.

According to Avinor Flysikring AS, it is normal procedure to verify position in order to identify the aircraft before issuing clearance for safe IFR altitude. Avinor Flysikring AS has also explained that it is not possible for the air traffic service to have local knowledge of all terrains and heights and that they cannot, therefore, take account of the terrain for flights under VFR or transitioning to IFR.

At the time of the incident, military activity off Lofoten was about to be concluded and many F-16 aircraft were returning to Bodø, at the same time as there were other, civilian aircraft in the area. In such situations, the air traffic controllers must devote a limited amount of time to each aircraft and prioritise continually.

Given the way the RNoAF normally operates low-level VFR flights in Northern Norway, it would hardly be expedient for the air traffic controllers to notify of possible proximity to the terrain. This would distract the pilots, who are normally well in control of where they are flying. Nonetheless, the Mosken incident shows that this is not always the case.

The traffic situation was a complex one when the incident occurred, and neither Bodø APP, which was handling multiple aircraft concurrently, nor Norway CTR, to whom

Mosken was not visible on the screen, could have been expected to prevent the incident. Despite this, the NSIA believes that the air traffic controllers can possibly learn something from the incident.

2.3.9 Summary

It is an important safety principle to have in-depth defence with several layers of barriers and robust solutions. This includes having systems and components that are independent of each other and work in different ways. The above barrier analysis shows that the pilots and applicable regulations were the primary barriers against collision with the terrain. Mission authorisation cannot be seen as an independent safety barrier given that powers of authorisation are delegated to personnel who belong to the operational environment. Good competence and understanding of risk are prerequisites for these barriers to work.

It has been known for a long time that the only independent barrier against collision with the terrain (TAWS) did not work in the tactical mode north of 60° N. The NSIA is of the opinion that there should have been more focus on this safety flaw and on ensuring the integrity of the remaining barrier system.

2.4 Crew resource management (CRM)

2.4.1 Introduction

The focus on crew resource management (CRM) has been important for developing the safety of civil aviation since the 1980s. The NSIA would therefore have expected better CRM in the sequence of events under consideration, both within the MG31 crew and between the two aircraft. The investigation has also found that there are shortcomings in the RNoAF with regard to developing CRM concepts and CRM training in the operational units. These factors are discussed in more detail below.

2.4.2 CRM in the sequence of events

In the NSIA's opinion, the sequence of events reflected poor CRM relating to the following:

- Ineffective communication – 'hint and hope'
- The task of navigation was not satisfactorily attended to on board MG31
- The role distribution, authority gradient and self-assertion among the MG31 crew and between the aircraft were inexpedient
- There was no agreed plan for the return flight from the exercise area and the crews failed to ask critical questions of PF MG31 concerning the choice of route

Both CVR recordings from the time of the incident and subsequent interviews indicate that, as both aircraft commander candidate and formation leader, the aircraft commander candidate (PM MG31) was not given sufficient opportunity to fill the role of leader. It is likely that the two more experienced pilots in the formation (PF MG31 and PF MG32)

challenged the authority of PM MG31, at the same time as PM MG31 was not sufficiently assertive in the role of leader. This was particularly clear during the phase when the formation had concluded the operation in the exercise area and was setting course for Bodø and the planned low-level flying part of the mission. The aircraft commander candidate suggested several times that they should reverse the same they had flown from Bodø to the exercise area, but this was rejected by the instructor.

The aircraft commander candidate's suggestions were not heeded and the instructor increasingly assumed control of the choice of route. PM MG31 was thus largely pushed out of the game until he no longer had a clear overview of the situation and the route forward. When the aircrews finally agreed to cancel the low-level flying part, PM MG31 became preoccupied with coordinating the split-up of the formation with the air traffic service. This took up most of the PM's capacity, at the expense of paying attention to the navigational aids in the cockpit.

Both the aircraft commander candidate and the instructor in MG31 wanted to accept the military air traffic control's (Viper) offer of IFR clearance for the return flight to Bodø. This was rejected on the suggestion of the aircraft commander (PF) in MG32 out of consideration for the low-level flying part around Bodø. At the same time, both CVR records from the time of the incident and subsequent interviews show that PF MG31, who was the (formal) formation leader, and the instructor did not communicate clearly. PF MG31 asked several questions regarding weather and light conditions of both PM MG31 and PF MG32 en route. The communication was to some extent marked by a 'hint and hope' approach, and it appears that PF MG31 was unable to make up his mind as to whether to cancel the low-level flying at Bodø on his own initiative. The question that PF MG31 asked PM MG31 about whether they should just abandon the low-level flying part is an indication of the aircraft commander candidate's uncertainty.

The authority gradient may also have come into play in this connection in that PF MG31 was reluctant to make a decision without the acceptance of PF MG32, who was more experienced and described by several people as an informal leader of the 335 squadron. The NSIA believes that the limited experience of PF MG31 in the role of instructor probably also contributed to the situation.

As mentioned above, the formation had no generally agreed plan for this leg of the flight, as the plan for returning from the exercise area had not been briefed. The investigation has nonetheless shown that it was the understanding of several of those involved that they would fly back to Bodø along the reverse route of that taken to the exercise area, without this being communicated en route. The return route to Bodø chosen by PF MG31 was not contested by other members of the aircrews, even though they have subsequently stated that they expected to reverse along the same route. The NSIA finds that communication on this point was not in line with good CRM principles. The aircraft commander candidate made suggestions, but not with a degree of assertion that expressed non-acceptance of the choice of route. Nor did PF MG32, the most experienced pilot in the formation, ask any questions. The NSIA therefore considers the choice of route to have been accepted by the formation.

In the NSIA's opinion, once the decision to split up the formation had been taken, CRM in MG31 did not to a sufficient degree help to ensure safe navigation. As mentioned above, PM MG31 was largely preoccupied with external communication. During the same period, PF MG31 mostly focused on looking out of the cockpit. This meant that the

'navigate' part of the 'Aviate-Navigate-Communicate' doctrine was not satisfactorily attended to. A more experienced instructor would possibly have recognised the lack of attention to safe navigation. At the same time, it was the fact that PF MG31 gave priority to looking out of the cockpit that led to observation of the terrain and saved the day.

The breakdown of CRM in MG31 persisted right through the avoidance manoeuvre up until the final phase of the flight. The MG31 crew gained control of the aircraft and continued the flight to Evenes, where they performed a normal landing. The NSIA sees this as an example of the crew's resilience[50], including as a team. They were able to recover and gain control of the situation so that an accident was prevented[51].

2.4.3 CRM in the RNoAF

The 335 squadron has not established a concept for structured CRM training or related procedures. CRM in the 335 squadron was largely based on CRM training in connection with simulator training and CRM briefings on ground days, and the emphasis was on the pilots being on good terms with each other.

Following the Kebnekaise accident, Safetec conducted an observation study of CRM practice in the 335 squadron in 2014. Safetec found little variance between the aircrews and considered their behaviour on board to be largely in line with good CRM practice. Nonetheless, Safetec proposed 14 measures to further enhance CRM in the squadron. According to the RNoAF's reply to the Defence Staff in 2018, the Air Operations Inspectorate and 335 squadron reviewed Safetec's recommendations, and concluded which of them were relevant and how they were to be followed up. Other than that, the NSIA has received no concrete documentation of how Safetec's observation study and recommendations were followed up, prioritised or addressed.

That CRM has not been sufficiently strengthened in the 335 squadron may have to do with CRM training not having been standardised for the RNoAF as a whole and having been left to the operational units. Furthermore, despite its recommendations, Safetec's observation study may have left the squadron with the impression that CRM was satisfactory. One year before the Mosken incident occurred, following a serious incident involving a Sea King helicopter in 2018, the Chief of the RNoAF asked the Inspector of Air Operations to consider the implementation of a standardised CRM training programme in the RNoAF's operational air units. The Inspector of Air Operations had not replied to this request when the incident occurred.

[50] Oxford Learner's Dictionaries has the following definition of 'resilience': '*the ability of people or things to recover quickly after something unpleasant, such as shock, injury, etc.*'

[51] This was also commented on in the AIBN's Report SL 2016/11 following a serious aviation incident involving a Widerøe aircraft on the approach to Svolvær in 2010, as well as in Report SL 2020/16 following a serious aviation incident involving a Danish airline en route from Bergen to Ålesund in 2016.

2.4.4 Summary

After the Mosken incident, the RNoAF has developed a basic CRM course for aircrews and mission support personnel. The Chief of the RNoAF has also taken steps to further develop CRM in the RNoAF (see Appendix C). Hence no safety recommendation is submitted by the NSIA on this point.

The NSIA also assumes that, on establishing a CRM training programme in the RNoAF, the programme will be adapted to the various systems, for example that the C-130J has an additional resource (loadmaster) available in the cockpit, and the need for CRM within each aircrew and between the crews in a formation.

2.6 Risk control and dimensioning

2.6.1 Introduction

In the following, the NSIA will discuss risk control, firstly in relation to the relevant risk assessments and processes in preparation of the mission in question, and secondly with regard to the RNoAF's dimensioning of missions in relation to resources and balancing of risk in peacetime.

2.6.2 Risk assessments and risk control

The new low-level flying concept, to be practised as part of the 335 squadron's mission on the day of the incident, had not been fully developed and internalised. Together with the squadron, the Air Operations Inspectorate had developed rules for the concept, but without any risk assessment having been carried out beforehand. Neither the squadron nor the Air Operations Inspectorate had consulted the Institute of Aviation Medicine or other environments regarding human factors, eyesight and limit values for illumination when using NVG. The squadron had also conducted two exercises to test the concept, but the second exercise had not been evaluated and the exercises had not been translated into concrete guidelines or procedures at the time of the 335 squadron's participation in CR20. The NSIA is of the opinion that the new low-level flying concept was weakly founded and not fully developed or ready for use, particularly in connection with an exercise such as CR20.

The NSIA believes that the decision to set off and consider the conditions en route, despite illumination levels below the regulatory requirement, had to do with the fact that the concept was still being tested out. Hence, SOF/DETCO and the aircrew did not consider the minimum illumination requirement (2.2 millilux) to be an absolute limit value. Furthermore, the risk assessment relating to CR20 had identified risks associated with low-level flying and NVG operations, including uncertainties relating to VFR minima. This was not followed up or clarified before the exercise started, which resulted in the minimum requirement (BSL F 1-1) not being observed during the mission.

The squadron also conducted a risk assessment prior to the mission under consideration. The NSIA has reviewed the form that was completed by the MG31 aircrew and found some deficiencies. Among other things, one of the elements was given an incorrect numerical value and several elements may have been given a too low score. Hence, the total score was lower than it should have been and did not reflect the risk and complexity of the mission, particularly considering that this was a checkout flight for the aircraft commander candidate. Furthermore, there was a failure to address several elements in the risk assessment that should have been addressed before starting to practise the new low-level flying concept, including a recommendation to conduct a reconnaissance flight of the route in daylight, which was not heeded. Corresponding measures were also described in the risk assessment for CR20.

In the interviews with squadron personnel conducted by the NSIA and RNoAF investigation team, it emerged that risk assessments were primarily seen as a tool for raising awareness, and that a system for reviewing, assessing, deciding and evaluating the effect of any risk-reduction measures hardly existed. All in all, the investigation has shown that, even though the squadron apparently has a systematic approach to preparing risk assessments prior to exercises and deployments, the approach is less systematic when

it comes to use of the risk assessments in the implementation phase. Awareness also seems to be somewhat lacking as regards what concrete actions need to be taken when the risk score is high.

The NSIA agrees with the RNoAF investigation team's description of there being potential for improvement in the squadron's approach to risk assessments when it comes to ensuring that identified hazards are actually assessed and addressed. The same improvement potential may be present in other operational units and areas in the RNoAF. Conducting risk assessments without having any requirements or systems in place for following up concrete actions, can give rise to a false sense of security in that people relax because all the relevant risks having been considered. In that connection, the following is quoted from *The Nimrod Review* (2009, p. 534):

> *…the purpose of the Safety Case regime was to "encourage people to think as actively as they can to reduce risks". Instead, in some instances, Safety Cases seem to be achieving the opposite effect: giving people a false sense of security that a Safety Case is some sort of paper 'vault' into which risks may be safely deposited and forgotten about. There is a pervading sense that the mere fact of a Safety Case means the platform is safe.*

The RNoAF's air operations will always entail some inherent risk. The purpose of the RNoAF's risk management must be to seek to achieve the proper balance between missions/operations and safety, including that risk is kept within an acceptable range in connection with training and exercises conducted in peacetime. The NSIA would like to see a clearer description from the RNoAF management, however, of what constitutes acceptable risk in connection with peacetime missions. Missions entailing a high level of risk (red) are initiated without being subject to any requirement for compensatory action, only to the requirement that the risk is approved by superior personnel.

2.6.3 Dimensioning– mission portfolio in relation to resources

Dimensioning of missions/production versus resources is an important element of safety management with a view to keeping risk within an acceptable range; see the adaptation model in Figure 25. A broad and demanding mission portfolio for the 335 squadron has resulted in less time for defence capacity building. Hence, every mission has been seen as an opportunity to practise and maintain personnel qualifications in accordance with PAQS.

Information received from NAOC and NJHQ about the planning of missions for the 335 squadron show that they knew how many aircraft and aircrews there were. NAOC and NJHQ claim that they have tried to adapt and protect the squadron from excessive workloads, but the NSIA is under the impression that this has not been effective.

It is concluded in the RNoAF investigation that *'it appears to be unclear whether sufficient correspondence exists between available resources and the number of missions the unit is expected to solve, including both operational deliveries and defence capacity building'*. The RNoAF investigation team therefore recommended that the RNoAF management conduct an overall evaluation of the mission portfolio for the C-130J aircraft (Recommendation No 1).

The RNoAF investigation also raised the question of whether the existing training programme for the C-130J and related continuity requirements were sufficient to ensure a satisfactory minimum level of defence capacity building in tactical disciplines. In the NSIA's view, it would be a natural consequence of a review of the mission portfolio and defence capacity building to evaluate PAQS in relation to skills and continuity requirements for each discipline. That would entail an evaluation of whether the requirements in PAQS are adequate and feasible, and of how compliance can be ensured.

