AVIATION SAFETY INVESTIGATION REPORT

6th Aviation Regiment – NHIndustries MRH-90 Taipan A40-040, Spatial Disorientation leading to Controlled Flight Into Terrain (CFIT), Whitsunday Islands, QLD, 28 July 2023.

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Defence acknowledges the Traditional Custodians of Country throughout Australia. Defence recognises their continuing connection to traditional lands and waters and would like to pay respect to their Elders both past and present.

Defence would also like to pay respect to the Aboriginal and Torres Strait Islander people who have contributed to the defence of Australia in times of peace and war.

Defence has authorised the release of this Aviation Safety Investigation Report with certain personal, commercial-in-confidence, international partner and operationally sensitive information removed from the body of the report due to its security classification. Additionally, four enclosures are not available to the public due to sensitive material related to medical-in-confidence information and personal privacy.

ISBN: 978-0-9874958-0-8 (print)

ISBN: 978-0-9874958-1-5 (online)

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MANDATE OF THE DEFENCE FLIGHT SAFETY BUREAU

Joint Directive 21/2021, The Defence Aviation Safety Framework, requires the Defence Aviation Authority (Defence AA) to establish an accident and incident investigative capability. A key objective of the Defence Aviation Safety Program (DASP) is the independent investigation of accidents and incidents in order to prevent recurrence and improve safety performance. Furthermore, a key principle of the DASP is that recommendations from aviation accident investigations are to be acted upon as a matter of urgency in order to assure confidence in Defence Aviation safety management.

In accordance with international convention, the Defence Flight Safety Bureau (DFSB) has been established to independently investigate all Defence Aviation accidents, select incidents of serious and or complex nature, and select systemic safety issues. DFSB is functionally independent of authorities responsible for Defence Aviation regulation, and in general, any other party or entity that could conflict with, or influence, its objectivity.

Director DFSB is accorded independent powers to approve an investigation and establish an Aviation Safety Investigation Team (ASIT), informing the Defence AA and the applicable Environmental Commander. The ASIT conducts investigations under the authority of the Director of the DFSB as the Officer-in-Charge and under the procedural control of the Investigator-in-Charge. DFSB investigations are conducted in line with international standards and recommended practices outlined in Annex 13 (Aviation Accident and Incident Investigation) and Annex 19 (Safety Management) to the Convention on International Civil Aviation (ICAO), and ICAO Document 9756 (Manual of Aircraft Accident and Incident Investigation). Given the unique nature and demands of military flying, DFSB investigations may vary from these standards and practices based upon the nature and circumstances of the event, the complexity of the investigation and anticipated safety outcomes.

The objective of investigations is to identify and reduce safety-related risk. Investigations follow a structured process to gather information and evidence, determine the sequence of events, determine what active failures occurred, analyse how and why those active failures occurred, and compile findings. Investigations seek to identify the systemic factors that contributed to the event to enable appropriate and effective recommendations designed to improve the safety system. Safety actions and recommendations focus on the implementation (or improvement) of controls that will eliminate or minimise safety hazards and prevent re-occurrence of the event. Safety actions and recommendations may also be made against evidence of sub-optimal practices, even if not contributory to the event, in order to further enhance safety programs.

Safety actions and recommendations will not recommend disciplinary or administrative action against individuals, and as such, this report and the evidence obtained during the investigation is not intended to be used in punitive proceedings against individuals. Where safety actions were deemed necessary before the investigation or report are complete, relevant authorities will be informed of the immediate action required in order to decide whether such action is appropriate and should be implemented accordingly.

This Aviation Safety Investigation Report (ASIR) was prepared for the Defence AA, Director General of the Defence Aviation Safety Authority, Chief of Army and Commander Aviation Command. The ASIR should not be released to agencies external to Defence without obtaining prior approval from the Director of the DFSB.

6TH AVIATION REGIMENT – NHINDUSTRIES MRH-90 TAIPAN A40-040, SPATIAL DISORIENTATION LEADING TO CONTROLLED FLIGHT INTO TERRAIN (CFIT), WHITSUNDAY ISLANDS, QLD, 28 JULY 2023.

EXECUTIVE SUMMARY

1. On the night of 28 July 2023, a forward-deployed element of 6th Aviation Regiment (6 Avn Regt), operating from Proserpine Airport, Queensland, was tasked with conducting a night extraction of Ground Force Elements (GFE) from Lindeman Island, Queensland, as part of Exercise TALISMAN SABRE 2023 (Ex TS23). The mission involved a formation of four MRH-90 (Multi-Role Helicopter) Taipan aircraft: callsigns Bushman (BSMN) 81, 82, 83 and 84. BSMN 83, the accident aircraft, was the third aircraft in the formation. At 2236 local (K), 22 minutes into the mission, BSMN 83 crashed into the water near Lindeman Island. All four crew were fatally injured.

2. 6 Avn Regt is the Special Operations Regiment of 16 Aviation Brigade (16 Avn Bde). It provides mobility and assault support to special operations. 16 Avn Bde is a subordinate formation to Headquarters Aviation Command (HQ AVNCOMD), responsible to raise, train and sustain Army Aviation units. Commander AVNCOMD is the Military Air Operator- Accountable Manager (MAO-AM) for Army Aviation.

3. The MRH-90 is the Australian variant of the NHIndustries NH-90. The aircraft is a medium lift, twin-turbine engine, conventional helicopter designed to transport troops and cargo by day and/or night, in visual, instrument and Degraded Visual Environments (DVE). The accident aircraft was tail number A40-040, and was configured for overwater and Helicopter Insertion and Extraction Techniques at the time of the accident.

4. As the ADF's independent aviation accident investigation organisation, the Defence Flight Safety Bureau (DFSB) was responsible for the safety investigation into the accident. The Aviation Safety Investigation Team (ASIT) re-created the event sequence, primarily through the on-board Voice and Flight Data Recorder (VFDR) evidence and witness interviews. The ASIT used the Defence Aviation Safety Analysis Model (DSAM) to identify the individual or team actions, and contributing factors including local conditions, absent and failed risk controls, and organisational influences.

5. Examination of the wreckage of MRH-90 Taipan A40-040 did not identify any pre-existing damage to the airframe and major systems, nor any malfunctions of major systems throughout the flight, or prior to impact with water. The technical investigation concluded that the aircraft impacted the water on the front left-hand side of the airframe in a nose-down and left-wing-low attitude. The ASIT concluded that the aircraft's major systems such as engines, gearboxes, main and tail rotor transmissions, and flight controls were operating normally and were serviceable throughout the flight and at impact with the water.

6. The ASIT was supported during the immediate investigation activities and analysis by a number of organisations and subject matter experts. DFSB would like to formally acknowledge the support and expertise of these individuals and organisations, without which the investigation would not have been as thorough.

7. DFSB would also like to acknowledge the professionalism, openness and honesty of the members of 6 Avn Regt, and Army AVNCOMD during the conduct of this investigation. Without the voluntary disclosure of information and evidence, in accordance with Defence Aviation's 'generative safety culture', the identification of key systemic issues, and the development of effective safety recommendations would not have been possible.

The accident and primary cause

8. At approximately 2214K on 28 Jul 23, BSMN 83 departed Proserpine Airport as the third aircraft in a formation of four MRH-90 Taipan helicopters. The four BSMN aircraft were flying in a heavy left formation using Night Vision Devices (NVDs) in preparation for an extraction of GFE. As per the Flight Authorisation Brief, cabin doors on all formation aircraft were closed from departure at Proserpine Airport and were to be opened by the aircrewmen (ACMN) as the formation progressed from the holding pattern through the Initial Point (IP) in preparation for the approach into the Landing Zone (LZ).

9. The Co-pilot (CP) of BSMN 83 occupied the left-hand cockpit seat and flew the aircraft from departure and for the majority of the transit to the holding pattern, which required the CP to fly cross-cockpit in the heavy left formation. At 2233:34K, the Aircraft Captain (AC), who was the Non-Flying Pilot (NFP), took control of the aircraft from the CP as the formation passed through a rain shower and commenced a descent into the holding pattern near the IP. The investigation found that the AC's decision to take control of the aircraft was likely in response to recognising that the CP was facing challenges to maintain formation in the varying weather and illumination conditions. It is likely the AC intended to mentor the CP and reposition the aircraft into the correct formation position prior to handing control of the aircraft back to the CP. However, the AC retained control of the aircraft due to the challenging flying conditions.

10. At 2234:13K, the formation entered the holding pattern in the vicinity of the IP while awaiting direction from the GFE to commence the extraction from the LZ. Although a right- hand holding pattern was briefed in Mission Orders, BSMN 81 announced and entered a left- hand holding pattern in order to avoid rain showers between and to the north of the IP and the LZ.

11. The investigation found that visibility ahead of BSMN 83's flight path in the holding pattern was variable and likely degraded. During the second turn in the holding pattern, and very likely without a discernible horizon, BSMN 83 started to climb above the datum altitude of the formation (approximately 200 ft above the water). Within a period of 14 seconds, BSMN 83 climbed from 224 ft to a maximum height of 362 ft. Of note, the AC's (FP) flying technique to adjust and maintain formation position on BSMN 82 resulted in frequent overriding (dis-engagement and re-engagement) of the aircraft's Automatic Flight Control System (AFCS) Radar Height (RHT) hold. The investigation found that it was virtually certain the RHT hold was overridden allowing the aircraft to climb.

12. During the climb, BSMN 83's formation position also moved progressively towards a trail position on BSMN 82, which likely reduced the AC's (FP) ability to scan to BSMN 81 to assess their formation position. With the cabin doors closed, the ACMN of BSMN 83 had restricted visibility to the other formation aircraft, which limited their ability to contribute effectively to the pilots' Situation Awareness. Through analysis of flight data modelling, and crew commentary, the investigation found that the actual distance of BSMN 83 to BSMN 82 was significantly further than the AC's (FP) visual assessment. Misperception of distance to BSMN 82, combined with varying contrast and illumination conditions, and the limitations associated with using NVDs as the primary visual reference, more than likely degraded the AC's (FP) ability to differentiate individual reference features and cues to maintain formation position.

13. Analysis of cockpit voice recordings revealed that there were no intra-aircraft or inter-formation crew communications for the period of the climb. There was no evidence of any other mission-related issue, secondary task or distracting stimulus that may have diverted the attention of BSMN 83's pilots from maintaining the aircraft's position within the formation. In the absence of other reasonable scenarios, the investigation concluded that the inadvertent and unrecognised climb of BSMN 83 was attributable to both the AC (FP) and CP (NFP) experiencing a loss of Spatial Orientation – commonly referred to as Type I (Unrecognised) Spatial Disorientation (SD). Therefore, the progressive change in aircraft pitch attitude from 5.8 degrees nose-up to 4.7 degrees nose-down as the aircraft climbed, and the increase in airspeed from 77 Knots Indicated Airspeed (KIAS) to 109 KIAS, was more than likely not recognised by both pilots.

14. At 2236:13K, the CP (NFP) stated, 'Have you still got [em]' and the AC (FP) calmly responded, 'Yeah, still got [em] mate.' It is extremely likely that the CP's (NFP) question coincided with their loss of visual sight of BSMN 82. Through modelling of cockpit Field of Views, the investigation found that the AC (FP) almost certainly lost visual sight of BSMN 82 immediately after responding to the CP (NFP) as BSMN 82 disappeared under the nose of BSMN 83.

15. At 2236:15K, the AC (FP) rolled the aircraft quickly to the right to 31 degrees Angle of Bank (AoB) before rolling back quickly to 8 degrees left AoB. The investigation found the rolling manoeuvres were likely an attempt by the AC (FP) to regain visual sight of BSMN 82.

16. At 2236:19K, without recognising that the aircraft's pitch attitude was lowering and the airspeed was increasing, the AC (FP) applied a large forward longitudinal cyclic input at, or near, the forward stop of the cyclic's range of movement. It is likely that the AC (FP) perceived that the aircraft had not yet transitioned from a pitch-up attitude to pitch-down attitude. However, the rapid and continual application of forward cyclic pitched the aircraft's nose further down, which combined with a lack of recognition of the aircraft's increasing airspeed, resulted in a very high and unrecoverable rate of descent towards the water.

17. During the 2.5 seconds after the AC's (FP) pushover, the relative distance between BSMN 83 and BSMN 82 closed rapidly from approximately 100 metres to 50 metres, with BSMN 83 passing closely to the right of, and below BSMN 82 with right AoB. It is more than likely that the AC (FP) regained visual sight of BSMN 82 at some point after the pushover, and it is likely that the AC held cyclic input to the right to avoid a mid-air collision with BSMN 82. The AC (FP) held forward cyclic input throughout the descent, and while under control of the AC, BSMN 83 impacted the water, destroying the aircraft and fatally injuring the four crew.

18. To the extent by which the ASIT could examine the wreckage and analyse the VFDR, there was no evidence of technical failure of the aircraft or major systems. Therefore, on the basis of evidence analysed by the ASIT, the most plausible cause of the accident was Type I (Unrecognised) SD leading to Controlled Flight Into Terrain (CFIT).

19. As is the case with the majority of aircraft accidents, the investigation found that the accident was the result of a combination of contributing factors. These included the local conditions influencing the performance of the AC and CP of BSMN 83, limitations in some of the organisation's risk controls, organisational influences that affected the functioning of AVNCOMD's safety system, and external influences arising from Defence Aviation regulatory requirements and assurance processes. In addition, the investigation identified other factors that held the potential to increase safety risk.

Local conditions

20. Local conditions are those conditions that exist in the immediate context or environment, which can have an influence on individual/team actions or technical failures. The investigation found a number of local conditions, spanning the use of aircraft systems, nature of the task, environmental conditions and human performance limitations, which in combination contributed to the accident. These are summarised below:

21. **Weather and illumination.** The investigation found that the forecast weather (cloud base and visibility) and illumination levels were within authorised limits for the mission. However, visibility was degraded at times due to localised showers, which influenced BSMN 81's decision to conduct a left-hand, vice the briefed right-hand, holding pattern. As a result of the left turn in heavy left formation, it is likely that the pilots of BSMN 83 experienced an increase in workload to maintain position. As BSMN 83 exited the final left turn, it is very likely the horizon was not discernible in the sector BSMN 83's pilots were looking, in order to maintain station. It is very likely that rain showers and low cloud-base reduced celestial illumination and the visual contrast through NVD, which impeded visual references and cues used to maintain formation on preceding aircraft.

22. **Workspace environment.** The MRH-90 cockpit is a visually restricted environment due to the windscreen pillar, the large cockpit coaming and the overhead console. The investigation found that restricted visibility towards BSMN 82 and BSMN 81 increased pilot workload, particularly when BSMN 83's CP was flying cross-cockpit in the heavy left formation position.

23. **Station-keeping technique and use of RHT hold in formation flying.** The investigation found that it is common practice for ADF MRH-90 pilots to adjust and maintain position during low level, formation, flight over water using NVDs, by depressing the collective trigger switch, manoeuvring the aircraft into the correct position, and releasing the trigger. This technique results in frequent overriding of the RHT hold function of the AFCS, which increases the likelihood of introducing human error. This removes an organisational risk control designed to reduce pilot workload and prevent the aircraft descending below a pre-determined datum height when conducting low level, flight over water at night or in degraded visual environments.

24. **Instrument scan.** Night-aided formation flying requires a disciplined technique, scan and work cycle to integrate instruments and aircraft performance information, while also maintaining visual/lighting references and assessing spacing and closure. This is critical in degraded visual environments where maintaining Spatial Orientation with respect to the horizon, terrain and formation position is increasingly difficult. The investigation identified that Army Aviation Orders, Instructions and Procedures (OIP) and flying training provided varied and non-standardised references to the integration of instrument scans within formation flying techniques and work cycles. Similarly, the ASIT found through interviews that there was variability between MRH-90 pilots in their approach and priority placed on instrument scans during night formation flying. Lack of standardisation and individual pilot flexibility with respect to night formation flying techniques, instrument scans and work cycles sets pre-conditions for varied and sub-optimal techniques and performance. The investigation found it was very likely the attentional focus of BSMN 83's AC (FP), and likely the CP (NFP), in challenging flying conditions, narrowed to prioritise maintaining formation position visually to the detriment of instrument scan.

25. **Type 1 (Unrecognised) Spatial Disorientation (SD).** It is very likely that attentional narrowing of the pilots was compounded by misleading sensory inputs (visual, vestibular, and somatosensory) that did not draw their attention to the departure from formation parameters. This likely resulted in the AC (FP) and the CP (NFP) experiencing Type I (Unrecognised) SD.

26. Successful performance and flight safety depends on aircrew having an accurate mental model of the current state of the operational environment, commonly referred to as Situation Awareness (SA). Spatial Orientation, a component of SA, refers specifically to the human ability to maintain body orientation and/or posture in relation to the surrounding environment. Orientation normally involves both the subconscious integration of sensory cues and the conscious interpretation of external information, and can be particularly difficult to maintain in the three-dimensional environment of flight. Loss of Spatial Orientation is known as Spatial Disorientation (SD), and is categorised as either Type I (Unrecognised), or Type II (Recognised). In Type I (Unrecognised) SD, the pilot is unaware of the loss of orientation, and continues to fly the aircraft based on a false perception of their own, and their aircraft's orientation with reference to the surrounding environment. This is the most dangerous, and accounts for the majority of SD accidents and fatalities.

27. Gradual changes to the aircraft's pitch attitude, airspeed and altitude remained unrecognised by the pilots in BSMN 83, and created a situation in which everything felt normal, despite a worsening deviation from formation parameters as the aircraft climbed. Unaware of their loss of Spatial Orientation and SA, the AC (FP) and CP (NFP) of BSMN 83 likely had reduced cognitive ability to interpret and respond in a timely manner to the sudden and unexpected loss of visual sight of BSMN 82. The investigation found that once the pushover occurred, the pilots did not have sufficient time to rebuild Spatial Orientation, transition to

instruments to regain SA, and apply appropriate Unusual Attitude (UA) recovery techniques to prevent the impact with water.

28. **Aviation fatigue management.** To establish whether fatigue contributed to the accident, the ASIT sought to understand whether the pilots of BSMN 83 were likely to have been fatigued, and whether the actions, inactions or decisions that were causal in the event were consistent with the effects of fatigue. The ASIT considered a number of data sources, including estimated sleep and wake times of the BSMN 83 crewmembers derived from interviews and sleep data from other aircrew, VFDR voice analysis, biomathematical fatigue modelling, individual leave balances and annual Snapshot survey results.

29. The investigation found that BSMN 83's AC and CP were likely experiencing a level of fatigue shown to impede optimal performance and increase susceptibility to Type I (Unrecognised) SD. The estimated level of fatigue of BSMN 83's AC was considered sufficient to affect their actions and decisions in the event sequence. Factors identified as contributing to fatigue included disruptive work patterns, resulting in restricted sleep and extended periods of being awake, the deployed sleep environment, and the prolonged period waiting in the aircraft prior to departure for extraction of the GFE.

30. **Non-Technical Skills (NTS).** The investigation identified a number of NTS-related issues that set pre-conditions to increase safety risk. These included:
    a. BSMN 83's AC (FP) and CP (NFP) did not demonstrate awareness of the aircraft's climb and departure from the standard formation position, which likely represents a breakdown in 'Flying Pilot' and 'Pilot Monitoring/Non-Flying Pilot' responsibilities and associated crew communication and coordination.
    b. Management and distribution of the collective workload of BSMN 83's crew to maintain SA was likely suboptimal.
    c. The decision and Flight Authorisation to close the formation's cabin doors likely impeded the ability of BSMN 83's ACMN to contribute effectively to the SA of the AC (FP) and CP (NFP).
    d. It was likely that after taking control of the aircraft, BSMN 83's AC (FP) directed the CP's attention away from NFP duties, which inadvertently affected the crew's overall SA.

31. **Professional standards.** It is the view of the ASIT that professional standards play an essential role in accident prevention by setting clear expectations for conduct, decision-making and accountability. Although discounted as having directly contributed to the event, the investigation revealed deviations from prescribed procedures relating to the use of the low-height warning system, engagement of the AFCS RHT hold upper-mode, execution of the handover/takeover procedure and the Emission Control policy.

Risk controls

32. Risk controls are the measures put in place by an organisation to facilitate and assure safe performance of the operational components of the system. The ASIT considered a range of risk controls present at the time of the accident, including aircraft systems and equipment, procedures, processes and practices, training and assessment, people management, supervision and authorisation. The investigation found the following:

33. **TopOwl/Helmet Mounted Sight and Display (HMSD).** The ASIT considered the likelihood of the HMSD display system contributing to the event outcome. In particular, the investigation considered the symbology upgrade from HMSDv4.00 to HMSDv5.10, and the subsequent testing and implemented risk controls. Prior to Service Release, the Army Aviation Test and Evaluation Section (AATES) identified the HMSD attitude symbology showed an ambiguity in the attitude presentation in off-axis lateral viewing (most pronounced at 90 degrees left and right) from the longitudinal axis of the nose of the aircraft. Subsequently, the Aviation Branch Standards Section conducted an Operational Evaluation to expand AATES testing to broader flight regimes and environments. While both AATES and Standards Section test and evaluation reports agreed that there were deficiencies relating to attitude presentation, the two agencies disagreed

on the severity of the hazard. Aviation Branch approved Service Release of the upgrade, with specific requirements for training and OIP, as recommended by the Operational Evaluation Report. Both the AC and the CP were compliant with the training requirements at the time of the accident. However, the ASIT found that additional hazard analysis and risk assessments, as required in the documentation prepared for Service Release, had not been completed.

34. Regardless, the investigation determined that it was very unlikely the known hazards relating to the HMSD v5.10 contributed to the loss of Spatial Orientation. This conclusion was based on the Line of Sight of the BSMN 83 pilots, which was slightly offset from the aircraft's longitudinal axis, and that the pilots were likely looking 'through' the HMSD symbology to maintain attentional focus on BSMN 82.

35. **Use of Radar Height (RHT) hold/formation technique.** BSMN 83's AC used a common MRH-90 flying technique to depress the trim switch (thereby overriding the AFCS RHT function) to adjust and maintain the aircraft's position within the formation. The ASIT found that this technique was in alignment with standard policy, guidance and training for general formation flight, but not in alignment with more restrictive Standing Instructions for RHT to be engaged for low level, flight over water at night. The ASIT's review of OIP and risk management artefacts found that while separate formation flight regimes had detailed instruction, guidance and risk controls, they were siloed in application and management. Contradictions between OIP and taught techniques with respect to use of RHT during formation flying introduces potential to degrade a key risk control for maintenance of height during low level, formation, flight over water. The ASIT found that AVNCOMD had not adequately addressed this contradiction as a result of lack of standardisation in OIP and training, and by not ensuring that such organisational risk controls were being applied.

36. **Cabin doors.** Although AVNCOMD policy stated that, where practicable, cabin doors should be open for formation flying, and that restricted visibility limits the ACMNs' ability to provide formation clearances to the pilots when the cabin doors are closed, the crew's decision and Flight Authorisation to depart with the doors closed was permissible in accordance with OIP. The investigation found that AVNCOMD did not document or standardise restrictions, additional risk control measures or changes to techniques and procedures for formation flight with the cabin doors closed.

37. **Monitoring responsibilities.** The ASIT considered the role of the NFP in Army Aviation operations and associated responsibilities. Monitoring of an aircraft's flight path and performance parameters by the NFP, and addressing deviations promptly, is a well-known and recurring challenge in aviation safety. A critical aspect of monitoring includes defining intervention protocols and steps when a NFP identifies a deviation from the aircraft's expected flight path or parameters that could affect the safe operation of the aircraft. The investigation found that, although AVNCOMD policy required the NFP to announce when a deviation was identified, it did not include a structured intervention protocol detailing if, when, or how the NFP should initiate a takeover procedure from the FP. While issues related to the adequacy and execution of NFP intervention protocols as having contributed to the accident were discounted, the investigation identified this as an opportunity for safety improvement. The investigation also highlighted potential benefits of replacing the term NFP with Pilot Monitoring (PM) in order to promote the active nature of the role, and to emphasise that both pilots contribute to the safe operation of the aircraft.

38. **Training.** The ASIT considered the training pathways for the AC and the CP, with particular focus on low level, formation, flight over water and night flying. The ASIT did not find that differences between the AC's and CP's ab initio and type-transition pilot training pathways (pre- and post-Project Air 5428 Pilot Training System) contributed to the accident. Both pilots had met the Army standards of training for the roles they were assigned as 6 Avn Regt MRH-90 pilots. The ASIT noted that the implementation of Air 5428 has reduced opportunities for Army pilots to experience formation prior to posting to an operational squadron. Overwater operations training was initially introduced at the Helicopter Aircrew Training System, and

subsequently removed until posting to an operational squadron. This likely shifts training burden from a standardised and resourced training system structured for initial training, to an operational squadron with competing priorities. The ASIT did not identify evidence indicating that Army pilots undertake dedicated training designed to address the compounding complexities associated with flight over water, at night, and in formation. The ASIT is also of the view that a lack of standardisation and flexibility of the interpretation for the use of RHT set the pre-conditions for varied application of RHT for different mission types.

39. **Aviation fatigue management.** AVNCOMD had a significant suite of policy documents to support the management of aviation fatigue-related hazards, including structured fatigue training programs and active monitoring of fatigue as a significant safety issue. Despite having a multi-layered framework, the investigation found that AVNCOMD policy relating to prescriptive limitations was only partially effective as a fatigue management risk control and was inconsistent with requirements specified in Defence Aviation Safety Regulations – Aviation Fatigue Management (DASR AVFM). Policy relating to rostering practices was also found to be sub-optimal. This contributed to an environment where fatigue-related risks were not mitigated effectively, nor were they standardised and applied across the flying regiments. While all BSMN formation aircrew received and were current in aviation fatigue management training, the investigation identified some inconsistencies and gaps in education and training delivered by DFSB and the Institute of Aviation Medicine (IAM).

40. **Non-Technical Skills.** The investigation found that 6 Avn Regt's policy framework supporting NTS skills-based training and assessment was comparatively under-developed to those implemented in other AVNCOMD flying regiments. NTS skills-based training moves beyond the classroom and involves exposing aircrew to training scenarios that provide the opportunity to practise NTS skills in complex operating environments, in addition to enabling assessment and feedback on NTS performance. The investigation identified that implementation of enhanced NTS regulatory requirements via DASR NTS, in addition to addressing variability in NTS skills-based training and assessment within AVNCOMD, to be areas of priority to improve safety outcomes. The investigation also identified that DFSB was not a member of the ADF Flying Training Advisory Group (FTAG). Inclusion of aviation NTS training within the scope of the FTAG will enhance the monitoring of its effectiveness.

41. **Aeromedical training.** The investigation found that the context of initial Aviation Medicine (AVMED) training is fixed-wing centric, with limited focus on rotary-wing specific Configuration, Role and Environment (CRE). Additionally, a review of Army aircrew AVMED refresher training delivered by the Army Senior Aviation Medical Officer (SAVMO) found that some elements of Learning Outcomes for Aeromedical Factors and Human Performance Limitations, as prescribed by IAM, were not included. Of note, the documented training undertaken by BSMN 83's CP did not address physiological orientation and the risk of SD. The ASIT also found that IAM did not audit or independently review the delivery of Army Aviation AVMED refresher training, and therefore did not have an appropriate governance framework to identify or remediate inconsistencies or deficiencies in externally delivered AVMED Refresher training.

42. **Flying Supervision and Flight Authorisation.** Flying Supervision and Flight Authorisation for 6 Avn Regt's deployment to Ex TS23 required consideration of a range of factors, including the unique CRE of the deployed location, living and sleeping conditions, training considerations, crewing and risk management plans specific to planned mission types. The ASIT found a number of sub-optimal Flying Supervision controls, including a lack of defined policy in OIP as to the distinction between the roles and responsibilities of Flying Supervisors and Flight Authorisation Officers.

43. Flying Supervisors made appropriate decisions to allocate qualified and current crews for the BSMN formation. However, departure of one of the Troop Commanders on the day of the incident mission added complexity and workload for the remaining executives. An appropriately qualified and appointed Flight Authorising Officer conducted Flight Authorisation for the mission. The investigation found that

while the Flight Authorisation Brief covered weather considerations, it did not specifically cover hazards and risks arising from the forecast environmental conditions, such as rain showers, variable contrast and illumination, and the potential for a lack of discernible horizon. The ASIT also found that AVNCOMD's Flight Authorisation Aide Memoir did not specifically highlight requirements to ensure that hazards and risks associated with SD were covered in the Flight Authorisation Brief.

44. **Ex TS23 risk management plan.** The investigation found that in preparation for Ex TS23, 6 Avn Regt drafted an Aviation Integrated and Aggregated Risk Tool (AVIART) 'New Risk', which included a risk associated with 'high workload' and 'increased fatigue', resulting in 'aircraft mishandling and CFIT'. At the 16 Avn Bde pre-exercise Battle-Worthiness Board, it was determined that extant AVIART Core Risks and OIP adequately covered all hazards and risks associated with 6 Avn Regt's deployment to Ex TS23, and therefore the 'New Risk' was moved to 'Historic'. The ASIT noted that the Commanding Officer (CO) of 6 Avn Regt verbally implemented additional controls. However, the overarching Ex TS23 Special Operations Forces 'Risk Worksheet' did not adequately reference specific aviation hazards and risks. The ASIT considered that the lack of an aviation-specific and documented Risk Management Plan (RMP) reduced the opportunity for 16 Avn Bde to assure, and 6 Avn Regt to ensure, that hazards and risks associated with the unique CRE for the deployment were considered and mitigated.

45. **Upset Prevention and Recovery Training (UPRT).** While not an identified limitation, the investigation highlighted UPRT as a potential training methodology to build upon existing approaches to Unusual Attitude (UA) training. Unlike traditional UA training, UPRT adopts a broader focus on preventing and responding to unexpected scenarios. It integrates human factors and aeromedical considerations, such as managing and responding to surprise, startle and Type II (Recognised) SD, and is designed to improve the resilience and capacity of aircrew to deal with unexpected situations.

Organisational influences

46. Organisational influences are those conditions that establish, maintain or otherwise influence the effectiveness of an organisation's risk controls. They include Safety Management System processes, organisational resources, planning and communication.

47. **MRH-90 context and constraints.** As a function of the Defence Aviation Safety Program (DASP), Army Aviation has been subject to a number of routine oversight activities and internal reviews, including, but not limited to, Airworthiness Boards, DASA and AVNCOMD Operational Airworthiness Audits, and DFSB annual Snapshot surveys. Additionally, the investigation found a number of non-routine reviews and reports related specifically to the operation and management of Army Aviation and the MRH-90 capability. These reviews were comprehensive examinations of safety and capability issues, and as such, the ASIT did not seek to critically analyse or replicate their content. The investigation noted, however, that the MRH-90 and Army Aviation system as a whole, were clearly under significant strain, with a high level of complexity and risk associated with 'Initial', 'Continued' and resultant cascading effects on 'Continuing' Airworthiness' of the MRH-90 platform. The reviews continued to point to complex, under-resourced systems, in both the maintenance and operational environment. The investigation found that the breadth of reviews and associated recommendations added pressure and workload to an already overstretched workforce.

48. It is difficult to predict exactly how, and when, complex system interactions may result in an accident, however, the investigation found that organisational pre-conditions for an elevated level of risk to airworthiness and flight safety were generally well recognised, documented and accepted. In particular, the MAO-AM clearly accepted, documented and communicated that MRH-90 operations presented a MEDIUM level of risk of safety to personnel despite significant and disproportionate efforts to minimise risk across the MRH-90 enterprise.

49. **AVNCOMD MAO Integrated Quality and Safety Management System (iQSMS).** The ASIT's review of the Army Aviation iQSMS identified that HQ AVNCOMD was expending significant effort to remediate known deficiencies and improve processes to demonstrate compliance with Defence Aviation Quality Management System (QMS) and SMS regulatory requirements. However, the investigation found that the breadth and pace of change management – internal and external reviews, oversight activities and investigations, transition to new aircraft types, management and retirement of aging platforms, force modernisation and the introduction of new capabilities – created an environment where demands on Army Aviation often exceeded workforce capacity.

50. **Aviation risk management.** AVNCOMD has implemented a structured system to document aviation risk management artefacts using the AVIART database. However, the ASIT notes that AVNCOMD's use of 'Core Risks' and 'New Risks' to document hazard analysis and safety risk assessment varies from guidance provided in the Defence Aviation Safety Manual (DASM). The DASM details requirements for a cascading structure of Core Risk Profiles (CRP), Mission Risk Profiles (MRP) and Risk Management Plans (RMP). In particular, the ASIT highlights that AVIART lacks foundational CRPs to capture platform operations and identify all risks associated with the conduct and support of regular, non-role specific operations. Similarly, the ASIT highlights opportunities for safety improvement through clearly defining a framework and methodology for the aggregation of Core Risks for specific roles, functions or missions. For example, low level, formation, flight over water using Night Vision Imaging Systems (NVIS).