Through the interviews conducted during the investigation, the NSIA has learnt that the 335 squadron's situation is by no means unique; other operational units are also short of personnel. The NSIA has also been informed that there is a shortage of several categories of personnel in the RNoAF, including pilots. The NSIA has not looked into the background to this or related decisions. The most important point to make for the NSIA is that the RNoAF must ensure that its mission portfolio is dimensioned in relation to the available resources, so that safety is not compromised.

2.6.4 Summary and safety recommendation

The investigation into this serious incident has shown that the balance between conducting missions and ensuring safety has been challenged in the 335 squadron. Among other things, the NSIA is of the opinion that the RNoAF's competence and guidelines for risk control have not been enough to make up for this.

Based on the investigation, the NSIA submits one safety recommendation to the RNoAF to review and improve its risk control processes. with a view to identifying hazards, safety barriers and risk factors, defining acceptance criteria and requirements for compensatory measures and follow-up of same.

The NSIA has not looked at the mission portfolio of other operational air units in the RNoAF, but expects, as pointed out in the Chief of the RNoAF's letter in response to the internal investigation report, that they will also be subject to evaluations corresponding to the one of the 335 squadron (see also Appendix C). Hence no safety recommendation is submitted by the NSIA on this point.

2.7 Safety culture

2.7.1 Introduction

By safety culture is meant an organisation's culture relating to safety. Bang (2013) has summed up the many definitions of organisational culture in a single definition:

Organisational culture is a set of common norms, values and perceptions of reality developed by an organisation when its members interact with each other and their surroundings, and that is manifested in their actions and attitudes at work.

In the present case, the NSIA has not conducted a comprehensive investigation into the 335 squadron or RNoAF's safety culture. Nonetheless, the NSIA wants to discuss some observations of cultural features that have emerged through the investigation and that may have had a bearing on the incident and have consequences for the safety of the RNoAF's air operations.

2.7.2 Observations in the 335 squadron

The 335 squadron has been described as a closed environment, receiving few external impulses and largely operating independently with a high delivery rate. It is true that the squadron includes several pilots with experience of other aircraft types, so that there has been some transfer of experience from other parts of the organisation.

The investigation showed that a total of four pilots made choices and assessments that were not in accordance with the regulations or best practice. In other words, it is not a matter of a single pilot overstepping the limits. The incident involved four pilots who, together, represented the range of experience and background of the pilots in the 335 squadron. The NSIA has formed the impression that the pilots are skilled, motivated and solution- oriented. Based on the openness displayed during the investigation, the NSIA has the impression that there is a good collegial environment in which the 'just culture' concept is addressed.

The NSIA found that the planning, authorisation and execution of the mission indicated that there was a certain degree of overconfidence and self-assurance among the crews and SOF/DETCO. The NSIA is under the impression that the 335 squadron may have developed a high degree of risk tolerance over time, probably as a result of the squadron's wide-ranging and demanding mission portfolio in both Norway and abroad, recognition and praise after solving missions, and a strong motivation to solve and master different missions.

In interviews with squadron personnel, both the NSIA and the RNoAF investigation team have become aware of several examples that indicate that the unit's personnel sometimes have a pragmatic approach to rules and regulations. Neither the aircrew nor SOF/DETCO were fully informed of regulations on weather conditions required for flying under VFR at night (BSL F 1-1). The NSIA also notes that the regulations in question may have been difficult to fully absorb, as they contain provisions particular to Norway and several cross-references. The NSIA has also been informed that some rules are broken with a view to solving missions.

The investigation showed that the Norwegian rules and regulations for the C-130J still suffer from gaps and deficiencies, despite having been extensively revised in 2015. The NSIA agrees with the Air Operations Inspectorate's observation that, over time, this may have affected the squadron's respect for and compliance with rules and regulations. Furthermore, the RNoAF investigation team pointed out that few common arenas limit the possibility of being a learning organisation.

Even though the workload had been somewhat high prior to the mission, and even though PF MG31 had status 'red' in some disciples in PAQS, the demanding air mission was not changed or adjusted accordingly. In the NSIA's opinion, this supports the impression of a culture that has room for improvement in relation to safety and professional conduct.

Hence the NSIA cannot rule out the possibility that the safety margins in the operation may have been narrowed by certain cultural features of the 335 squadron: the existence of informal leaders, the eagerness to obtain status 'green' in PAQS and a pragmatic approach to rules and regulations. These features also include high tolerance of risk as well as an assertive, flexible, mission-focused and solution-oriented approach.

2.7.3 Pressure to deliver and performance culture

The Chief of the RNoAF has described the RNoAF as being characterised by personnel who wish to solve their assigned missions, in other words, a performance culture. This is described as a very important characteristic in the RNoAF, while it can also constitute a risk. The RNoAF investigation uses the term 'pressure culture' to describe this assertive, mission-focused and solution-oriented culture that can entail taking excessive risk.

The NSIA agrees with the RNoAF investigation team's assessment that it is *'likely that some degree of pressure culture contributed to a complex and risky mission being performed on 11 March 2020, despite the aircrews having low continuity, some expired ratings and inadequate knowledge of rules and regulations'.* The RNoAF investigation team has recommended that the 335 squadron evaluate and clarify the degree to which the 'pressure culture' affects safety levels (Recommendation No 5). At the same time, the NSIA believes that what gives rise to the pressure culture in the 335 squadron is an inner wish to perform combined with an external pressure to deliver imposed by management and others.

The investigation indicates that the pressure to deliver has been present in the 335 squadron since the C-130J was phased in in 2008/2009, through an urgent procurement process without operative testing and evaluation (OT&E). This caused the 335 squadron to transition from being purely an air transport squadron to becoming a squadron that provided tactical air transport capacity. As reported by the former Commander of 135 Air Wing, the mission was to improve and rationalise the squadron's deliveries using the new J model aircraft.

The AW101 report also describes the phenomenon whereby management is unable to say stop when directly involved in the operational delivery. On that basis, the NSIA believes that both the Mosken incident and the AW101 incident at Sola can be related to similar underlying mechanisms related to the pressure to deliver. Furthermore, both the 335 squadron and 134 Air Wing management have stated that they have regularly reported on the high level of pressure to their superiors, as did the OT&E AW101 department, without this leading to any change. These are thus indications that some degree of 'pressure culture' may be present at several levels of the RNoAF organisation and affect several parts of the RNoAF.

2.7.4 General considerations

The NSIA refers to the report from the RNoAF's working group on overall safety management, in which safety culture was also addressed. The working group pointed out that the RNoAF focuses almost exclusively on the 'just culture' concept and not on other elements of a good safety culture, such as an informed, flexible, learning and reporting culture. It is pointed out that, had the RNoAF's safety culture been 'informed', there would have been greater awareness of how eagerness to be solution-oriented and handle cases as they arise can harm the ability to achieve organisational learning. Another challenge is the many assumptions underlying the RNoAF's safety efforts, which are not sufficiently based on facts and knowledge. The Armed Forces Materiel Safety Authority has also pointed out that the defence sector's operational units, including the RNoAF units, score low on learning culture.

The NSIA acknowledges that pressure to deliver and performance culture are necessary components of military operations. What worries the NSIA relates to the shift towards a 'pressure culture' that approaches the limit for acceptable risk (the 'practical drift' referred to in Figure 25) during peacetime exercises and missions, as was the case in the 335 squadron. In an organisation that is not sufficiently informed and learning, risks can be introduced with the introduction of new tasks and systems that the organisation is not properly equipped to handle. As a consequence, risk is not identified, assessed or dealt with before a serious incident or accident 'suddenly' occurs.

The RNoAF is about to introduce several new types of aircraft and helicopter, including the F-35, NH90, AW101 and P-8A. Planning is also in progress for the procurement of new helicopters for the Norwegian Special Forces. Considering that human resources will also constitute a limitation in that connection and may be further challenged, it is important to learn from both the Mosken and AW101 incidents.

2.7.5 Summary and safety recommendation

Based on the investigation, the NSIA is of the opinion that the RNoAF should evaluate and clarify whether and to what extent pressure to deliver and performance culture affect safety levels throughout the organisation, which is in fact an extension of the RNoAF investigation team's Recommendation No 5, which was addressed to the squadron. The NSIA is of the opinion that pressure to deliver and a high-performance culture, combined with an organisation that is not sufficiently well informed and learning, could affect the level of safety in all the RNoAF's activities.

The NSIA therefore submits one safety recommendation that the RNoAF conduct a survey to enable it to describe and gain the best possible understanding of the organisation's safety culture, both at the management level and in the operational units. Such a survey can establish a benchmark for subsequent safety work and efforts to improve the organisation's safety culture. A similar recommendation was made by the RNoAF's working group for overall safety management.

2.8 The Kebnekaise accident

2.8.1 Introduction

The incident at Mosken is especially serious in light of the Kebnekaise accident in 2012. The investigation has therefore also sought to identify any factors that were common to the two incidents. In addition, the NSIA has looked into how findings and recommendations were followed up by the RNoAF after Kebnekaise, and whether any shortcomings in the follow-up could possibly have had a bearing on the Mosken incident eight years after. This is discussed in more detail below.

2.8.2 Comparison between the Kebnekaise accident and the Mosken incident

The NSIA found that the Kebnekaise accident and the serious incident at Mosken eight years later had certain features in common. Both incidents related to CFIT and involved a C130-J Hercules transport aircraft participating in the Cold Response winter exercise. The two aircraft were engaged on different missions, however:

- The Mosken incident occurred after a COMAO mission during low-level formation flying with NVG under visual conditions (VMC) and carrying personnel to be transferred to Evenes.

- The Kebnekaise accident involved a transport aircraft flying under instrument meteorological conditions (IMC) on its descent to Kiruna Airport for the purpose of picking up Norwegian military forces and materiel and subsequently return to Evenes.

One important difference between the two incidents is that while the aircrew involved in the Kebnekaise accident followed rules and regulations, this was not the case in the Mosken incident. An essential factor in the Kebnekaise accident was that the crew followed clearance granted by the tower at Kiruna to an altitude that did not provide sufficient terrain separation. In the Mosken incident, the minimum requirement for illumination was not met when the mission was authorised, the aircrews deviated from the route and continued low-level flying, among other things because flying over the open sea gave them a false sense of security.

The Swedish SHK was neither able to ascertain what planning had taken place prior to the flight nor how such planning had been followed up during the flight. On the flight operation side, the investigation found shortcomings in the RNoAF with respect to procedures for planning and following up air missions to prevent aircraft from going below the minimum safe altitude. The air force closed the recommendation by clarifying the regulatory framework (BML) and procedures for authorisation with respect to terrain separation and calculation of minimum safe flight level, and by updating the squadron's planning procedures.

In connection with the Mosken incident, the NSIA also found deficiencies in the planning and authorisation process. This concerned weather and light conditions in particular. Furthermore, the return flight from the exercise area was not briefed, whereby the formation ended up following an unplanned route. The minimum safe flight level had initially been addressed during the planning, on the assumption that the formation followed the same route in reverse back from the exercise area.

In connection with the Kebnekaise accident, the crew followed the clearance they thought would keep them above the minimum safe altitude. The Swedish SHK pointed out several possible reasons why the aircrew did not consider the descent to flight level 70 to be risky: the planning, the weather, confidence in the air traffic service, crew composition and experience, confidence in GCAS/TAWS, vigilance and rules and regulations. As a result, the task of navigation received too little attention with respect to safe altitude. The Swedish SHK did not rule out the possibility of a system weakness when transitioning from the C-130H to the new C-130J crew configuration without a dedicated navigator, but did not find that this had had any decisive bearing on incident.

In the Mosken incident, the task of navigation also received too little attention from the aircrew. The NSIA has identified several possible explanations, including: deviation from the pre-planned route, weather and light conditions, CRM and workload in the cockpit, a sense of security when flying over open sea, use of NVG and use of navigational aids. As a result of all these factors taken together, there were weaknesses in the crew's situational awareness in both the Kebnekaise accident and the Mosken incident.

Common to both incidents was that the aircraft's ground collision avoidance systems (GCAS/TAWS) issued no warnings. In both cases, the crew was operating with TAWS set to tactical mode, for which there was no terrain database for areas north of 60° N.

In its investigation, the Swedish SHK found that there may have been weaknesses in the crew's knowledge about and use of GCAS/TAWS. Had the system been set to normal mode, it would have warned of the danger of collision at Kebnekaise. That was why, after the Kebnekaise accident, the RNoAF changed its Standard Operative Procedures (SOP) so that TAWS Tactical was only to be used on tactical flights under VMC.

The NSIA's interviews relating to the incident at Mosken have shown that the crew knew too little about the ground collision avoidance systems. The crew was aware that they had no database for Tactical TAWS North of 60 °N, and it would have been impossible to complete the COMAO mission and the planned low-level flying sequence with the system set to normal mode, as it would have resulted in a number of false alarms.

The Swedish SHK's investigation of the Kebnekaise accident showed that the RNoAF failed to provide the aircraft with the requisite clearances and information required under applicable regulations. At the same time, it was pointed out that it is always the aircraft commander who has primary responsibility for terrain separation. In connection with the near collision at Mosken, the NSIA has discussed whether the air traffic service could potentially have functioned as a safety barrier. The NSIA is of the opinion that the air traffic service could not be expected to prevent the situation that gave rise to the present incident.

2.8.3 The RNoAF's follow-up after the Kebnekaise accident

The investigation has shown that the C-130J was phased in as an urgent procurement[52], without conducting OT&E. The aircraft system was put into operation without a crewing concept, operational procedures, work procedures and technical solutions being evaluated and adapted to Norwegian conditions and the 335 squadron's operations. The factors were pointed out by the Swedish SHK, NORKOM and the Chief of the NJHQ after the Kebnekaise accident in 2012. They were also mentioned by Safetec in connection with its CRM study of the 335 squadron in 2014.

Based on what the NSIA knows about the most recent procurements of aircraft systems for the RNoAF, the OT&E processes have been substantially improved in recent years. The C-130J is one of the RNoAF's older aircraft systems. Since there is consensus that important principles were not observed when the C-130J was phased in, the NSIA sees no reason to look into the documentation from that period or to extend its investigation relating to the procurement of the C-130J. The NSIA assumes, however, that the time that has lapsed since the Kebnekaise accident has been spent rectifying any system weaknesses that were introduced when transitioning from the H to the J model.

It is clear from the NSIA's interviews with personnel at different levels in the RNoAF that the Kebnekaise accident left its mark on the 335 squadron and the whole RNoAF. The NSIA found that, in the years following the accident, much was done to improve what the Swedish SHK referred to as 'latent weaknesses' in the RNoAF.

[52] Ref. the letter of 26 February 2014 from the Chief of the NJHQ

The investigation showed that the RNoAF followed up many of the findings relating to the Kebnekaise accident (see Appendix B). That is a conclusion drawn from the NSIA's own review of reports following the Kebnekaise accident, recommendations to the RNoAF from the Swedish SHK, NORKOM and the Chief of the NJHQ, measures implemented by the RNoAF, and information the NSIA has gained through interviews. The NSIA notes, however, that the recommendations from the Swedish SHK and NORKOM were seen as closed without all the measures described by the RNoAF having been initiated and completed. The NSIA has requested further documentation, but the RNoAF has been unable to provide this.

The investigation has also shown that the Defence Staff did not translate the recommendations from the Chief of the NJHQ's letter into concrete guidelines for RNoAF following the publication of the Kebnekaise report. Based on what the RNoAF reported to the Defence Staff in September 2018, the NSIA found that the RNoAF may nonetheless have addressed the Chief of the NJHQ's recommendations in the course of the four years (2014-2018). In this case too, the NSIA lacks sufficient documentation, however.

The NSIA would particularly like to draw attention to the following aspects of the RNoAF's follow-up after the Kebnekaise accident, which are of relevance to the Mosken incident:

- The NSIA lacks documentation of how the findings and recommendations from Safetec's observation study and the RNoAF's own study of crew configuration were addressed and translated into practice. Once again, the NSIA refers to The Nimrod Review (2009) and its reference to the concept of a 'paper vault' where risk can be stored without action being taken (see Section 2.6.2)Furthermore, in its reply to the recommendations from the Swedish SHK, the RNoAF stated that *'The Royal Norwegian Air Force will consider the number and scope of the type of missions the C-130J system should be trained and ready to undertake at all times'* (see Appendix B). The NSIA has not received any documentation of such an assessment. The Mosken incident shows that there is still a way to go.

- Despite the extensive revision of the Norwegian rules and regulations for the C-130J after the Kebnekaise accident, the investigation has shown that they still contain shortcomings in 2020. Among other things, it was not specified what requirements applied to flight visibility and distance to clouds for operations with the C-130J. Several pilots interviewed by the NSIA have also described the regulatory framework for C-130J operations as complex and time-consuming to look through. Hence, the recommendation from the Swedish SHK to *'Develop clear rules, manuals and procedures, which make it easier for flight crews to conduct safe air operations' (RM 2013:02 R4) (RM 2013:02 R4)* cannot be said to have been satisfactorily followed up by the RNoAF. An unclear and complex regulatory framework is also likely to have affected the squadron's respect for and compliance with applicable rules and regulations over time.

2.8.4 Summary

Overall, the NSIA finds that lack of situational awareness and attention to navigation were factors that the Kebnekaise accident and Mosken incident had in common. In the Mosken incident, the mission entailed too high a risk and was not in accordance with the regulatory framework for C-130J operations. In both cases, the TAWS system could have alerted the crew to the risk of collision with the terrain, had it been available, worked as intended and been operated as designed. Unclear and complex rules and regulation, and weaknesses in the safety culture may have been other underlying factors in both incidents.

The investigation showed that the RNoAF followed up many of the findings relating to the Kebnekaise accident in the years that followed. The accident did not to a sufficient degree lead to fundamental and systemic changes, however. It appears that in certain respects, the investigation of the Kebnekaise accident did not plough deep enough to uncover latent weaknesses in the RNoAF. Furthermore, several of the recommendations did not specify requirements for results and verifiability, and the RNoAF could therefore close them without having made sufficient changes.

2.9 Safety management system and safety management

2.9.1 Introduction

Safety management is defined as all the activities, practices and management functions established by an organisation for the purpose of controlling sources of risk and avoiding undesirable incidents. As mentioned above, safety management comprises formal processes such as a safety management system, as well as less formal processes. The NSIA has not conducted a complete audit of the RNoAF's safety management system and safety management. The NSIA has looked in some detail at the framework for the organisation and its safety management system, and conducted an overall assessment of how well the RNoAF's safety management has worked.

2.9.2 Organisation and safety management system

The investigation has shown that the RNoAF's safety management organisation is not fully established, and that handling and follow-up of safety in the RNoAF is divided between different functions with different areas of responsibility.

While the Chief of the RNoAF has overall responsibility for safety, operational unit commanders have day-to-day responsibility for safety. This means that each individual commander of an operational unit has (operational and technical) responsibility for aviation safety within his unit. The Chief of Staff and Deputy Chief of the RNoAF are delegated responsibility for the overall safety management system by the Chief of the RNoAF. There is a direct line of contact from the air wing commanders, who are responsible for implementing the safety requirements provided for in *Bestemmelse om sikkerhetsstyring i Luftforsvaret* (BFL 010-1), to the Chief of the RNoAF.

The RNoAF Flight Safety Inspectorate (FTI), led by the RNoAF Flight Safety Inspector, plays an important role in the RNoAF as advisory body to the Chief of the RNoAF in matters to do with flight and ground safety. The RNoAF's local flight and ground safety organisations report to the RNoAF Flight Safety Inspector in matters relating to flight and ground safety. The flight and ground safety organisation has not been delegated responsibility for the safety management system. However, in the absence of a well-functioning internal follow-up system, the Flight Safety Inspectorate addresses and maintains an overview of recommendations relating to RNoAF activities. The local flight safety organisation at Gardermoen Air Station, headed by the Senior Flight Safety Officer, has correspondingly played an important role in processing and following up incident reports and risk assessments in that operational unit.

In conceptual terms, the RNoAF's safety organisation appears to be in line with the recognised principles that responsibility and the authority to make decisions on safety are vested in the line management and that, with regard to safety, the staff function contributes support to the line organisation's decision makers (Sandberg and Albrechtsen, 2017). The AIBN would nonetheless like to second the DAINB's comments (2019, p. 53) in connection with the AW101 rollover, namely that it is challenging to distinguish between the RNoAF's safety management organisation and its flight safety organisation.

Because the implementation of a safety management system in the RNoAF in accordance with BFL 010-1 had failed to produce the desired results, a working group was set up with a view to establishing an overall safety management system in the RNoAF. The

working group has produced what appears to be a thorough report, and the NSIA largely agrees with its assessments and recommendations.

The NSIA points out that safety related to preventing injury/damage and loss of lives/materiel losses resulting from weaknesses and limitations in individuals, organisations and systems must have top priority in the RNoAF's safety management system. Expecting the safety management system to cover multiple areas of safety[53] seems rather ambitious.

The NSIA also considers that there is a danger that requirements for more reporting and control in other areas of safety and security can cause operational safety management (i.e. addressing air operations and risk) to be increasingly pushed to the rear in favour of administration and formal management tasks. Furthermore, the NSIA considers that there is a danger that flight safety can be consumed by more general HSE risks and GDPR related tasks and requirements.

2.9.3 Safety management – overall assessment

The investigation indicates that too much of the responsibility for safety is left to the operational environment, where the pressure to deliver is combined with limited resources. The RNoAF report describes that, where ambition levels are pursued at the expense of safety, the RNoAF management relies on those in command of operational units to say stop and communicate this to their superiors. In other words, the RNoAF management largely relies on safety being ensured as long as they are not otherwise informed. It is also assumed that those in command of operational units are able to set the limit for acceptable risk, and balance missions with resources, which the investigation has shown to not be the case. In the NSIA's opinion, this form of safety management is inadequate in the face of the performance culture that marks the RNoAF.

The NSIA finds that the serious incident and the aircrew's choices and assessments, rather than representing a one-off event, are symptomatic of systemic problems relating to safety. It means that functioning, framework and formal structures relating to the 335 squadron have persistently failed. In the NSIA's view, the failure to identify and follow up the 335 squadron's weaknesses relating to safety was due to fundamental shortcomings in the safety management. Lack of overall perspective and follow-up appear to have resulted in a failure to observe that the 335 squadron was drifting towards the limit of what can be considered acceptable risk during training in peacetime. On that basis, the NSIA also questions whether safety is adequately ensured in other operational units of the RNoAF.

The NSIA understands that the RNoAF has to prioritise between different aircraft systems, and that it is essential to follow up the new systems that are being phased in. In the NSIA's opinion, the RNoAF's safety management lacks good processes/methods for detecting unfortunate trends, as well as systematic prioritisation and follow-up of areas of risk. One example is the fact that the 134 Air Wing management displayed most concern for the 717 squadron prior to the CR20 exercise. The NSIA cannot see that the RNoAF

[53] Six areas of safety and security have been defined in the RNoAF: operational safety, materiel safety, environmental protection, personal safety, security service and data protection. The working group for overall safety management recommends three discipline areas/areas of safety: Aviation safety (Flight safety); Health, safety and the environment (HSE); and Security.

management has systematically conducted risk assessments and identified safety-critical factors relating to the different operational units.

In particular, the dimensioning of the 335 squadron was never followed up; its resources and personnel were not balanced with the demanding mission portfolio, which in turn caused a drift towards the limit for acceptable risk ('practical drift', ref. Figure 25). The examples of the 335 squadron's occasional breaches of rules and regulations are indications of inadequate internal control and follow-up at management level.

As mentioned, safety management includes ensuring that personnel with safety-critical tasks have the right competence. The investigation has shown that this element of the RNoAF's safety management has not been satisfactorily addressed, including that there has been too little attention to instruction and training in CRM. It is also questionable whether the skill and continuity requirements (PAQS) are adequate and feasible. The working group for overall safety management has also pointed out that there is a need to significantly raise the level of competence relating to an overall safety management system and individual areas of safety in the RNoAF.

Several previous reports on incidents involving the 335 squadron have pointed out that there is a lack of clarity in the regulatory framework for C-130J operations, insufficient knowledge, a lack of common fora and an extensive mission portfolio, factors that also had a bearing on the present incident. The NSIA sees this as an indication that learning, transfer of experience and improvement work based on incident investigations have not been satisfactory. Factors that may have contributed to this state of affairs include reduced case processing capacity and a high workload.

In the case of the 335 squadron and the C-130J system, the effort that was put into remedying the findings following the Kebnekaise accident in 2012 and the absence of any further accidents may have left the RNoAF with the impression that risk was under control. In the NSIA's opinion, however, the investigation of six incidents[54] and one fatal accident since the C-130J was phased in in 2008 should have been enough for the RNoAF to identify this aircraft system as a high-risk system requiring enhanced follow-up. Considering the number of aircraft, aircrews and hours of flight time in the 335 squadron, seven serious incidents in the course of ten years is a relatively high number.

[54] Incidents that have been subject to extensive investigation by the RNoAF.

2.9.4 Summary

Even though military aviation is normally associated with greater risk than civil aviation and the RNoAF is not bound by civil aviation legislation, the NSIA expects the RNoAF's safety management to be based on recognised principles, including a combination of an experience-based and a risk-based safety management system. The NSIA believes that this investigation has demonstrated that this has not been adequately ensured.

The investigation has shown that the RNoAF has put into place several elements of a safety management system, but that they have not been combined into an integrated and overall system for its activities. This may have affected the RNoAF's vigilance relating to risk, its decision-making processes and continuous safety improvement work.

The NSIA largely agrees with the assessments and recommendations in the report on overall safety management in the RNoAF. The NSIA does not submit any specific safety recommendations in this area, warns against any form of weakening of the safety work relating to air operations, the RNoAF's core activity.

2.10 Supervision and follow-up

2.10.1 Introduction

The incident is an example of how operational units are not always able to identify their own shortcomings and weaknesses. The RNoAF investigation report raised the question of whether the RNoAF has the resources to solve its missions within acceptable limits and whether existing control mechanisms are suited to identifying practical drift and unsafe practices in operational units that the units themselves are unaware of. This is discussed further below.

2.10.2 Control mechanisms and resources

The RNoAF investigation report describes the correction of risky behaviour as a management responsibility, and the examples of the 335 squadron's occasional breaches of rules and regulations are seen as indicative of management not having identified or corrected risky or unsafe practices in the unit. The NSIA agrees with that description and considers that the RNoAF's internal supervision and follow-up appear to be inadequate.

The Air Operations Inspectorate had not conducted any ordinary supervisory activities of the squadron since January 2012 (before the Kebnekaise accident), among other things because competence/resources were in short supply. Even though some inspections and verifications have been conducted in connection with international operations, the NSIA is of the opinion that the level of supervision and control is inadequate.

The NSIA sees a need for that the Air Operations Inspectorate to have a C-130J guest pilot who is checked out to fly the C-130J, in order to be able to verify and supervise air operations. The fact that the squadron's need for personnel has been met at the expense of the Air Operations Inspectorate's possibility of conducting supervision and follow-up because of a shortage of personnel gives cause for concern, however. Because the Air Operations Inspectorate did not have a C-130J staff officer, the introduction of the new low-level flying concept was largely left up to the squadron, and necessary clarification and follow-up were inadequate. This is an indication that the RNoAF's general resource/personnel shortage can leave gaps in important safety functions.

The RNoAF investigation team recommended that the RNoAF ensure that specialised operational air competence be made available to the levels above the 335 squadron (Recommendation No 2). The NSIA has not looked at competence relating to other aircraft systems, but assumes that the RNoAF will ensure that they are also provided with necessary competence, as pointed out by the Chief of the RNoAF's communication regarding the RNoAF investigation report (see Appendix C).