51. The investigation found that AVIART Core Risks demonstrated an inconsistent approach to hazard and risk control descriptions, a lack of standardisation of key taxonomy and references to OIP that document risk controls, and lack of reference to the means by which the standardisation, application and effectiveness of controls are to be assured. Furthermore, the ASIT found that Core Risks often lack clarity of the point of loss-of-control of the hazardous activity, threats/causes and delineation of prevention versus recovery controls.

52. The investigation called attention to the numerous action items, including outcomes from Class A and Class B safety investigations, DASP oversight and assurance activities, Aviation Safety Reports and other internal processes, which remained open prior to Ex TS23. Of particular note, action items to close recommendations from the investigation of a near mid-air collision between two MRH-90s during Exercise VIGILANT SCIMITAR 2020 were not progressed in a timely manner. Closure of action items related to aviation fatigue management, NTS, formation and NVIS operations prior to Ex TS23 might have minimised such organisational pre-conditions highlighted within this Aviation Safety Investigation Report (ASIR).

53. The ASIT acknowledges that AVNCOMD has continued to implement a number of safety initiatives and continuous improvement activities. Significant effort has been directed at understanding and managing the risks associated with the conduct of night, formation, overwater operations and aviation fatigue management. The investigation draws attention to the criticality of balancing resource versus demand in this context, and the need to ensure focused and effective actions.

54. **Defence Aviation safety regulatory assurance.** The ASIT examined the efficacy of the DASR and supporting policy, guidance material, education and training related to key causal and contributory factors, whereby the following opportunities for safety improvement were identified:

   a. **Multi-crew aircraft operations.** A review of DASR and supporting regulatory artefacts identified no regulation or guidance related to roles or responsibilities of aircrew in multi-crew settings. It also revealed minimal reference to a pilot not on the aircraft's controls. A limited review of civilian airworthiness authorities by the ASIT, indicates that this is inconsistent with global aviation practices.

   b. **Aviation fatigue management.** Notwithstanding the strengths of DASR AVFM as an outcome-based regulation to mitigate hazards and risks related to aviation fatigue, limitations remain in regulatory obligations and guidance related to scheduling, rostering practice and fatigue-training requirements.

Similarly, DASR AVFM Acceptable Means of Compliance lacks prescription and may lead to uncertainty in interpretation of compliance relating to how required safety outcomes can be achieved.

c. **Non-Technical Skills.** The investigation drew attention to the promulgation of DASR NTS in February 2024, which represented a significant change to NTS training to enhance the management of NTS-related hazards across Defence Aviation. The ASIT noted that DFSB had not promulgated sufficient and contemporary supporting policy, guidance material, and education and training for the regulated community. This sets pre-conditions for inconsistent interpretation and implementation of, and by default, compliance with this major regulatory reform.

d. **Spatial Disorientation (SD).** The investigation found that the prevalence of SD experiences by aircrew across Defence Aviation was indicative of potential weaknesses in related hazard controls, emphasising the need to monitor and continuously improve upon existing combined DASA, DFSB and AVNCOMD hazard identification and risk mitigation approaches.

55. **DASA oversight and enforcement.** The investigation identified that the regulatory oversight approach and schedule conducted by DASA's Directorate of Aviation Operations (DAVNOPS) limited the opportunity of the regulator of Defence Aviation to provide assurance of the Army Aviation MAO's compliance with DASR AVFM. More broadly, the investigation identified that the DAVNOPS approach, which relies on future oversight activities to verify compliance with DASR, creates opportunities for safety gaps to emerge and to remain unidentified and unresolved. This is inconsistent with DASA's broader regulatory approach and sets the pre-conditions for non-compliances to go unnoticed for periods of time, particularly when organisations alter their practices or do not respond to regulatory changes.

56. **Defence Aviation safety risk management.** The investigation identified broad concerns relating to standardisation, knowledge and application of organisational-level aviation risk management practices across Defence Aviation, in particular with respect to the documentation of key risk artefacts for aircraft operations. The ASIT also notes that this is a recurring theme from previous safety investigations and research conducted by DFSB. Overall, the ASIT found that there is a general lack of coherency, standardisation and prescription spanning policy, regulations, guidance material, and education and training at various layers of the DASP to both assure and ensure the efficacy of Defence Aviation's operational risk management framework.

Safety actions already undertaken

57. The ASIT acknowledges AVNCOMD implemented a significant number of safety initiatives and continuous improvement activities throughout the course of the investigation. AVNCOMD's review and analysis of preliminary reports and briefings provided by the ASIT at each of phase of the investigation resulted in improved risk controls and revised OIP for the conduct of missions involving NVIS, DVE, formation, and low level flight over water, as well as aviation fatigue management. Additionally, COMD AVNCOMD initiated the development of an overarching Army Aviation Safety Campaign Plan to support the implementation of the Battlefield Aviation Program Integrated Program Plan, proactively addressing known and anticipated system risks to improve safety.

Recommendations

58. The primary aim of an aviation safety investigation is to identify and mitigate system deficiencies. Accordingly, the safety recommendations made in the report focus on implementing or improving controls to eliminate or minimise the safety hazard or risk, in order to prevent recurrence. As is often the case in complex investigations, the investigation also revealed safety issues that were not directly related to the causes and/or contributing factors of the accident, but which nevertheless were identified as issues requiring recommendations for safety improvement.

59. The ASIT developed safety recommendations aimed at mitigating the identified risk, while allowing the responsible organisations the flexibility to determine the most appropriate means of implementation.

60. The recommendations are grouped according to safety themes and/or specific safety issues spanning the elements of the DASP (external organisational influences), conditions within or affecting Army Aviation, and the MAO's SMS (internal organisational influences) and AVNCOMD risk controls. Summarised, these include:

a. A recommendation to the Defence Aviation Authority to review the framework for the reporting of strategic organisational hazards by independent reviews of aviation safety.

b. A recommendation to the Director General of the Defence Aviation Safety Authority (DG DASA) to review policy for the issuance and retention of organisational authorisations by the DAVNOPS.

c. Recommendations to DG DASA, the Army Aviation MAO-AM, and COMD 16 AVN BDE related to Aviation SMS and Deliberate Risk Management for flight operations. The recommendations aim to improve the application and efficacy of DASA independent safety assurance, to improve the AVNCOMD risk management framework and methodology, and the AVNCOMD SMS framework, including roles, responsibilities, accountabilities, training and competency of key safety personnel.

d. Recommendations to DG DASA and the Army Aviation MAO-AM related to QMS. The recommendations aim to improve the efficacy of interpretation and application of the regulatory Acceptable Means of Compliance (AMC) and Guidance Material (GM) for DASR SMS, and for the Army Aviation MAO-AM to review implementation and integration of the QMS within Army Aviation.

e. Recommendations to DG DASA, Director DFSB, Commander Air Force Training Group (as the Manager Joint Training for ADF Flying Training) and the Army Aviation MAO-AM related to NTS training and assessment. The recommendations aim to improve regulatory AMC and GM for DASR NTS, improve the provision of policy, guidance material and training to support implementation of DASR NTS by the regulated community, and to improve the standardisation (where appropriate) of NTS education, training and assessment across the ADF flying training system.

f. Recommendations to DG DASA, DASA DAVNOPS, Director DFSB, the CO IAM and the Army Aviation MAO-AM related to fatigue management. The recommendations aim to improve regulatory AMC and GM for DASR AVFM, improve the provision of policy, guidance material and training to support implementation of DASR AVFM by the regulated community, ensure alignment between DFSB and IAM in the provision of that material, and for the Army Aviation MAO-AM to standardise (where appropriate) aviation fatigue management across subordinate organisations.

g. Recommendations to DG DASA, CO IAM, the Deputy Commander of the Fleet Air Arm (DCOMFAA) and the Army Aviation MAO-AM related to Aeromedical Factors and SD. The recommendations aim to improve reference and guidance material, as well as training for aeromedical factors and SD in line with international best practice, for both rotary- and fixed-wing aviation operations.

h. Recommendations to the Army Aviation MAO-AM related to Flying Supervision and Flight Authorisation, to improve independent control of flight planning and mission execution, and to ensure efficacy of hazard identification and risk controls.

i. Recommendations to the Army Aviation MAO-AM related to low-flying minimum heights, specialised equipment and altitude warning systems, to ensure the safe management of low-flying activities.

j. Recommendations to DASA DAVNOPS and the Army Aviation MAO-AM related to NVIS, to improve regulatory AMC and GM, policy and procedures to ensure safety outcomes when NVDs are the primary means of vision.

k. Recommendations to the Army Aviation MAO-AM, DCOMFAA and the Commandant of the Army Aviation Training Centre (COMDT AAvnTC) with respect to formation flying procedures and techniques. The recommendations aim to improve policy and procedures related to formation flight regimes, as well as aggregated mission profiles such as low level, formation, flight over water using NVIS and/or in DVEs.

l. Recommendations to DG DASA and the Army Aviation MAO-AM in relation to multi-crew operating environments, particularly role clarity and responsibilities related to 'pilot in control' and 'Pilot Monitoring' requirements.

m. One recommendation was made to the Army Aviation MAO-AM with respect to procedures for the management of Aeronautical Life Support Equipment.

n. One recommendation was made to Headquarters Joint Operations Command, specifically the Air and Space Operations Centre, Joint Personnel Recovery aimed at improving guidance for Search and Rescue communication plans.

61. The ASIT recognises that addressees made accountable and responsible for recommendations are best positioned to identify and implement appropriate measures within the context of their aviation operations. As part of this process, the ASIT will remain engaged in assessing the extent to which planned safety actions address the identified safety issues, ensuring that meaningful and effective improvements are achieved.

Final comments and key lessons

The ultimate aim of this ASIR is to improve aviation safety.

62. The independent aviation safety investigation into the MRH-90 Taipan A40-040 accident on 28 Jul 23 draws out critical observations and lessons that are relevant to the broader Defence Aviation enterprise. The ASIT recommends that all individuals and organisations that support or conduct Defence Aviation operations review this report with a view to understanding and applying lessons to their own activities.

63. Overall, the investigation found that the primary cause of the accident was Type 1 (Unrecognised) SD, leading to controlled flight into terrain. The most fundamental lesson for Defence Aviation is to recognise that all aircrew are exposed to spatially disorienting effects due to the unique nature of military operations in degraded visual environments, low illumination levels or poor contrast conditions. Defence Aviation has placed a significant emphasis on training, competency and assessment to operate in such environments and conditions, and to apply UA techniques to react and recover from Type II (Recognised) SD events. However, the ASIT reached the conclusion that training, competency and assessment to promote awareness of Type I (Unrecognised) SD, such as the warning signs and indicators of decreasing SA and/or complete loss of Spatial Orientation, is a challenging and complex task. Preventative and recovery controls to minimise SD-related risks must build upon extant Aviation Medicine, aeromedical factors and human performance limitations education and training to include actions to anticipate, avoid and communicate SD risk factors within operational environments.

64. Additionally, this investigation reinforced several recurring themes observed across other major civil and military accident investigations. The ASIT draws attention to the following themes:

a. *Safety risk management is not static.* Hazards must be continually evaluated in the context of the specific operational environment. Without ongoing evaluation, organisations risk operating under incorrect assumptions, and potentially leave hazards unaddressed.

b. *Proficiency in both technical and NTS (eg decision-making, communication, SA, and leadership and management) provides the foundation for safe and efficient aviation operations.* This investigation emphasises the importance and necessity of investing in NTS training to equip crews to adapt, coordinate and respond effectively in dynamic operating environments.

c. *Compliance alone is insufficient.* When systems are under pressure, focus can become increasingly on the process rather than confirming the effectiveness of the process. This investigation highlights the criticality of understanding and measuring the effectiveness of processes.

d. *Organisations and regulators must guard against the false assumption that adherence to regulations and OIP inherently equates to safe operations.* Safety risk management and the oversight of safety systems requires the effectiveness of the risk controls to be evaluated and to ensure that they are functioning as intended in real-world conditions.

e. Complex systems, organisational change, and regulatory and safety governance requirements require careful balancing of resource and demand. Action must be taken to understand and react to safety information at every level of the organisation, but with the operators at the forefront of how change is implemented.

65. Defence Aviation has long had a culture of 'can do', with high-achieving and driven personnel working in challenging and complex environments. This accident has drawn attention to the fallibility of humans in complex systems, and acts as a stark reminder of the importance of the systems and processes built to support effective performance and ensure safety in operating environments. It should also prompt organisational reflection on the enduring aspiration to build a 'generative safety culture' – the need to maintain a persistent state of vigilance, be receptive to learning, have a willingness to respond to opportunities, and a collective commitment to enhancing aviation safety.

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INTRODUCTION

1.1.1 On 28 July 2023, a 6th Aviation Regiment (6 Avn Regt) MRH-90, operating as the third aircraft in a formation of four MRH-90s during a night mission for Exercise TALISMAN SABRE 2023 (Ex TS23), crashed into the water near Lindeman Island, Queensland. Tragically, all four crew were fatally injured.

1.1.2 As the ADF's independent aviation investigation capability, the Defence Flight Safety Bureau (DFSB) was responsible for the safety investigation into the accident. This Aviation Safety Investigation Report (ASIR) describes the event sequence, determined primarily through on-board Voice and Flight Data Recorder (VFDR) evidence and witness interviews, and identifies the systemic factors that contributed to the event, determined through extensive review, research, and analysis.

1.1.3 The conduct of DFSB investigations follows a structured process outside of the Defence Aviation reporting system (Sentinel) with the investigation outcomes entered into the reporting system once finalised by the originating unit. Findings are categorised as follows:

a. **Findings.** Findings are safety factors that directly and negatively relate to the circumstances of the event.

b. **Indirect Findings.** Indirect Findings are safety factors that did not directly and negatively contribute to the event, but are worth noting, or have the potential to increase safety risk in the future.

c. **Observations.** Observations are included to provide important information about topics other than those defined as findings or indirect findings.

1.1.4 The full list of findings is at Annex A and a list of Recommendations at Annex B.

1.1.5 This ASIR makes use of probabilistic language (for example, likely, very likely) in its analysis and findings. The full range of this probabilistic language is listed and defined at Annex C. A list of acronyms and glossary of terms is available at Annex D. Times are expressed in local Queensland time (Kilo (K))[1], except for the accident sequence where timings are drawn directly from the VFDR and expressed in Coordinated Universal Time (UTC or Zulu (Z)). Due to the nature of the mission, some evidence and analysis is held on the Defence Secret Network. Access to this information is by request, and will only be released in accordance with the Defence Security Framework and the need to know principle.

1.1.6 The Aviation Safety Investigation Team (ASIT) recreated the sequence of events using data extracted from the on-board recording system (combined VFDR) and evidence collected through interviews. Annex E provides a timeline, which should be read in conjunction with the event sequence details provided in the analysis, Section 2.1 of this report.

1.1.7 The ASIT was supported during the immediate investigation activities and analysis by a number of organisations and subject matter experts. The list of contributors is at Annex F. DFSB would like to formally acknowledge the support and expertise of these individuals and organisations, without which the investigation would not have been as thorough.

1.1.8 DFSB would also like to acknowledge the professionalism, openness and honesty of the members of 6 Avn Regt, and Army Aviation Command (AVNCOMD) during the conduct of this investigation. Without this, the identification of key systemic issues, and the development of effective safety recommendations would not have been possible.

FACTUAL INFORMATION

1.2 History of the flight

1.2.1 On the night of 28 Jul 23, a forward-deployed element of 6 Avn Regt, operating out of Proserpine Airport, Queensland, was tasked with conducting a night extraction of Ground Force Elements (GFE) from Lindeman Island as part of Ex TS23. The mission involved a formation of four MRH-90 (Multi Role Helicopter) Taipan aircraft: callsigns Bushman (BSMN) 81, 82, 83, and 84. BSMN 83 was the accident aircraft. The planned flight path for the BSMN formation is shown at Figure 1.

1 Kilo Time Zone is UTC + 10 hours.

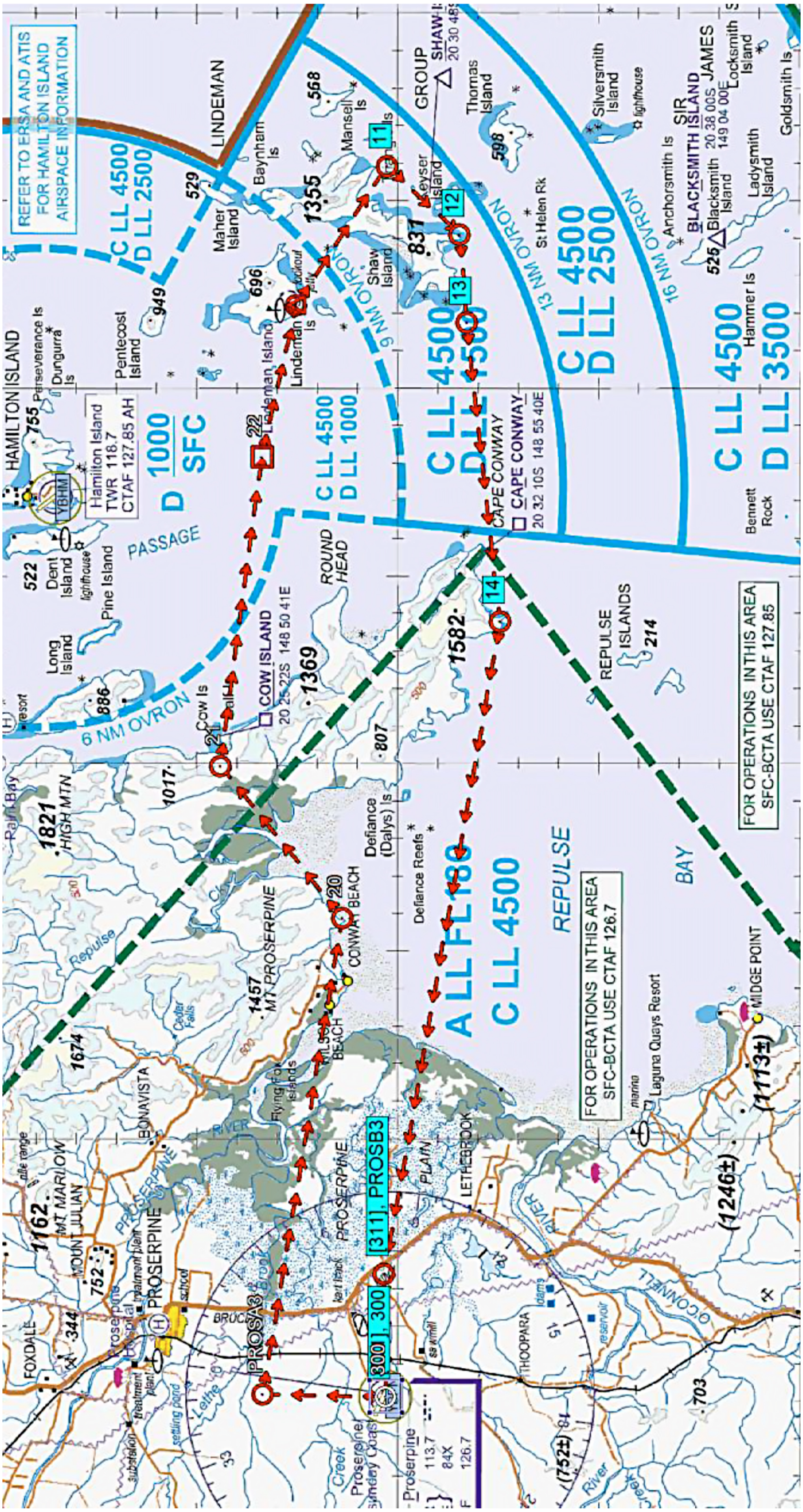

Figure 1: Planned flight path, as briefed during Mission Orders

1.2.2 The crews of the BSMN formation commenced duty at 1300K. Mission Orders commenced at approximately 1410K, and were delivered by the Co-pilot (CP) of BSMN 81.

Following Mission Orders, the formation conducted a Rehearsal of Concept (ROC) Drill[2] (paragraph 2.4.8). The mission was authorised by the Detachment Commander, Officer Commanding (OC) 173 Special Operations Air Squadron (173 SOAS), 6 Avn Regt, who was the Aircraft Captain (AC) of BSMN 84 and the Air Mission Commander.

1.2.3 At 1954K BSMN 83 commenced the Auxiliary Power Unit (APU) start sequence. The CP of BSMN83 was not present for the APU start sequence, due to them rectifying an unserviceability with the Quick Release Pack (QRP) connection pins of their Thales TopOwl Helmet Mounted Sight and Display (HMSD)3[3]. The CP of BSMN83 re-joined the crew at 2001K.

1.2.4 At 2114K BSMN 83 started engines. The formation was required to conduct a hot (rotors-running) refuel at the designated Forward Arming and Refuelling Point (FARP) at Proserpine Airport. BSMN 81 taxied to the FARP at 2124K, followed by the remainder of the formation in order. During the refuel, BSMN 81's Radar Altimeter (RADALT) failed, requiring an aircraft swap.

1.2.5 At 2214K, BSMN 83 departed Proserpine Airport as the number 3 aircraft in a heavy left formation. The CP was Flying Pilot (FP). The formation departed Proserpine Airport in an eastbound direction at approximately 400 feet (ft) Above Ground Level (AGL). Aircraft doors were closed, and the Flight Control System (FCS) Tactical (TAC) mode was selected (see paragraphs 1.7.10 (doors) and 1.7.22 (TAC mode)). The BSMN formation continued over land following the planned track. BSMN 83 crewmembers were recorded discussing maintenance of the distance from BSMN 82 of 2 rotor diameter (RD)4[4].

1.2.6 BSMN 83 called 'feet wet'[5] at 2221K, approximately 1 nautical mile (NM) to the west of Conway Beach and at approximately 325 ft AGL. As the formation approached the ridgeline crossing of the Cape Conway Peninsula to enter the Whitsunday Passage, low cloud[6] prompted BSMN 81 to amend the flight plan by turning right to track coastal over water around the peninsula (see Figure 2). The aircraft FCS remained in TAC mode (see paragraph 1.7.22 for further discussion).

1.2.7 At 2233:31K BSMN 83 started to diverge high from the formation prompting the AC to take control of the aircraft at 2233:34K. The AC re-established formation position at a height of 240 ft. Eighteen seconds after the AC took control of the aircraft, the FCS Attitude (ATT) mode was selected, immediately followed by activation of the Automatic Flight Control System (AFCS) collective upper mode Radar Height (RHT) Hold (more details are at paragraph 2.5.6). BSMN 83 entered the briefed formation left holding pattern at 2234:18K; the first of two left turns.

1.2.8 At 2236:06K, the lead aircraft, BSMN 81, rolled out of a left turn onto the inbound leg of the hold maintaining 214 ft AGL and 81 Knots Indicated Air Speed (KIAS). Before BSMN 83 completed this turn, it commenced an accelerating climb from 76 KIAS. At 2236:19K, BSMN 83, at an altitude of 356 ft and 111 KIAS, suddenly pitched nose down. Multiple pitch and roll inputs were recorded on the VFDR. At 2236:22K, BSMN 84 transmitted over the radio, '83, pull up, pull up, pull up, pull up.' At 2236:25K, at position 20° 24' 33.876'' S 148° 56' 27.24'' E, approximately 6 km to the south of Hamilton Island and 11.5 km to the north-west of Lindeman Island, BSMN83 impacted the water. There were no further parameters recorded on the VFDR.

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2 A ROC is a walkthrough of the mission, often used as an additional risk control to identify and brief contingency plans.

3 No record of maintenance was found for this rectification.

4 The MRH90 STANMAN states that formation spacing is judged visually with the rotor diameter (~17 m) as an aid. This visual spacing concept is not from rotor to rotor, but is a visual determination from the extremity of each aircraft.

5 'Feet wet': phrase to describe when an aircraft is flying over water.

6 US Federal Aviation Administration publication - PHAK Chapter 12 (Weather Theory) - describes low cloud as clouds that form near the Earth's surface and extend up to about 6 500 feet AGL. Typical low clouds are stratus, stratocumulus, and nimbostratus. Clouds in this family create low ceilings, hamper visibility, and can change rapidly. Because of this, they influence flight planning and can make visual flight rules (VFR) flight impossible.

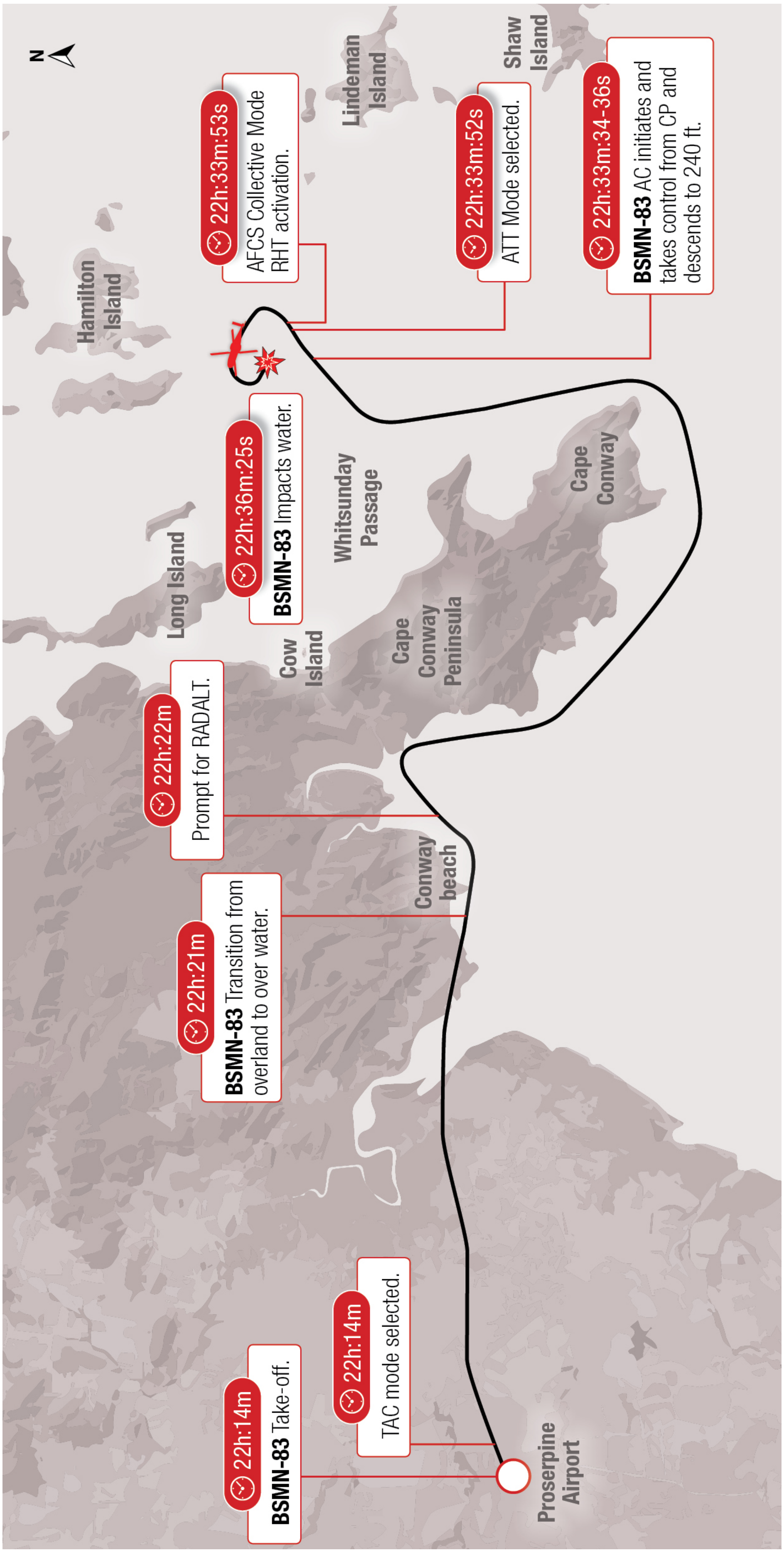

Figure 2: Sequence of events from take-off to impact

1.3 Injuries to persons

1.3.1 All four crewmembers on board were fatally injured. There were no passengers, or external parties injured in the accident.

1.4 Damage to aircraft

1.4.1 Australian Army MRH-90 Taipan A40-040 was destroyed[7] upon impact with the water. The accident was classified as a Class A Event (Reference B).

1.5 Other damage

1.5.1 The ASIT provided a list of essential and highly-desirable aircraft components, required for the investigation, to the Joint Task Force (JTF) 1116, the lead agency responsible to coordinate the recovery operation for A40-040. ASIT correspondence (References C and D) noted that by 15 Sep 23, all essential aircraft components had been recovered, and 90% of highly-desirable aircraft components had been recovered. On 15 Sep 23, command and control arrangements for coordination of wreckage recovery operations was transferred from JTF 1116 to HQ AVNCOMD.

1.5.2 JTF 1116 signed an Environmental Clearance Certificate (Reference E) on 24 Aug 23 stating that some aircraft components and materials were unrecoverable. Pacific Marine Group (PMG) provided a report of remaining wreckage to Headquarters Joint Operations Command (HQ JOC) (Reference F). This information was provided to the Great Barrier Reef Marine Park Authority to facilitate future environmental management of the accident site.

1.6 Personnel information

1.6.1 **Bushman 83.** The crew of BSMN 83 consisted of two pilots and two aircrewmen (ACMN), as per the minimum crew requirement stipulated in Army Aviation Standing Instructions (Aviation) – Operations (SI(AVN) OPS) (Reference G). Crew qualifications, experience and recency were recorded on Patriot Excalibur (PEX) and a summary is shown in Table 1 (full details are available in Annex G).

7 Reference A (DASM), Part 2, paragraph 1.18, c, (1) – Aircraft Damage Level

OFFICIAL

TABLE 1: BUSHMAN 83 CREW QUALIFICATIONS, EXPERIENCE AND RECENCY

ITEM	AC	CP	WO2	LH ACMN
Rank	CAPT	LT	WO2	CPL
Category	B[8]	C[9]	QAI-A[10]	C[11]
Total flight hours	1731.6	576.2	3470.1	691.4
Total flight hours on MRH-90	1399.0	383.6	371.0	653.4
Total captain hours	514.0	7.4	-	-
Total captain hours on MRH-90	445.6	5.0	-	-
Total hours last 30 days	21.3	32.2	26.7	16.7
Total hours last 7 days	10.9	14.0	5.0	8.0
Total hours Night Vision Devices (NVD)	373.6	120.2	1163.2	261.4
Total hours last 30 days NVD	3.7	6.9	15.0	3.5

1.6.2 **Aircraft Captain (AC).** The AC was an MRH-90 Category B Special Operations qualified captain. The AC graduated from ADF Basic Flying Training School (BFTS) at Tamworth in December 2014, and from Army Pilots course at the Army Aviation Training Centre (AAvnTC) as a Category D MRH-90 pilot in March 2017. The AC gained the following aircraft endorsements: CT-4B, B206B-1 Kiowa, MRH-90 Taipan and the RNZAF NH9012[12].

1.6.3 The AC was posted first to the 5th Aviation Regiment (5 Avn Regt), then served with the Royal New Zealand Air Force (RNZAF) between 2018 and 2019. In New Zealand, the AC qualified on, and flew the NH90.

8 As per Reference H, a Category B Pilot is, 'Highly Proficient – Mission Ready Captain. Competent to perform selected Brigade/Unit Training Assessment Plan (BTAP/UTAP) specified mission tasks.' Privileges include:
May mentor, training and assess aircrew on the application of technical and non-technical skills to achieve aviation mission task/s once a qualification from SI(AVN) OPS 2-105 or 2-108 is gained. May mentor and assess mission planning and execution on tasks defined by the Operating Unit CO.

9 As per Reference H, a Category C Pilot is, 'Proficient – Mission Ready Co-pilot. Competent to perform BTAP/UTAP specified mission tasks.'

10 As per Reference I, a Category A Qualified Aircrewman Instructor (QAI), 'Has the privilege to instruct and standardise Instructors, and manage the flying standardisation system. They have been assessed as competent IAW an approved course of training to instruct Airbourne Instructional Technique (AIT).'