Furthermore, the NSIA's interviews indicate that the coordination between 134 Air Wing, Gardermoen Air Station and the 335 squadron was not suited to identifying and correcting unsafe practices. This is probably a consequence of both geographic distance and the tradition whereby the 335 squadron has operated independently. The Commander of 134 Air Wing's area of control is wide-ranging and varied, entailing responsibility for two different operational air squadrons and one helicopter squadron split between the Rygge and Bardufoss air bases. In addition, the 335 squadron has regularly been deployed on international missions abroad.

The air wing commander follows up the squadron at Gardermoen through weekly management meetings and talks. However, there is no internal control system for flight safety, under which the squadrons would be followed up through audits and inspections. Sometimes, the 335 squadron has also been assigned tasks directly, without involving the air wing level, so that the air wing has not been able to act as a buffer for the squadron's operations. Furthermore, the air wing commander was not involved in the development of the new low-level flying concept.

The RNoAF investigation report refers to the RNoAF management having placed great confidence in the air wing and squadron commanders and expects those in charge of operations to adjust the level of activity in the interest of safety Those in charge of operations are not always able to identify a squadron's limitations and say stop, however. The RNoAF investigation team therefore recommended that the RNoAF management take steps to facilitate closer follow-up and control of the operational units, including supervisory activities and evaluations, with the emphasis on supervision and active presence in the operational unit (Recommendation No 3). The NSIA supports this recommendation.

2.10.3 Form of supervision

By not giving priority to providing the Air Operations Inspectorate with C-130J competence, the RNoAF contributed to the low-level flying concept not being closely followed up. At the same time, the NSIA has to some extent gained the impression that certain critical matters were taken for granted and not considered a problem because of the informal ties between the Air Operations inspectorate as competent and supervisory authority and, in this case, the 335 squadron as operator. One example is that the regulatory framework was drawn up before the concept had been tested and risk-assessed.

The development of supervision in other sectors has generally shown a shift towards system supervision, whereby enterprises are required to document that they have systems in place that meet regulatory requirements and that their governing systems for safety management are effective and appropriate. This means that supervision increasingly addresses management and control. In parallel with system supervision, internal control and day-to-day follow-up by the operators themselves (operational units in the RNoAF) are required to ensure compliance with rules and regulations. As mentioned above, such an internal control system was not in place.

The investigative findings suggest that the RNoAF fails to distinguish clearly between supervision as a task for the competent authority and internal control of flight safety at enterprise level. The organisation seems to rely too much on the Air operations Inspectorate's supervisory activities to identify and adjust unsafe practices at squadron level, instead of establishing systems for internal control and safety management for the operational units. In the absence of supervision and verifications by the Air Operations Inspectorate, the operational unit has thus largely been allowed to operate on its own, without follow-up or internal control.

Other inspection authorities, such as the Civil Aviation Authority Norway and the Norwegian Railway Authority, have increasingly emphasised risk-based supervision through focusing on identifying unfortunate trends and important areas of risk, rather than detailed inspections of multiple areas associated with low risk. The inspection authorities can adjust the level of risk based on factors such as the age of materiel, introduction of

new systems, experience and competence, organisational factors, experience from previous inspections, accidents and serious incidents, reporting of near-misses and trends etc. However, as the RNoAF has been without a system for identifying, prioritising and following up areas of risk, the Air Operations Inspectorate's supervisory activities do not appear to be risk-based.

2.10.4 Military aviation authority

2.10.4.1 *Responsibility and organisation*

Having the Chief of the RNoAF as both military aviation authority and operator is a classic example of letting the fox guard the henhouse. It is true that military aviation authority responsibilities have been delegated from the Chief of the RNoAF to the Air Operations Inspector. The Air Operations Inspectorate is the RNoAF's body for exercising military aviation authority and supervises the RNoAF's operational units. At the same time, the operational units are also directly subordinate to the Chief of the RNoAF.

Even though the Air Operations Inspectorate is not seen by the RNoAF as belonging to its 'operators', the NSIA finds the close organisational ties between the operator and the authority unfortunate, particularly in an organisation marked by pressure and willingness to deliver and rapid job rotation with personnel moving both laterally and vertically within the system. The RNoAF maintains that safety is ensured through active management and risk management. A practical drift towards the limit for acceptable risk (ref. Figure 25) tends to be more easily recognised by an external body than by the people who are part of the system on a daily basis, however. The NSIA has doubts about whether the RNoAF is capable of identifying and remedying its own systemic safety issues, and raises the question of whether the military aviation authority should be independent of the RNoAF.

An external supervisory body is unlikely to have accepted an interval of eight years between full audits of an organisation as in the case of the Air Operations Inspectorate's supervision of the 335 squadron. If subject to external supervision, the RNoAF would also have to comply with external requirements and document the effects of its own decisions, risk assessments, internal inspections and incident reports. An external supervisory body would also have to monitor more closely the organisation's handling of recommendations following accidents such as Kebnekaise.

As mentioned above, several countries have an independent, overall military aviation authority. The UK Military Aviation Authority was established in 2010 as a direct consequence of the Nimrod accident in Afghanistan and the subsequent investigation. We find similar stories elsewhere, including in the Netherlands. In Norway, the military aviation authority has neither independence nor overall responsibility. Instead, the sector has three internal bodies charged with supervising military aviation, all with different sources of legal authority for their remits.

Military aviation authority is divided between the RNoAF as competent and supervisory authority for operations, and the NDMA as competent and supervisory authority for airworthiness. At the same time, the RNoAF is both operator and user, and the NDMA is responsible for both procurement and ownership management of military aircraft. In addition, there is the Armed Forces Materiel Safety Authority, an organisation under the

Ministry of Defence charged with ensuring the safety of defence materiel. The authority's remit includes supervising airworthiness, although with limited resources. Its remit does not include supervision of air operations.

An overall supervisory authority would be charged with all the above-mentioned tasks: supervision of operations, airworthiness and materiel. A supervisory body charged with all these tasks would be able to assess the safety of the defence sector's aircraft from a broadly based and multidisciplinary perspective. In this connection, the NSIA refers to the fact that safety has to do with a complex interaction between technology, man, organisation and the environment. The value of interdisciplinary supervision is referred to in Norwegian Official Report (NOU) No 22 2019 (p. 136) '*The changes in the organisation* [of the RNoAF] *entail more internal interdisciplinary cooperation and more external dialogue, as safety in this field does not arise in a vacuum.'* Report No 17 to the Storting (2002-2003) *Om statlige tilsyn* and its description of ideals for supervision.

In the NSIA's opinion, the division of responsibility and organisation of military aviation authority do not appear to be expedient. They appear to be fragmented and unnecessarily complex, and can entail conflicting roles and weaken supervision as a safety barrier.

2.10.4.2 *The need for an independent and overall supervisory authority*

The following is reproduced from Report No 17 to the Storting (2002-2003) *Om statlige tilsyn* (p. 10*)*: '*Incidents such as the Åsta and Sleipner accidents and the subsequent discussion and investigation into these tragedies have highlighted the importance of having strong and competent supervisory bodies'*. The NSIA believes that this may be especially so in the defence sector, including in military aviation, where complex operations take place that are wholly or partially exempt from regulatory frameworks, including for safe operation.

The working group on ship safety (2020) recommended supervision by an separate entity external to the defence sector. The working group recommended that the entity be established as a department of the Norwegian Maritime Authority (NMA), and that the entity be supplemented with military technical and operative expertise. The Ministry of Defence is proposed as competent authority and managing agency. The Ministry of Defence is also in the process of considering an overall supervisory solution for the defence sector, including military aviation and naval activities.

It is not the NSIA's task to decide on a future independent and overall military aviation authority's place in the organisation. The main point is to separate supervision from service production, i.e. that the authority be separate from the RNoAF as operator of military aircraft and from the NDMA as ownership manager and procurement authority for military aircraft. It must also be an overall supervisory authority in that it must have the requisite remit, resources and competence to supervise operations, airworthiness and materiel.

In general, a supervisory authority will be able to draw up regulations, approve and inspect aircraft, materiel, organisations and individuals, and have the tools to implement measures as necessary when it finds that rules and regulations are not complied with. The NSIA thus considers aviation authority and supervisory authority to be equivalent authorities, as in civil aviation. The core task of the supervisory function is to verify

compliance with given requirements (See Report No 17 to the Storting (2002-2003) *Om statlige tilsyn*). The supervisory body normally includes regulatory competence, or the rules are handed down by the legislator or a ministry. If only the supervisory function is assigned to a separate entity while the RNoAF retains its powers as military aviation authority, including regulatory powers, the rules will originate with the organisation being supervised. The NSIA considers this unfortunate, as it entails that the organisation being supervised is in control of how the regulations are interpreted, which weakens supervision as a safety barrier.

The NSIA realises that it will be necessary for the supervisory authority to have some degree of proximity and knowledge of risk levels, operating patterns and missions in order to be able to draw up regulations that define operational limitations for military aviation, and to detect and deal with any systemic safety problems in military aviation. In that connection, the NSIA refers to the report from the working group on ship safety (2020) and the criteria for supervision described there[55]. Independence versus proximity to the operational level was also discussed in The Nimrod Review (2009, p. 499).

Considering the many new airplane and helicopter types that are being put into operation by the RNoAF, the NSIA finds it especially important to establish an overall, independent supervisory body. At the same time, the NSIA realises that resources are required to establish such a supervisory solution for the defence sector's aircraft. The imbalance between competence and resources, on the one hand, and mission portfolio and ambitions, on the other, appears to challenge the safety of RNoAF operations. It is therefore important to ensure that the establishment of an external supervisory body does not lead to a weakening of the RNoAF's competence and resources. According to the RNoAF, there is currently not enough personnel available with the requisite competence to staff an external military aviation authority in addition to its own organisation. These factors must be thoroughly reviewed in connection with the Ministry of Defence's study of an overall supervisory scheme for the defence sector.

2.10.5 Summary and safety recommendation

Seen in light of the pressure to deliver, the fact that more than eight years had passed since the last full audit of the 335 squadron, and with reference to the Kebnekaise accident, the NSIA questions the RNoAF's ability to detect and correct own systemic safety problems, and concludes that the investigation has made it clear that there is a need for an external supervisory body.

Based on the investigation, the Norwegian Safety Investigation Agency recommends that the Ministry of Defence establish an independent, overall military aviation authority. This aviation authority must be allocated new resources and not be established at the expense of the RNoAF's existing activities.

[55] Particular reference is made to Section 5.4.2.4 on competence in the defence sector and Section 5.4.2.6 on safeguarding the Armed Force's operational capabilities in the report from the working group on ship safety (2020).

3. CONCLUSION

3.1 Main conclusion

It was largely coincidence and the last-minute actions of the aircraft commander that prevented the loss of another RNoAF C-130J aircraft and crew. Had the first aircraft in the formation initiated the manoeuvre less than one second later, the outcome would have been a catastrophic collision with Mosken.

The NSIA understands the incident to have been caused by a combination of local conditions, active failures and latent weaknesses. The local conditions can be related to a combination of demanding weather and light conditions, low-level flying with night optics and commander check-out. The active failures were that the formation deviated from the planned route and weaknesses in the crew resource management (CRM). In addition, the authorised mission entailed too high a risk and was not in accordance with the regulatory framework for C-130J operations. The authorisation process thus failed to function as a safety barrier. The latent weaknesses in particular can be linked to the RNoAF's safety management, a pressure to deliver combined with under-staffing and a high-performance culture, and inadequate supervision and follow-up. The RNoAF's management had not identified safety-related weaknesses in the 335 squadron. Also, the RNoAF did not adequately dimension missions in relation to the available resources.

The NSIA supports the recommendations made in the RNoAF investigation report and the guidelines issued by the Chief of the RNoAF. At the same time, the NSIA is of the opinion that the RNoAF should intensify its safety management work, including risk control, competence building and safety culture. The NSIA also questions whether the RNoAF is capable of identifying and remedying its own systemic safety issues, and believes that the investigation has identified a need for an external supervisory body.