11 As per Reference I, a Category C ACMN, 'Is competent (Proficient) to perform selected Formation/UTAP specified mission tasks, and may supervise Category D ACMN.'

12 The MRH-90 is the Australian variant of the NH90 helicopter.

1.6.4 The AC held an MRH-90 NVD Mission Command qualification and an MRH-90 Command Instrument Rating. The AC was Night Vision Imaging System (NVIS) current.

1.6.5 **Aircraft Co-pilot (CP).** The CP was an MRH-90 Category C Special Operations qualified CP. The CP graduated from Army Pilot's Course at No. 1 Flying Training School (1 FTS) at RAAF Base East Sale in Jul 2020. The CP progressed to ab initio helicopter training on Joint Helicopter School (JHS) 0007 at the Helicopter Aircrew Training System (HATS), HMAS *Albatross*, Nowra, graduating from HATS in June 2021. The CP then graduated from Army Pilots course at AAvnTC as a Category D MRH-90 pilot in April 2022. The CP gained the following aircraft endorsements: Airbus EC-135 and MRH-90 Taipan.

1.6.6 The CP was posted first to 5 Avn Regt in 2022, and then to 6 Avn Regt at the beginning of 2023.

1.6.7 The CP held an MRH-90 NVD Mission Restricted qualification and an MRH-90 Restricted Instrument qualification. The CP was NVIS current.

1.6.8 **Aircraft Right Hand Aircrewman (RH ACMN).** The RH ACMN was an MRH-90 Category A Special Operations Instructor Aircrewman and the 6 Avn Regt Standardisation Warrant Officer (RSTWO). The RH ACMN conducted initial aircrewman training on the Bell UH-1H Iroquois in 2003, and graduated on the S-70A-9 Black Hawk as a Category D Aircrewman in 2004. The RH ACMN had an extensive career, operating in S-70A-9 Black Hawk, Bell 412, Airbus EC-135 and MRH-90 Taipan helicopters. The RH ACMN completed Aircrewman Instructor training in 2008. The RH ACMN's postings included AAvnTC, HATS, 5 Avn Regt and 6 Avn Regt.

1.6.9 The RH ACMN held an MRH-90 Qualified Aircrewman Instructor (QAI) Category A categorisation and an MRH-90 NVD aircrewman qualification. The RH ACMN was NVIS current.

1.6.10 **Aircraft Left Hand Aircrewman (LH ACMN).** The LH ACMN was an MRH-90 Category C Special Operations Junior Aircrewman. The LH ACMN conducted initial aircrewman training on the Airbus EC-135 in 2019, and graduated on the MRH-90 in 2020 as a MRH-90 Category D Aircrewman. The LH ACMN was posted to 6 Avn Regt from initial training.

1.6.11 The LH ACMN held an MRH-90 NVD aircrewman qualification. The LH ACMN was NVIS current

INDIRECT FINDING[1]	**The crew of BSMN 83 were qualified, competent and current to perform the mission.**

1.6.12 **Sleep and wake times.** Figure 3, Figure 4 and Table 2 represent the estimated sleep and wake times of the BSMN 83 crewmembers. Information is based on estimates derived from interviews and sleep data from other aircrew. The estimated sleep and wake times represents the window of sleep opportunity, which may be more than the amount of actual sleep obtained. More information is in Enclosure 1.

Figure 3: BSMN 83 AC sleep and wake times (5 Days) 13[13]

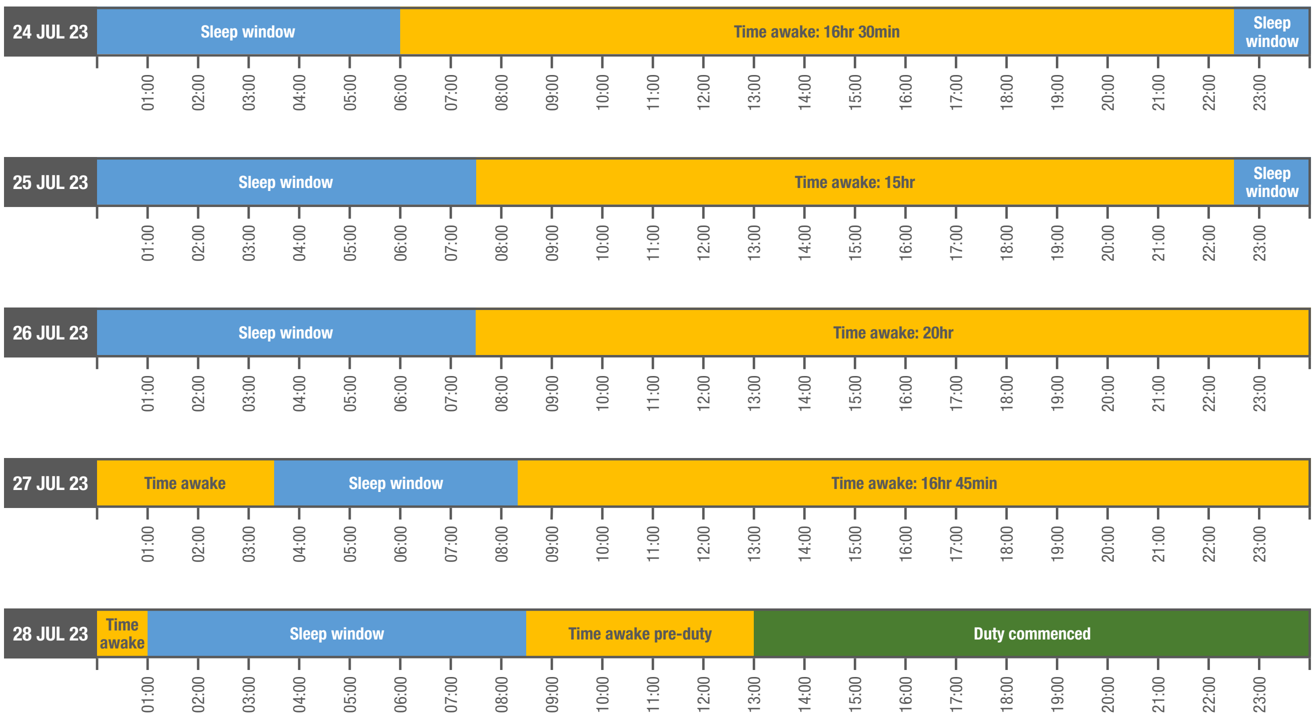

Figure 4: BSMN 83 CP sleep and wake times (5 days)

13 Text messaging indicates that on the 27 Jul 23 the AC woke at 0700 and again at 0930. The AC likely had a nap opportunity between 0800 and 0930, however, the amount of sleep obtained is unknown.

TABLE 2: BSMN 83 RH ACMN, AND LH ACMN SLEEP PERIODS (24 HOURS PRIOR)

CREW MEMBER	SLEEP (27 JUL 23)	WAKE (28 JUL 23)
RH ACMN	2200K	0730-0800K
LH ACMN	2330K	0730-0900K

1.7 Aircraft information

1.7.1 The MRH-90 is the Australian variant of the NHIndustries (NHI) NH90. The NH90 was developed and manufactured by NHI, a company owned by Airbus Helicopters, Leonardo, and Fokker Aerostructures. The aircraft is a medium-lift, twin-turbine engine, conventional helicopter designed to transport troops and cargo by day and/or night, in visual, instrument and degraded visual environment flying. There are two main variants of the NH90, the Tactical Transport Helicopter (TTH) for Army land-based operations and the maritime version NATO Frigate Helicopter (NFH). The MRH-90 is a standard TTH NH90 with user customisations (such as Forward Looking Infrared (FLIR)) and assembled by Australian Aerospace (Figure 5).

Figure 5: MRH-90 Taipan

1.7.2 The Australian Defence Force (ADF) ordered 47 MRH-90s under Air 9000 Phases 2, 4, and 6 as the replacement for the Army's Sikorsky S-70A-9 Black Hawk, and the Navy's SK-50 Sea King. The Navy received 6 MRH-90s for embarked and disembarked maritime support. At the time of the accident, Army was the sole ADF operator of the MRH-90, as the Navy ceased flying MRH-90s on 16 May 2022 to transition to the additional MH-60R Seahawks acquired under Project SEA9100.

1.7.3 The Army aircraft were operated, maintained, supported, and managed by Army and Airbus Australia Pacific and were geographically dispersed between Townsville, Brisbane, Oakey, and Holsworthy.

1.7.4 Relevant A40-040 aircraft data is listed in Table 3.

TABLE 3: AIRCRAFT DATA

CALLSIGN	**BSMN 83**
Aircraft manufacturer	NHIndustries
Aircraft type	MRH-90 Taipan
Helicopter identification number	TAUA40
Manufacturer serial number	1331
Aircraft registration	A40-040
Year of acceptance	2016
Total airframe hours	1108.1
Last service completed	874.9 hours
Next service due	1190.2 hours

1.7.5 **Configuration.** Reference J shows that A40-040 was configured for overwater operations and Helicopter Insertion and Extraction Techniques (HIET), with the enhanced cargo hook, and both the left- and right-hand Fast Roping and Extracting Devices (FRED), and the Central Rappelling and Extracting Device (CRED) fitted. The aircraft was also fitted with the Emergency Flotation System (EFS), a 45 ft caving ladder and a 406 litter kit (stretcher). The aircraft Counter Measure Dispensing System (CMDS) was not armed.

1.7.6 A40-040 was fitted with 12 passenger seats, two of which were turned 90 degrees to face forward.

1.7.7 **Weight and balance.** Weight and balance calculations are a critical element for flight planning and management. The MRH-90 is sensitive to weight variations of fuel, crew and payload.

1.7.8 Reference K (Chart C - Basic Weight and Balance record) is used to calculate the basic weight and balance of the MRH-90. This was last updated for A40-040 on 25 Jul 23, with a basic weight of 7384 kg. Calculation of the basic weight is discussed at Enclosure 2. This basic weight and Centre of Gravity (CoG) is then used by aircrew to determine the weight and CoG for a given mission, taking into account all other equipment, personnel, and fuel used on the aircraft for the flight.

1.7.9 The ASIT was unable to locate the weight and balance documentation completed by the aircrew for the accident flight, however, based on available information (aircraft basic weight, four crew, 1084 kg of fuel, and the role equipment being carried) it is estimated that the aircraft take-off weight was approximately 9137 kg, which is within the weight and balance envelope.

INDIRECT FINDING[2] **It is virtually certain that A40-040 (BSMN 83) was within the approved weight and balance envelope for the mission.**

1.7.10 **Cabin sliding doors.** Depending on the mission profile, the two cabin sliding doors fitted to the MRH-90 may be positioned in either the fully forward (open) or fully rearward (closed) positions. At the time of the accident, BSMN 83 cabin doors were closed.

1.7.11 **Formation lighting.** The MRH-90 has four modified formation lights that operate in the visible (red) and Infrared (IR) light spectrums. NVD formation flight in low ambient illumination conditions requires supplementary external lighting, in accordance with the MRH90 STANMAN[14] (Reference L). The IR All Purpose Adhesive Light Strips (IR-APALS) are an interim supplementary external formation lighting solution used with the aircraft's existing formation lights. IR-APALS are battery powered and turned on by ACMN prior to flight. The IR-APALS settings cannot be adjusted in flight. Figure 6 shows the location of the IR-APALS and the modified formation lights. BSMN formation aircraft were fitted with IR-APALS on the night of the accident, which were 'STEADY ON' in accordance with (IAW) Reference L requirements for the flight.'STEADY ON' in accordance with (IAW) Reference L requirements for the flight.

Figure 6: IR-APALS and modified formation lighting locations

1.7.12 MRH90 STANMAN (Reference L) provides the following guidance regarding aircraft lighting for aided[15] operations:

- Conduct of NVD formation flight in forecast of actual ambient illumination conditions of less than 2 mLx[16] requires supplementary external lighting known as IR-APALS.
- IR-APALS shall be fitted in operating areas with ambient illumination conditions below 10 mLx.

14 STANMAN is the abbreviation for Aircraft Standardisation Manual.

15 Aided denotes night flying operations with NVIS.

16 Millilux (mLx) is a unit of illumination, equal to one thousandth of a lux. For reference, 2 mLx is equivalent to a starlit clear moonless night including afterglow (Paul Schlyter, Radiometry and photometry in astronomy FAQ. 2006)

1.7.13 6 Avn Regt regularly conduct night operations and routinely use IR-APALS for Special Operations (SO) formation.

1.7.14 **Pilot night vision devices.** The MRH-90 Helmet Mounted Sight and Display (HMSD) is an integrated sighting system developed by Thales Group to provide an additional Situation Awareness[17] aid during all phases of flight. The system is designed to enable the pilot to track selected aircraft flight parameters displayed as part of the HMSD symbology set, reducing the need to scan displays inside the cockpit. The system is also capable of overlaying the FLIR (for the flying pilot only) or Night Vision Device (NVD) image through the sighting system with the applicable symbology.

1.7.15 *This information has been redacted due to its security classification.*

This information has been redacted due to its security classification

Figure 7: Thales TopOwl Helmet Mounted Sight and Display system

17 Situation Awareness is the awareness of a large group of factors that are important in keeping the aircraft safe from hazardous situations or a potentially dangerous flight path. See Section 2.17.1.

1.7.16 The IIT has a Field of View (FOV) limited to 40 degrees. Head movement is required to scan for peripheral cues outside the FOV. The 40 degrees FOV is a design maximum. In practice, actual FOV is less than the design maximum (MRH90 STANMAN, Reference L). In comparison to the IIT FOV the average human FOV averages around 200 degree horizontally and 130 degrees vertically depending upon the individual, see Figure 8 (Reference M).

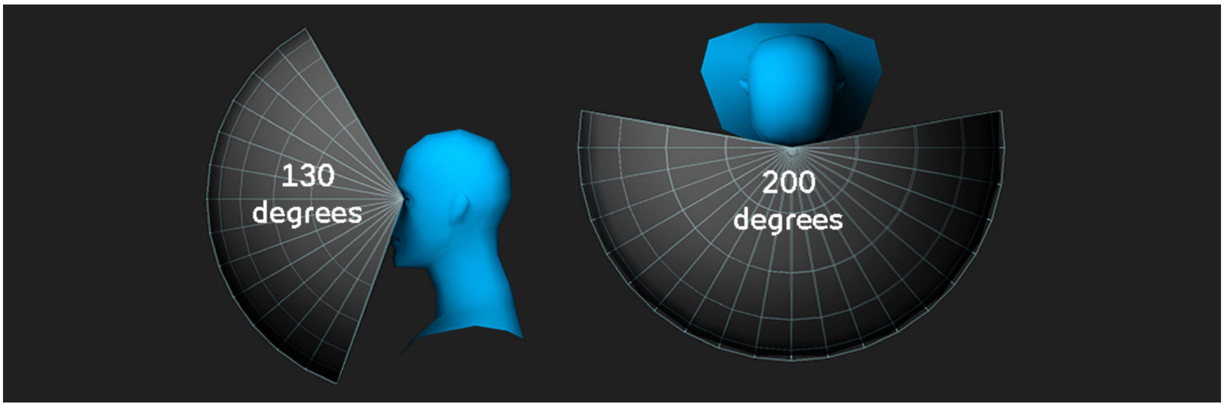

Figure 8: Average human Field of View (Source: Visual Angles | Tobii XR Devzone)

1.7.17 Maintenance of HMSD optical alignment is required to ensure pilots do not succumb to adverse physiological effects that are associated with the system. There are five available checks to confirm serviceability of the HMSD, they are:

a. Pre-flight:

(1) **Hoffman ANV - 20/20 check.** This is a resolution and contrast check to confirm the absence of IIT FOV image anomalies utilising the Hoffman 20/20 Test set for NVD. The check is detailed in the HMSD Operator's Log Book (Reference N). The check is not in Standing Instructions, however, the Operator Log Book does state that the check is to be conducted for night aided operations. There is no alternative test that the pilot can do pre-flight if the Hoffman 20/20 Test set is not available.

(2) **Optical Alignment.** The Optical Alignment is conducted using an LED Board and Alignment Calculator. This is performed by Aeronautical Life Support Equipment (ALSE) maintenance personnel on condition (that is, it is only performed if the aircrew suspect that the HMSD is out of alignment). This process is detailed in the HMSD Operator's Log Book (Reference N), and results are loaded into maintenance software that will alert the personnel conducting the alignment should the HMSD not pass the test.

(3) **Field of View Check.** The FOV Check is performed by ALSE maintenance personnel 'on condition', that is, any indication there is the possibility of an unserviceability. The check is used to confirm serviceability of the IIT.

b. In the aircraft:

(1) **Boresighting Check procedure.** The Boresighting Check is used to confirm the alignment of the helmet-mounted sight with the helicopter azimuth/elevation/roll reference axes and is normally initiated on the ground, but can be done during flight if required to check alignment. The MRH-90 Operator Manual (Reference O) states that the procedure is conducted by the pilots at the beginning of the flight.

(2) **Boresighting procedure.** This procedure, IAW the MRH-90 Operator Manual (Reference O), is required to align the helmet-mounted sight with the helicopter azimuth/elevation/roll reference axes if the Boresighting Check fails.

1.7.18 **Aircrewman NVD.** MRH-90 ACMN use the AN-AVS-9 white phosphorus Aviators Night Vision Imaging System (ANVIS). These are helmet-mounted passive NVDs that amplify existing light sources, such as the moon, stars, and cultural lighting, so that the viewed scene becomes more clearly visible to the operator. Reference P stipulates that, 'Prior to use on a night flight, the first operator of an NVG Set is to perform pre-flight focusing checks using the Hoffman 20/20 Test Set.' If a Hoffman ANV-20/20 Test Set is not available, the next option is to conduct a field test. Similar to the TopOwl IIT, ANVIS has a limited FOV.

1.7.19 **Flight Control System.** The MRH-90 is fitted with an electrical, quadruplex (dual digital, dual analogue) Flight Control System (FCS). The FCS comprises the Primary Flight Control System (PFCS), which controls basic FCS functions, and the Automatic Flight Control System (AFCS) that controls mission task functions.

1.7.20 The MRH-90 is a fully fly-by-wire aircraft that utilises quadruple-redundant equipment to deliver a digital signal to a hydraulic actuator on the control surfaces. The PFCS includes Basic and Backup Modes to assure safety of flight. The Basic Modes include Attitude (ATT), Alignment (ALIGN)[18], Stability Augmentation System (SAS)[19], and Nap of Earth (NOE). NOE comprises two modes: Tactical (TAC) and Stability and Control Augmentation System (SCAS)[20].

1.7.21 The default mode of the system, and therefore primary mode, is the ATT mode. This is an attitude hold mode that maintains roll and pitch information as trimmed by the pilot. In order to change the attitude of the aircraft, the pilot has four options. These include:

a. changing the attitude using the cyclic and then setting the attitude hold function by depressing the cyclic TRIM REL button (Figure 9)
b. changing the attitude using the cyclic and then setting the pitch and/or roll hold functions using the cyclic TRIM switch (also referred to as the FCS cyclic beep trim or coolie hat); known as the calling the trims (Figure 9)
c. using the cyclic TRIM switch to 'beep' trim changes to the attitude reference moving the cyclic against the trim force, which will provide feedback to the pilot

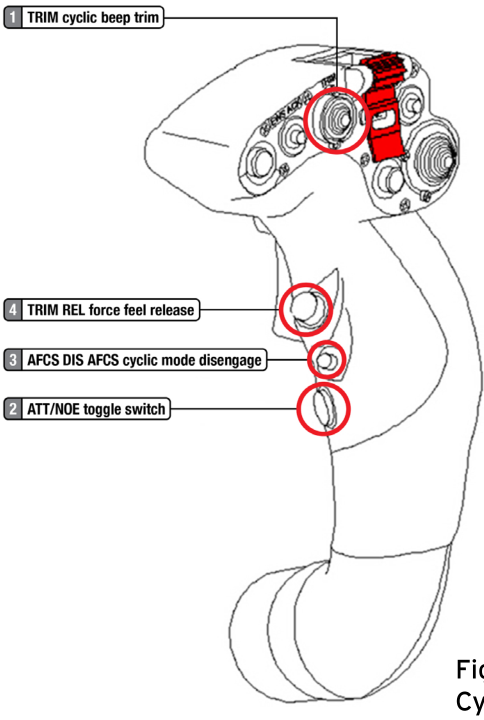

Figure 9: MRH-90 Cyclic Lever Grip

18 Alignment (ALIGN). Default mode when the inertial reference sensors are in alignment phase.

19 Stability Augmentation System (SAS). Engaged when two inertial reference sensors/dynamic sensor units fail. When selected for training (Training – Analogue SAS (T-ASAS)), it simulates the analogue backup used when both digital flight computers are unserviceable. It provides a training minimum stabilisation and uncoupling.

20 Stability and Control Augmentation System (SCAS). This mode includes stabilisation, uncoupling, yaw rate hold in the hover and ball centring in the cruise. This only allows for efficient control of the aircraft with pilot 'hands-on' as it provides short-term attitude retention only.

1.7.22 TAC mode is the more commonly used during NOE flight, being designed for low level or dynamic flying regimes such as formation flying. TAC mode maintains a datum attitude with a trim follow up feature. When utilising this mode the pilot does not need to push the cyclic TRIM REL button and instead moves the cyclic to set a new attitude. The system then follows up the trim to hold this new attitude, creating a smooth flying sensation. The feedback felt by the pilot in TAC mode is significantly less than pushing against the trim in ATT mode as the follow up trim to null feedback occurs faster.

1.7.23 The AFCS complements the flight control system and is commonly referred to as the 'Upper Modes'. Heading hold, Airspeed hold, Radar Height (RHT) Hold, Altitude Hold, Altitude Acquire, Vertical Speed, Transition Up/Down, Hover, Navigation, Approach and Go Around modes are all available to the pilots, however, require the Basic mode of ATT to be in use.

1.7.24 The RHT system is an upper mode of the AFCS and facilitates the capture, acquisition and hold of a desired radar height reference datum through the collective axis. This system must be serviceable for NVD flight, and is to be selected when operating overwater at night, at heights below 500ft above the surface (Reference Q).

1.7.25 **Decision Height.** The MRH-90 is fitted with a height warning system, referred to as Decision Height (DH). The DH warning, displayed as the message 'DH' in the artificial horizon indicator, is shown when the current height is below the selected DH value on the Display Management System (DMS). The 'DH' characters flash for a period of 10 seconds, initialised each time the current height descends below the DH value. While the message flashes, an audio alarm is also activated by the intercommunication system.

1.7.26 The DH value in the DMS can be set independently between the FP and Non-Flying Pilot (NFP). The DH is used for low level and instrument flying operations. Direction on required DH value settings is provided in MRH90 STANMAN (Reference L) and SI(6AVN) OPS 3-209 (Reference R). Table 4 details the DH value set by the BSMN crews on the night of the accident. See paragraphs 2.14.6 and 2.20.19 for more information on DH.

TABLE 4: BSMN FORMATION DECISION HEIGHT SETTINGS FOR EACH PILOT

AIRCRAFT	LEFT-HAND SIDE (LHS)	RIGHT-HAND SIDE (RHS)
BSMN 81	50 ft	0 ft
BSMN 82	80 ft	80 ft
BSMN 83	0 ft	45 ft
BSMN 84	45 ft	0 ft

INDIRECT FINDING[3] **The application of Decision Height settings was inconsistent among the aircraft in the BSMN formation.**

1.8 Meteorological information

1.8.1 The Terminal Area Forecast (TAF)[21] for Hamilton Island Airport, valid for the mission duration, provided by the Bureau of Meteorology (BoM), is shown at Figure 10 below.

```
TAF YBHM 281104Z 2812/2900
13017KT 9999 SCT010 SCT020
FM281800 17015KT 9999 SCT010 SCT020
TEMPO 2812/2821 9999 BKN010
RMK
T 21 21 20 20 Q 1021 1020 1020 1021
```

Figure 10: Terminal Area Forecast for Hamilton Island Airport

1.8.2 Figure 10 is decoded as follows (times in UTC):

a. **Line 1.** Terminal Area Forecast for Hamilton Island Airport, issued at 1104Z on 28 Jul 23, valid from 1200Z on 28 Jul 23 to 0001Z on 29 Jul 23.

b. **Line 2.** Wind from 130° true at 17 kts, visibility greater than 10 km, cloud scattered[22] at 1000 ft and scattered at 2000 ft above aerodrome elevation.

c. **Line 3.** From 1800Z on 28 Jul 23, wind from 170° true at 15 kts, visibility greater than 10 km, cloud scattered at 1000 ft, scattered at 2000ft above aerodrome elevation.

d. **Line 4.** Significant temporary variation from the prevailing conditions for up to 60 minutes between 1200Z and 2100Z on 28 Jul 23: visibility greater than 10 km, cloud broken at 1000 ft above aerodrome elevation.

e. **Line 5.** Temperature 21°C at 1200Z, 21°C at 1500Z, 20°C at 1800Z, and 20°C at 2100Z, Mean Sea Level Pressure 1021 millibars (mb) at 1200Z, 1020 mb at 1500Z, 1020 mb at 1800Z, and 1021 mb at 2100Z.

1.8.3 The TAF for Proserpine Airport, valid for the mission duration, provided by the BoM, is shown at Figure 11 below.

```
TAF YBPN 281112Z 2812/2900
16008KT 9999 SCT012 BKN030
FM281800 18006KT 9999 SCT030
TEMPO 2812/2819 9999 BKN012
RMK
T 17 16 16 15 Q 1022 1021 1020 1022
```

Figure 11: Terminal Area Forecast for Proserpine Airport

1.8.4 Figure 11 is decoded as follows (times in UTC):

a. **Line 1.** Terminal Area Forecast for Proserpine Airport, issued at 1112Z on 28 Jul 23, valid from 1200Z on 28 Jul 23 to 0001Z on 29 Jul 23.

b. **Line 2.** Wind from 160° true at 8 kts, visibility greater than 10 km, cloud scattered at 1200 ft and broken[23] at 3000 ft above aerodrome elevation.

c. **Line 3.** From 1800Z on 28 Jul 23, wind from 180° true at 6 kts, visibility greater than 10 km, cloud scattered at 3000 ft above aerodrome elevation.

d. **Line 4.** Significant temporary variation from the prevailing conditions for up to 60 minutes between 1200Z and 1900Z on 28 Jul 23: visibility greater than 10 km, cloud broken at 1200 ft above aerodrome elevation.

e. **Line 5**. Temperature 17°C at 1200Z, 16°C at 1500Z, 16°C at 1800Z, and 15°C at 2100Z, Mean Sea Level Pressure 1022 mb at 1200Z, 1021 mb at 1500Z, 1020 mb at 1800Z, and 1022 mb at 2100Z.

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21 Terminal Area Forecast (TAF) – A TAF is a coded statement of meteorological conditions expected at an aerodrome and within a radius of five nautical miles of the aerodrome reference point.

22 Scattered (SCT) means the cloud coverages is from 3 to 4 'oktas' (eighths) of sky

23 Broken (BKN) means cloud cover from 5-7 ocktas (eighths) of the sky.

1.8.5 The crews of the BSMN formation reported areas of cloud over land, with orographic lifting observed to be associated with islands in the area. All BSMN callsigns described passing a shower while en route to the initial point (IP)[24] prior to entering the holding pattern, with Hamilton Island being visible through the passing shower. A line of showers was located to the west of the IP and was moving towards the north-west. Showers were observed over Lindeman Island approaching the IP and were moving west.

1.8.6 A weather camera located at Hamilton Island captured the weather conditions in the vicinity of Hamilton Island at 2235K, approximately one minute before the accident (shown at Figure 12). Showers can be observed towards the south-west of Hamilton Island, with areas of clear sky visible to the east and north-east, matching the description of the weather provided by the crews of BSMN.

Figure 12: Hamilton Island Weather Camera at 2235K

1.8.7 The Bowen weather radar depicted showers in the vicinity of Hamilton and Lindeman Islands at 2234K and 2239K, moving north-west, see Figure 13.

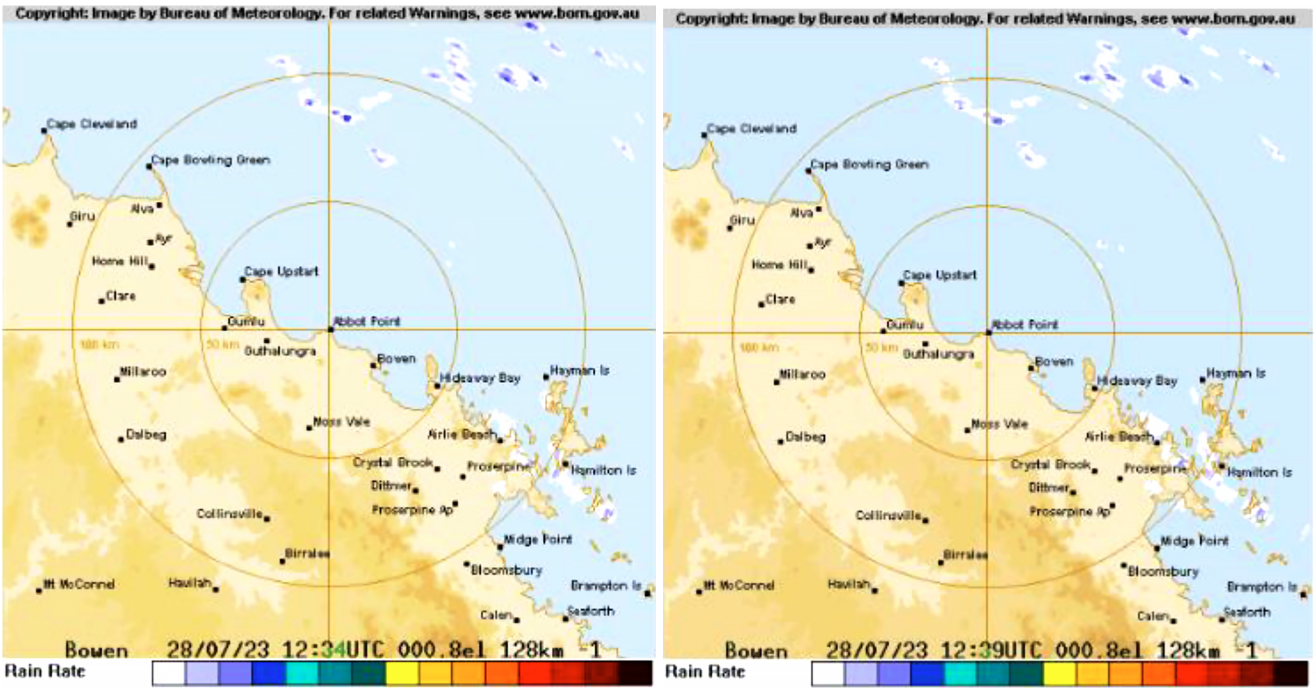

Figure 13: Bowen Weather RADAR, 128 km scale at 2234K and 2239K

24 An IP is the point at which the attack or landing phase of the mission begins.

1.8.8 **Illumination**. Figure 14 is the Darkness Planning Chart presented during Mission Orders. This is the standard illumination planning tool used by 6 Avn Regt. On the night of 28 Jul 23, highlighted by the red box, relevant forecasted data included:

a. Sunset: 1747K

b. End of nautical twilight2[25]: 1837K

c. Moonset: 0250K

d. Lunar illumination: 81%

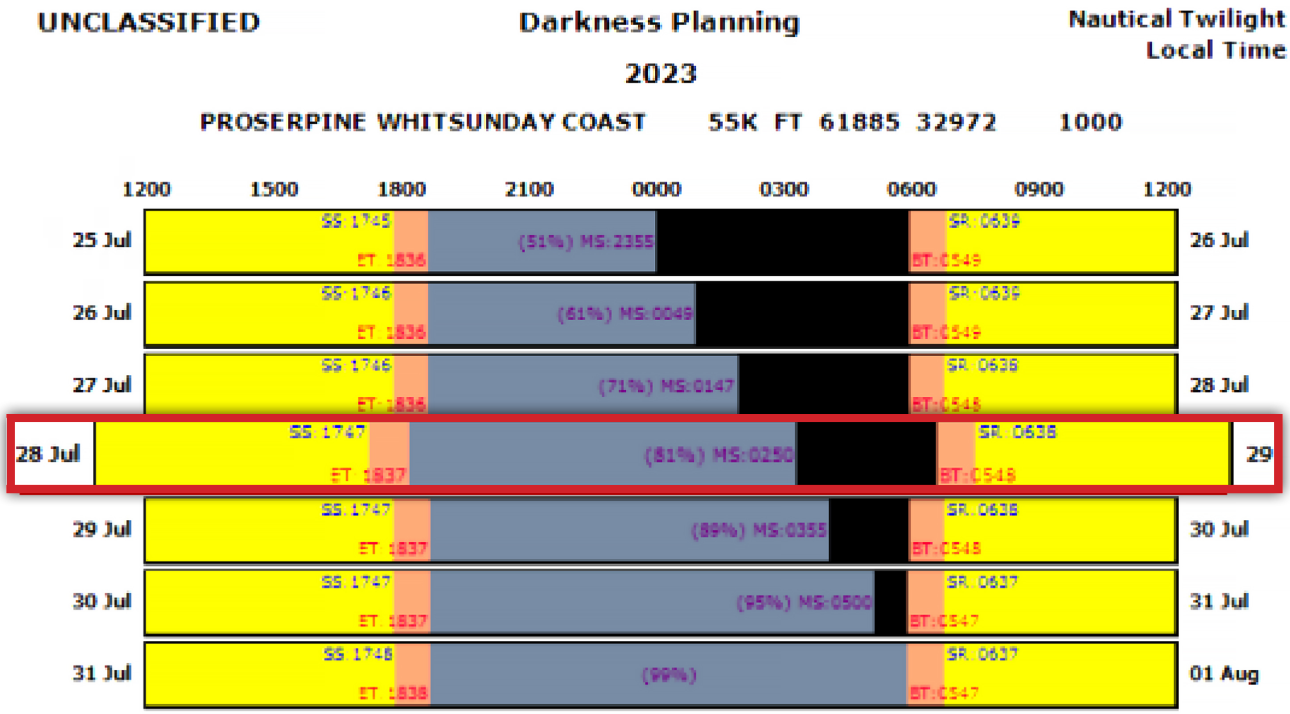

Figure 14: Darkness Planning Chart presented during Mission Orders

1.8.9 The Solar Lunar Almanac Prediction (SLAP) tool was utilised by the ASIT to predict the lunar illumination in the vicinity of BSMN's operating area on the night of the event. Figure 15 shows a lunar illumination of 75%. The Time on Target (TOT) line on Figure 15 depicts Lux values at 2230K, approximately six minutes prior to the event, and provides the following range of values for differing weather conditions:

a. Clear to scattered cloud: 0.025 - 0.049 Lux (25-39 millilux [mLx])

b. Partly cloudy: 0.017 - 0.025 Lux (17-25 mLx)

c. Mostly cloudy: 0.005 - 0.017 Lux (5-17 mLx)

d. Dark overcast: 0.000 - 0.005 Lux (0-5 mLx)

25 Nautical twilight occurs when the sun is between 6 degrees and 12 degrees below the horizon, whereas civil twilight occurs when the sun is between 0 degrees and 6 degrees below the horizon.

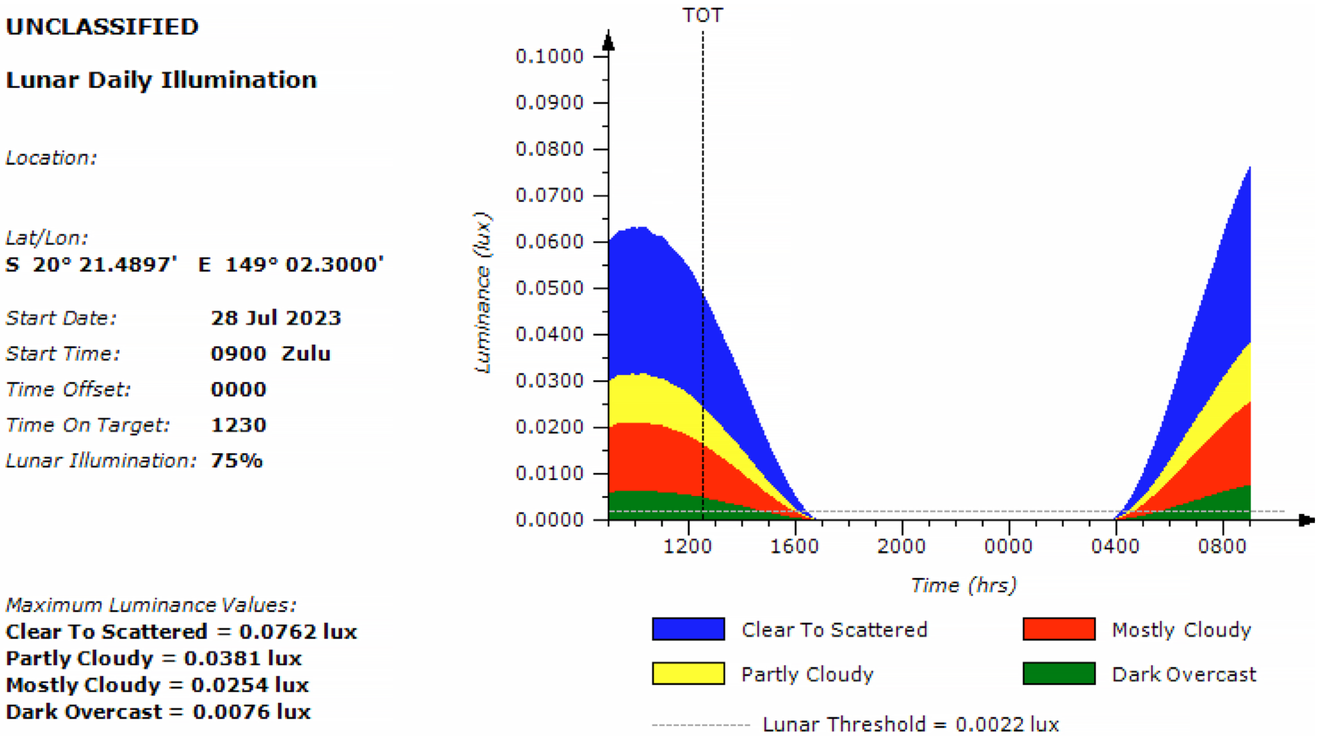

Figure 15: Solar Lunar Almanac Prediction for 28 Jul 23

1.9 Aerodrome and landing zone information

1.9.1 Whitsunday Coast Airport (IATA: PPP, ICAO: YBPN), also known as Proserpine Airport, is located in Gunyarra, Queensland, Australia, 14 km south of Proserpine. It has a single 2073 m asphalt runway and a runway designator of 11/29. Proserpine Airport has an elevation of 82 ft above mean sea level (AMSL).

1.9.2 The formation of BSMN aircraft was intending to land at individual Landing Points within a confined area landing zone on the Lindeman Island golf course. The landing zone elevation was 157 ft AMSL.

1.10 Voice and Flight Data Recorder

1.10.1 The MRH-90's Voice and Flight Data Recorder (VFDR) collects and stores voice (intercom and cockpit area), ambient noise and flight data in the Crash Survivable Memory Unit (CSMU). The CSMU has a solid-state memory capable of storing at least two hours of intercom audio, two hours of audio from the Cockpit Area Microphone (CAM) and up to 10 hours of flight data.

1.10.2 The VFDR is located on the lower shelf of the avionics bay on the left hand side of the aircraft. An Underwater Locator Beacon (ULB) is mounted on the VFDR, and when immersed in water, automatically activates and transmits a pulsed acoustic signal (10 ms pulse once per second at 37.5 kHz) for up to 30 days.

1.10.3 HMAS *Huon's* dive team successfully recovered the VFDR from the ocean floor (40 m) on Monday 07 Aug 23. The VFDR sustained slight external damage to the casing and had seawater ingress. On its recovery, the VFDR was submerged in a container of distilled water for the preservation of evidence and transport.

1.10.4 The CSMU of the VFDRs of the other three formation aircraft (A40-006, A40-008 and A40-029) were also downloaded by the ASIT.

1.10.5 DFSB engaged with Australian Transport Safety Bureau (ATSB) subject matter experts to support data recovery. The ATSB's data recovery lab was used to open A40-040's VFDR for access to the CSMU. The CSMU was cleaned and dried, and its connectors inspected under microscope for damage, and then cleaned. Mega ohm and resistance checks were carried out IAW the Original Equipment Manufacturer's (OEM) instructions and compared to a serviceable CSMU before attempting electrical connection.

1.10.6 A40-040's CSMU was connected to a Common Flight Data Readout Station (FDRS) and a successful VFDR download effected. The following five binary files were downloaded: SN 1025 Data, Audio Aerial, Audio Co-pilot, Audio Intercom, and Audio Pilot files.

1.10.7 The downloaded binary files were converted to parametric flight data and cockpit audio files for further analysis. Analysis of the flight data was carried out by DFSB, supported by Airbus Australia Pacific, NHI and Defence Science and Technology Group (DSTG). The DSTG Report forms Enclosure 3.

INDIRECT FINDING 4 | **A40-040's Voice and Flight Data Recorder (VFDR) functioned correctly and operated as designed.**

1.11 Wreckage and impact information

1.11.1 The aircraft impacted the water approximately 6 nm north-west of Lindeman Island and 3 nm south of Hamilton Island, on a magnetic heading of 116 degrees (south-east direction). BSMN 84 and US AC-130 crews identified an oil slick near the impact site within minutes of the accident. The largest component identifiable immediately after impact was the floating rear fuselage and tail pylon section of A40-040.

1.11.2 Figure 16 shows aircraft debris spread 304 m across the seabed in a south-easterly direction from the impact site, and between 38.5 m to 41 m below the surface on the seabed. Sea floor currents in the area can be up to 4 kts (10 km/h), dispersing the wreckage, and subsequently hampering diving-recovery operations with visibility at times down to 30 centimetres. These conditions also meant that seabed material (sand and silt) covered wreckage items and made it difficult to locate previously identified items. The main wreckage-recovery phase took place between 04 Aug 23 and 15 Oct 23, at which point the ASIT's input to the onsite recovery process ceased. The recovery involved numerous assets from military, police and civilian agencies, with 64 recovery dives completed at an average time of 42 minutes in the water. Further details regarding the aircraft impact site and debris field is provided in the full technical report (Enclosure 2).

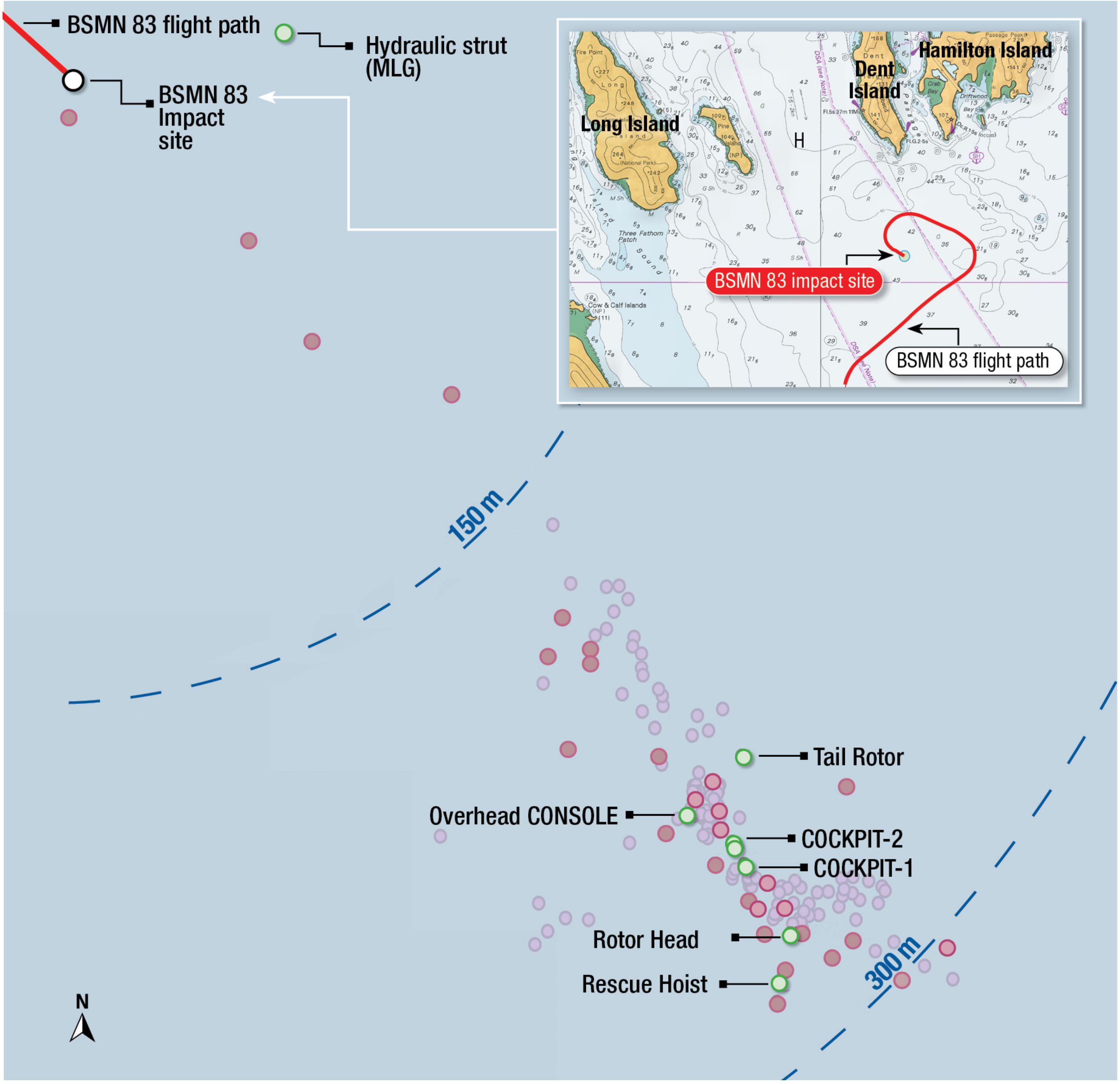

Figure 16: Aircraft impact site and debris field

1.11.3 The ASIT estimated that approximately 70% of the aircraft fuselage was recovered from the debris field, which included a significant amount of fractured pieces of the composite fuselage. The Main Rotor Gear Box (MRGB) assembly and sub-assemblies were recovered from the seabed. The MRGB was significantly damaged and had broken away from the main fuselage. Both engines were intact and remained connected to the MRGB. All four main rotor blades exhibited significant damage, with the outer sections of two (blue and black) blades experiencing substantial delamination and structural disruption. The tail section was recovered from the seabed with the tail rotor gear box (TRGB) and tail rotor blades still attached. Figure 17 is the recovered rear fuselage and tail pylon section. The aircraft floats were recovered as part of the rear fuselage recovery. The flotation equipment had not been activated by either water entry or deployed manually by the crew. Further imagery and details of the recovered wreckage is provided in the technical report at Enclosure 2.

Figure 17: Rear fuselage and tail pylon section

1.11.4 **Recovered Aeronautical Life Support Equipment (ALSE).** Aeronautical Life Support Logistic Management Unit (ALSLMU), as the Centre of Expertise (CoE) for ALSE, assisted the ASIT with the identification and examination of recovered ALSE, including worn ALSE, platform ALSE, and airframe seats and harnesses. Further complementary analysis was conducted by DSTG. Reports are provided in Enclosures 4 and 5.

1.11.5 Recovered ALSE applicable to the investigation, and requiring ALSLMU analysis, was transported to RAAF Edinburgh. This included: all four aircrew helmets[26]; remnants of the four aircrew Air Warrior ensembles including six Seacrewsader Life Preservers; damaged first aid kits; an intact personnel survival C3 pack; damaged components from helmets; and the remnants of the four involved aircrewmembers' clothing.

1.12 Survivability

1.12.1 DSTG and ALSLMU conducted a forensic analysis of the aircraft seating and other life support equipment to evaluate the loads experienced by these items at impact and their performance with respect to crew survivability and their design intent. The DSTG report is at Enclosure 5. DSTG estimated the impact of the G-forces were likely greater than 254 G at the front seat locations, and greater than 84 G at the centre of the aircraft cabin. The crash conditions that aircraft A40-040 was subjected to far exceeded the design requirements for rotary wing aircraft. Both the Medical and DSTG reports assess that the accident was not survivable.

26 The four aircrew helmets were recovered from the surface in the vicinity of the accident site within the first few hours of the search and rescue (SAR) operation.

INDIRECT FINDING[5]	Impact forces exceeded design requirements for the aircraft.

INDIRECT FINDING[6]	The accident was not survivable.

1.12.2 **Airframe seats and harnesses.** ALSLMU assisted the ASIT with identification of the recovered airframe seats and harnesses. Recovered troop seats were identified via harness strap serial numbers, with most seats recovered. Only the upright frame of the position 10 troop seat was recovered, and therefore the troop seat and associated harness could not be inspected to verify if the senior aircrewman was restrained by the harness at impact; noting this was the probable assigned seat of the RH ACMN. The expected position of the LH ACMN in a seated position is seat position 9, rearward of the left cabin door. The troop seat from position 9 was recovered, inspected and although the seat frame had significant damage, there was limited damage to the harness, with ALSLMU finding it likely the belts did not restrain any weight during the impact. ALSLMU assessment concluded that based on the evidence available, both ACMN were 'on harness' at the time of impact.

1.12.3 Both the left and right cockpit seats were recovered along with their seat cushions. There was significant damage to the right cockpit seat, lower right side and seat structure assembly. The left cockpit seat showed significant tearing to the seat pan. The seat cushions are not serial number tracked or fitted to specific positions identified in the maintenance records. However, ALSLMU was able to visually match each cushion to the applicable seat by comparison of the damage sustained to each seat and cushion. The damage to the left cockpit seat pan, aligned with a torn area on the left side of the central seat pan cut-out area of one of the seat cushions. This damage was also consistent with damage identified on the CP's Air Warrior Leg Straps. ALSLMU assessed that the CP was occupying the left cockpit seat, with the AC occupying the right seat at the time of the accident.

1.12.4 The right seat left lap belt and negative G-strap webbing belt was severed with various abrasions to the seat's other belts. The right lap belt was disconnected with no significant visual damage to the rotary buckle. The left seat negative G-strap was torn from its mounting point on the underside of the seat pan. However, there was limited damage to the rotary buckle and only abrasions to the harness assembly with no belts connected within the rotary buckle. DSTG forensic teardown of the buckle did not show any indications of a mechanical failure that could have resulted in uncommanded release of the restraints. In summary, the analysis was fastened at the time of impact, with the exception of the right lap belt, while the left pilot seat harness was likely not securely fastened at impact. Analysis was not able to determine the reason for this configuration.

1.12.5 **Aeronautical Life Support Equipment (ALSE).** DSTG analysis of the two basic helmets (Figure 7), worn by the AC and CP, indicated that the helmets sustained significant damage. DSTG analysis determined that the impact forces likely exceeded 10 kilonewtons (kN).

1.12.6 The AC's Air Warrior Primary Survival Gear Carrier (PSGC) was not recovered. Examination of the recovered Low Profile Flotation Collar (LPFC) showed the casing was torn, however the buoyancy chamber was intact. ALSLMU assessed the CP's Air Warrior PSGC was catastrophically damaged during the accident with the left side of the buoyancy chamber torn away. The RH ACMN's PSGC was mostly intact, with the right side pouches torn. The buoyancy chamber was recovered partially packed in the LPFC and was largely undamaged. The LH ACMN's PSGC had damage largely on the left side, with the buoyancy chamber partially stowed in the LPFC.

1.12.7 ALSLMU found no evidence suggesting any attempts by crewmembers to activate the flotation chambers nor access any of the survival aids contained within the Air Warrior PSGC. ALSLMU's analysis of the recovered ALSE assessed the impact forces were un-survivable and outside of the expected survivability design limits of the worn ALSE. Furthermore, DSTG assessment on the crashworthy performance of the aircraft cabin and seats, considered against the design specifications, could not be determined as the impact of the aircraft significantly exceeded the design impact conditions for cabin structure and seating.

1.12.8 The ALSLMU report, Investigation into Recovered Aeronautical Life Support Equipment MRH-90 Taipan (A40-040) – Accident – 28 July 2023 (Enclosure 4), identified a number of issues related to maintenance, procedures, documentation and unserviceabilities of 6 Avn Regt ALSE management. In particular, the standardisation and application of maintenance and procedures for the management and continuous charge of ALSE was found to be suboptimal. The ASIT notes the ALSLMU report findings and recommendations are necessary for ALSE safety improvement, but found these issues to be non-contributory to the accident on 28 Jul 23. The ALSLMU report (Enclosure 4) is sensitive in nature, and will be retained in the custody of Director DFSB.

INDIRECT FINDING[7]	**6 Avn Regt ALSE standardisation and application of maintenance and procedures for the management and continuous charge of ALSE was suboptimal.**

1.13 Aeromedical considerations

1.13.1 The RAAF Institute of Aviation Medicine (IAM) provided aeromedical investigation support to the ASIT. The comprehensive medical report is at Enclosure 6, however, due to the sensitive and Medical-In-Confidence nature of aeromedical investigation information, this report is retained in the custody of the Commanding Officer (CO) of IAM. Details can only be viewed by an ASIT-approved medical officer, or by authorisation of CO IAM (Reference A).

1.13.2 The report states that, from an aeromedical perspective, the impact forces experienced by the airframe and occupants were far in excess of the design crash-protection specifications for the airframe, ALSE, and human impact tolerances to short duration accelerations. The identity of each crewmember was established by the Queensland Coroner.

FINDING[8]	**Impact forces experienced by the crew of BSMN 83 far exceeded human impact tolerances.**

1.13.3 **Crew incapacitation.** Crew incapacitation following a medical event was considered unlikely. VFDR voice recordings leading up to the point of impact do not indicate a medical event, nor incapacitation by any crewmember. Review of crew medical documents (Enclosure 6) identified that all four members of the crew were in-date for the Medical Employment Category and Specialist Employment Category – Aircrew fitness. While both pilots had a 4-3 medical restriction (Requires periodic access to specialist care), IAM assessed those conditions were appropriately managed. Enclosure 6 states that, 'Medical incapacitation of a pilot, in particular the FP is not considered to be a contributory or causal factor in the crash.'

INDIRECT FINDING[9]	**There was no evidence of incapacitation of the crew of BSMN 83 prior to impact.**

1.14 Search and Rescue

1.14.1 Reference S contains the Ex TS23 Search and Rescue (SAR) Plan, detailing procedures to be used in the event of an aircraft accident involving ADF and foreign military. The document states the roles and responsibilities when responding to real-world (vice exercise simulated) SAR requirements. SAR takes precedence over exercise activities, which are to be suspended in the affected area for the duration. Civilian assets may be used to support military SAR operations.

1.14.2 In the event of a real-world SAR, tactical commanders were to coordinate the immediate response with organic capability, and alert the chain-of-command. Notification was required to be made to the Combined Exercise Control Group (CECG) Main, CECG Air Response Cell, and HQ Joint Operations Command – Air Operations Centre Joint Personnel Recovery Centre.

1.14.3 BSMN 84 witnessed BSMN 83 impacting the water, and immediately called, 'Knock it off, knock it off, knock it off,' on formation frequency. The AC of BSMN 84 assumed Scene of Action Commander (SAC), and alerted the remainder of the formation that BSMN 83 was in the water. BSMN 84 directed BSMN 81 and 82 to hold to the east, not below 500 ft.

1.14.4 At 2237K BSMN 84 alerted Unit Operations[27] at Proserpine Airport. BSMN 84 transmitted, 'No Duff real time Fallen Angel' (code words to indicate a real-time crashed helicopter), to all exercise callsigns in the vicinity. BSMN 84, as SAC, commenced search operations over the accident site, and requested all available assets in the immediate area to assist. There was initial confusion by non-ADF participants as to whether this was a real event, however, this was quickly cleared up through the use of common and non-military specific language.

INDIRECT FINDING[10]

BSMN 84's communication of the accident and use of operational codewords and terminology initially caused confusion with non-ADF participants as to whether this was a simulated exercise scenario or a real aviation accident.

1.14.5 Unit Operations stood up the Emergency Co-ordination Centre (ECC), and commenced the 6 Avn Regt Emergency checklist. At 2247K BSMN 84 advised CO 6 Avn Regt of the accident and provided a situation report. At 2247K, the Australian Maritime Safety Authority[28] (AMSA) was notified that an MRH-90 participating in Ex TS23 had ditched in the vicinity of Lindeman Island. In accordance with Ex TS23 and Military SAR procedures, 6 Avn Regt continued the immediate SAR response, using BSMN 84, 81 and 82. The ECC, in consultation with HQJOC and AMSA coordinated additional assets to support the air and sea response. At 0427K 6 Avn Regt officially requested AMSA run the coordination of the aviation and maritime SAR.

1.15 Defence Flight Safety Bureau (DFSB) notification and response

1.15.1 The DFSB Duty Officer was notified of the accident by phone at 2316K on 28 Jul 23, and convened an Immediate Response Meeting. The ASIT was formed and deployed via military air to Proserpine, arriving in location within 24 hours of the accident. The ASIT was met by Commander 16th Aviation Brigade (16 Avn Bde) who briefed the locations of quarantined documents and personal items of evidence. When the ASIT arrived, the crews of BSMN and most of the 6 Avn Regt detachment had relocated from Proserpine back to Holsworthy, NSW. Queensland Police had begun evidence recovery and processing. The ASIT began processing evidence on Sun 30 Jul 23, but were hampered by the concurrent dismounting of the Proserpine camp. On 30 Jul 23, a second ASIT team deployed to 6 Avn Regt in Holsworthy to conduct witness interviews. ALSLMU arrived in Proserpine on 01 Aug 23 to support the ASIT in identifying and processing ALSE evidence. The 6 Avn Regt detachment Aviation Medical Officer (AVMO) was on site at the time of the accident, and acted under the direction of the Senior AVMO (SAVMO) until their arrival.

27 Unit Operations were the 173 SOAS tactical operations cell, who manage mission support for 6 Avn Regt operations.

28 AMSA are Australia's national agency responsible for maritime aviation search and rescue.

1.16 Tests and research

1.16.1 A number of tests and research were undertaken to support the investigation. These are listed, along with the organisations who supported these activities, in Annex F.

1.17 Organisational and management information

1.17.1 **Statement of Operating Intent and Usage (SOIU).** Reference T is the SOIU for the MRH-90 Taipan. The SOIU V1.0 was issued on 30 Jan 19, jointly approved by Commander Australian Fleet (COMAUSFLT) and Commander Forces Command (COMD FORCOMD) and endorsed by DASA on 18 Dec 18, as required by DASR ARO.50 – Statement of Operating Intent and Usage (Reference U).

1.17.2 The Army AVNCOMD Military Air Operator (MAO) Operations Compliance Statement (OCS) Version 1.2 dated 11 Jul 2023 (Reference V), states that the Director Aviation Capability Management (DACM) as the capability manager representative and sponsor of the SOIU is responsible for the annual review and amendment of SOIUs for all Army aircraft types. The SOIU had not undergone amendment since 2018 and had not included an update for 6 Avn Regt MRH-90 operations.

1.17.3 **Commander Aviation Command (COMD AVNCOMD).** COMD AVNCOMD is the Military Air Operator – Accountable Manager (MAO-AM)[29] for Army Aviation. Army AVNCOMD was issued a Military Air Operator Certificate (MAOC) on 16 Sep 21 (Reference W) which authorises Army military flight operations.

1.17.4 **Hazard Tracking Authority.** Deputy Commander (DCOMD) AVNCOMD was the Hazard Tracking Authority (HTA) for Army Aviation at the time of the accident. HTA's primary duties include responsibility for hazard identification, safety risk assessment and mitigation, and chairing Aviation Hazard Review Boards to ensure all appropriate aviation safety investigation actions have been taken and recommendations actioned.

1.17.5 **16 Avn Bde.** 16 Avn Bde is a subordinate formation to HQ AVNCOMD. Commander (COMD) 16 Avn Bde is responsible to raise, train and sustain Army Aviation units, to maintain preparedness in accordance with the CDF Preparedness Directive (CPD), and prepare force elements for operations. COMD 16 Avn Bde retains command and control of subordinate aviation regiments and sub-units unless deployed or force-assigned to another HQ (for example, under Theatre Command to Commander Joint Operations). Regardless, COMD 16 Avn Bde retains responsibility for command, aviation safety and Technical Control (TECHCON) of subordinated aviation regiments. These authorities are delegated IAW Reference X.

1.17.6 **6 Avn Regt.** 6 Avn Regt is the Special Operations Regiment of 16 Avn Bde. It provides mobility and assault support to special operations in a combined, joint or inter-agency environment. 6 Avn Regt is subordinate to 16 Avn Bde, but Operation Control[30] (OPCON) is held by Special Operations Command (SOCOMD). 173 SQN is one of the two flying squadrons of 6 Avn Regt, and was the parent unit for accident aircraft and crew.

1.17.7 The Army Aviation organisational structure at the time of the accident is depicted at Figure 18.

29 ASR defines the Accountable Manager (AM) as the person designated by the Approved Organisation, and identified in the Organisation Exposition or Compliance Statement, who is accountable for maintaining safety standards required by relevant DASR and any additional standards specified.

30 OPCON is the authority delegated to a commander to direct forces assigned so that the commander may accomplish specific missions or tasks, usually limited by function, time or location. It does not include administrative or logistic control.

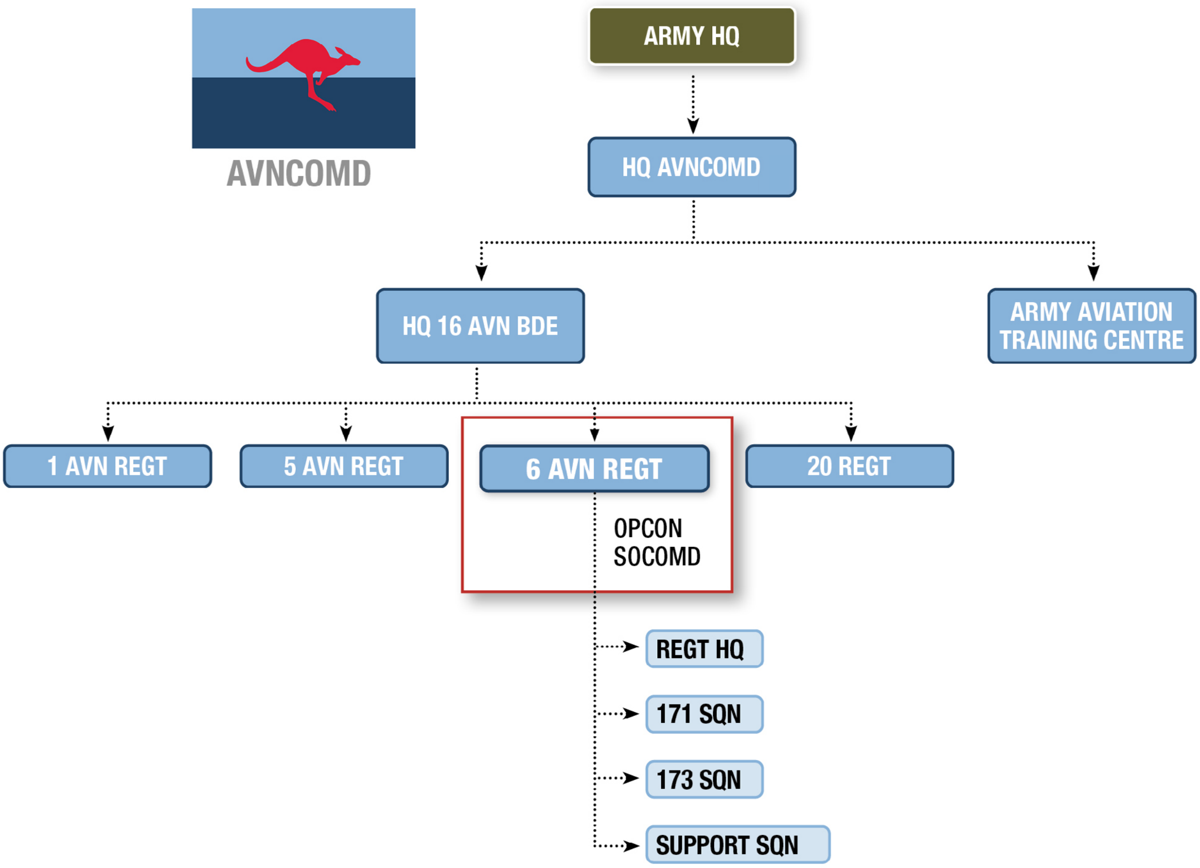

Figure 18: Organisational structure

1.18 Previous related Aviation Safety Reports

1.18.1 Similar occurrences. The ASIT reviewed past aviation safety accident and incident reports from DFSB records, foreign military, and civilian accident reports, using the following broad parameters that were identified as possible lines of enquiry:

a. Operations – Night Vision Imaging System (NVIS) operations, formation flight, aircraft protection systems, Non-Technical Skills (NTS) including spatial and Situation Awareness, scan and monitoring

b. Organisational – risk management, policy and training related to the above themes, fatigue management, supervision and authorisation aspects.