3.2 Investigation results

3.2.1 The sequence of events, operational and technical factors

a) During the planning, the checkout flight was extended from participation in COMAO to a more demanding mission. The operation included a low-level flying concept with NVG, which the 335 wanted to practise.

b) This left less time to plan each individual element of the operation and several factors were not given enough attention, including minimum requirements for flying VFR in the dark and planning the return flight from the exercise area.

c) The aircrew and SOF/DETCO chose a 'wait and see' approach to the light conditions even though the minimum illumination requirement (2.2 millilux) was not met when the mission was initiated. The crew had no possibility of measuring illumination in the area en route, however.

d) The mission was not adjusted on the basis of a risk assessment. SOF/DETCO authorised a complex and high-risk mission.

e) The formation deviated from the original plan as the weather conditions did not allow for VMC flying at 1,000 ft AGL, and the formation levelled out at 500 ft AGL.

f) The formation did not comply with the minimum requirements relating to cloud base at night set out in BSL F 1-1. Had the formation observed the regulations, it would have had to climb out of the cloud cover and followed the alternative plan, which was to fly at 12,000–13,000 ft.

g) The crew chose to follow a new and more direct route towards Bodø that was neither pre-planned nor authorised, without climbing to a safe altitude at the same time.

h) The aircrew's continuous risk assessment was inadequate and it did not adequately identify and make corrections for risks arising en route. This may be related to the following:

- NVG operations tend to lower people's mental capacity and hence also their situational awareness.
- The crew had a false sense of security when flying over the open sea, in addition to some degree of overconfidence and self-assurance relating to the operation.
- The crew was strongly motivated to practise the whole mission portfolio and gain status 'green' in PAQS, and to complete and solve missions.

i) They eventually realised that the weather and light conditions were too poor for the planned low-flying training over the area around Bodø and decided to split the formation. At that point in time, the formation was unaware of the terrain they were approaching.

j) Crew cooperation was not satisfactory or in line with good CRM:

- Ineffective communication – 'hint and hope'
- The task of navigation was not satisfactorily addressed in MG31
- The role distribution, authority gradient and self-assertion among the MG31 crew and between the aircraft were inexpedient
- There was no agreed plan for the return flight from the exercise area, and the crews failed to ask critical questions of PF MG31 concerning the choice of route

k) Information about Mosken Island and the obstacle it represented was available from several navigational aids in the cockpit, but the MG31 crew had little remaining capacity to monitor these aids.

l) All the pilots used NVG and had satisfactory night vision. The light environment in the cockpit may have had some impact, however.

m) PF MG31 detected the risk of collision visually at the last moment and initiated an avoidance manoeuvre. Had the same manoeuvre been initiated less than one second later, the outcome would have been a catastrophic collision with the terrain.

n) The MG32 crew became aware of the terrain via the digital map and the weather radar as the formation was splitting up, approximately 30 seconds before MG31

carried out its avoidance manoeuvre. As a consequence of limited situational awareness, the MG32 crew did not warn of the terrain ahead.

o) The aircrews received no warnings of the possible danger of collision from the aircraft systems. Set to tactical mode, TAWS had no coverage north of 60° N at the time of the incident.

p) Had an updated terrain database been available, and had TAWS worked and been operated as intended, the crew would have been alerted approximately 1.4 NM before reaching Mosken.

q) The traffic situation was complex when the incident occurred, and the air traffic services could not be expected to prevent the situation. Bodø APP was handling many airplanes at the time, and the heights of the peaks on Mosken were not shown on their screens. Norway CTR could not see Mosken on its screen.

r) When PF MG31 initiated the manoeuvre to avoid collision with Mosken, the auto-throttle function was not deactivated before full engine power was applied. The throttle levers were therefore pulled back automatically, and the engine power reduced. While this was happening, the aircraft's nose angle was gradually reduced until PF MG31 realised this and remedied the situation.

3.2.2 Organisational and systemic factors

a) The new low-level flying concept was too weakly founded to be put into operation, particularly during an exercise such as CR20. Since the concept was not fully developed, SOF/DETCO and the aircrews did not consider the minimum illumination requirement (2.2 millilux) to be an absolute limit value.

b) On tactical flights north of 60° N, the pilots and the regulations were the primary safety barriers against collision with the terrain. Authorisation cannot be seen as an independent safety barrier given that powers of authorisation have been delegated to personnel who belong to the operational environment. The integrity of these barriers was not sufficiently ensured through competence and understanding of risk.

c) The 335 squadron has not established a concept for structured CRM training or related procedures. This has to do with CRM training not having been standardised for the RNoAF as a whole and having been left to the individual operational units.

d) The RNoAF had not established acceptance criteria and requirements for compensatory measures for risk assessments. The 335 squadron's risk assessments (both before the CR20 exercise and before the mission) were primarily seen as a tool for raising awareness. There was hardly any system for reviewing, assessing, deciding and evaluating the effect of any risk-reduction measures.

e) There is a general shortage of pilots in the RNoAF. Furthermore, the 335 squadron had a broad and demanding mission portfolio. This entailed a high workload, few common arenas and less time for defence capacity building/training. Hence, every mission was used as an opportunity to practise and maintain personnel qualifications.

f) An inner wish to perform combined with an external pressure to deliver imposed by management and other parties, may have contributed to reducing the safety margins of the 335 squadron's operations, and thus created a form of 'pressure culture'.

g) There are still gaps and deficiencies in Norwegian rules and regulations relating to the C-130J.. Over time, this may have affected the squadron's respect for and compliance with the regulatory framework.

h) The investigation indicated that some degree of 'pressure culture' may be present at several levels of the organisation and affect several parts of the RNoAF. At the same time, both the RNoAF[56] and the Armed Forces Material Safety Authority have pointed out that the RNoAF lacks a sufficiently informed learning culture.

i) Many of the findings relating to the Kebnekaise accident were followed up by the RNoAF during the years that followed, but that did not lead to sufficient fundamental and systemic changes.

j) The RNoAF had not identified the C-130J as a high-risk aircraft system, even though there had been investigations into six incidents and one fatal accident in the course of 12 years (2008–2020). The recommendations and findings made after incidents and accidents appear to not have been adequately followed up.

k) The RNoAF has put in place several elements of a safety management system, but they have not been combined into an integrated and overall system for its activities. This may have affected the RNoAF's vigilance relating to risk, its decision-making processes and continuous safety improvement work.

l) The RNoAF's internal control and follow-up of the 335 squadron have been inadequate. The 134 Air Wing's area of control was wide-ranging and there was no internal control of flight safety. The Air Operations Inspectorate, in its capacity as competent and supervisory authority, had not conducted any full audit of the 335 squadron for eight years. Priority had been given to supplying competence to the 335 squadron at the expense of the Air Operations Inspectorate.

m) The defence sector lacks an independent, overall military aviation authority (supervisory authority) that is separate from the RNoAF as operator of military aircraft and from the Norwegian Defence Material Agency as ownership manager and procurement authority for military aircraft.

n) There are three internal bodies charged with supervising military aviation, all with different sources of legal authority for their remits. They appear to be fragmented and unnecessarily complex, and can entail conflicting roles and weaken supervision as a safety barrier.

[56] The RNoAF's working group for overall safety management.

4. SAFETY RECOMMENDATIONS

Based on the investigation, and the fact that the Royal Norwegian Air Force has already implemented measures in several important areas, the Norwegian Safety Investigation Authority submits the following three safety recommendations[57] for the purpose of improving safety:

Safety recommendation Defence no 2021/05T

The investigation into the near collision with the rocky island Mosken on 11 March 2020 involving a C-130J Hercules aircraft has shown that the mission that was authorised was complex and involved a high level of risk. The mission was not adjusted on the basis of a risk assessment. The Royal Norwegian Air Force had not established acceptance criteria and requirements for compensatory measures for risk assessments of missions.

The Norwegian Safety Investigation Authority recommends that the Royal Norwegian Air Force review and improve its risk management procedures with a view to identifying hazards, safety barriers and risk factors, defining acceptance criteria and requirements for compensatory measures and follow-up of same.

Safety recommendation Defence no 2021/06T

The investigation into the near collision with the rocky island Mosken on 11 March 2020 involving a C-130J Hercules aircraft has shown that an internal wish to perform and external pressure to deliver exerted by management and other parties may have contributed to reducing the safety margins of the 335 squadron's operations. The Norwegian Safety Investigation Authority is of the opinion that pressure to deliver and a high-performance culture, combined with an organisation that is not sufficiently well informed and learning, could affect the level of safety throughout the Royal Norwegian Air Force's activities.

The Norwegian Safety Investigation Authority recommends that the Royal Norwegian Air Force conduct a survey to enable it to describe and understand the organisation's safety culture, both at command level and in operational units, as well as possible. Such a survey can establish a benchmark for subsequent safety work and efforts to improve the organisation's safety culture.

[57] The report, including any recommendations, shall be submitted to the Armed Forces and other relevant authorities for follow-up, cf. Section 5 of the Defence Accident Investigation Act and Section 14 of the Regulations relating to the investigation of accidents and incidents in the Norwegian Armed Forces.

Safety recommendation Defence no 2021/07T

The investigation into the near collision with the rocky island Mosken on 11 March 2020 involving a C-130J Hercules aircraft has shown that the Royal Norwegian Air Force's safety management, internal supervision and follow-up of the 335 squadron have been inadequate. The Royal Norwegian Air Force's leadership has failed to identified safety-related weaknesses in the 335 squadron. The Norwegian Safety Investigation Authority questions whether the Royal Norwegian Air Force is capable of identifying and remedying its own systemic safety issues, and believes that the investigation has identified a need for an external supervisory body.

The Norwegian Safety Investigation Authority recommends that the Ministry of Defence establish an independent and comprehensive military aviation authority (supervisory authority). This aviation authority must be allocated new resources and not be established at the expense of the Royal Norwegian Air Force's existing activities.

The Norwegian Safety Investigation Authority

Lillestrøm, 16 April 2021

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APPENDICES (NORWEGIAN ONLY)

Appendix A: Abbreviations

Appendix B: Sikkerhetstilrådinger etter Kebnekaise-ulykken 15. mars 2012 og Luftforsvarets oppfølging

Appendix C: Tilrådinger med begrunnelser fra forsvarsintern undersøkelsesrapport og sjef Luftforsvarets føringer

Appendix D: Redegjørelse fra FOH vedrørende oppdrag til 335 skvadron

Appendix A: Abbreviations

AGL	Above Ground Level
ATO	Air Tasking Order
BML	Regulation on military aviation
AOB	Angle of bank
AOD	Air Operations Directive
CFIT	Controlled flight into terrain
COMAO	Composite Air Operations
CRC	Control and Reporting Centre
CRM	Crew Resource Management
CR20	Cold Response 2020
CVR	Cockpit Voice Recorder
DFDR	Digital Flight Data Recorder
DETCO	Detachment Commander
EMAR	European Military Airworthiness Requirements
FMI	The Institute of Aviation Medicine
FOV	Field of view
FTI	The RNoAF Flight Safety Inspectorate
GCAS	Ground Collision Avoidance System
GIL	Formerly Inspector General of the RNoAF, now Chief of the RNoAF
GPS	Global Positioning System
HDD	Head Down Display
HUD	Head Up Display
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
LM	Loadmaster
LOI	Air Operations Inspectorate
MG 31	Mustang 31 – formation leader
MG 32	Mustang 32 – second aircraft in the formation
MGM	Monopulse Ground Map
MS	Mission Support
NAOC	Norwegian Air Operations Centre
NATCON	Norwegian Air Traffic Control System
NORKOM	A delegation from the NJHQ, assisted the Swedish SHK in the Kebnekaise investigation

NORTAD	Norwegian Tactical Airlift Detachment
NVIS	Night Vision Imaging System
NJHQ	The Norwegian Armed Forces' Joint Head Quarters
NSIA	Norwegian Safety Investigation Authority
NVG	Night Vision Googles
ORM	Operational Risk Management
OT&E	Operational Testing & Evaluation
PAQS	Personnel and Qualification Status
PM	Pilot monitoring
PF	Pilot flying
PFD	Primary Flight Display
RML	Military airworthiness rules
RMM	Removable Memory Module
RNoAF	The Royal Norwegian Air Force
SMS	Safety Management System
SOF	Supervisor of Flying
STEP	Sequantial Timed Events Plotting
Swedish SHK	Swedish Accident Investigation Authority
TACEVAL/NATEVAL	Tactical evaluation / National evaluation
TAWS	Terrain Awareness and Warning System
TIZ	Traffic information zone
VFR	Visual Flight Rules

Vedlegg B: Sikkerhetstilrådinger etter Kebnekaise-ulykken 15. mars 2012 og Luftforsvarets oppfølging

Tabellen på de neste sidene er basert på følgende kilder:

[1] Skriv fra Luftforsvaret til svensk SHK «*Luftforsvarets tiltak etter C-130 ulykken i mars 2012»,* 18. februar 2014

[2] Skriv fra svensk SHK til Luftforsvaret *«Norska Luftforsvarets svar på SHK:s rekommendationer RM 2013:02 R1-R4*», 23. mai 2014

[3] Skriv fra Luftforsvaret til svensk SHK «*Luftforsvarets tiltak etter C-130 ulykken i mars 2012 – Tilsvar»,* 11. september 2014

[4] Redegjørelse fra Luftforsvaret *«Operativ flygeplan – hvorfor gikk Luftforsvaret bort fra kravet om å føre dette.»*

[5] Skriv fra Luftforsvaret til Forsvarsstaben *«Oppfølging av tiltak i Luftforsvaret – Kebnekaiseulykken»,* 14. september 2018

[6] Skriv fra LOI til Sjef LOI «*Oppfølging 335 skvadron – overføring kunnskap/rutiner ifm navigasjonsinformasjon»*, 21. januar 2014

[7] Hovedrapport fra Safetec til LOI *«Observasjonsstudie av CRM i 335-skvadron»,* 20. mai 2014

[8] Redegjørelse fra Luftforsvaret om status på bestemmelser/instrukser, mars 2018

Nr.	Utgiver	Sikkerhetstilråding/anbefaling	Luftforsvarets oppfølging og tiltak	Merknad SHK
1	**Svensk SHK**	Det norske Luftforsvaret anbefales å implementere rutiner som forhindrer at luftfartøy flys under den laveste sikre høyde eller flygenivå for strekningen under IFR flyginger (RM 2013:02 R1).	1. Luftforsvarets flygere og støttepersonell informert om årsaken til ulykken. [1] 2. Revidert BML (2013) presiserer at fartøysjefen til enhver tid er ansvarlig for terrengseparasjon. [1] 3. «Laveste sikre flygenivå» inkludert i sjekkliste for autorisering. [3] 4. Beregning av laveste sikre flygenivå, erstattet krav om operativ flygeplan i revidert BML (2017). [4]	
2	**Svensk SHK**	Det norske Luftforsvaret anbefales å sikre seg at flybesetninger har kunnskap og anvender rutiner som medfører at bakkekollisjonssystemet anvendes på en forsvarlig måte (RM 2013:02 R2).	5. 335 skvadron gått grundig gjennom systemene GCAS og TAWS for å øke forståelsen for virkemåte og begrensninger. [1] 6. Standard Operativ Procedures (SOP) endret slik at TAWS Tactical Mode kun blir benyttet under taktisk flyging i VMC forhold (kun ved visuell kontakt med terrenget under). [1] 7. Luftforsvaret arbeider videre med å få utviklet/anskaffet terrengdatabase for Tactical Mode nord av 60 grader. [1]	7. SHK har mottatt redegjørelse fra FMA vedrørende terrengdatabase for Tactical Mode.
3	**Svensk SHK**	Det norske Luftforsvaret anbefales å utrede nærmere, og om nødvendig iverksette tiltak, for å sikre at nåværende besetningskonfigurasjon på C130-J tar med alle aspekter i planleggingen og gjennomføringen av sikker flyging (RM 2013:02 R3).	8. LOI iverksatt studie for å avklare om navigatørens rolle og oppgaver er ivaretatt i nytt besetningskonsept: «*Preliminær rapport viser at navigatørens arbeidsoppgaver og ansvar i hovedsak er ivaretatt slik 335 skvadron opererer med C-130J i dag. Det ble identifisert avvik vedrørende ansvarsforhold og rutiner i planlegging/forberedelser av flyoppdrag. LOI har i samarbeid med skvadronen iverksatt tiltak for å lukke disse avvikene.*» [1] Avvikene som ble identifisert gikk på oppgaver og rutiner for Mission Support (MS) personell. [5] og [6]	8. SHK har ikke mottatt endelig rapport på studie for å avklare navigatørens rolle og oppgaver som skulle foreligge 31. mars 2014. [1] Det ble anbefalt å sette av mer tid og ressurser for å gjøre videre undersøkelser i henhold til liste satt opp i pkt. 1.3, med fokus på Jan Mayen og trans-atlantiske operasjoner. [1] SHK har ikke mottatt dokumentasjon på at dette ble gjennomført.