1.18.2 There were multiple Aviation Safety Reports (ASRs) directly related to Spatial Disorientation (SD) and loss of Situation Awareness (SA) in Defence Aviation, with the majority specific to rotary wing operations. Many of those were related to NVIS operations, and many also were during formation operations. This was also evident in review of foreign military accidents. Accidents and incidents of note include:

a. **MH-60R CFIT on Approach to HMAS *Brisbane*, 13 Oct 21 (DEFEV21100447).** During a night-aided circuit to HMAS *Brisbane*, the aircrew were subjected to an infrared illumination associated with a CCTV camera on the ship. The NVGs subsequently bloomed, removing the aircrew's primary visual reference with the ship at 150 ft above sea level. The aircraft impacted the water 19 seconds later 240 m aft of Brisbane and all aircrew successfully egressed the helicopter. The ASIT identified a degradation of Situation Awareness of both the AC and AvWO as well as an absent instrument scan. The ASIT determined this was an organisational event with many contributing factors eroding the safeguards in place. Relevant to the above themes, the ASIT identified a lack of depth in aviation risk management, and a reliance on administrative controls. The ASIT also noted the potential for safety and risk management gaps during operations that span separate, complex and interconnected systems (in the case of this accident, ship and helicopter operations).

b. **Ex VS20 Multi Role Helicopter inter-formation loss of separation, 11 Nov 20 (DEFEV20110489).** As part of Exercise VIGILANT SCIMITAR 2020, three MRH-90s from 5 Avn Regt were conducting a series of tactical flying sorties in combination with Tiger Armed Reconnaissance Helicopter (ARH). At night using NVD in formation, an MRH-90 took evasive action to avoid a separation breakdown with the MRH-90 lead. After completion of this manoeuvre, the two MRH-90s tracks converged, resulting in the trailing MRH-90 passing in front and slightly below the lead MRH-90 at a calculated distance of 40 ft (12 m). The ASIT determined the pilot lost Situation Awareness and had reduced recency in night formation flying preceding the exercise. Low illumination was a contributory factor, which was not addressed adequately at the flight authorisation stage. The ASIT identified previous occurrences, which had not been addressed appropriately, as well as poor risk management, particularly when considering the cumulative risk in proficiency and experience for the exercise.

c. **173 SOAS MRH-90 - Reduction in obstacle clearance during NVD formation landing abort, 09 Jun 20 (DEFEV20060374).** At night under NVD during a heavy right formation approach to landing the CP flying cross-cockpit lost visual references with the preceding aircraft as the formation entered a rain shower. The formation aborted the landing and the aircraft came within 35 ft of rising terrain. The ASR highlights poor weather, fatigue, communication, high workload and organisational pressures as contributing factors. The reviewer notes overall diminished experience and exposure to adverse weather as a consideration to panelling on Special Operations Qualification Course (SOQC) versus applying additional weather restrictions on crew in order to maintain capability.

1.18.3 Common themes that emerged from SD-related accident and incident reports included poor weather and low illumination, overwater, NVIS operations and NTS deficiencies. Of the SD events where the crews recovered successfully, recovery risk controls including aborting, handing over or intervention by another pilot. Communication, reversion to known drills and patter, good NTS and automation were all seen as defences. Civilian accident reports also highlighted the importance of education, training and crew communication as a defence. Broadly, Type I SD (Unrecognised) (defined at paragraph 2.17.5), was the most likely to result in catastrophic outcomes.

1.18.4 **Other relevant occurrences.** The ASIT looked particularly at ADF aviation accidents and incidents when considering organisational factors related to lines of enquiry. The search and summary was not exhaustive, but focused on accidents and serious incidents where more detailed review of organisational factors was conducted. The ASIT identified a number of enduring issues, which align with areas of opportunity noted in more detail in later parts of this report. These issues included, hazard identification, risk management, crew experience levels and recency, and organisational learning. Of particular note, and discussed in more detail in the Organisational Influences section of this report, were deficiencies and enduring challenges with Army Aviation's ability to track ASRs, implement actions and recommendations and effect organisational change in a timely manner. As well as those already described, the ASIT also identified the following accidents and incidents of note:

a. **ARH TIGER A38-021 Wire-strike on 11 Jun 19 (DEVEV19060365).** An ARH Tiger, from the School of Army Aviation was conducting an instructional flight near Oakey, Queensland. The aircraft struck suspended electrical wires while conducting 'Nap of the Earth' flying. This investigation concluded that although crew actions were contributory to the wire-strike, deficiencies in organisational compliance and risk management exposed the crew to a significant safety event that Army had previously experienced (AAvNTC -026-2012, ARH Tiger A38-026 Wire Strike on 8 Mar 12).

b. **MRH-90 Engine Failure resulting in Ditching, Jervis Bay, NSW, 22 Mar 23 (DEFEV23031302).** The ASIT acknowledges that the investigation into this accident, and the subsequent report had not been completed at the time of the A40-040 accident on 28 Jul 23. The Jervis Bay accident was the result of a catastrophic, contained engine failure of the left-hand engine. The investigation highlighted deficiencies in the integration and communication of operational and airworthiness hazard identification and risk management, Orders, Instructions and Publications (OIP), crew experience and NTS.

c. **Maintenance Policy Overfly of MRH-90 Pintle Axle BS3 and MRH Policy Review, of 17 Apr 20 (DEFEV20040254).** The ASIT determined the Pintle Axle overfly event occurred as a result of a decision error made by an Airbus Australia Pacific (AAP) Maintenance Requirements Determination analyst when attempting to apply an Original Equipment Manufacturer (OEM) maintenance policy change into CAMM2 (Aircraft Computer Aided Maintenance Management System). A review of the actions to address deficiencies impacting the MRH-90 enterprise identified in excess of 500 recommendations from numerous documented audits, reviews and investigations into MRH-90 continuing airworthiness and maintenance complexity. In order to determine why past recommendations lacked the efficacy to reduce the recurrence rate of maintenance overfly events, the ASIT noted that only 29% of the recommendations instigated could be tracked and that a number of open recommendations had no supporting evidence of action/implementation.

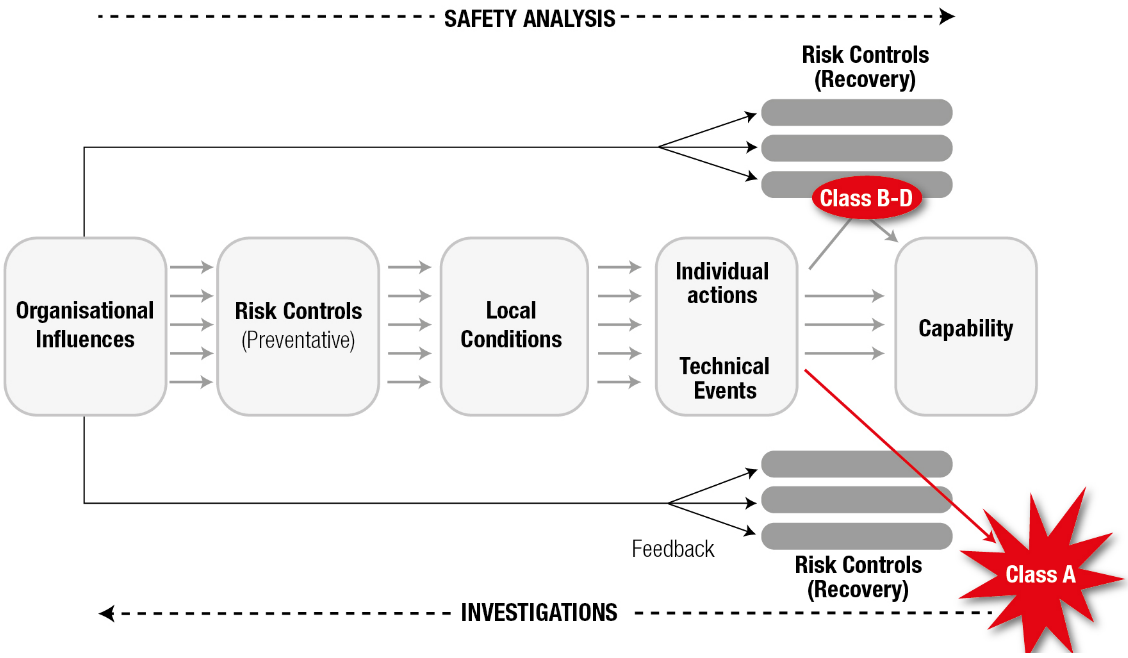

Figure 19: Defence Aviation Safety Analysis Model

ANALYSIS

2.1 Analysis methodology

2.1.1 The ASIT analysis used the Defence Aviation Safety Analysis Model (DSAM) (Figure 19) (Reference Y) to identify the individual or team actions that contributed directly to the event, and then identified the subsequent contributory factors:

a. **Individual and team actions.** Individual actions are always committed actively (someone did or did not do something) and have a direct relation with the event. They are observable behaviours performed by operational personnel. Although individual actions can both reduce or increase risk, when the term is used it can be taken to refer to individual/team actions that increase risk.

b. **Local conditions.** Local conditions are those conditions that exist in the immediate context or environment in which individual/team actions or technical failures occur and can have an influence on the individual/team actions or technical failures. Local conditions include the characteristics of individuals (for example knowledge, skills of the individual or team, team interactions, and personal factors), the equipment involved, as well as the nature of the task and the environment (for example the workspace, the physical environment, and weather).

c. **Absent, partially failed, or failed risk controls**. Risk controls are the measures put in place by an organisation to facilitate and assure safe performance of the operational components of the system. Absent or failed preventative and recovery risk controls can be viewed as holes in an organisation's safety management system.

d. **Organisational influences.** Organisational influences are those conditions that establish, maintain or otherwise influence the effectiveness of an organisation's risk controls. They include safety management system processes, organisational resources, planning and communication.

2.1.2 **Just Culture.** The DSAM emphasises that unsafe acts have a key role to play in the development of safety events and accidents. However, the origin of unsafe acts often lies in management systems, not with the individuals who may have made the unsafe acts. In other words, the model emphasises a whole-of-system approach towards improving safety rather than focusing on the individuals who initiate or undertake unsafe acts.

2.1.3 Any actions taken by command in preventing the recurrence of a safety incident must be carefully considered. Central to achieving a generative safety culture is the fair and just treatment of individuals. Disciplinary or administrative processes that may be associated with the event must be managed separately in order to preserve a generative safety culture and a willingness to report.

2.1.4 More information on the DSAM is available in Reference Y and on the DFSB website. In order to ensure that the context of the crew actions is understood, the report commences with the event sequence in chronological order. Significant findings, in line with the DSAM levels are in the conclusion.

2.2 Technical report

2.2.1 Examination of the wreckage of MRH-90 Taipan A40-040 did not identify any existing damage to the airframe and major systems nor any malfunctions of major systems throughout the flight or prior to impact with water. The degree of aircraft damage is indicative of the last flight data recordings of 135 KIAS and a 5200 ft/min descent rate, suggesting the aircraft impacted the water at high speed. Damage to the main rotor components revealed that the rotor blades were turning at high speed, with the engines operational and driving the rotors at the time of impact. The Aviation Safety Investigation Team (ASIT) could find no evidence of fatigue damage or pre-impact failure of the airframe or major aircraft systems within the scope of the investigation.

2.2.2 Analysis of data acquired from the Voice and Flight Data Recorder (VFDR) confirmed there were no discrepancies between the pilot's physical control inputs and aircraft's Flight Control System outputs.

2.2.3 The technical investigation concluded that the aircraft impacted the water on the front left-hand side of the airframe in a nose down and left-wing-low attitude. This was drawn from evidence related to the presence of cockpit components in the rear fuselage and associated impact damage to the airframe and major systems. Of note, the Preliminary Report (Reference Z) indicated that the aircraft might have impacted the water at an angle of bank to the right. Since the last data reading was 1 to 2 seconds prior to impact, it would not have picked up the attitude change from right bank to left bank.

2.2.4 The ASIT concluded that the aircraft's major systems such as engines, gearboxes, main and tail rotor transmissions, and flight controls were operating normally and were serviceable throughout the flight and at impact with the water. Within the scope of the investigation, the ASIT could not find any evidence of an aircraft unserviceability during the technical Lines of Enquiry (LOE).

2.2.5 The technical report is at Enclosure 2.

INDIRECT FINDING[11]	To the extent by which the ASIT could examine the wreckage and analyse the Voice and Flight Data Recorder (VFDR), there was no evidence of technical failure of the aircraft or major systems.

2.3 Exercise TALISMAN SABRE (Ex TS23)

2.3.1 Ex TS23 is a bilateral US/Australian military exercise, the largest conducted in Australia. In 2023, 19 countries participated in the exercise, using multiple Defence and non-Defence training areas. Ex TS23 is a key opportunity to test multinational operations.

2.3.2 **Command and control.** 6 Avn Regt crews were augmenting a US-led Combined Joint Special Operations Task Group to support all SO aviation activities. 6 Avn Regt had been operating in its assigned location for five days prior to the accident.

2.3.3 **Tasking.** Four MRH-90 aircraft from 173 SOAS, 6 Avn Regt, were to conduct a Full Mission Profile (FMP) 2, which was later amended to an extraction of Ground Force Elements (GFE) from Lindeman Island on Fri, 28 Jul 23. The mission was planned to be flown on 27 Jul 23, but due to a delay with the previous FMP 1 mission, and a rotation of the GFE required for FMP2, it was delayed to 28 Jul 23. Mission Orders detailed a heavy left formation under callsign BSMN, with each aircraft identified as BSMN 81 (Lead) through to BSMN 84 (trail aircraft). The mission was to take off from Proserpine Airport, transit over land and water to Lindeman Island at low level, before landing at pre-determined landing points for the GFE extraction. The extraction was to be called on order, which required the formation to remain at Proserpine Airport until the first code word, and then after transit, hold in position until the extraction code word provided direction to extract the GFE.

2.3.4 **Planning and preparation.** Planning for the mission commenced 24 hours prior to the Mission Orders, and involved the four BSMN crews and the Standards Officer (GFE Liaison). Members of the crew worked through until approximately 0100K on the morning of the event. The crew and formation configuration had been determined by the Troop Commander (TPCOMD) and Qualified Flying Instructors (QFIs) the night before. The event pilots were considered 'junior' SO pilots[31], therefore, the STDS ACMN was crewed on BSMN 83 to provide additional experience to the crew as a whole. Planned duty day was to begin at 1300K, and finish no later than 0300K, a planned crew duty day of 14 hours.

2.4 Day of event

2.4.1 **Start of duty.** Duty for the day commenced at 1300K, and crewmembers woke for the day between 0830K and midday. Detailed analysis of work and rest cycles for the accident crew is in section 2.19. Members of the formation described the day as an unusually low-tempo day, in that there was ample time to prepare for the flight post orders. Crews described the preparation as relaxed.

31 The statement 'junior' is specific to Special Operations tasking, not overall experience levels. Based on interviews, the AC completed Special Operations Qualifications Course (AC) in November 2022 and the CP completed the Special Operations Qualification Course (CP) in June 2023. See Table 1.

2.4.2 **Departure of detachment Troop Commander (TPCOMD).** On the afternoon of the event day, the detachment TPCOMD departed Proserpine to return to Holsworthy. TPCOMD and associated duties were transferred to BSMN 83 AC.

2.4.3 **Mission Orders.** Mission Orders commenced at 1410K, which was 10 minutes later than planned. Orders took approximately 60 minutes and covered necessary mission details. Orders were delivered by the Flight Lead (BSMN 81 CP), who was being assessed as part of their SO Captaincy Competency in accordance with the Unit Training Assessment Program (UTAP) [32]. Other members of the formation delivered weather and the S2 (intelligence) picture, as per Standard Operating Procedures (SOPs)[33]. Orders included routine and acute hazards expected on the mission, and risk management in place. The mission was considered by BSMN crewmembers as non-complex as it did not involve an SO approach. The Forward Arming and Refuelling Point (FARP) and the refuel plan for the formation was considered the highest risk to the mission (as noted in Mission Orders, and in interviews). The following key points were addressed in Mission Orders:

a. **Doors.** The event mission had been planned and briefed to depart Proserpine Airport with the doors in the open position.

b. **Flares.** Orders included a plan to conduct a flare-dispense event following the GFE extraction. This would enable crews to complete a UTAP requirement for Countermeasure Dispense (CMD) Qualification. Flares were loaded on BSMN 81 and 82. Crews were briefed on the requirements for the different phases of flight (minimum 2 RD separation for the majority of the mission, and then 7 RD separation during the flare dispense phase).

c. **Meteorological information.** The forecast weather briefed for the mission met the criteria for 'Normal' conditions for NVD flight; 1000 ft cloud base and 3000 m visibility with no recovery planning requirements (Reference AA). Interviews found that CO 6 Avn Regt had stipulated to the Air Mission Commander that no missions were to be conducted in less than Normal conditions; therefore, as risk-mitigated, the mission was able to proceed as planned. Moon Illumination was 75% with local cloud covering 5-6 eighths of the sky.

INDIRECT FINDING[12]	Forecast weather and illumination conditions were within authorised limits for the mission to proceed.

2.4.4 **HMSD.** The AC of BSMN 83 requested a HMSD pre-flight visual resolution and contrast check[34]; however, was informed by maintenance personnel that the Hoffman 20/20 Test Set for NVD was not available. 6 Avn Regt had only one serviceable test set at the time of Ex TS23, and priority was for that to remain at the unit. Aircrew may conduct an alignment check, and equipment was available to support that on deployment, though this does not check resolution and contrast.

INDIRECT FINDING[13]	6 Avn Regt deployed to Ex TS23 without a Hoffman 20/20 Test Set.

2.4.5 The ASIT noted that the crew did not report any HMSD anomalies pre-departure (there were spare HMSDs in location that could have been switched out if required). There was no commentary recorded on the VFDR voice data that would indicate a failure, IIT FOV anomaly, or suggestion of physiological effects that could be related. The ASIT therefore consider it very likely that the HMSD was functioning correctly at the time of the accident.

32 UTAP – Individuals are required to undertake continuous training program events to ensure readiness for operational response. It is normal for training serials to be added to flying events.

33 Ps are held on the Defence Secret Network. Further details need to be requested from HQ AVNCOMD and will only be released in accordance with the Defence Security Framework and the need to know principle.

34 The Hoffman 20/20 Test Set checks for blurriness, contrast and/or dark spots.

INDIRECT FINDING[14]	It is very likely that the Helmet Mounted Sight and Displays (HMSD) of the pilots of BSMN 83 were functioning correctly throughout the mission and during the key accident sequence of events.

2.4.6 **Formation configuration.** The mission was briefed as a streamed departure and transition to heavy left formation (see Figure 20). BSMN 83 was the third aircraft in formation, required to take visual line-up cues from BSMN 81, and visual spacing cues from BSMN 82. The third aircraft station in the heavy left formation is considered the most difficult position to fly of the four, as position maintenance requires reference to both of the preceding aircraft for station keeping (Reference BB). Flying from the cross-cockpit (left seat) position exacerbates the difficulty due to airframe design factors that can obscure visual references. See paragraph 2.7.4 for further analysis.

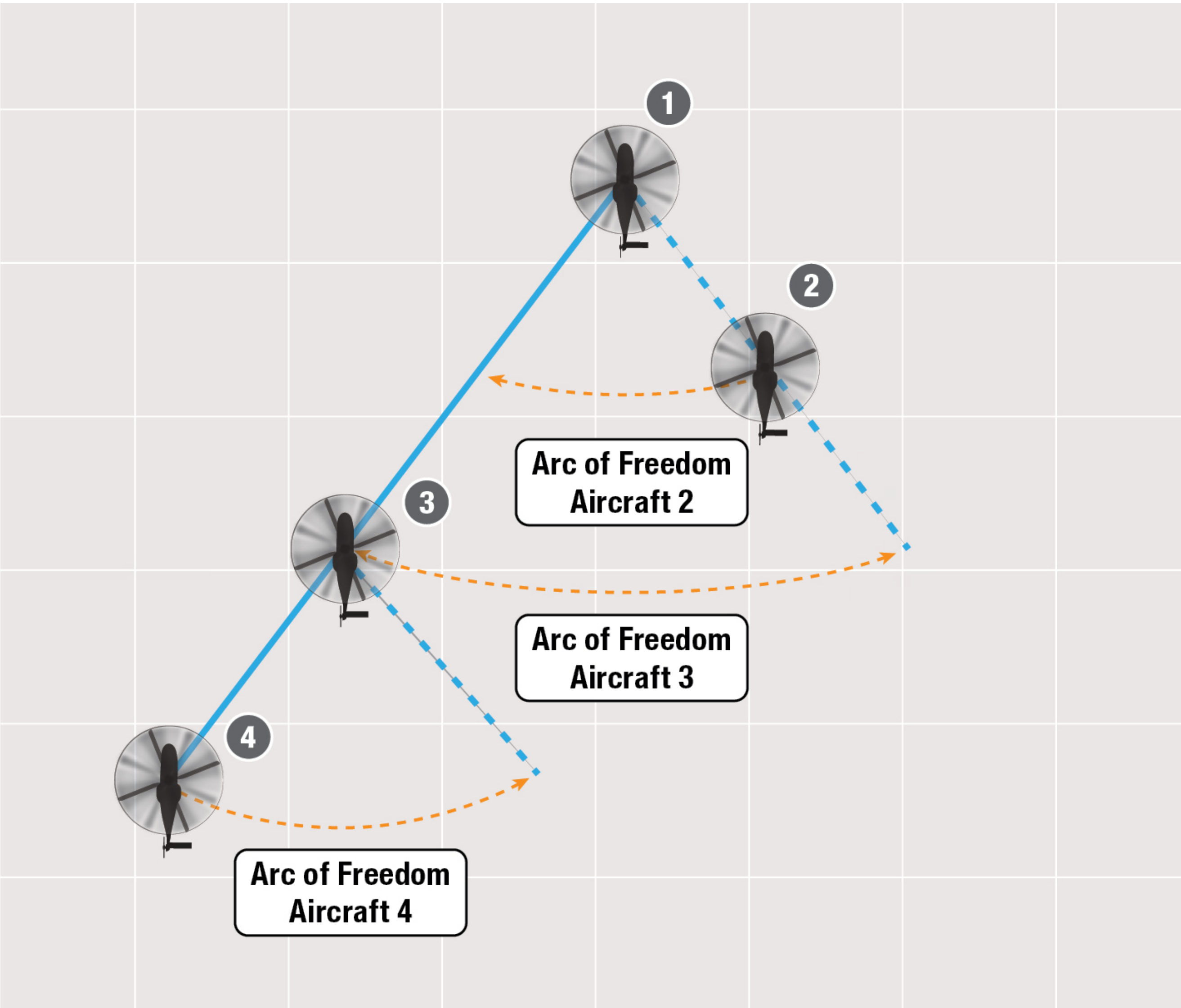

Figure 20: Heavy Left formation

2.4.7 Crew configuration. Crew seating was not recorded pre-flight (noting there is no requirement for it to be recorded). Crew positions were determined through post-event analysis of the VFDR, including voice analysis, and analysis of recovered life-support equipment (Enclosure 4). The ASIT determined that the AC was in the front right-hand side (RHS) seat, the CP was in the front left-hand side (LHS) seat, the senior ACMN was in the rear RHS of the cabin and the junior ACMN was in the rear LHS of the cabin as depicted in Figure 21.

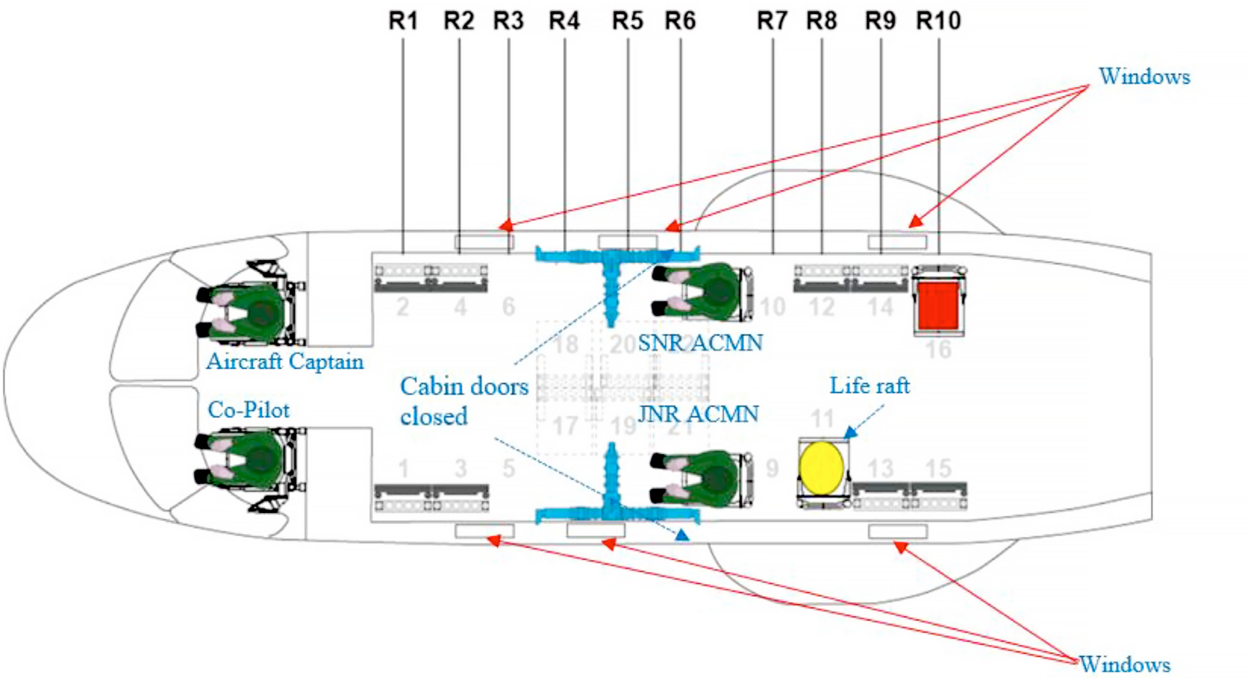

Figure 21: BSMN 83 seating positions[35]

INDIRECT FINDING[15]	**BSMN 83's crew were positioned within the aircraft as follows: Aircraft Captain (AC) in the right-hand cockpit seat; Co-pilot (CP) in the left-hand cockpit seat; senior aircrewman (RH ACMN) in the right-hand side of the cabin; and the junior aircrewman (LH ACMN) in the left-hand side of the cabin.**

2.4.8 **Rehearsal of Concept (ROC).** As the final sequence of mission orders, the formation conducted a ROC to go through crew duties, mission criteria, and contingency plans. Contingencies for cloud on the saddle (see Figure 22) and changed flight paths were discussed. Between Mission Orders and the conclusion of the ROC, BSMN 83 RH ACMN requested that the doors remain closed until approaching the IP, in order to protect the ACMN from expected adverse weather. Previous experience of the RH ACMN, including a mission the night prior, had identified that the issued cold weather gear was not effective at protecting the ACMN from inclement weather and cold temperatures. Based on the anticipated rain showers and wind chill factor associated with flying with the doors open, the decision to keep the doors closed until the final leg of the flight path leading to the landing points (IP to target run) was confirmed. The decision to close the doors is discussed further in paragraph 2.4.10.

35 The actual position where the life raft was fitted in BSMN 83 was not able to be determined.

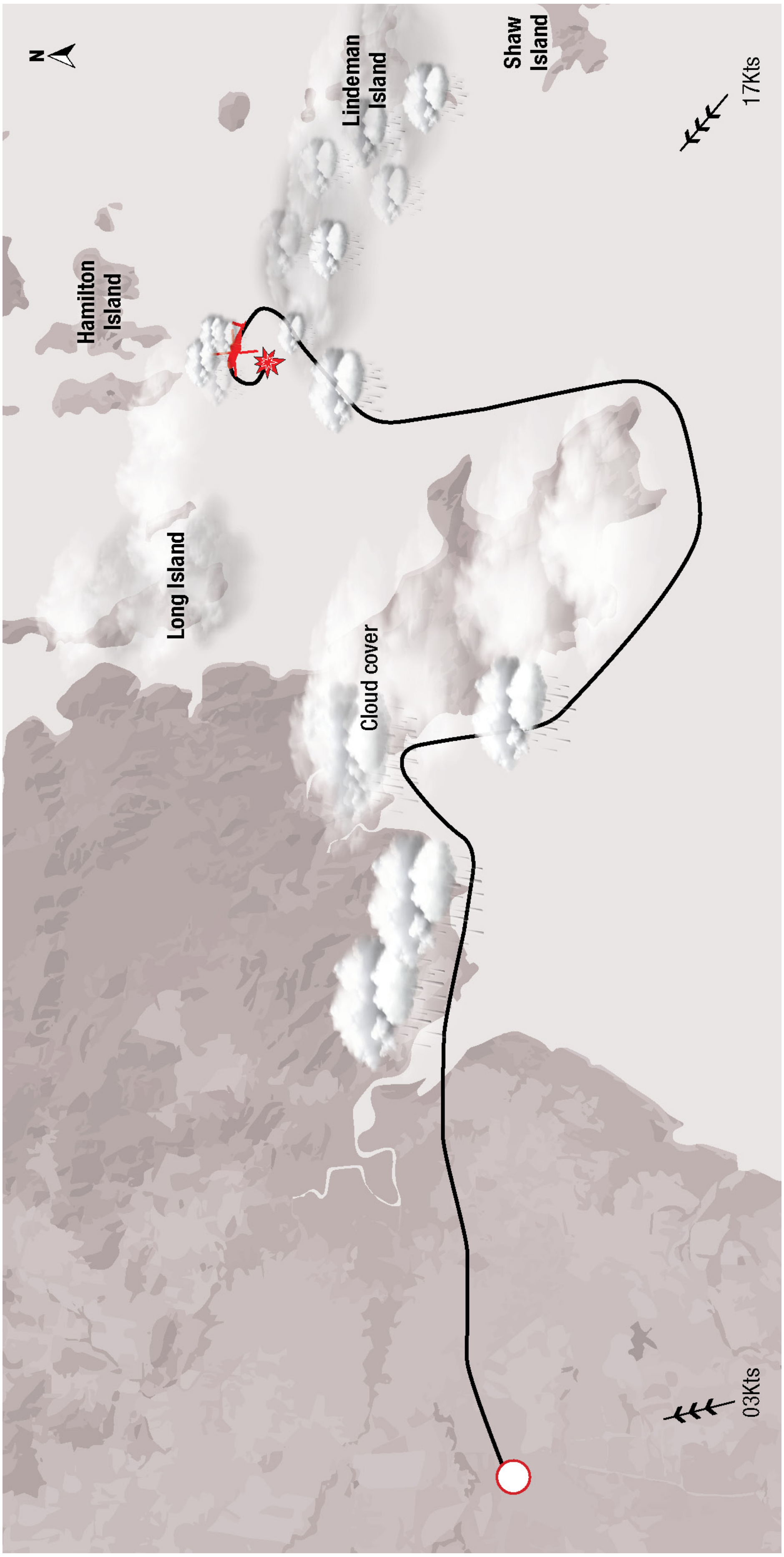

Figure 22: Cloud cover on the peninsula saddle

2.4.9 **Flight Authorisation.** The mission was authorised by the Air Mission Commander (AC of BSMN 84), IAW Reference CC for flight not below 200 ft Above Highest Obstacle (AHO), no closer than 2 RD and no closer than 7 RD on active side for flares. All BSMN crewmembers were present at the authorisation brief.

2.4.10 The authorisation confirmed doors were to be closed for all four aircraft on departure, but were to be open when passing through the IP. The configuration change introduced a known hazard where the ACMN cannot provide clearance when the cabin doors are closed (IAW Reference L). This will be discussed further at paragraph 2.24.1.

2.4.11 Authorisation was pre-recorded on Patriot Excalibur (PEX), and verbally authorised by the Air Mission Commander. There was one other available Flight Authorising Officer (FLTAUTHO) on the night, the Regiment Standards Officer (RSTDO), but the ASIT determined from interviews that the decision not to use the RSTDO was based on crew duty limits. Risk management for the mission was briefed IAW References DD, EE, FF and GG. Flight Authorisation is discussed in detail in Section 2.35.