Nr.	Utgiver	Sikkerhetstilråding/anbefaling	Luftforsvarets oppfølging og tiltak	Merknad SHK
			9. Safetec observasjonsstudie av CRM i 335 skvadron. [1] og [7] «*LOI og 335 skvadron gikk sammen gjennom Safetec sine anbefalinger, og kom frem til hvilke som var relevante og hvordan disse skulle følges opp.*» [5] 10. Luftforsvaret vil vurdere antall og omfang av oppdragstyper C-130J systemet til enhver tid skal være trent på og klar til å gjennomføre. [1]	9. SHK har ikke mottatt dokumentasjon på hvordan de anbefalte tiltakene og funnene fra Safetecs studie ble fulgt opp. 10. SHK har ikke mottatt dokumentasjon på vurdering av oppdragstyper som skulle endelig besluttes ila april 2014.
4	**Svensk SHK**	Det norske Luftforsvaret anbefales å utarbeide tydelige regler, manualer og rutiner som gjør det lettere for flybesetninger å gjennomføre flyoperasjoner på en sikker måte (RM 2013:02 R4).	11. Revidert BML (2013) [1] 12. LOI iverksatt omfattende arbeid for å oppdatere bestemmelser og håndbøker. [1] 13. Arbeidet med revisjoner/oppdateringer av publikasjoner gjøres fortløpende. Endringer i BML gjort over flere revisjoner. [8] 14. Publikasjoner som omfatter operasjoner med C-130J oppdatert til et nivå som tilrettelegger for sikre operasjoner. [8]	
5	**NORKOM**	LF anbefales å gjennomføre «Operativ Test & Evaluering» (OT&E) ved innfasing av nye strukturelementer (fly, helikopter, UAS). Tilpasset bestemmelsesverk må etableres samtidig.	15. Revidert BML (2013) presiserer prosedyrer og ansvarsforhold rundt gjennomføring av OT&E. [1] 16. OT&E skal gjennomføres i perioden 2014-2015 i forbindelse med oppdatering av C-130J til Blokk 7 og 8. [1] 17. OT&E skal gjennomføres ved innfasing av nye redningshelikopter og kampfly. [1]	16. SHK har ikke mottatt dokumentasjon på gjennomført OT&E for oppdatering av C-130J.
6	**NORKOM**	LF anbefales å evaluere sitt utdannings-system for flyoperativ virksomhet.	18. Luftforsvaret iverksatte en evaluering av flyoperativ utdanning. [1] 19. Innholdet på kursene for etterutdanning av flygere og flybesetningsmedlemmer er justert og oppdatert. [1]	18. SHK har ikke mottatt dokumentasjon på evaluering av flyoperativ utdanning som skulle gjennomføres innen 2014.

Nr.	Utgiver	Sikkerhetstilråding/anbefaling	Luftforsvarets oppfølging og tiltak	Merknad SHK
7	**NORKOM**	LF anbefales å evaluere sin ledelses-struktur for å sikre at militær luftfartsmyndighet fullt ut ivaretas iht. Luftfartsloven og Bestemmelser for militær luftfart (BML).	20. Nasjonalt Luftoperasjonssenter (NAOC) ble opprettet 1. august 2014 og medfører en tydeligere faglig sammenheng mellom ledelsen av taktiske luftoperasjoner og GIL som militær luftfartsmyndighet. [1]	
8	**Sjef FOH**	Besetningskonseptet til C-130J blir evaluert[58].	8. LOI iverksatt studie for å avklare om navigatørens rolle og oppgaver er ivaretatt i nytt besetningskonsept: «*Preliminær rapport viser at navigatørens arbeidsoppgaver og ansvar i hovedsak er ivaretatt slik 335 skvadron opererer med C-130J i dag. Det ble identifisert avvik vedrørende ansvarsforhold og rutiner i planlegging/forberedelser av flyoppdrag. LOI har i samarbeid med skvadronen iverksatt tiltak for å lukke disse avvikene.*» [1] Avvikene som ble identifisert gikk på oppgaver og rutiner for Mission Support (MS) personell. [5] og [6]	8. SHK har ikke mottatt endelig rapport på studie for å avklare navigatørens rolle og oppgaver som skulle foreligge 31. mars 2014. [1] Det ble anbefalt å sette av mer tid og ressurser for å gjøre videre undersøkelser i henhold til liste satt opp i pkt. 1.3, med fokus på Jan Mayen og trans-atlantiske operasjoner. [1] SHK har ikke mottatt dokumentasjon på at dette ble gjennomført.
9	**Sjef FOH**	Luftforsvaret redegjør for planleggingsrutiner[59], CRM rutiner og treningsprogram (inkludert bakketreningsprogram og flysimulator) for 335 skvadron.	21. Standard Operating Procedures (SOP) for MS beskriver skvadronens planleggingsrutiner. «*Sist oppdatert 3. april 2018 og lukker etter Luftforsvarets vurderinger alle avvik rundt oppdragsforberedelser som ble identifisert av SHK/NORKOM.*» [5] 9. Safetec observasjonsstudie av CRM i 335 skvadron. [1] og [6] «*LOI og 335 skvadron gikk sammen gjennom Safetec sine anbefalinger, og kom frem til hvilke som var relevante og hvordan disse skulle følges opp.*» [5]	9. SHK har ikke mottatt konkret dokumentasjon på hvordan de anbefalte tiltakene og funnene fra Safetecs studie ble videre fulgt opp.

[58] «*SJ FOH anbefaler at oppdragsporteføljen til C-130J reduseres til kun å omfatte regulær transport av personell og last, ikke blir benyttet i internasjonale operasjoner og flyging inn i områder med høy trussel og at taktiske flydisipliner settes på hold, inntil denne vurderingen er gjennomført.*»
[59] I denne sammenheng bør man vurdere sivile arbeidsrutiner og se på virkefeltet til «Mission Support».

Nr.	Utgiver	Sikkerhetstilråding/anbefaling	Luftforsvarets oppfølging og tiltak	Merknad SHK
			10. Treningsprogram for C-130J flygere og lastemestere er beskrevet i RFL121(A) «Regulations for C-130J Hercules Aircrew Training». Sist revidert 6. juli 2017. [5]	
10	**Sjef FOH**	Forsvaret gjennomgår virkefelt og myndighet for flytryggingsorganisasjonen med tanke på justeringer basert på opplysninger som fremkommer i undersøkelsen (inkludert ved materiellanskaffelser).	22. «*Etter Luftforsvarets vurdering er flytryggingsorganisasjonens virkeområde i dag klart definert i tillegg til at organisasjonen er tilført ytterligere ressurser* [2015] *for å ivareta fagansvaret for fly- og bakketrygging på en tilfredsstillende måte. Ansvaret for å følge opp materiellanskaffelser og driftssetting av materiell ivaretas på en tilfredsstillende måte gjennom Luftforsvarets sikkerhetsstyringssystem.»* [5]	
11	**Sjef FOH**	Luftforsvaret gjennomgår sivile/militære regelverk med Luftfartstilsynet for å indentifisere eventuelle tvetydige forhold med referanse til rapportens drøfting av minimumshøyder.	23. «*BML har vært revidert tre ganger siden ulykken i 2012. Luftfartstilsynet har vært involvert i disse revisjonene. Luftforsvaret mener således at BML er godt synkronisert med sivile regler.»* [5] 24. Det var ikke diskrepans mellom sivilt og militært regelverk, men mellom svenske og internasjonalt (ICAO) regelverk når det gjelder uttrykket «*Lowest usable flightlevel*». Norske regler var og er i samsvar med ICAOs regler. *«Luftforsvaret mener derfor dette er et noe søkt argument for at vi gjennomgår sivilt/militært regelverk med Luftfartstilsynet*». [5]	

Vedlegg C: Tilrådinger med begrunnelser fra forsvarsintern undersøkelsesrapport, sjef Luftforsvarets føringer, status på iverksatte tiltak og videreutvikling av Luftforsvarets sikkerhetsarbeid

Tabell 1: Tilrådinger fra forsvarsintern undersøkelsesrapport, føringer fra SJ L og status på iverksatte tiltak. Kilde: Luftforsvaret

UGs tilrådinger	Føringer fra sjef Luftforsvaret	Status på iverksatte tiltak per 11. mars 2021
Tilråding 1 Oppdragsportefølje Undersøkelsen har vist at 335 skvadron har en bred og krevende oppdragsportefølje. Det fremstår som uklart om det eksisterer et tilstrekkelig samsvar mellom tilgjengelige ressurser og forventet oppdragsløsning, herunder både operative leveranser og styrkeproduksjon. Etter UGs vurdering bør Luftforsvarets ledelse (LFL), i dialog med 335 skvadron gjennomføre en helhetlig vurdering av oppdragsporteføljen til C-130J. Størrelse og innhold på porteføljen bør veies opp mot skvadronens forutsetninger og rammefaktorer. Dersom oppdragsporteføljen ikke er overkommelig, må det foretas prioriteringer. **1.** UG tilråder at LFL foretar en helhetlig evaluering av oppdragsporteføljen til C-130J.	SJ L støtter UGs tilråding og ber sjef NAOC, koordinert med LOI og LST, om å evaluere, konkretisere og avstemme oppdragsportefølje til C-130J opp mot eksisterende ressursgrunnlag. *Frist: 01.09.2020* SJ L forutsetter også at Tilråding 1 Oppdragsportefølje gjennomføres for øvrige strukturelementer i Luftforsvaret.	Som umiddelbare tiltak gjennomførte NAOC samtaler med 134 LV/335 skvadron for å legge en plan for høsten 2020 for å ivareta nødvendig trening og oppsetning for kommende oppdrag i utlandet (NORTADII for FN operasjonen MINUSMA). Det ble også lagt planer for å senke leveransekravene fra FOH for vanlige transportoppdrag høsten 2020 og vinter/vår 2021 slik at de var i balanse med eksisterende ressursgrunnlag. Det er også etablert kontinuerlige planleggingsmøter mellom NAOC og luftvingene, herunder 134 LV/335 skvadron, som har både 14 dagers og 4–6 ukers perspektiv for å sammenstille og koordinere mengde og nivå på trening og operasjoner mot faktisk ressursgrunnlag. Sjef Luftforsvaret presiserer at balansering mellom ambisjonsnivå og tilgjengelige ressurser er et kontinuerlig arbeid, og er hovedfokus i årlig oppdragsdialog oppover med FSJ og nedover med luftvingsjefene. Det er også hovedfokus i løpende planlegging og koordinering av Luftforsvarets operasjoner og styrkeproduksjonsaktiviterer gjennom NAOC mot FOH, og i prioriteringer og avstemming mot faktisk ressursgrunnlag gjenspeiles tydelig i ulike graderte ordre-produkter. Sjef Luftforsvaret anser tilrådingen og medfølgende oppdrag som lukket, men LF vil fortsette det kontinuerlig arbeid med å avstemme oppdrag mot eksisterende ressursgrunnlag for alle strukturelementer gjennom etablerte prosesser.

UGs tilrådinger	Føringer fra sjef Luftforsvaret	Status på iverksatte tiltak per 11. mars 2021
Tilråding 2 Kompetansestyring Undersøkelsen har vist at den eksisterende bemanningssituasjonen i Luftforsvaret, kombinert med Luftforsvarets ledelse (LFL) sin kompetansestyring, har medført at det i svært liten grad finnes personell med C-130J flygerkompetanse på sentralt nivå i Luftforsvarets organisasjon. Hverken LOI eller NAOC har personell med C-130J flygererfaring i sine staber. Mangelfull C-130J kompetanse på sentralt nivå svekker LFL sine forutsetninger for å identifisere og korrigere eventuell utrygg praksis som skvadronen selv ikke er oppmerksom på. Etter UGs vurdering bør LFL ta stilling til om kompetansestyringen i Luftforsvaret bør justeres for å sikre at personell med flyoperativ og flysystemspesifikk kompetanse tilføres fag- og operasjonssøyla. En slik justering vil trolig resultere i en reduksjon av skvadronens operative leveranser, i hvert fall på kort sikt. Hendelsen indikerer at en slik justering er nødvendig for å opprettholde et tilfredsstillende sikkerhetsnivå på 335 skvadron. **2.** UG tilråder at LFL kompetansestyrer nødvendig faglig flyoperativ kompetanse til nivåene over 335 skvadron for å utøve myndighet og ivareta ansvaret for ledelse og supervisjon. Tilsvarende bør samtidig vurderes for øvrige flyoperative skvadroner.	SJ L støtter UGs tilråding og ber STSJ/NK L påse at nødvendig C-130J fagkompetanse (flyger) tilføres LOI. *Frist: 01.09.2020* SJ L forutsetter også at Tilråding 2 Kompetansestyring gjennomføres for øvrige strukturelementer i Luftforsvaret.	Flyger med C-130J kompetanse er tilbeordret LOI og oppdraget er lukket.

UGs tilrådinger	Føringer fra sjef Luftforsvaret	Status på iverksatte tiltak per 11. mars 2021
Tilråding 3 Tilsyn og evaluering Undersøkelsen har vist at Luftforsvarets ledelse (LFL) uttrykker stor grad av tillitt til luftving- og skvadronssjefene. Samtidig kommuniserer LFL at de har en klar forventning om at de operative sjefene selv skal justere ambisjonsnivået for å sikre at man ikke går på akkord med safety eller vern. Tidligere erfaring tilsier derimot at LFL ikke kan anta at en operativ sjef eller avdeling på egen hånd skal være i stand til å identifisere sine egne utilstrekkeligheter. Dette underbygger behovet for at LFL etablerer og vedlikeholder gode kontrollrutiner som blant annet er egnet til å avdekke eventuell utrygg praksis (drift) ved skvadronen. Undersøkelsen har i tillegg vist at 335 skvadron ikke har vært gjenstand for en inspeksjon i regi av fagmyndigheten siden januar 2012. Andre tilsynsaktiviteter har også vært begrenset i lengre tid. Etter UGs vurdering bør LFL legge til rette for en tettere grad av oppfølging og kontroll av avdelingen. Dette bør inkludere tilsyn og evalueringer i regi av LFL, der supervisjon og aktiv tilstedeværelse på avdelingen vektlegges. **3.** UG tilråder at LFL foretar en vurdering av om eksisterende rutiner for oppfølging og kontroll av 335 skvadron er tilstrekkelig for å opprettholde et forsvarlig nivå innen både fag-, operasjons- og styringsdimensjonen.	SJ L støtter UGs tilråding og ber STSJ/NK L, koordinert med LOI og NAOC, vurdere om eksisterende rutiner for oppfølging og kontroll av 335 skvadron er tilstrekkelige innen både fag-, operasjons- og styringsdimensjonen. *Frist: 01.10.2020*	Etter omorganiseringen av LOI med virke fra august 2018 fikk LOI en mer tydelig rolle innenfor tilsyn og internkontroll med den luftmilitære virksomheten. I lys av dette har LOI utarbeidet en risikobasert tilsynsplan for 2021. I denne planen for 2021 fremkommer tilsyn med 335 skvadron, og hvor det er lagt opp til to tilsyn i 2021 (inspeksjon og verifikasjon). I operasjonsdimensjonen føres det ikke direkte kontroll med avdelingene. Samtidig vises det til redegjørelsen under Tilråding 1 med hensyn til avstemming av oppdragsportefølje for 335 skvadron mot eksisterende ressursgrunnlag, og etablerte prosesser for kontinuerlig avstemming av oppdrag mot eksisterende ressursgrunnlag for alle strukturelementer. LST har et overordnet styringsperspektiv mot luftvingene som underliggende budsjett- og resultatansvarlige (BRA) enheter. Oppfølging av alle BRA med underlagte skvadroner gjøres gjennom etablerte årlige oppdragsdialoger (styringsdialog), hvor ressurstilgang og -forbruk sett i forhold til oppdrag kontrolleres og avstemmes. Dette følges opp gjennom løpende dialog og faste rapporteringsrutiner i gjennomføringsåret. Hovedkontrollen ivaretas gjennom tertialvis sjefsinvolvert rapportering fra skvadron til luftving, via NAOC og til LST og videre til FST. Det bemerkes videre at Flytryggingsinspektoratet er en svært viktig multiplikator til alle tre nevnte dimensjoner gjennom halvårlig fly- og bakketryggingsrapportering fra alle skvadroner, luftvinger og skoler samt rådgiving til sjefer på alle nivå.

UGs tilrådinger	Føringer fra sjef Luftforsvaret	Status på iverksatte tiltak per 11. mars 2021
		Samlet sett vurderer sjef Luftforsvaret at eksisterende rutiner for oppfølging og kontroll av 335 skvadron og andre underlagte avdelinger er tilstrekkelig. Samtidig erkjennes behov for forbedring, og det pågående arbeidet med videreutvikling av sikkerhetsstyring og sikkerhetsledelse skal bidra til ytterligere styrket oppfølging og kontroll med underlagte avdelinger. Sjef Luftforsvaret anser tilrådingen og medfølgende oppdrag som lukket, men LF vil fortsette arbeidet med å styrke oppfølging og kontroll med Luftforsvarets avdelinger.
Tilråding 4 Regelverk Undersøkelsen har vist at regelverket knyttet til flyging etter visuelle flygeregler (VFR) i mørket er mangelfullt, særlig med hensyn til minimumskrav for værforhold og lysintensitet. Det er også behov for å tydeliggjøre hvilke regler som kommer til anvendelse dersom man skal fly VFR i mørket ute å følge en forhåndsplanlagt lavflygingsrute over terreng. Etter UGs vurdering bør regelverket for VFR-flyging i mørket kvalitetssikres og tydeliggjøres for å legge til rette for at flyging i mørket gjennomføres innenfor akseptable rammer. **4.** UG tilråder at LOI gjennomgår og tydeliggjør krav til flyging etter visuelle flyregler i mørket, med og uten NVG, i lav høyde.	SJ L støtter UGs tilråding og ber sjef LOI om å utbedre feil og mangler i regelverket forbundet med flygingen etter visuelle flygeregler i mørket, med og uten NVG, i lav høyde SJ L ber sjef LOI evaluere eksisterende regelverksstruktur for operativ virksomhet og avklare om den er tilstrekkelig transparent og oversiktlig, og ved behov iverksette tiltak for å sikre at flyoperativt personell har tilstrekkelige forutsetninger for å utøve operativ virksomhet innenfor regelverkets rammer. *Frist: 01.12.2020*	LFs regelverksstruktur er gjennomgått og vurdert. Sjef LOI mener at regelverket har en logisk oppbygning og ikke bør endres på. 335 skvadron har hatt særlig fokus på regelverk, og personellet er nå godt kjent med regelverk for operasjoner med C-130J. Sammen med LOI har 335 skvadron gjennomgått aktuelt sivilt regelverk, og utdrag fra sivilt regelverk har blitt operasjonalisert, gjengitt i Red Marker og inkludert i deler av bakketreningsprogrammet. I tillegg vil LOI, i samarbeid med skvadronen, fortløpende vurdere om det er hensiktsmessig å gjenta deler av sivilt regelverk i LFs eget regelverk for å gjøre det lettere tilgjengelig for personellet. Sjef Luftforsvaret anser tilrådingen og medfølgende oppdrag som lukket.

UGs tilrådinger	Føringer fra sjef Luftforsvaret	Status på iverksatte tiltak per 11. mars 2021
Tilråding 5 Press-kultur Undersøkelsen har vist at det eksisteres en grad av press-kultur ved 335-skvadron. Selv om en slik kultur kan være en styrke for avdelingen, kan den også utgjøre en fare dersom avdelingen ikke er tilstrekkelig oppmerksom på hvilke risikofaktorer en slik kultur medfører. Dersom en slik kultur får utvikle seg ukorrigert over tid vil den kunne påvirke flysikkerheten negativt. Etter UGs vurdering er det sannsynlig at en grad av press-kultur bidro til at man gjennomførte et komplekst og risikofylt oppdrag den 11. mars 2020, til tross for at besetningene hadde lav kontinuitet, begrenset utsjekk og mangelfull kjennskap til regelverket. Økt bevissthet omkring risikoen forbundet med en press-kultur, både på avdelings- og individnivå, vil trolig bidra til økt flysikkerhet ved at avdelingen i større grad gjøres oppmerksom på faren ved å «strekke strikken for langt». **5.** UG tilråder at 335 skvadron evaluerer og synliggjør i hvilken grad press-kulturen påvirker sikkerhetsnivået ved avdelingen, og at det på bakgrunn av evalueringen iverksettes hensiktsmessige tiltak for å ivareta sikkerheten.	SJ L støtter UGs tilråding og ber sjef 335 skvadron om å evaluere og håndtere risiko knyttet til press-kultur, samt gjennomføre intern kompetanseheving innen CRM og bruk av NVG. *Frist: 01.11.2020*	335 skvadron har gjennomført to læringsseminarer i etterkant av hendelsen. Første læringsseminar ble avholdt 8.–9. juni 2020. Hensikten med seminaret var å starte arbeidet rundt tilråding nummer 5 i rapporten, press-kultur. Nytt læringsseminar ble gjennomført 13.–14. oktober samme år, som del av en bakketreningsuke. Det ble avsatt en dag til gjennomføring av CRM utdanning og en dag med fokus rundt press-kultur og flytrygging. Det er erkjent at press-kultur eksisterer ved avdelingen. Samtidig vil det ta tid å avdekke og bli bevisst alle former for uttrykk av et slikt press eller aksept for press. Håndtering av press-kultur vil være en pågående prosess som skvadronen og LF må fortsette å sette fokus på. Sjef 335 skvadron valgte etter hendelsen å ikke gjennomføre/trene lavtflyging og droppoperasjoner med NVG. Bakgrunnen var at avdelingen trengte kompetanseheving før dette ble autorisert. Gjennomføring/trening på avgang og landing med NVG ble opprettholdt som normalt. 335 skvadron har gjennomført kompetanseheving knyttet til NVG operasjoner. Trening på alle elementer innen NVG-operasjoner vil først gjenopptas når avdelingen har opparbeidet seg tilstrekkelig kompetanse. Dette vil også være gjenstand for videre arbeid med oppdragsporteføljen til 335 skvadron. Sjef Luftforsvaret anser tilrådingen og vurdering ifm balansering av medfølgende oppdrag som lukket, men legger til grunn at bevisstgjøring og håndtering av press-kultur og kompetanseheving er en kontinuerlig prosess.

UGs tilrådinger	Føringer fra sjef Luftforsvaret	Status på iverksatte tiltak per 11. mars 2021
Tilråding 6 Fellesarenaer Undersøkelsen har vist at det i praksis eksisterer få fellesarenaer på 335 skvadron der personellet har anledning til å møtes i den hensikt å bidra til læring og kontinuerlig forbedring. Til tross for at skvadronen i lengre tid har forsøkt å prioritere tid til fellesarenaer, hender det ofte at et oppdrag eller annen aktivitet må prioriteres, noe som enten medfører kansellering av bakkedagen eller redusert tilstedeværelse. Problemstillingen knyttet til få fellesarenaer og konsekvensene av dette har også blitt adressert i en rekke tidligere undersøkelsesrapporter etter alvorlige hendelser og uhell med C-130J. Etter UGs vurdering har fraværet av et tilstrekkelig antall fellesarenaer over tid bidratt til å svekke skvadronens forutsetninger for å sikre læring og kontinuerlig forbedring. Samtidig ønsker UG å fremholde viktigheten av at personellet har fokus på å tilegne seg nødvendig teorikunnskap også utenom fellesarenaene. For å legge til rette for øke flysikkerhet bør fellesarenaer for erfaringsoverføring og læring, herunder bakketrening og bakkedager, gis nødvendig prioritet – en prioritet som tidvis vil få konsekvenser for evnen til å løse enkelte oppdrag. For å sikre nødvendig prioritet må slike arenaer forankres på ledelsesnivå i Luftforsvaret. **6.** UG tilråder at LFL legger til rette for at 335 skvadron gis tilstrekkelig forutsetninger for å fokusere på læring og kontinuerlig forbedring.	SJ L støtter UGs tilråding og ber sjef 335 skvadron om å utarbeide en plan for gjennomføring av fellesarenaer på skvadronen for å sikre læring og kontinuerlig forbedring. Sjef NAOC bes påse at skvadronen skjermes i tilstrekkelig grad slik at planen lar seg gjennomføre. *Frist: 01.09.2020*	Det ble ved to tilfeller gjennomført bakketreningsuke ved 335 skvadron høsten 2020. Sjef Luftforsvaret anser tilrådingen og medfølgende oppdrag som lukket, men legger til grunn at planlegging og nødvendig fellesarenaer for å sikre læring og erfaringsoverføring fortsetter.

UGs tilrådinger	Føringer fra sjef Luftforsvaret	Status på iverksatte tiltak per 11. mars 2021
Tilråding 7 Endring av prosedyre Undersøkelsen har vist at flyets håndbok inneholder en prosedyre for GCAS/TAWS PULL UP Alert Recovery. Denne prosedyren kommer blant annet til anvendelse dersom det oppstår et behov for å foreta en umiddelbar manøver for å unngå sammenstøt med terreng. Da Pilot Flying (PF) initierte manøveren for å unngå et sammenstøt med Mosken, ble throttle-håndtakene satt i «TAKEOFF power»-posisjon. Ettersom PF ikke frikoblet autothrottle-funksjonen, ble throttle-håndtakene automatisk trukket tilbake, noe som resulterte i redusert motorkraft. Eksisterende prosedyre omhandlet ikke frikobling av autothrottle. Etter UGs vurdering vil det være hensiktsmessig å revidere prosedyren GCAS/TAWS PULL UP Alert Recovery, slik at den også adresserer frikobling av autothrottle. • UG tilråder at Forsvarsmateriell Luftkapasiteter tar stilling til om frikobling av autothrottle bør adresseres som del av prosedyren i flyets håndbok for GCAS/TAWS PULL UP Alert Recovery.	SJ L støtter UGs tilråding og anmoder Forsvarsmateriell Luftkapasiteter om å fremsende endringsforslag tilknyttet alle «Recovery-prosedyrer» i flyets manual, CSTO NOIC-130J-1, der «Takeoff Power» benyttes. *Frist: 01.10.2020*	Oppdragets del 1: FMA har vært i dialog med Locheed Martin som har utarbeidet nye prosedyrer. Disse vil bli gjort gjeldende i de tekniske dokumentene fra april 2021. Oppdragets del 2 ble gjennomført rett etter at oppdraget ble gitt. Sjef Luftforsvaret anser tilrådingen og medfølgende oppdrag som lukket.