EVENT SEQUENCE

2.4.12 The event sequence, and individual and team actions that contributed (positively or negatively) to the event provide important contextual information to identify underlying safety issues that exist in the system.

2.4.13 This section will describe the event sequence in chronological order, providing additional information to support 'why' actions and inactions occurred. Later sections of the report will provide more detailed theoretical and explanatory information on Local Conditions, Risk Controls and Organisational Influences in line with the DSAM.

2.5 Departure and transit

2.5.1 **Pre-departure.** The formation crews reached their aircraft and started the APUs at 1945K, and engines at 2114K. Crews departed for the FARP at 2124K to conduct hot[36] refuel prior to mission start. VFDR voice data from the event aircraft identified that the RH ACMN had forgotten tasks and equipment, including turning on the IR-APALS[37] and their helmet, which were identified and then rectified. Additionally, the CP identified an issue with their helmet. This was reported to, and cleared for use by ALSE for the mission. Post-accident ALSLMU analysis identified that at the time of the accident, the CP's helmet and Air Warrior were serviceable and correctly configured.

2.5.2 **FARP.** During the hot re-fuel, BSMN 81's aircraft RADALT failed, requiring an aircraft change, and transfer of flares. This did not necessarily impact timing, but if the spare aircraft had not worked, BSMN 83 would have had to give up their aircraft[38].

2.5.3 BSMN 82 CP noted that they had difficulty setting their horizon bar on HMSD due to an obstructed horizon at Proserpine Airport.

2.5.4 **Departure.** The formation departed the FARP at 2214K. At the time of departure, the weather had degraded, but still met the criteria (Reference AA) for 'Normal'[39] and was considered suitable for the mission. Reported actual weather conditions were better than expected. However, as the formation was approaching the planned flight path between Conway Beach and Cow Island, low cloud over the ridge prompted BSMN 81 (flight lead) to amend the flight path to turn right and track along the coastline (see Figure 22). Weather data captured at Proserpine Airport (YBPN) indicated cloud cover of scattered

36 Hot refuel refers to an engines on and rotors running refuel.

37 The IR-APALS are required for formation lighting. They were turned on by the RH ACMN prior to departure.

38 Mission Orders stated that BSMN 83 and crew were the 'bump' aircraft, meaning that they would be the first to drop off the mission in the event of an aircraft unserviceability.

39 Normal conditions'; 1000 ft cloud base and 3000 m visibility with no recovery planning requirements.

(3-4 oktas[40]) at 1200 ft and broken (5-7 oktas) at 3000 ft, susceptible to periods of degraded weather (increased cloud coverage) for up to an hour. Hamilton Island Airport (YBMN) had similar worsening weather conditions. The SLAP tool highlights the impacts of increased cloud and its effects on illumination, reducing it to 0.0076 lux (Figure 15). It is very likely that after departure, the crews would have seen areas of reduced illumination possibly at these levels affecting visibility. Regardless, this would not require the crew to cancel the mission.

2.5.5 **Station keeping.** The mission was planned to be flown in 'loose' (3-5 RD) formation, and was authorised for no closer than 2 RD and no closer than 7 RD on the active flares side. The AC of BSMN 83 directed the CP to fly at 2 RD, and the crew continued to fly at a perceived 2-3 RD from BSMN 82 (note: the actual distance from BSMN 82 was determined to be consistently greater than 2 RD, see paragraph 2.7.10 for additional analysis). It is likely that 2 RD was directed due to weather conditions, based on conversation noting that flying closer provides better visual cues when operating in poor visibility.

2.5.6 **Radar Height (RHT) Hold.** The CP (FP) did not set the RHT when transitioning to overwater flight below 500 ft AGL at night, as required by SI(6AVN) OPS 3-209 (Reference R)[41]. The AC (NFP) asked if they wanted RHT, but the CP (FP) replied in the negative. The language used by the AC (NFP) was not directive, and they did not challenge the CP's (FP) choice. The system and its use on the night is discussed in more detail in section 2.27.

INDIRECT FINDING[16]	**BSMN 83 had flown for an extended period over water below 500 feet at night without the Automatic Flight Control System Radar Height upper mode engaged.**

INDIRECT FINDING[17]	**BSMN 83 did not conform with SI(6AVN) OPS 3-209 - Flight Over Water to engage the Automatic Flight Control System Radar Height upper mode over water when operating below 500ft at night.**

40 Okta is a measurement of cloud coverage equal to one-eighth of the sky.

41 There were no recorded or observed failures of the RHT. Coupled with the recorded conversation, it is reasonable to conclude that the RHT was not engaged during the transit and before the AC took control.

2.6 Phases of the accident event sequence

2.6.1 The event sequence has been broken down into three phases for the purpose of clarity and readability. Those phases of the event sequence are depicted in Figure 23. Times for the following sections are in UTC (Z).

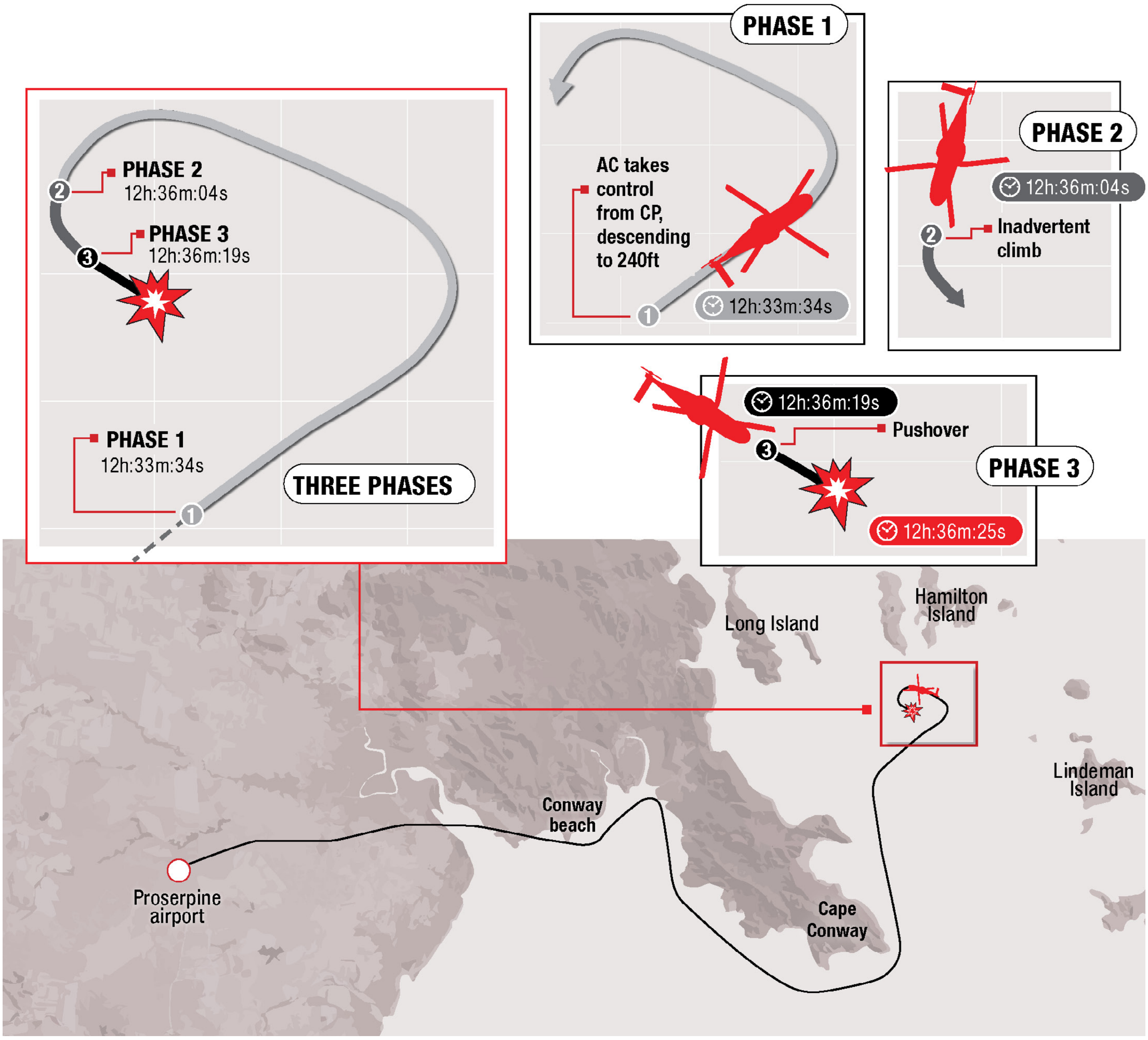

Figure 23: Phases of event sequence

2.7 Phase 1. Take-Over/Hand-Over

2.7.1 This section covers the period from the time BSMN 83 AC conducted a take-over[42] of aircraft control from the CP, at time 1233:34Z, prior to entering the holding pattern, until the initiation of the inadvertent and unrecognised climb (paragraph 2.8.5) at time 1236:04Z – a duration of 2 minutes and 30 seconds.

2.7.2 **Station keeping.** The CP was in the LHS and the FP flying cross-cockpit during the transit (paragraph 2.4.6). There were indications that the CP (FP) was having difficulty maintaining station. VFDR voice data indicates the AC and RH ACMN were providing station keeping advice (in a calm manner), corroborated by BSMN 84 making multiple comments about BSMN 83's sub-optimal station keeping. The crewmembers of BSMN 84 recall noticing that BSMN 83 had difficulty in maintaining station

42 Take-over: The procedure for taking over the flight controls of an aircraft as defined in MRH90 STANMAN (Reference L).

(supported by contemporary comments recorded on the VFDR voice data). They surmised that this was due to the position (number 3 in formation) and the experience level of the CP. BSMN 84 crewmembers recall thinking that the manoeuvring was within normal expectations given those considerations, and that the AC would be providing mentoring and support. This is not an unreasonable assumption as the CP's training continuum did not address low level flight formation over water at night (for more detail, see section 2.29).

2.7.3 BSMN 82 identified that the weather conditions made formation flying challenging that night, especially for the CP (who was of similar experience levels to BSMN 83 CP). Additionally, the CP of BSMN 82 had set an incorrect datum on their HMSD horizon bar. BSMN 82 CP noted that this was 'disorientating' and resulted in placing the aircraft consistently higher on plane than BSMN 81. The ASIT found these conditions set a higher workload for the CP (FP) of BSMN 83 in their station keeping.

INDIRECT FINDING[18] **It is very likely that BSMN 83's CP (FP) was experiencing an increased workload maintaining formation station due to BSMN 82's CP (FP) having difficulty in maintaining the same height plane as BSMN 81.**

2.7.4 **Take-over.** The CP (FP) was seated in the LHS, so station keeping on BSMN 82 was cross-cockpit to the front right of the aircraft. This resulted in the CP having to look around the centre pillar of the windscreen to maintain formation position. Reference L and anecdotal evidence describe flying in position 3, looking cross-cockpit[43] in a heavy left formation as a high-workload environment due to the constant need to manipulate the collective and cyclic to maintain height, line, speed and spacing from the preceding aircraft. The VFDR voice analysis indicates the AC had been providing regular coaching to the CP (FP) with respect to station keeping and what likely to expect from BSMN 82.

INDIRECT FINDING[19] **BSMN 83's CP was required to fly cross-cockpit to maintain position in the heavy left formation.**

INDIRECT FINDING[20] **Cross-cockpit flying from position three in heavy left formation increases pilot workload.**

2.7.5 At 1233:24Z the RH ACMN announced, 'Coming into a shower shortly.' This coincided with a climb away from the formation. Figure 24 shows the delayed and accordion effect (green line) in formation, where BSMN 81 starts the planned descent, BSMN 82 follows 2-3 seconds later and then BSMN 83. BSMN 84 was sitting further back from the rest of the formation which is why their path (yellow) does not match the rest of the formation. The VFDR voice data indicates that the BSMN 83 CP is under an increased workload, and the AC is aware of this, and monitoring their workload and performance. It is very likely that the increasing complexity of the situation[44] prompted the AC to take control of the aircraft at 1233:34Z. It is also likely the AC was influenced by the better visual picture of BSMN 82 from the right-hand seat (RHS).

FINDING[21] **It is very likely that BSMN 83's AC (NFP) took control of the aircraft due to the increasing complexity of the situation and after the CP (FP) gained altitude above the formation.**

43 MRH90 STANMAN states,'Too high on the preceding aircraft may contribute to losing sight, especially when flying cross-cockpit.'

44 The increasing complexity of the situation includes a combination of the degrading weather conditions, the slight climb away from the formation as it starts the descent, the visual limitations associated with cross-cockpit station keeping, and the experience of the CP in flying in these conditions.

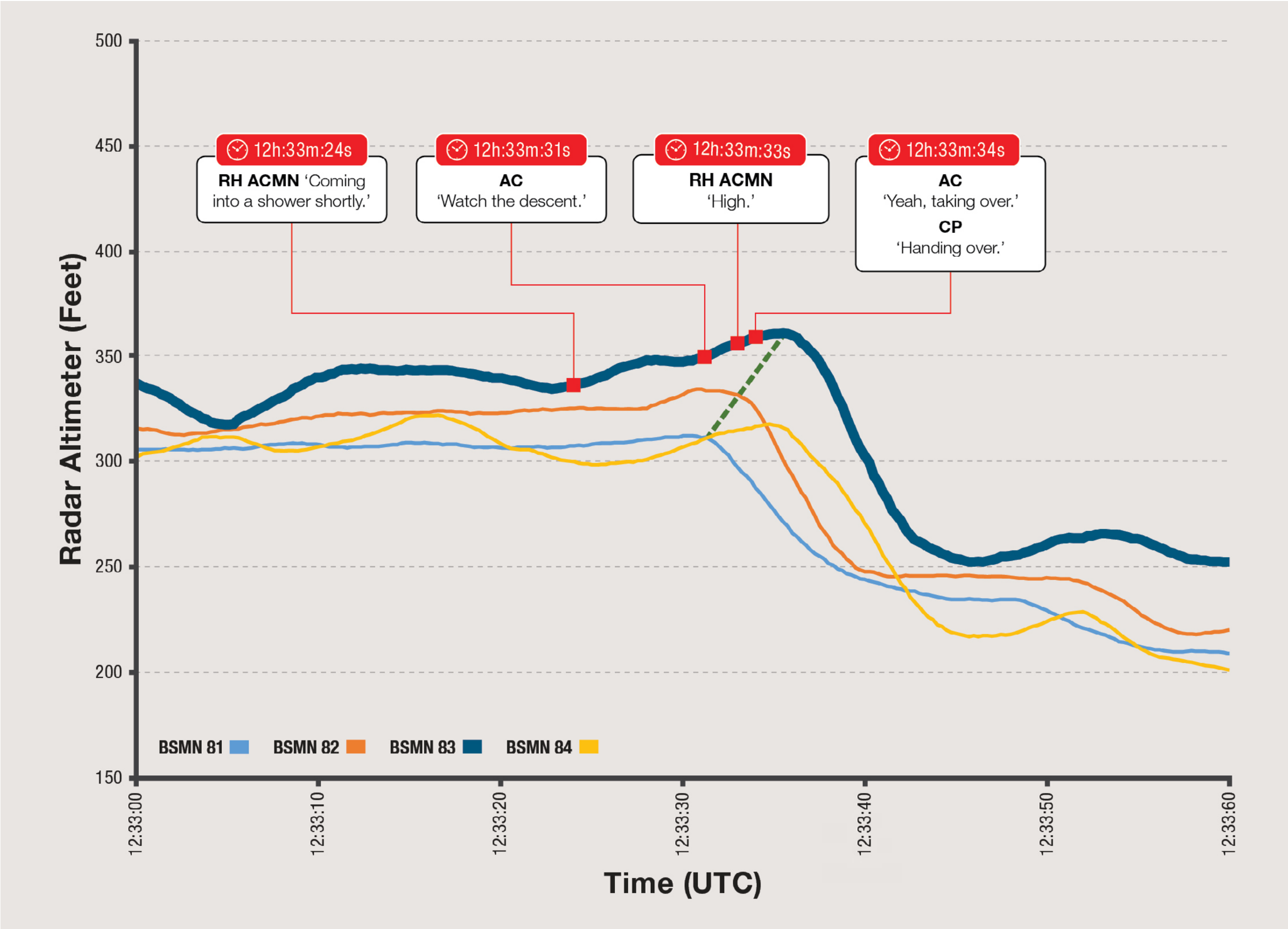

Figure 24: Formation RADALT height from 1233:00Z-1233:59Z

2.7.6 After a prompt of 'high' from the RH ACMN, the VFDR voice data recorded a take-over/hand-over where the AC stated, 'Yeah, taking over,' to which the CP immediately responded, 'Handing over.' VFDR flight data indicates that the AC began an immediate descent to regain formation parameters. The Rate of Descent (RoD) increased to 1000 ft/min during the descent. This transfer of control was not conducted IAW the MRH90 STANMAN (Reference L), which requires certain executive words to be used. However, communications were calm, and indications were both pilots knew their roles and responsibilities. It is likely, based on the recordings that the AC intended to demonstrate formation manoeuvring and energy management of the aircraft, prior to handing back control to the CP.

INDIRECT FINDING[22]	**The transfer of control of the aircraft by BSMN 83's AC from the CP was not conducted in accordance with the MRH90 STANMAN.**

INDIRECT FINDING[23]	**The take-over effectively transferred control to BSMN 83's AC as the FP with no ambiguity of pilot roles and responsibilities.**

2.7.7 At 1234:13Z the formation flight lead (BSMN 81) announced and commenced a left hold, opposite to the holding direction briefed in Mission Orders, to avoid rain showers between the IP and the target. A left turn, in heavy left formation, in the number 3 position, is considered more challenging than a right turn due to geometry of the turn (see example at Figure 25). Notwithstanding the permitted use of the arc of manoeuvre (see Figure 20), this normally requires BSMN 83 to be on the inside of the turn at a reduced speed to maintain position. It is also very likely that, given the position of BSMN 83 in the formation, they were required to look toward the sector with limited horizon.

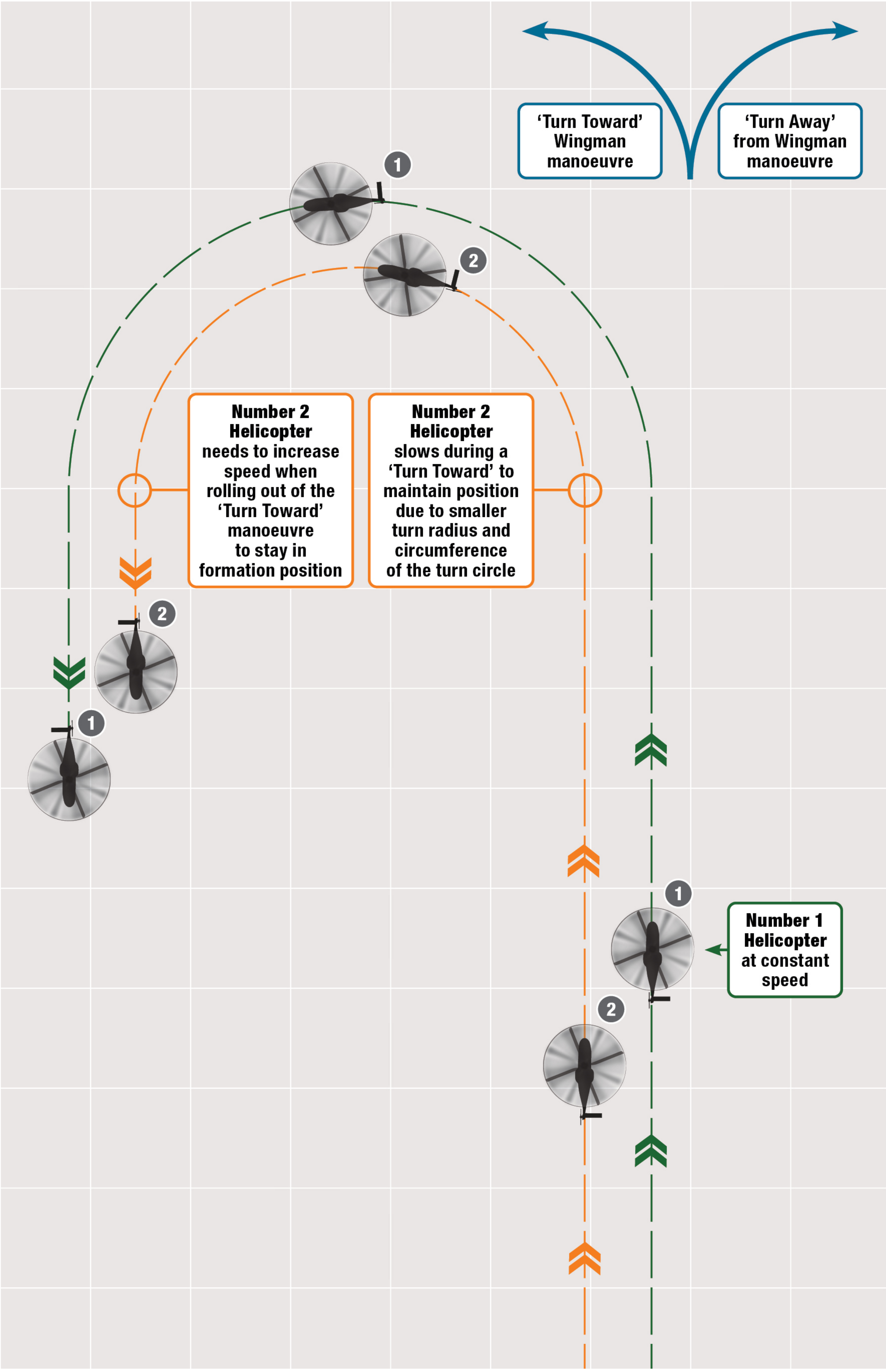

Figure 25: Illustration of formation turn geometry

2.7.8 Thirteen seconds after the TO/HO (at 1233:47Z) the AC (FP) directed the CP (NFP) '…engage RADALT…,' referring to the AFCS RHT hold. TAC flight control mode was changed to ATT mode in order to engage AFCS RHT hold. At 1234:42Z, 51 seconds after RHT mode selection, the AC commented to the CP on the benefits of RHT hold in station keeping. Once established at 200 ft AGL, the formation entered the left holding pattern while waiting for the call to collect the GFE. The formation was flying through rain showers, which reduced visibility and degraded the horizon.

INDIRECT FINDING 24 — **BSMN 83's AC (FP) changed the flight control system to Attitude (ATT) mode and selected Radar Height (RHT) hold mode after taking control of the aircraft from the CP.**

2.7.9 **Retention of control.** The VFDR voice recordings indicate it is likely the AC's motivation in taking control was to re-establish the aircraft's position in the formation, and to provide continued mentoring to the CP on station keeping, prior to handing back control to the CP. The weather was worsening as the formation was flying through rain showers, and the visibility was deteriorating in the direction of travel[45]. BSMN 82 was 'flying high', which would also have increased the complexity of maintaining station. Thirty-seven seconds after the AC took control of the aircraft they stated, 'I'm going to get you in…,' likely a reference to positioning the aircraft closer to BSMN 82 before handing back control. This is supported by comments made in the turn, including: 'I'll just get around the corner for you mate,' and 'While we're dealing with the rain shower… I'll deal with this alright.'

2.7.10 Figure 26 shows the BSMN formation's relative geometry at four positions along the flight path from the VFDR data where the BSMN 83 crew had commented on weather, or on their visual assessment of maintaining between 2.5 and 3 RD spacing from BSMN 82. The figure also shows the actual RD between BSMN 82 and BSMN 83 at these positions (confirmed by DSTG analysis). The ASIT found that the BSMN 83 crew assessment of spacing from BSMN 82 throughout the flight was consistently in error by more than double (actual > 6 RD), believing they were much closer than they really were. The ASIT has not been able to determine how this significant error in assessed range occurred but notes the MRH90 STANMAN (Reference L) night flying chapter states, 'Reduced perception makes it difficult to accurately determine separation from other aircraft' (see section 2.18 for further details on visual limitations).

FINDING 25 — **The crew of BSMN 83 assessed their visual range to be closer than the actual range to BSMN 82.**

OBSERVATION 26 — **The ASIT could not determine the reason why the crew of BSMN 83 assessed their visual range to be closer than the actual range to BSMN 82.**

45 Weather information based on VFDR voice data and post-event interviews with formation members.

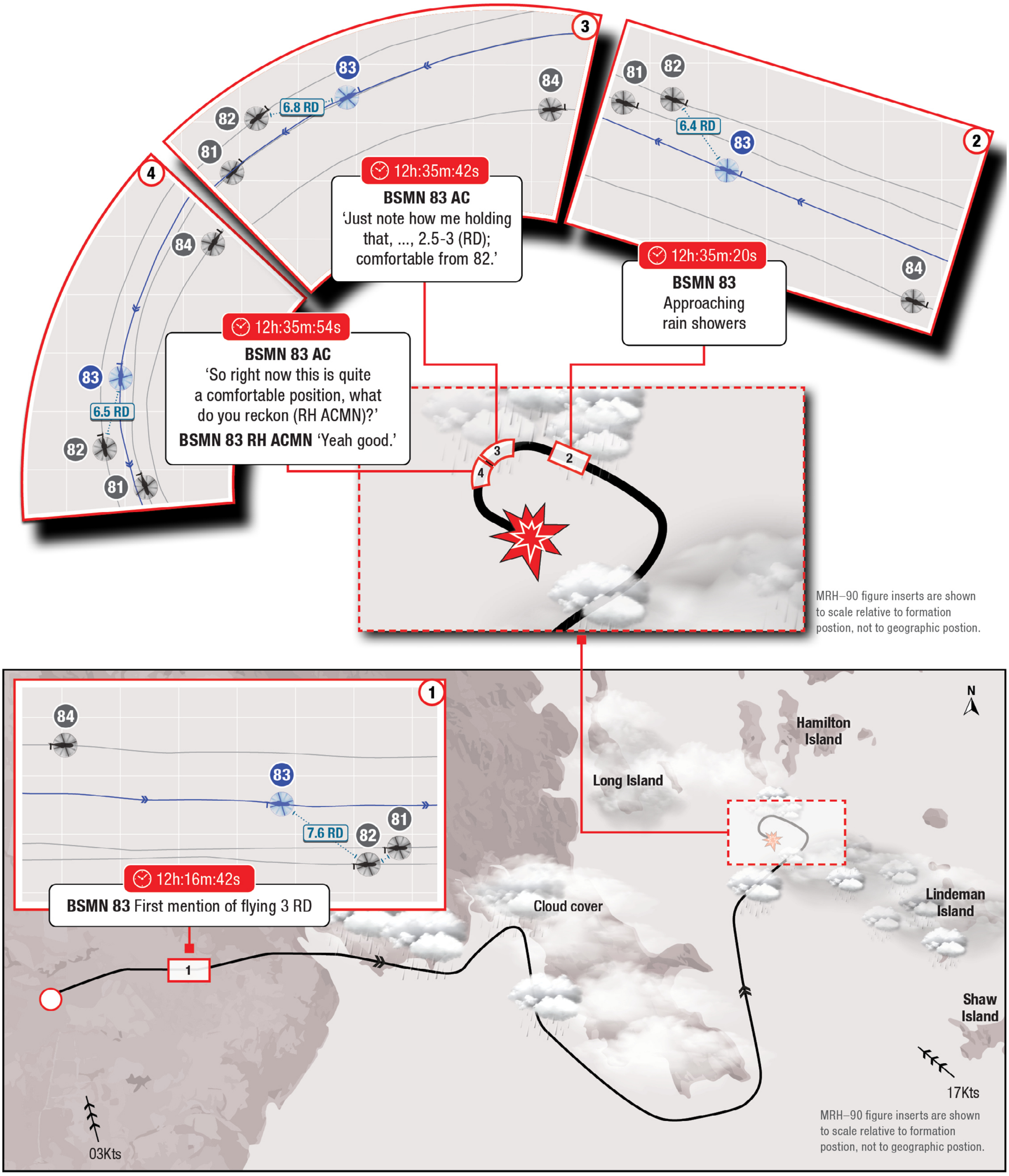

Figure 26: BSMN formation relative position (including spacing – RD)

2.7.11 Figure 26 also details the BSMN formation aircraft ground tracks at the four positions in the heavy left formation. Insets 2, 3 and 4 highlight that entering showers, BSMN 83 moves from the left side of the formation, to behind, then slightly on the right-side of BSMN 81's (lead) ground track. Figure 20 shows the permitted arcs of manoeuvre for wing aircraft in heavy left formation, noting that stabilised positions behind lead are normally avoided, as opening and closure rates are difficult to judge when directly behind another aircraft.

2.7.12 Based on the analysis of the VFDR flight path data (Enclosure 7), it is almost certain that BSMN 83 was flying a 'staggered/echelon'[46] formation position solely off BSMN 82 in the final left turn (refer Figure 26, inset 3 and 4). This resulted in BSMN 83 flying a 'trail' position behind BSMN 81. BSMN 83's AC (FP) did not change the trail position on BSMN 81; noting arcs of manoeuvre are permitted, but sustained flight in trail less than 10 RD under NVD conditions is prohibited IAW the MRH90 STANMAN (Reference L). A heavy left position would have required the FP to take line cues from BSMN 81 and spacing cues from BSMN 82. The staggered/echelon position allowed the FP to focus attention solely on BSMN 82 for both line and spacing, freeing attentional resources in a high-workload environment[47].

2.7.13 At 1234:30Z, the AC (FP) asked the CP, '...are you back on mate...,' to which the CP replied, 'Affirm.' The ASIT assesses that this comment, coupled with the comments that infer that control would be handed back to the CP, has primed the CP to focus attention externally on 'formatting off' BSMN 82, to the detriment of NFP (monitoring) duties. This is further explained in section 2.16.

FINDING 27	**The attention of BSMN 83's CP was very likely focused externally, to the detriment of NFP duties, as they expected to imminently resume control of the aircraft.**

2.7.14 An immediate hand-over of flight controls did not occur as the AC decided to maintain control of the aircraft until they were 'around the corner'. Furthermore, approximately five seconds after commencing the turn, BSMN 83 flew into rain showers, prompting the AC to state, 'It's getting dicey.'

2.7.15 The comment, 'It's getting dicey,' coincided with the commencement of yaw input. Enclosures 3 and 8 show that from 1235:27Z the yaw input was introduced. FDR data shows that this was predominately a left yaw input and was present during the climb, until just prior to impact with the water. DSTG analysis of lateral acceleration of BSMN 83 with formation bank attitudes showed that BSMN 83 was side-slipping[48] during the second turn in the holding pattern. The Flight Navigation Display (FND) displays an orange caution on the eyebrow panel to indicate to the pilot that the yaw pedals require re-centring, as in, flight out of balance is occurring. These indications are only displayed on the Multi-Function Display (MFD), not HMSD and do not have accompanying audio. It is almost certain the pilots were not scanning the FND when the yaw deviation was taking place, and were therefore unable to identify the deviation.

2.7.16 The MRH-90 PFCS contains a ball-centring function with the PFCS maintaining the aircraft in balance above 40KIAS. This function is deactivated by pilot pressure on yaw pedals, described in the Operator manual as a 'fly-through' function. The MRH90 STANMAN, Annex A to Chap 3 (Reference L) details when in ATT mode, 'It is preferred to remove feet from the pedals in cruise (after 'flyaway' & > 40 KIAS) in order to allow correct functioning of this system.' The MRH90 STANMAN also details this as a common fault in Chapter 16 (IF) – Incorrect Balance. Not removing feet from the pedals.

2.7.17 Feedback from helicopter instructional SMEs described tensing on the controls with feet touching or interfering with the yaw pedals (to cause the ball centring to disengage) as a symptom of high-workload in a pilot. This is supported by the MRH90 STANMAN (Reference L) listed common errors during formation flight.

FINDING 28	**It is virtually certain that the application of yaw pedal inputs by BSMN 83's AC (FP) from 1235:27Z onwards was inadvertent.**

46 A standard echelon position is aligned back from the lead at approximately 30-45 degrees. BSMN 83 was in swept left echelon ('skinny') 20 degrees or less from BSMN 82. 'Staggered' refers to the same line as 'echelon', but differs in the spacing and plane used during turns. For the purpose of this report, the terms have the same meaning regarding the line position of a wing aircraft reference to the lead aircraft they are flying formation off.

47 Visually aided (NVD) low level night flight, in a multi-ship formation through weather, is a high-workload environment.

48 Side-slipping is an aerodynamic state where an aircraft is moving sideways as well as forward.

FINDING [29] The application of yaw pedal inputs from 1235:27Z was likely indicative that BSMN 83's AC (FP) was experiencing an increased workload due to the degrading weather conditions.

2.7.18 Approaching the half-way point in the final turn, the AC provided advice on station keeping with BSMN 82. His statement, 'Just note how me holding that, you know, 2 ½ to 3 [RD], comfortable…from 82… manoeuvring in showers, can get a little bit dicey, unless you've got a better vision of the aircraft,' indicates that the AC may have been responding to the degrading weather conditions by manoeuvring the aircraft to get a better vision of BSMN 82. It is extremely likely that the FP's attention was focused outside the aircraft while actively manipulating the aircraft controls.

2.7.19 This piece of mentoring would also have directed the CP's attention to BSMN 82, if the CP was not already looking in that direction. Verbally directing the CP's attention out of the cockpit likely degraded the NFP's monitoring duties (as detailed in Reference L) and created an expectation that the CP (NFP) would be taking control of the aircraft in the immediate future. This is further discussed in sections 2.15 and 2.30.

2.7.20 The RH ACMN confirmed the AC's (FP) assessment of being in a 'comfortable position' (noting the limitations on ACMN FOV with the door shut). However, DSTG analysis (Enclosure 7) confirmed that the aircraft was more than 6 RD away from BSMN 82.

2.7.21 There was no VFDR evidence of the flight controls being handed over to the CP before impact with the water.

FINDING [30] It is extremely likely that, in responding to the operating conditions, including the degrading weather, the attention of BSMN 83's AC (FP) was exclusively focused outside the aircraft to prioritise maintaining visual sight of BSMN 82.

FINDING [31] It is very likely that the AC's (FP) direction of attention to the CP (NFP) of BSMN 83 towards BSMN 82 in preparation for a hand-over/take-over degraded NFP monitoring duties.

2.8 Phase 2. Inadvertent climb

2.8.1 Phase 2 is the period of flight from the beginning of the climb, until immediately prior to the initiation of the pushover, from 1236:04Z - 1236:19Z (15 seconds).

2.8.2 **Control inputs.** As previously stated, flying in heavy left requires the flying pilot of BSMN 83 to take their line cues from BSMN 81 and their spacing cues from BSMN 82. It is the more challenging position to fly in the formation for this reason. Normally, by day, an aircraft will take visual turn cues from the preceding aircraft's rotor disc, which is the earliest indication of turn. During aided formation, visual turn cues are more difficult to detect, and therefore, delayed, as the visual cues are from the preceding aircraft's cabin (which is not as definite as the disc during day flight). In this event, BSMN 83 was further from BSMN 82 than assessed, making detection of cabin changes from both BSMN 81 and 82 even more difficult. It is also very likely they were not taking line cues from BSMN 81 due to the larger-than-perceived sight-line distance and degrading visual environment, as they were in a trail position on BSMN 81 and a lesser angle (more skinny) on BSMN 82.

2.8.3 During periods of degraded visuals (low illumination, low contrast or obscurants such as rain showers) it is common practice to fly closer to the preceding aircraft to maintain position, and to have better fidelity on pitch changes of the preceding aircraft. Based on BSMN 83's position to BSMN 81 (trail) it is very likely the AC (FP) of BSMN 83 was taking all formation cues from BSMN 82 in order to maintain position and adherence to the collision avoidance principle[49].

2.8.4 When a turn towards the formation occurs (in this case, left turn, as BSMN 83 was on the inside of the turn to BSMN 82), the inside aircraft needs to slow to maintain line position because of the smaller turn radius (see Figure 25). Allowing the aircraft to slide behind the line (skinny) and towards the tail of the lead can be advantageous, as the inside turn radius becomes closer to the lead's turn radius, resulting in a smaller airspeed reduction for the wing aircraft to maintain station. This allows smaller control inputs by the wing aircraft's FP to maintain station, as more energy (higher airspeed) is retained. However, the wing aircraft must still anticipate, accelerate, and match lead's speed rolling out of the turn to maintain station. VFDR analysis identified that at this point, BSMN 83 had slowed from formation speed in the turn (from 83-84 kts at 1235:56Z to 77 kts by 1236:08Z). Just prior to the rolling out of the turn, BSMN 83's AC (FP) made cyclic and collective control inputs to increase speed, however, the collective input was not commensurate with the cyclic control input. It is very likely that these control inputs were made without reference to performance instruments (see section 2.16). Both are required to increase speed, therefore, the larger collective input instigated a rate of climb in addition to the intended increase in speed.

2.8.5 **Inadvertent and unrecognised climb.** At 1236:04Z BSMN 83 started to climb. There was no crew communication advising the intent to climb or that a climb had commenced. The aircraft climbed from 224 ft at 1236:04Z and reached a maximum height of 362 ft 14 seconds later. Peak Rate of Climb (RoC) at 1236:11Z was 845 ft/min. During the climb, the pitch progressively changed from 5.8 degrees pitch up to 4.7 degrees pitch down, a change of 10.5 degrees. Concurrently, the airspeed progressively increased from 77 KIAS to 109 KIAS, a change of 32 KIAS. Engine torque, All Engines Operating (AEO), as set by the collective, averaged 201 Newton metres (Nm) at the start of climb and increased to an average of 542 Nm at the top of climb. Neither the AC (FP) nor the crew of BSMN 83 commented on any of the above changes.

2.8.6 There was no evidence of technical malfunction, or pilot incapacitation that would have induced uncommanded control inputs (refer to sections 1.13.3 and 2.2) nor any plausible operational reason for the climb. Therefore, it is considered virtually certain that the climb of BSMN 83 was inadvertent and unrecognised.

FINDING[32] **It is virtually certain that BSMN 83's climb above the formation's datum altitude of 200 ft was inadvertent and not recognised by either the AC (FP) or CP (NFP).**

2.8.7 Distraction event discounted. The ASIT considered the possibility of a distraction event leading to the FP and NFP losing awareness of their position in the formation. Distraction can be broadly defined as a process, condition or activity that diverts the attention of a pilot away from their primary task[50]. There were no intra-aircraft and inter-formation communications for the period of the climb, and there was no evidence of any other mission related issue, secondary task or distracting stimulus that may have diverted the attention of the crew away from maintaining the position of BSMN 83 in the formation. Therefore, it is very unlikely that a distraction of sufficient magnitude and duration contributed to the inadvertent climb.

FINDING[33] **It is very unlikely that a distraction of sufficient magnitude and duration contributed to BSMN 83's inadvertent climb.**

49 The Collision Avoidance Principle is that trailing aircraft are to be able to see and avoid all preceding formation aircraft – unless procedural separation is achieved. Depending on the number of aircraft, this is often described as: 4 avoids 3, 3 avoids 2, 2 avoids 1.

50 Australian Transport Safety Bureau. An examination of accidents and incidents involving pilot distraction in Australia between 1997 and 2004

2.8.8 **Loss of Spatial Orientation.** In the absence of other reasonable scenarios to explain the inadvertent climb, the most plausible explanation for the departure from formation parameters is degraded flight crew Situation Awareness, caused by the FP's loss of Spatial Orientation (see section 2.16).

FINDING[34]	**It is likely that BSMN 83's departure from the formation position was due to degraded crew Situation Awareness, primarily resulting from the AC's (FP) loss of Spatial Orientation.**

2.8.9 The task of station keeping in formation requires the FP to continuously monitor formation parameters and to manually manipulate aircraft controls in order to maintain the required height, speed, line and distance from the preceding aircraft. This technique is solely reliant on the FP maintaining visual reference to other aircraft and making appropriate flight control adjustments to maintain their position, see section 2.29.

2.8.10 The sustained cognitive focus required to maintain formation parameters, in combination with operating low level over water at night utilising NVIS, in reduced visibility low contrast conditions, increased the AC's (FP) workload and resulted in the AC (FP) fixating their focus of attention on BSMN 82. The increased cognitive workload and attentional narrowing of the AC (FP) is further supported by application of yaw pedal inputs that indicated the AC (FP) was likely tensing on the controls (see para 2.7.16).

2.8.11 This narrowing of attentional focus likely occurred to the exclusion of cross-checking instruments and maintaining visual reference to BSMN 81. It is the view of the ASIT that this set of conditions severely diminished the FP's ability to maintain Spatial Orientation.

FINDING[35]	**It is likely that the combination of a demanding technique for formation station keeping and the degraded visual environmental conditions led to increased cognitive workload and the attentional narrowing of BSMN 83's AC (FP).**

FINDING[36]	**It is likely that narrowing of attentional focus diminished the ability of the AC (FP) of BSMN 83 to maintain Spatial Orientation.**

2.8.12 VFDR voice analysis indicated that BSMN 83 experienced flight in rain showers during the final turn of the holding pattern. This coincided with a turn away from Hamilton Island cultural lighting and terrain to the west, and a turn toward featureless, low-contrast terrain in the southeast area of the Whitsunday Passage (Figure 22). Supported by weather data, and witness interviews, it is considered likely that the local rain shower resulted in a lack of visual horizon and reduced visual acuity along the flight path.

2.8.13 It is very likely that the distance between BSMN 83 and BSMN 82 and low contrast conditions impeded the AC's (FP) ability to differentiate individual reference features used for the maintenance of station keeping to BSMN 82. In addition to the above, BSMN 83's position in formation was narrow (skinny) on BSMN 82. The reduced angle is likely to have reduced the FP's ability to see lighting reference features on BSMN 82 (that is, easier to see at an angle) and impeded the ability to incorporate BSMN 81 accurately into their scan.

FINDING[37]	**It is very likely that misinterpretation of distance between BSMN 83 and BSMN 82, combined with low-contrast conditions, impeded the ability of BSMN 83's AC (FP) to differentiate individual reference features used for maintenance of station keeping to BSMN 82.**

FINDING 38 **It is likely that BSMN 83's formation position, which moved progressively towards the trail position on BSMN 82, reduced the AC's (FP) ability to see lighting reference features on BSMN 82 and limited their ability to incorporate BSMN 81 into their scan.**

2.8.14 The ASIT assesses that, given this context, it is likely that the FP would instead have established and maintained the relative position of BSMN 82 in their windscreen to enable formation station keeping. In order to keep BSMN 82 in the same relative position in the windscreen, the AC (FP) continued to apply increased collective and nose-down cyclic from the acceleration out of the turn, which inadvertently increased the aircraft's pitch-down, airspeed and altitude, and resulting in the inadvertent and unrecognised climb. It is very likely that the AC (FP) misperceived their orientation to BSMN 82 and was rotating around their position in the windscreen as they were searching for a cue from BSMN 82 that was taking longer to detect based on the distance and environmental factors. The ASIT considers that the combination of a breakdown in instrument scan, and inattentional blindness[51] likely resulted in the AC (FP) not identifying the HMSD horizon line moving up the FOV (see section 2.15) (Figure 27) as the pitch of the aircraft continued to pitch down in the climb (see section 2.18).

FINDING 39 **It is very likely that BSMN 83's AC (FP) misperceived their orientation to BSMN 82 while the position of BSMN 82 remained in a relatively stable position in the windscreen during the inadvertent climb.**

FINDING 40 **It is likely that a combination of a breakdown in instrument scan and inattentional blindness resulted in BSMN 83's AC (FP) not identifying the change of the aircraft's pitch attitude.**

This information has been redacted due to its security classification

Figure 27: Representation of HMSD V5.10 symbology

51 Inattentional blindness is defined as the phenomenon where individuals fail to notice obvious but unexpected objects or events in their visual field when their attention is engaged with another task, even if the unexpected stimulus is within their spatial focus of attention (Yintao et al (2023). Attention with or without working memory: mnemonic reselection of attended information. Trends in Cognitive Sciences, Vol 27, 1111-1122).

2.8.15 This explanation is consistent with FDR analysis that confirms the absence of any corrective flight control inputs to re-establish formation flight parameters, and the distance between BSMN 83 and BSMN 82 during the period of the climb (12:36:04Z to 12:36:14Z) remained between 121 metres and 130 metres. That is, BSMN 83 flew an arc centred on BSMN 82.

2.8.16 It is the view of the ASIT that the AC (FP) unknowingly experienced a loss of Spatial Orientation, commonly referred to as Type I (Unrecognised) Spatial Disorientation (SD)[52], through the climb. As shown in Figure 28, the AC (FP) perceived that the aircraft was in the correct position and alignment with BSMN 82 and controlled the aircraft in accordance with this. In the absence of sufficient visual cues (section 2.22) or other internal or external sources to alert the AC (FP), the gradual changes to the aircraft's pitch attitude, airspeed and altitude remained unrecognised. This created a situation in which everything felt normal, despite a worsening deviation from formation parameters as the aircraft climbed.

FINDING[41]	**It is very likely that BSMN 83's AC (FP) unknowingly experienced a loss of Spatial Orientation; commonly referred to as Type I (Unrecognised) Spatial Disorientation, through the climb.**

Figure 28: Actual vs Perceived relative position with preceding aircraft

2.8.17 **Contribution of crew.** It is not clear if the CP (NFP) noticed the inadvertent climb. However, it is very likely (see paragraph 2.7.13) that their attention was drawn to BSMN 82 in preparation for resuming control of the aircraft, and that this reduced their ability to perform NFP duties of monitoring flight instruments. MRH90 STANMAN (Reference L) requires the NFP to maintain Situation Awareness of aircraft performance capability, however, there is no prescribed or formally taught scanning technique (see section 2.29). In the absence of other reasonable scenarios, it is considered likely that the CP (NFP) was affected by the same set of conditions that compromised the Spatial Orientation of the AC (FP).

52 Refer to Section 2.18 for more in-depth analysis of factors related to Spatial Orientation, Situation Awareness and Spatial Disorientation.

FINDING 42	**It is likely that BSMN 83's CP (NFP) was affected by the same set of conditions that compromised the Spatial Orientation of the AC (FP) and experienced Type I (Unrecognised) Spatial Disorientation.**

2.8.18 The BSMN 83 cabin doors were closed during this phase of flight, narrowing the FOV for the ACMN, and making accurate assessment of aircraft position with reference to other aircraft extremely difficult. IAW a caution in MRH90 STANMAN (Reference L), ACMN are unable to provide formation clearances with the doors closed. Additionally, doors- closed reduces physical cues associated with changes to aircraft state, including reducing noise, and increased wind flow into the cabin, that may have otherwise alerted the crew to the changing aircraft state.

2.8.19 Ultimately, it is very likely that the CP (NFP) did not effectively monitor aircraft parameters, which contributed to degraded crew Situation Awareness (SA). Additionally, the closure of the cabin doors impeded the ACMN's ability to enhance the crew's overall SA (see section 2.24.3). These factors impeded the AC (FP) from detecting the inadvertent climb.

FINDING 43	**It is very likely that the crew of BSMN 83 experienced degraded SA to detect the AC's (FP) deviation from formation because the AC (FP) was drawing the CP's (NFP) attention away from pilot monitoring duties and the ACMN experienced restricted visibility of other formation aircraft while the cabin doors were closed.**

2.8.20 **Loss of visual contact with BSMN 82.** At 1236:13Z, 9 seconds after the climb was inadvertently initiated by the AC (FP), and with BSMN 83 at a height of 320 ft and climbing, the CP (NFP) stated, 'Have you still got [em].' BSMN 82 was maintaining a height of 216 ft at this time. Based on analysis of the flight path and FOV for the CP (left-hand seat), it is extremely likely the CP's (NFP) question was made at the particular point in time the CP lost visual on BSMN 82.

2.8.21 At 1236:14Z, just prior to the top of the climb, the AC (FP) calmly responded, 'Yeah, still got em mate.' Based on analysis of the flight path FOV for the AC (FP) (right-hand seat), it is likely that the AC (FP) was visual with BSMN 82 at this point. It is likely the AC (FP) lost visual contact with BSMN 82 immediately thereafter, as BSMN 82 disappeared under their nose. This is supported by DSTG FOV and FDR analysis.

FINDING 44	**It is extremely likely that BSMN 83's CP (NFP) lost visual sight of BSMN 82 during the climb.**

2.8.22 At 1236:15Z, immediately after the AC (FP) indicated they were still visual with BSMN 82, the AC (FP) quickly rolled the aircraft to the right to 31 degrees Angle of Bank (AoB) before quickly rolling back to a left 8 degrees AoB. The ASIT considers the actions of the AC (FP) to be indicative of manoeuvring to aid in regaining visual on the preceding formation aircraft they believed had disappeared under their aircraft's nose.

FINDING 45	**It is extremely likely that BSMN 83's AC (FP) lost visual sight of BSMN 82 prior to the top of the climb.**

FINDING 46	**It is extremely likely that manoeuvring by BSMN 83's AC (FP) prior to the pushover was an attempt to regain visual sight of BSMN 82.**

2.8.23 **Crew response to loss of visual contact.** In analysing the actions of the AC (FP) and CP (NFP), the

ASIT considered the appropriateness of the crew's response to the loss of visual contact with BSMN 82

2.8.24 There was no recorded internal or external communication from either the AC (FP) or CP (NFP) that indicated they had lost visual contact with BSMN 82. Neither the AC (FP) nor the CP (NFP) announced they were blind[53] on the preceding aircraft (see section 2.20). As previously stated, it is also extremely likely that upon losing visual contact with BSMN 82, the AC (FP) immediately manoeuvred the aircraft in an attempt to regain sight.

FINDING[47] **Neither BSMN 83's AC (FP) nor the CP (NFP) announced to the crew or other formation aircraft they had lost visual sight of BSMN 82.**

2.8.25 When an unexpected change occurs, individuals can experience a level of confusion and difficulty reconciling the new information with their established mental model. Instead of immediately recognising the shift, they may filter or distort the new information to fit their original expectations, leading to a delay in understanding the true nature of the situation. This is commonly referred to as an expectation bias.

2.8.26 In formation flying, it is also common for pilots to experience brief disruptions in maintaining visual contact with other aircraft. These disruptions often occur due to cockpit structures such as canopy frames, nose cone or even the physical positioning of the crew. These visual interruptions are short in duration, and pilots expect to regain visual reference quickly (see section 2.24).

2.8.27 Based on their mental model, it is very likely the AC (FP) and CP (NFP) of BSMN 83 expected no issues with their positioning in the formation. The ASIT believes this expectation bias likely impeded the ability of the AC (FP) and CP (NFP) to accurately interpret and respond to the unexpected loss of visual contact with BSMN 82.

2.8.28 The actions of the FP to quickly attempt to regain visual contact with BSMN 82, and the absence of associated verbal communication between the AC (FP) and CP (NFP), while suboptimal, are not viewed by the ASIT as inappropriate in the given context (see section 2.20).

FINDING[48] **It is likely that expectation bias impeded the ability of BSMN 83's AC (FP) and CP (NFP) to accurately interpret and respond to the unexpected loss of visual sight of BSMN 82.**

53 The term 'blind' is to be used to announce that visual contact has been lost with another friendly aircraft or ground position (opposite of visual).

2.9 Phase 3. The pushover

2.9.1 This section covers the period from the initiation of the pushover, until the impact with water. Table 5 and Figure 29 detail the rapid change in the state of the aircraft throughout Phase 3 (6 seconds).

TABLE 5: AIRCRAFT STATE

	PUSHOVER	MANOEUVRE	LAST VALID RECORDING
Time	1236:19Z	1236:22Z	1236:25Z
Radar Altimeter Height	**352** ft	**331** ft	**68** ft
Pitch	**5** deg nose down	**27** deg nose down	**28** deg nose down
Angle of Bank (AoB)	**8** deg (left)	**25** deg (right)	**2** deg (left)
Rate of Descent (RoD)	**180** ft/min	**1953** ft/min	**5865** ft/min
Airspeed	**108** KIAS (**200** km/h)	**129** KIAS (**239** km/h)	**140** KIAS (**259** km/h)

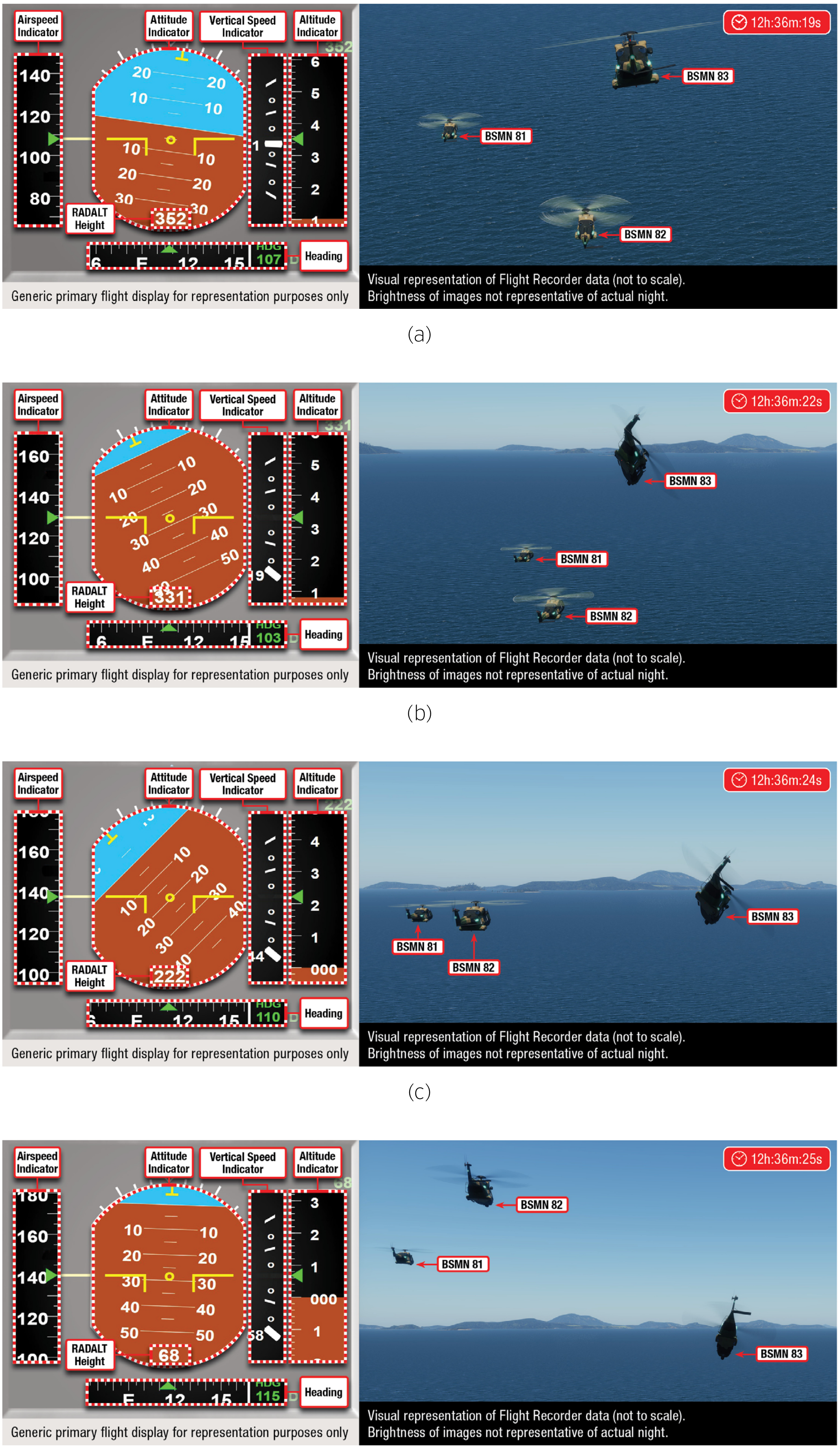

Figure 29: Aircraft state during Phase 3

(a) pushover (b) manoeuvre (c) unrecoverable (d) last valid recording.

2.9.2 **Initiation of pushover.** Analysis of the FDR indicates that at 1236:19Z, at the top of the climb, the FP initiated a large forward longitudinal cyclic input to at, or near, the forward stop. This forward cyclic input introduced an undesired aircraft state.

2.9.3 **Startle reaction discounted.** The ASIT considered the possibility of an involuntary startle reaction triggering the initiation of the pushover by the AC (FP). Startle is elicited by exposure to sudden, unexpected, and intense stimuli that typically generates an immediate, reflexive response. Startle is triggered by a sudden highly intensive stimulus and cannot be triggered by the absence of a stimulus[54]. No evidence was identified to indicate the crew were exposed to a sudden highly intensive stimulus prior to the pushover. Therefore, it is considered very unlikely that a startle response contributed to the initiation of the pushover.

2.9.4 **Motivation to regain visual contact.** In the absence of other reasonable scenarios to explain the pushover, the ASIT considers the actions of the AC (FP) were likely an attempt to rapidly regain visual contact with BSMN 82. This is consistent with the explanation for the FP's manoeuvring of the aircraft immediately following the loss of visual contact with BSMN 82. The aircraft state at the commencement of forward longitudinal cyclic input is shown in Table 5.

2.9.5 The ASIT considered the possible effects of surprise on the AC's (FP) performance. Surprise is defined as a cognitive-emotional response to something unexpected, which results from a mismatch between one's mental expectations and perceptions of one's environment. At 1236:14Z, the FP calmly responded, 'Yeah, still got em mate.' The AC's (FP) expression, 'Oh' was recorded at 1236:16Z, immediately prior to the initiation of the pushover. It is considered possible that the AC (FP), at this moment, was exposed to a surprise effect triggered by the unexpected loss of visual contact with BSMN 82. Surprise may reveal itself, depending on circumstances, in any of a number of behavioural indicators, such as spontaneous exclamations[55]. The cognitive response to surprise involves the direction of attention to the most salient features of the situation[56], which in this case was the loss of visual contact with BSMN 82. It is widely acknowledged that surprise often results in pilots not responding as they were trained, and may lead to inappropriate, intuitive actions. In this way, it is considered plausible that the AC's (FP) attention and motivation would have been prioritised towards immediately regaining visual contact with BSMN 82 and not towards the assessment of less salient sources of information (eg aircraft instruments). It is not known if the FP referred to flight instruments or noticed any discrepancy between their perceived and actual orientation prior to the pushover. It is likely the time between the likely loss of visual contact with BSMN 82 (1236:15Z) and the initiation of the pushover (1236:19Z) was insufficient to cognitively process new information and to regain orientation.

2.9.6 As previously stated, it is likely the AC (FP) misperceived their visual orientation relative to BSMN 82. This included the FP not detecting a reversal in pitch angle of the aircraft during the inadvertent climb from approximately +5 degrees nose up to about -5 degrees nose down. Based on bioengineering modelling of the physical forces acting on the crew (Enclosure 9), it is very likely the AC (FP) perceived the aircraft to have maintained a nose-up pitch of approximately +5 degrees through this period (see paragraph 2.17.3 Spatial Orientation).

2.9.7 It is the view of the ASIT that the undetected pitch attitude reversal, and the absence of communication, combined with the unsafe control input, further supports that the AC (FP) was unaware of the true state of the aircraft. While the AC (FP) likely perceived the aircraft to be in a nose-up pitch attitude with an airspeed of approximately 80 KIAS, the actual state of the aircraft was nose pitch down with an airspeed of 111 KIAS.

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54 European Aviation Safety Authority. (2018). Research Project: Startle Effect Management. Report Number NLR-CR-2018-242.

55 Reisenzein, R., Meyer, W., & Niepel, M. (2012). Surprise. In V. S. Rachmandran (Hrsg.), Encyclopaedia of Human Behaviour (2nd Ed., pp. 564–570.). London.

56 Rivera, J., Talone, A. B., Boesser, C. T., Jentsch, F., & Yeh, M. (2014). Startle and Surprise on the Flight Deck: Similarities, Differences, and Prevalence. 58, 1047-1051

2.9.8 Without realising the orientation error and the true state of the aircraft, it is likely the FP believed they were transitioning the aircraft from a pitch-up attitude to pitch-down attitude. The rapid introduction of forward cyclic acted to pitch the nose down further, and was initiated with a higher than expected airspeed, resulting in the undesired aircraft state.

FINDING[49]	**It is likely that BSMN 83's AC (FP) moved the cyclic forward to lower the pitch attitude of the aircraft to regain visual sight of BSMN 82.**

FINDING[50]	**It is likely that BSMN 83's AC (FP) believed they were transitioning the aircraft from a pitch-up attitude to a pitch-down attitude.**

FINDING[51]	**It is very likely that BSMN 83's AC (FP) experienced degraded Situation Awareness of the aircraft's attitude, altitude, airspeed and rate-of-descent.**

FINDING[52]	**Large forward cyclic input held by BSMN 83's AC (FP) resulted in an inadvertent high rate-of-descent, increasing airspeed and excessive closure on BSMN 82.**

2.9.9 **Turn in descent post pushover.** Two and a half seconds after the pushover (1236:21.5Z) the cyclic was displaced laterally to the right resulting in a 47 degree AoB. Cyclic input transitioned aft during the lateral cyclic movement; however, at no stage did the cyclic move rearward through the neutral position. Consequently, RoD continued to increase. At this time, BSMN 83's airspeed was 124 KIAS (~230 km/h) and the RoD was 1471 ft/min rapidly increasing. In contrast, BSMN 82 was at formation airspeed of approximately 80 KIAS (~148 km/h) and minimal RoC/RoD.

2.9.10 FOV analysis indicates that, after initiating the pushover, the FP of BSMN 83 likely regained visual on BSMN 82. The ASIT assesses that BSMN 83's position relative to BSMN 82 in combination with their differing forward and vertical velocity[57] lead to a significant rate of closure between the two aircraft. During the two and a half seconds after the pushover, FDR analysis indicates that the relative distance between the two aircraft decreased from approximately 100 metres to 50 metres. In response to this increasing closure, it is likely the FP acted to avoid a potential mid-air collision with BSMN 82 by executing an avoidance turn to the right.

FINDING[53]	**It is likely that BSMN 83's AC (FP) rolled the aircraft to the right to initiate a turn to avoid a collision with BSMN 82.**

2.9.11 **Control inputs during the descent.** The vertical acceleration (G-force) experienced during the pushover manoeuvre went from positive 1G (normal flight parameter) to negative 0.02G (weightless condition). In a low-G state, control power is reduced, and there is a delayed control response (flight control saturation) (Reference HH). This likely led to the AC (FP) experiencing control inputs being dampened, delayed and out of sync. FDR analysis shows lateral cyclic displacement to the right (+34 %) at 1236:21Z, resulting in the aircraft rolling to 47 degrees AoB. However, while the aircraft passed through 25 degrees right AoB a lateral cyclic displacement to the left (- 14 degrees) was conducted that had no immediate effect on the roll rate to the right. The aircraft continued through 25 degrees AoB ultimately reaching 47 degrees AoB to the right before aircraft angular movement commenced to the

57 BSMN 82 was at formation airspeed of approximately 80 KIAS and minimal RoC/RoD, whereas BSMN 83 was 124 KIAS and 1471 ft/min RoD and rapidly increasing.

left. Simulator testing replicating the flight sequence supported the potential flight control saturation during the descent (Reference II).

2.9.12 Figure 30 shows the VFDR cyclic control movement made by the AC (FP) just prior to the pushover through until the last valid recording (1236:17.5Z to 1236:25.5Z)[58]. Time positions 3 through 8 on Figure 30 show cyclic inputs towards the forward cyclic limit that resulted in the pushover. Of note, the cyclic position remained in the forward quadrants from pushover to the last valid recording.