Tabell 2: Føringer fra SJ L for å følge opp tre andre forbedringsområder som var identifisert gjennom den forsvarsinterne undersøkelsen, samt status på iverksatte tiltak. Kilde: Luftforsvaret

Føringer fra sjef Luftforsvaret	**Status på iverksatte tiltak per 11. mars 2021**
Prosjekt operativ balanse og helhetlig læringskultur i Luftforsvaret SJ L peker på at forholdene som er avdekket av UG er relatert til utfordringer og svakheter som Luftforsvaret har jobbet målrettet med gjennom flere år, deriblant initiativer for å skape en bedre operativ balanse i skvadroner og batterier (prosjekt hjertemedisin). SJ L erkjenner videre at det er behov for å forsterke arbeidet for å sikre økt læring og bedre operativ balanse i virksomheten. Med bakgrunn i dette besluttet SJ L å ta prosjekt hjertemedisin et steg videre ved å etablere et eget prosjekt med arbeidstittelen operativ balanse og helhetlig læringskultur i Luftforsvaret: SJ L vil etablere et eget prosjekt som skal sikre bedre operativ balanse og bidra til en forbedret helhetlig læringskultur i Luftforsvaret. Det skal utnevnes en dedikert prosjektleder med et eget mandat skal være pådriver og samarbeide tett med ansvarlige sjefer i Luftforsvaret. *Frist: 01.08.2020*	Prosjekt er etablert med eget mandat og ledes av en oberst. Del I (1) handler om operativ balanse og er jobbet med gjennom høsten 2020. Resultatene er fulgt opp i oppdragsdialog for 2021 og tas videre i etablerte prosesser. Det jobbes med å utarbeide kvalitative mål for styrkeproduksjon og et forenklet evalueringssystem i Luftforsvaret. Del II (2) omfatter et program for utvikling av en helhetlig læringskultur i LF og er delt i to faser: Fase 1 er en videreføring av «prosjekt hjertemedisin» som ble startet i 2018 og har særlig fokus på hvordan LF kan sørge for bedre forutsetninger for utøvelse av sjefsrollen på skvadrons- og batterinivå. Fase 2 handler om å utarbeide forslag til et program for videreutvikling av styrket læringskultur i LF, med søkelys på militært lederskap, profesjonsidentitet og mestringskultur. Prosjektet er pågående.
Crew Resource Management (CRM) Basert på funn og observasjoner i flere undersøkelsesrapporter, har SJ L besluttet å etablere et eget utdannings- og treningsprogram for CRM i Luftforsvaret: SJ L ber sjef LOI, koordinert med Sjef LS og sjef FMI, om å utvikle et eget grunnutdannings- og treningsprogram for CRM tilpasset Luftforsvarets flyoperative avdelinger. *Frist: 01.12.2020*	Det er utviklet et grunnleggende CRM kurs for flybesetninger og Mission Support-personell. Det første CRM-kurset ble gjennomført i forbindelse med introduksjonskurs for nye flybesetninger ved LFTS 10.–11. november 2020. Sjef Luftforsvaret anser oppdraget som lukket. Se for øvrig beskrivelsen om Luftforsvarets arbeid med videreutvikling av CRM.

Terrain Awareness and Warning System (TAWS) Med bakgrunn i innspill fra FMA LU vedrørende bruken av TAWS og med hensyn til den nylige implementeringen av en taktisk database, har SJ L besluttet følgende: SJ L ber sjef LOI kvalitetssikre at flybesetninger på C-130J har tilstrekkelig kunnskap og rutiner for å sikre at det taktiske bakkekollisjonssystemet anvendes på en forsvarlig måte. *Frist: 01.09.2020*	Handlemåten for hvordan flybesetningen skal reagere når bakkekollisjonssystemet aktiveres er godt beskrevet i flyet håndbok (*CSTO NO1C-130J-1, change 2*) og i *121-50 C-130J Hercules Standard Operating Procedures (SOP)*. Det har derimot ikke vært tydelig beskrevet i hvilken modus bakkekollisjonssystemet skulle brukes. Den 10. oktober 2020 ble det gitt ut en «Red Marker» (RM 20-20) ved 335 skvadron som gir føringer for hvilken modus som skal brukes. Føringene dekker bruk av GCAS/TAWS ved lavtflyging og flyging i mørke. Kombinasjonen av bakketreningsprogrammet, fornyet fokus på bakkekollisjonssystemet under simulator trening og en RM med tydelige retningslinjer gjør LOI trygge på at personellet ved 335 skvadron kan benytte det taktiske bakkekollisjonssystemet på en forsvarlig måte.

Tabell 3: Luftforsvarets videreutvikling av CRM og sikkerhetsstyring/-ledelse. Kilde: Luftforsvaret

Luftforsvarets arbeid med videreutvikling av CRM Luftforsvaret har erkjent et større behov for helhetlig, systematisk og strukturert CRM-opplæring på de operative avdelingene. Sjef Luftforsvaret har derfor gitt et nytt oppdrag om en dypere tilnærming til CRM i Luftforsvaret. Intensjonen er å minimere uønskede hendelser og unngå ulykker med luftfartøy, samt bidra til en styrket læringskultur i LF. Målsettingene gitt i oppdraget er å: • Definere LF fremtidige kompetansenivå på CRM. • Kartlegge nåsituasjonen på CRM. • Planlegge hvordan tette gapet mellom nåsituasjon og ønsket sluttilstand. Denne planen skal ferdigstilles og iverksettes innen 1. mars 2022. Sluttilstand er nådd når CRM er fullt implementert i LF slik at det gjennomsyrer vår utøvelse av luftmakt på en helhetlig, systematisk og strukturert måte, og fører til effektive luftoperasjoner med en sikker gjennomføring i fred, krise og krig. Det bør gjennomføres en evaluering av resultatet av gjennomføringen etter to år.
Luftforsvarets arbeid med videreutvikling av sikkerhetsstyring og sikkerhetsledelse LF vil kort redegjøre for status i pågående arbeid med videreutvikling av sikkerhetsstyring og sikkerhetsledelse i Luftforsvaret. Dette arbeidet ble iverksatt før Mosken-hendelsen. Arbeidet var basert på egen erkjennelse av at Luftforsvaret ikke har et tilfredsstillende nivå på egen sikkerhetsstyring. Hensikten var å utrede hvordan LFL kunne få på plass et nytt rammeverk for et sikkerhetsstyringssystem, med gode og hensiktsmessige prosesser. Det var også en uttalt ambisjon at sikkerhetsstyringssystemet skulle bidra til enklere og bedre sikkerhetsstyring for lederne, gjennom tydeliggjøring, forenkling og ressurseffektivisering. I mandatet, som ble godkjent 2. mars 2020, står det blant annet at arbeidsgruppen skal levere en rapport som inneholder følgende: • Forslag til et nytt rammeverk for en ny sikkerhetsstyringsmodell • En beskrivelse av forholdet mellom styring, kontroll og sikkerhetsstyring • En beskrivelse av prosesser relatert til Luftforsvarets kontinuerlige forbedring av sikkerheten. • Forslag til ny organisering av sikkerhetsarbeidet i Luftforsvaret, både på DIF- og BRA-nivå • Forslag til rutiner og systemer for hendelses-/avviksrapportering og –håndtering • Forslag til struktur for regelverk (bestemmelser, instrukser og prosedyrer m.v.), herunder mal for Handlingsplan og Ledelsens gjennomgang for alle sikkerhetsområder. Arbeidsgruppen har utarbeidet en grundig rapport som ble sendt på høring 19. november 2020 og ble fremlagt for sjef Luftforsvaret 20. januar 2021.

LF tar arbeidet med kontinuerlig forbedring av sikkerheten på største alvor. Sjef Luftforsvaret har gitt ytterligere oppdrag i egen organisasjon for videre arbeid med sikkerhetsstyring og sikkerhetsledelse i Luftforsvaret med korte tidsfrister, herunder;

- Organisering av sikkerhetsområdene innen helhetlig sikkerhetsstyringen i følgende hovedområder; Luftmilitær virksomhet, HMS og Security.
- Vurdering og tiltak for å sikre et tydeligere skille mellom luftfartsmyndigheten og fagmyndighet for luftmilitær virksomhet, herunder presisering av tilsyn vs. internkontroll.
- Vurdering av om ICAO Safety Management System som sikkerhetsstyringssystem følges i tilstrekkelig grad og hvilke avvik som eventuelt bør lukkes.
- Vurdering av organisatorisk plassering og innretting av en tydeligere adskilt MLFM internt i Luftforsvaret. Sjef Luftforsvaret ønsker ikke konkludere endelig oppheng av MLFM innenfor eller utenfor Luftforsvaret på nåværende tidspunkt, men vil avvente grundig vurdering av luftfart innenfor rammen av FD-ledet utredning om helhetlig tilsynsmyndighet i sektoren. Luftforsvaret vil bidra i dette arbeidet.
- Konkretisering/klargjøring av FTIs rolle og integrering i sikkerhetsstyringen.
- Utrede og anbefale organisering av en sikkerhetsavdeling/seksjon i LST.
- Utvikle en handlingsplan for videreutvikling av sikkerhetsstyring og sikkerhetsledelse i Luftforsvaret.

Sjef Luftforsvarets legger merket til at SHK i punkt 2.8.4 advarer mot en eventuell svekkelse av sikkerhetsarbeidet innenfor kjernevirksomheten som er flyoperasjoner. Hun kan forsikre om at hennes hovedfokus i det videre arbeidet med sikkerhetsstyring og sikkerhetsledelse vil være innenfor den luftmilitære virksomheten som omfatter både operativ- og materiellsikkerhet. Det pågående arbeidet vil være fokusert på etterfølgelse av SHKs sikkerhetstilråding om å forbedre våre prosesser for risikostyring. Det er også behov for forbedringer i systematisk arbeid innen de øvrige sikkerhetsområdene (HMS, forebyggende sikkerhet, miljø og GDPR) som vil bli ivaretatt i
videre arbeid.

Vedlegg D: Redegjørelse fra FOH vedrørende oppdrag til 335 skvadron

Spørsmål fra SHK med svar fra Forsvarets operative hovedkvarter (FOH) gjengis nedenfor:

1. I hvilken grad er den avdelingen som programmerer OIR-oppdragene til 335 klar over skvadronens utfordringer med få flybesetninger?

Svar FOH:

Forsvarets Operative Hovedkvarter (FOH) har god oversikt over de utfordringer 335 skvadronen har, både mht. skrogtilgang og flybesetninger gjennom kontinuerlig dialog med Norwegian Air Operations Centre (NAOC). Overordnet intensjon fra FOH sitt ståsted er derfor å skape forutsigbarhet og en lang planhorisont på de operative leveransene C-130J bidrar i, slik at Luftforsvaret har best mulige forutsetninger for å kunne planlegge egentrening og utsjekksflyvninger for de oppgavene som er definert i operative krav fra forsvarssjefen (FSJ). I tillegg for å skape forutsigbarhet knyttet til planlagt vedlikehold og tilgjengelighet på skrog.

For OIR oppdragene søker FOH derfor å ha en planhorisont på 6 måneder, hvor Luftforsvaret får mulighet til å komme med sine innspill før en oppdragsordre blir utstedt.

Med en svært begrenset flytransportkapasitet i Forsvaret er det utfordrende å balansere operative leveranser med tilstrekkelig tid for egentrening og utsjekksflyvninger, og det er derfor helt essensielt at FOH, gjennom dialog med NAOC, får kontinuerlig oppdatering på status i Luftforsvarets avdelinger.

2. Hvilke kriterier legges til grunn når viktigheten av disse oppdragene skal vektes?

Svar FOH:

En tidsriktig og forutsigbar understøttelse av norske styrkebidrag til internasjonale operasjoner er svært viktig for Sjef FOH. OIR-oppdragene har derfor en høy prioritet ift andre nasjonale oppdrag. Samtidig finnes det andre transportløsninger, både militært og sivilt, som søkes utnyttet i stor grad for å frakte personell og materiell ned til operasjonsområdet for norske OIR bidrag. Det er utfordrende å få sivile flyselskap til å fly til de destinasjonene vi nytter i operasjonsområdet for OIR grunnet sikkerhetssituasjonen i området. Transportløsninger gjennom NATO og bi-laterale/flernasjonale avtaler er en opsjon som søkes utnyttet til det fulle.

Allikevel oppstår det et delta som må dekkes med egne kapasiteter, både for rotasjon av styrkebidrag og etterforsyning av materiell og forsyninger. Oppdragene Sjef FOH løser er på bakgrunn av oppdrag gitt i Langtidsplanen for Forsvaret (LTP).

3. I hvilken grad vil skvadronen bli hørt dersom den melder fra at et planlagt OIR-oppdrag ikke bør gjennomføres av ulike grunner?

Svar FOH:

Planleggingen av OIR oppdragene starter med at det fremmes et operativt behov fra Nasjonalt Støtteelement (NSE) i operasjonsområdet. Basert på behovene som fremmes, starter FOH sin planlegging av oppdragene for de kommende 6 måneder. Luftforsvaret v/NAOC er involvert i planleggingen fra starten av, som en viktig premissleverandør for hvilke oppdrag Luftforsvaret kan bidra i med C-130J. Sjef NOAC ivaretar den direkte koordineringen med Luftvingen, som har C-130J i sin portefølje, og melder tilbake hvilke uker 335 skvadronen kan understøtte.

Grunnholdningen til FOH er å forsøke å skjerme 134lv/335skv for oppdrag så mye som mulig gjennom bruk av sivile eller allierte ressurser.

Der det oppstår et transportbehov som verken kan løses med C-130J eller andre sivile/militære transportløsninger vil det være opp til ledelsen i FOH å ta en avgjørelse på om oppdraget skal gjennomføres eller ikke.

FOH gjennomfører et transportsyndikat annenhver uke, hvor Luftforsvaret har mulighet til å komme med innspill til de oppdragene som er gitt i kommende periode. Dersom det oppstår behov for å gjøre endringer ift. planlagte oppdrag, søker FOH å finne alternative transportløsninger for det aktuelle oppdraget.