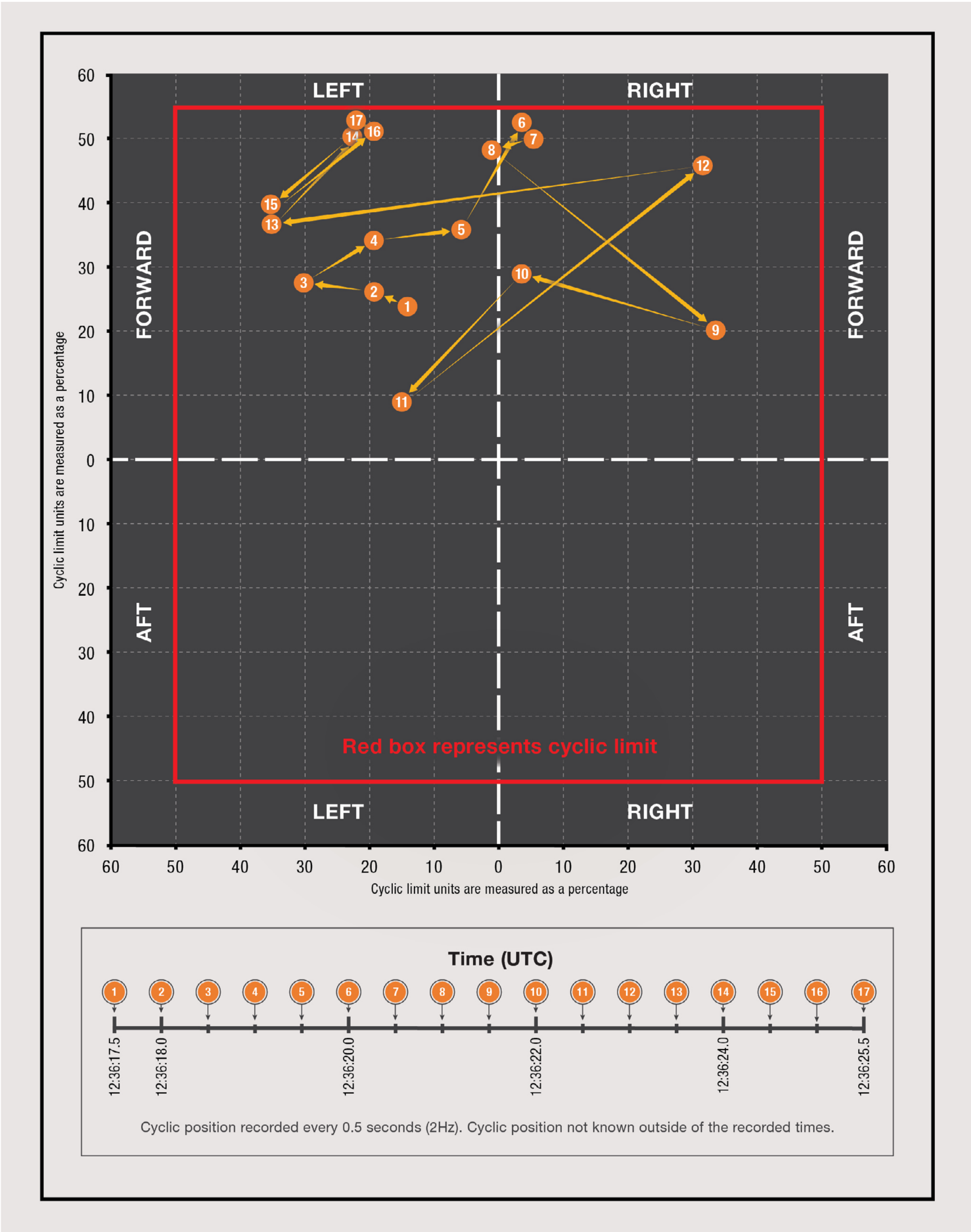

Figure 30: BSMN 83 cyclic movement 1236:17.5 – 1236:25.5Z

FINDING[54] It is very likely that BSMN 83's AC (FP) felt the control inputs and aircraft response during the negative G descent as dampened, delayed and out of synchronisation.

58 The VFDR cyclic position recording rate is 2 Hz (once every 0.5 of a second).

2.9.13 In addition to the potential flight control saturation, modelling of the physical forces acting on the pilots during the descent indicates that the acceleration force would have resulted in a perception of increasing pitch-up, even though the aircraft was pitched-down (Enclosure 9 - McGrath report). Consistent with this modelling, FDR analysis indicates the cyclic moved aft for half a second post the lateral displacement to the right (the avoidance turn) before being moved to the maximum forward position at 12:36:23Z. This is despite the aircraft pitch being 20 degrees nose-down. This cyclic control movement is indicative of a misperception of pitch by the FP. The ASIT assesses that the FP continued to push the aircraft pitch nose-down based on false sensory information that made them perceive the aircraft was pitching up (see paragraph 2.18.19). This exacerbated the undesired aircraft state that was initiated at the pushover.

2.9.14 During the descent, regardless of the flight control input, the aircraft was not recoverable given the aircraft energy state and trajectory. BSMN 83's last FDR input was captured at 1236:25Z (see Table 5). The aircraft pitch did not return to a positive (climb) angle prior to impact.

2.9.15 It is the view of the ASIT that the AC's (FP) control inputs from the initiation of the pushover until impact are consistent with Type I (Unrecognised) Spatial Disorientation.

FINDING[55]	It is very likely that BSMN 83's AC (FP) did not recognise their loss of Spatial Orientation of the aircraft's pitch attitude.

FINDING[56]	Control inputs by BSMN 83's AC (FP) from the initiation of the pushover until impact are consistent with Type I (Unrecognised) Spatial Disorientation.

2.9.16 **Additional human performance factors and Spatial Disorientation (SD).** Human performance-related factors were identified by the ASIT as having contributed to the FP's loss of Spatial Orientation and BSMN 83's departure from formation parameters that went undetected by the crew. These included factors that are known to impede Situation Awareness (SA) and Spatial Orientation such as sub-optimal Non-Technical Skills (NTS) and human performance limitations associated with workload, attention, and fatigue. Section 2.16 provides a deeper understanding of the underlying physiological and psychological mechanisms the ASIT considers likely to have contributed to the accident. This includes the interrelationship between SA, Spatial Orientation and SD as well as the likely contribution of Type 1 (Unrecognised) SD to the accident.

LOCAL CONDITIONS

2.10 Local conditions scope

2.10.1 Local conditions exist in the immediate context of the environment in which individual/team actions or technical failures occur. This section will discuss in more depth local conditions identified in the event sequence, such as SD, fatigue, human performance and weather.

2.11 Knowledge, skills and experience

2.11.1 **Crew qualifications and recency.** The crew of BSMN 83 were qualified, current and within crew endurance as required by Reference JJ and Reference G and Patriot Excalibur (PEX) (see Table 1). The ASIT noted however, that Army Aviation OIP, and PEX currency manager did not track either currency or recency for NVD formation flying. The lack of information recorded in PEX set the pre-condition for flying supervisors and authorising officers to not have a comprehensive understanding of a crew's recency and proficiency with respect to NVD formation flight when selecting crew composition and during the authorisation process.

INDIRECT FINDING[57] **Patriot Excalibur (PEX) did not have functionality for Flying Supervisors and Flight Authorisation Officers to review aircrew currency and recency for NVD formation flying.**

2.11.2 This issue had been identified in Reference KK, and the following recommendation made to DCOMD AVNCOMD: 'DCOMD AVNCOMD stipulate currency requirements for formation flying by day and night, and introduce tracking of these requirements in Patriot Excalibur for supervising and authorising purposes.' At the time of the event, this recommendation had not been implemented, however, since the accident on 28 Jul 23, AVNCOMD have introduced PEX Mission Task Recency requirements for formation and NVD flight.

2.11.3 Specific discussion of crew training is addressed in section 2.29.

2.12 Weather

2.12.1 The weather on the night of the event was within limits for night flying[59], however, the degrading conditions introduced complexity, influenced decision making, and increased workload. Cloud and visibility data recorded by the Bureau of Meteorology (BoM) on the event night shows a sudden decrease in horizontal visibility to 2000 m at 2230K at Hamilton Island Airport (approximately 3 nm to the north of the accident site). Figure 13 shows showers in the vicinity of Hamilton Island Airport and to the south where the BSMN formation was operating.

2.12.2 Immediately prior to the accident, both BSMN 83 and 84 mentioned flying through showers, and imagery captured by the Hamilton Island BoM weather camera (which is situated to the north of the formation position, and pointing south) showed significant cloud coverage (Figure 31). Other BSMN formation crews later recalled flying into a light shower prior to the accident and avoiding the heavier showers to the north towards Hamilton Island. Crews reported that flying through showers reduced visibility, which varied depending on the intensity of the precipitation along the formation's flight path.

FINDING[58] **It is likely that visibility ahead of BSMN 83's flightpath immediately prior to the accident degraded as a result of flying through a shower.**

Figure 31: Hamilton Island weather camera at 1235 facing south

59 During planning and prior to departure, the weather conditions were 'Normal' IAW Reference AA, but were likely degraded along BSMN 83's flightpath prior to the accident.

2.12.3 The decision by BSMN 81 to conduct a left-hand hold was thought appropriate by the ASIT given the showers in the vicinity of the formation, however, it did increase workload on BSMN 83 to maintain formation in a left-hand pattern. The orientation of the formation, as determined by VFDR analysis, coupled with the meteorological information, suggest that BSMN 83 was looking into showers, and the horizon was therefore significantly degraded. This is supported by the comment from the AC (FP): 'It's getting dicey,' at this point in the event sequence.

2.12.4 Localised rain showers and associated cloud coverage reduce celestial illumination and visual contrast between an object and its background. Operating at night using NVD in environments with reduced visual cues and contrast can make it difficult to discern the reference features on the preceding aircraft. Although the weather was assessed to be within limits, the ASIT assesses that the night's weather varied, with areas of showers that degraded visibility and obscured the horizon in localised areas. It is very likely that as BSMN 83 exited the final left turn, while maintaining visual contact with BSMN 82, the AC's (FP) NVD FOV was directed into a sector with no discernible horizon, further reducing visual cues for aircraft control and Spatial Orientation

FINDING 59 **It is very likely that a lack of a discernible horizon due to degraded visibility conditions limited the ability of BSMN 83's AC (FP) to use external visual references while exiting the final left turn.**

FINDING 60 **It is very likely that reduced visual cues in degraded weather conditions affected the ability of BSMN 83's AC (FP) to maintain Spatial Orientation while exiting the final left turn.**

2.13 Workspace environment

2.13.1 The MRH-90 cockpit is a visually restricted environment for the pilots as detailed in the MRH90 STANMAN (Reference L). Structural requirements due to the size of the helicopter include a windscreen pillar, which can impede FOV, particularly when flying cross-cockpit. Additionally, the avionics suite requires a large cockpit coaming[60], and an overhead console that further impede FOV. The windscreen area is comparatively small. A representation of the view, at night, is at Figure 32.

2.13.2 The FP is responsible for aircraft spacing and obstacle clearance. Reference L warns that flying with a cross-cockpit view, particularly on NVIS, may result in an undesirable increase in pilot workload. It recommends that cross-cockpit formation should be minimised.

2.13.3 Further detail on the FOV, cross-cockpit formation flying, and workload are discussed in sections 1.7, 2.7, and 2.14 of this report.

This information has been redacted due to its security classification

Figure 32: MRH-90 cockpit at night

60 The protruding border above the flight instrument panel designed to reduce glare/reflection.

2.14 Station keeping

2.14.1 There were indications that the CP was having difficulty maintaining station prior to the AC taking over, from VFDR voice recordings, and the recollections of BSMN 84. Further, as Phase 2 (the inadvertent climb) progressed, the ASIT found that the technique for formation station keeping and the degraded visual conditions increased workload, and narrowed the attention of the pilot.

2.14.2 **Use of Radar Height (RHT) in formation flying.** MRH90 STANMAN (Reference L) states that when RHT is engaged, it is possible to de-activate, override or re-reference the 'hold', in one of three ways (refer Figure 33 for switch positions on the collective lever grip):

a. by moving the collective against the trim
b. by depressing the collective trim release spring-loaded switch, commonly referred to by MRH-90 pilots as the trigger switch
c. by moving the four-way switch for collective trim (forward and aft).

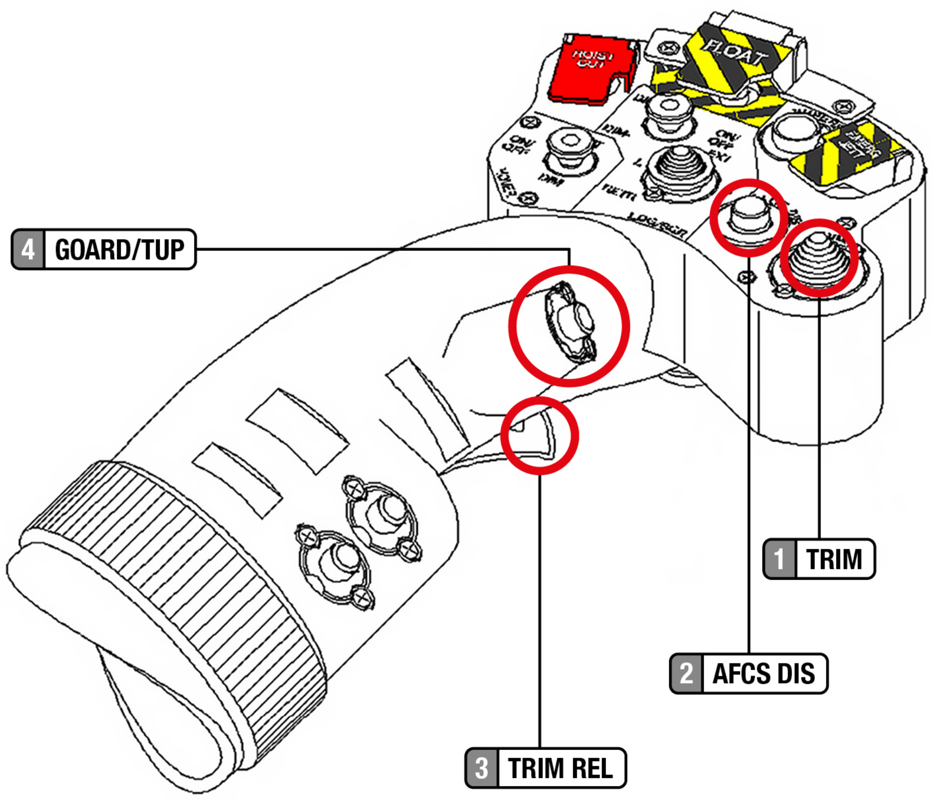

Figure 33: MRH-90 Collective Lever Grip

2.14.3 If the pilot moves the collective against the trim; that is, without depressing the trigger switch, the aircraft will return to the previously set RHT datum once the manual collective input is removed. In both other methods, the aircraft will reset the height of the aircraft at the point at which the mechanism (either trigger or trim) is released.

2.14.4 The technique (Reference L) for formation flying station keeping requires the FP to manipulate the collective and cyclic constantly in order to maintain height, line and spacing from the preceding aircraft. It is common practice for ADF MRH-90 pilots to depress the collective trigger switch, manoeuvre the aircraft into the correct position and then release the collective trigger switch. This practice is repeated constantly, as required to maintain station, throughout the flight. The technique is taught at AAvnTC during the MRH-90 Pilot Course (Reference LL), and conforms with standard formation flying technique for rotary wing operations in the ADF, as manoeuvring the aircraft via the upper modes (RHT is an upper mode) is deemed too slow.

2.14.5 It is the opinion of the ASIT that the practice of routinely overriding the RHT to make adjustments to spacing and height introduces the opportunity for human error. It is virtually certain that the AC (FP) was using the technique of depressing the collective trigger switch and overriding the RHT upper mode for formation station keeping. In this situation, as the crew's SA decreased, and BSMN 83 departed level flight, the disengagement of the RHT removed a risk control designed to reduce workload and keep the aircraft at a pre-designated height. This is discussed again in section 2.27.

FINDING 61	**The practice of routinely overriding the RHT to adjust and maintain formation position (height, line, speed/closure and distance) increases the likelihood of human error.**

FINDING 62	**It is virtually certain that BSMN 83's AC (FP) was using a standardised and taught technique to override the RHT upper mode frequently by depressing the collective trigger switch to adjust and maintain formation position.**

FINDING 63	**Frequent overriding of the RHT removed a risk control designed to reduce pilot workload and prevent altitude deviations while conducting low level flight over water.**

2.14.6 **Decision Height (DH).** The ASIT considered the DH setting as an additional control to support crews to identify and respond to descent below planned height. The MRH90 STANMAN (Reference L) details the option[61] of setting the DH to 10% below intended height for mission transit/en route operations. To prevent two alerts, operators often set the RHS and LHS DH settings differently. STANMAN guidance is that the second is set to 0 ft[62]. This system can be used for all phases of flight, however the transit/en route DH settings are not mandated, and are at the discretion of the AC.

2.14.7 If the MRH90 STANMAN (Reference L) guidance was used, and based on the minimum authorised height of 200 ft, the appropriate DH setting would have been 180 ft. Each of the four aircraft in the BSMN formation had different DH settings on the event night (see Table 4), and in all but one aircraft, the RHS and LHS were set differently. BSMN 83 had set 45 ft on the RHS and 0 ft set on the LHS. The VFDR does record DH alerts (either the Amber caution or the vocal message). However, as it would not have activated until the aircraft passed through 45ft, it is the assessment of the ASIT that the accident event sequence was so far progressed at that moment, that the crew would not have been able to react any differently. Additionally, if the DH was set to 180 ft, the alert would have occurred 1.5 seconds earlier and would not have provided enough time for the crew to recognise, react and recover the aircraft from the high rate of descent.

INDIRECT FINDING 64	**BSMN 83's Decision Height alerts were set at 45 ft on the LHS and 0 ft on the RHS.**

INDIRECT FINDING 65	**It is virtually certain that BSMN 83's Decision Height alerting system was serviceable.**

61 The MRH90 STANMAN contains inconsistent executive words (***shall*** and ***may***) regarding the DH setting requirements allowing aircrew interpretation. It details: 'The AC ***shall*** ensure an appropriate height for the DH alerting system to advise the pilots that the selected parameter has been activated.' Then immediately states an AC may ensure the DH function is set for mission transit/en route operations to a height 10% below a minimum height. Where ***shall*** is defined as a direct order from the Service Accountable Manager, and ***may*** denotes that the application of a procedure is optional.

62 The MRH90 STANMAN specifies that only the NFP ***may*** set their DH setting to the 10% below a minimum height, while the FP DH setting ***may*** remain at zero. Based on interview evidence, the reason is to prevent two alerts occurring.

INDIRECT FINDING[66]

Neither a Decision Height set IAW MRH90 STANMAN nor as set by the pilots of BSMN 83 would have provided adequate warning time to recover the aircraft from the high rate of descent passing through 200 ft.

INDIRECT FINDING[67]

Army Aviation Standing Instructions and MRH90 STANMAN direction for the use of MRH-90 low height warning systems, as written, set the preconditions for aircrew to exercise flexibility of interpretation and application depending on mission profiles and flight regimes.

2.15 Scan

2.15.1 As noted in para 2.18.6, Flight Over Water (FOW) at night on NVD must be conducted with an increased reliance on instruments, in order to reduce misinterpretation of the challenging NVD scene. MRH90 STANMAN (Reference L) states that, 'Constant cross reference to flight instruments is required during all night operations,' with specific mention of embarked (overwater) NVD operations and the potential for degraded NVD performance. Further, MRH90 STANMAN states that an instrument scan is an integral part of night flying particularly during low-light conditions; however, it also notes that common faults exhibited by pilots during night flight include not scanning instruments, and/or not actively scanning, including head movement, while using NVD.

2.15.2 The ASIT considered the importance of scan in maintaining aircraft parameters, particularly when aircraft systems (the RHT) are not in use, or are in intermittent use. Scan therefore becomes critical in recognising and managing aircraft state.

2.15.3 MRH90 STANMAN (Reference L) states that the FP is responsible for maintaining SA of aircraft performance capability, and the NFP is to monitor aircraft performance parameters. This implies that both FP and NFP are responsible for a scan, or work cycle that includes aircraft performance parameters.

2.15.4 Scan is taught from basic flight training. The Professional ADF Aviators' Reference Manual (PAARM) (Reference MM) states that the attitude indicator is the primary instrument, and that other instruments are scanned from that, and are selected as appropriate to the flight regime. This is known as the selective radial scan and is primarily taught for instrument flight. This is the foundation of the scan required for night unaided and NVD flight. The most basic work cycle taught at ab initio pilot training is Attitude-Lookout-Attitude-Performance (ALAP). This work cycle directs the pilot's attention, however, does not prescribe which performance instruments to scan as this is dependent on the flight regime. A work cycle incorporates instruments to scan with other requirements, such as look out, or, as in the case of MRH-90 formation flying: Height-Line-Spacing, and Up-Forward-In (Reference L).

2.15.5 Review of MRH90 STANMAN (Reference L) identified varied and disconnected references to scan, and work cycle. For example, the section on unaided night flight requires a disciplined scan of both visual cues and the aircraft's attitude and performance instruments. Despite clear reference to instrument scan being critical to embarked NVD operations, there is no similar guidance on the section on aided night flight. MRH90 STANMAN does provide prescriptive work cycle and scan requirements for Forward Looking InfraRed (FLIR) operations, but this is not found elsewhere for other flight regimes.

2.15.6 Review of the Aviation Pilot Regimental Officers Basic Course (ROBC) Program MRH-90 Course (Reference NN) identified that during the primary phase, students are taught to incorporate HMSD symbology into their scan for forward flight. Scan for forward flight maintenance is Attitude-Vector-Look Out-Performance. During formation flight, students are taught that the line-up features for formation flight include the rotor head on the horizon to provide vertical alignment (Figure 34). When the horizon is not visible, the HMSD horizon bar can be placed against the rotor head to provide vertical alignment.

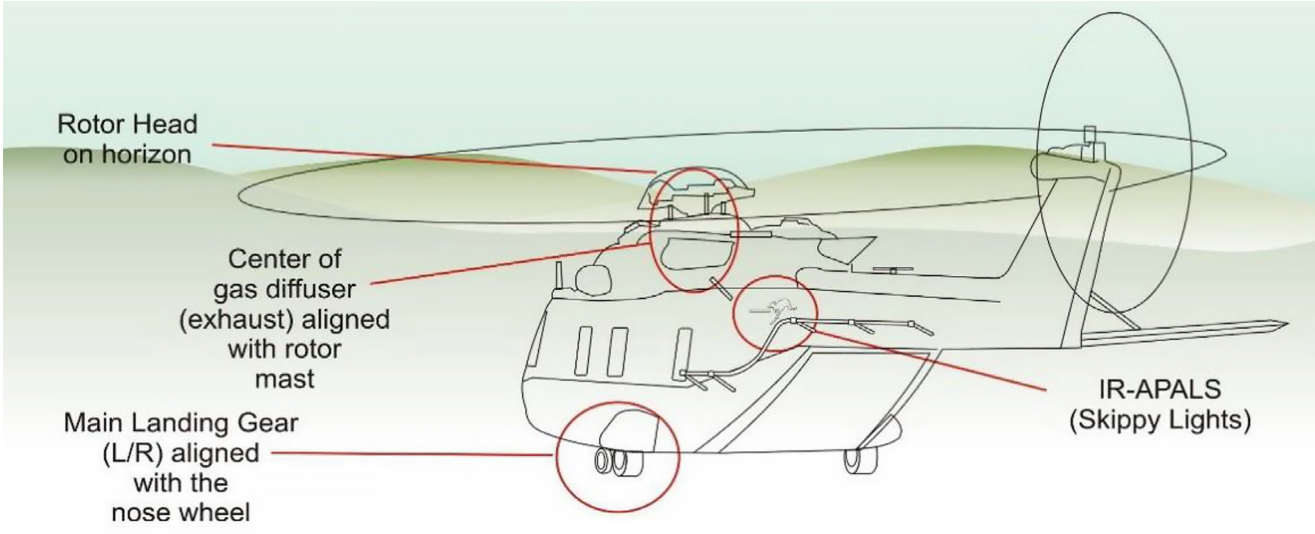

Figure 34: Stagger/echelon line-up features

2.15.7 Figure 27 is a representation of the display through TopOwl, with HMSD symbology. It is included to support the reader in contextualising scan and HMSD information, and not representative of the display indications that were available to the crew on the night of the accident.

2.15.8 The ASIT interviewed MRH-90 operators[63] with reference to scanning techniques and identified variability in individual approaches and level of importance placed on instrument scan. Variability in approaches for critical information gathering and confirmation techniques sets the pre-conditions for varied and sub-optimal performance.

2.15.9 As previously discussed, the focused attention of both the FP and the NFP, on BSMN 82, in an increased workload environment, likely degraded their scan and work cycle. The ASIT consider that a standardised, taught work cycle technique for each flight regime, coupled with unambiguous responsibility for performance parameter monitoring (see section 2.30) represent an opportunity to strengthen risk controls.

FINDING[68] **Variability in standardisation and application of the integration of instrument scans into night formation station keeping work cycles sets the pre-conditions for varied and sub-optimal techniques and performance.**

HUMAN PERFORMANCE

2.16 Spatial Disorientation

2.16.1 The following section outlines the theoretical foundations that support the analysis of the event sequence described in sections 2.5-2.9. By drawing on established principles from psychology and human factors, this section aims to provide a deeper understanding of the underlying mechanisms the ASIT considers likely to have contributed to the accident.

2.16.2 These theoretical concepts of Situation Awareness (SA) and Spatial Orientation, as well as its converse Spatial Disorientation (SD), are closely related. Collectively, these concepts provide a framework for analysing key components of the event.

2.16.3 The analysis of results was informed by the *Defence Aviation Non-Technical Skills Guidebook: Fundamentals for Aviation Professionals* (Reference OO).

63 Including QFIs, Commanders and Line Pilots

2.17 Theoretical concepts

2.17.1 **Situation Awareness.** Successful performance and flight safety depends upon the aircrew having an accurate mental model of the current state of the operational environment, commonly referred to as Situation Awareness (SA). The Five Eyes Air Force Interoperability Council (AFIC) provides the following standardised definition of SA (Reference PP):

> Situation awareness is the awareness of a large group of factors that are important in keeping the aircraft safe from hazardous situations or a potentially dangerous flight path. These factors include geographical location, weather, tactical environment, weapons capabilities, individual capacities, effective communication, administrative constraints, adherence to proper flight rules, and also spatial orientation.

2.17.2 Endsley's model of SA (described in Reference OO) divides SA into three levels. Level 1 SA involves perceiving critical factors in the flight environment, Level 2 SA involves interpreting and comprehending what those factors mean, and Level 3 SA involves anticipating the future state of the operational environment.

2.17.3 **Spatial Orientation.** Spatial Orientation is a component of the broader and more comprehensive perception and appreciation of the flight environment referred to as SA. Spatial Orientation refers to the natural human ability to maintain body orientation and/or posture in relation to the surrounding environment at rest and during motion. Spatial Orientation normally involves both the subconscious integration of sensory cues and the conscious interpretation of external information. In describing the challenge of maintaining Spatial Orientation in flight, FAA's Medical Facts for Pilots (Reference QQ) states:

> Humans are designed to maintain spatial orientation on the ground. The three-dimensional environment of flight is unfamiliar to the human body, creating sensory conflicts and illusions that make spatial orientation difficult, and sometimes impossible to achieve.

2.17.4 Spatial Disorientation. The loss of Spatial Orientation is commonly referred to as Spatial Disorientation (SD). AFIC provides the following standardised definition of SD (Reference PP):

> …a term used to describe a variety of incidents occurring in flight where the aviator fails to sense correctly the position, motion or attitude of the aircraft or of [themselves] within the fixed co-ordinate system provided by the surface of the earth and the gravitational vertical. In addition, errors in perception by the aviator of [their] position, motion or attitude with respect to [their] aircraft, or of [their] own aircraft relative to other aircraft, may also be embraced within a broader definition of spatial disorientation in flight.

2.17.5 For the purposes of this report, SD is categorised in two broad categories, explained below and illustrated in Figure 35:

a. **Type I** - Unrecognised. In this form of disorientation, the pilot is unaware that they are disoriented or that they have lost SA. The pilot, unaware of the problem, continues to fly the aircraft as normal. This is particularly dangerous, as the pilot will not take any appropriate corrective action, since they do not perceive that there is in fact a problem. This form of SD accounts for the majority of SD accidents and fatalities.

b. **Type II** - Recognised. Type II SD is more common than Type I. In this form of disorientation, the pilot becomes aware that there is a problem. The conflict between their own perceptions and that given to them by the instruments or the outside visual world alerts them to a problem, which they are then in a position to deal with. If this is successfully dealt with, a SD accident does not tend to result. In some cases, the pilot may become overwhelmed to the point where they are unable to successfully recover from the situation[64].

64 Often referred to as Type III – Incapacitating SD.

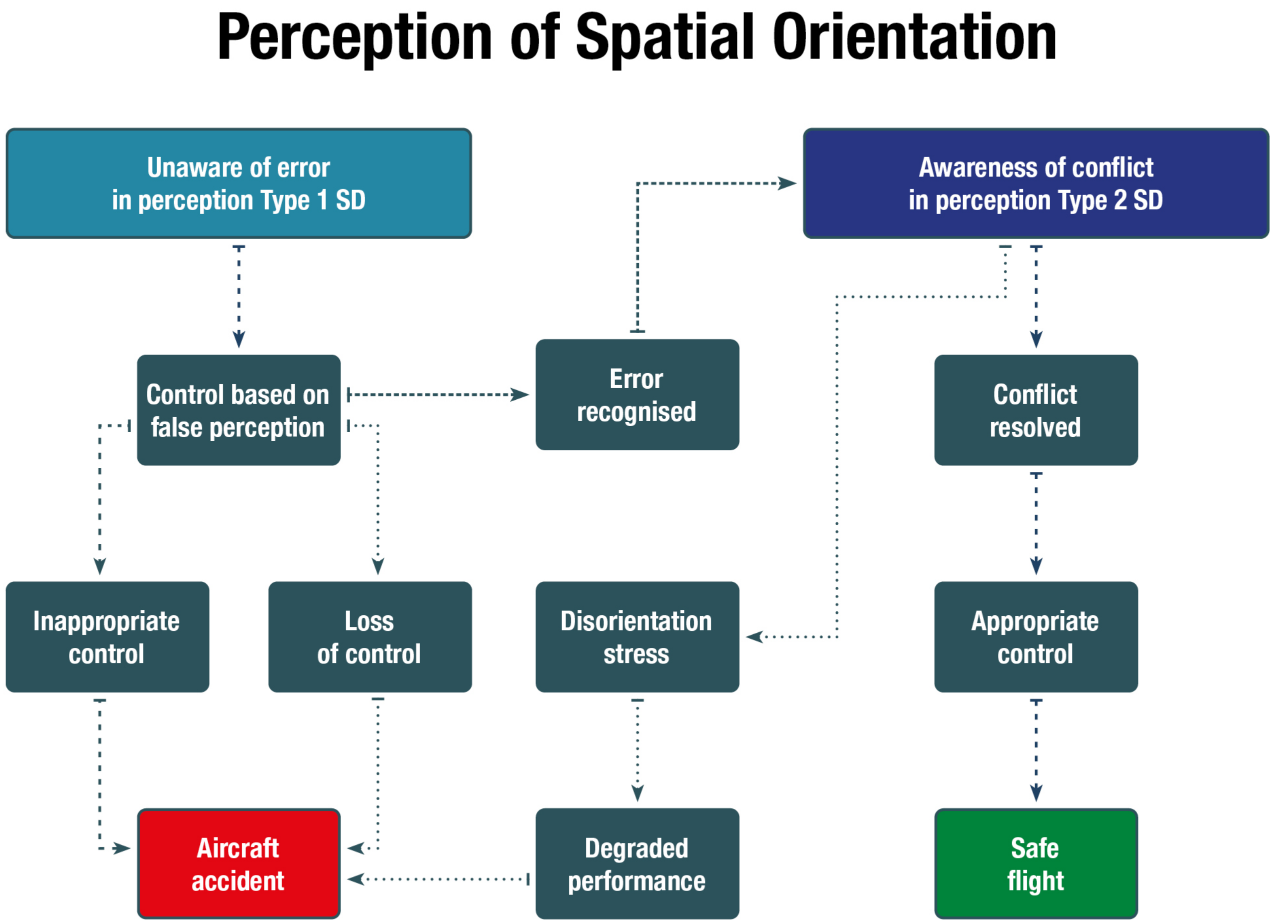

Figure 35: Illustration of how Type I and Type II Spatial Disorientation can influence the pilot's control of the aircraft[65]

2.17.6 With consideration to Endsley's model of SA, SD represents a loss of Level 1 SA. As the pilot has not detected a conflict between their own perceptions and that given to them by the instruments or the outside visual world, the erroneous information is integrated within their mental model. As a result, Level 2 SA and Level 3 SA is significantly degraded.

2.17.7 **Prevalence of SD safety events.** SD is an enduring and significant hazard to aviation safety. As detailed in Enclosure 9, in a review of all US Navy and Marine Corps Class A rotary-wing mishaps for the period FY 1997-2002, 29% were classified SD mishaps. SD mishaps were more deadly than other mishaps, with 71% of SD mishaps claiming lives versus 43% of non-SD mishaps. The influence of NVDs appears to be an important factor in aviation mishaps, with 64% of all SD mishaps occurring at night.

2.17.8 Research undertaken by DFSB on the frequency, severity and types of SD events experienced by Defence Aviation aircrew is consistent with research findings from civilian and foreign military settings. DFSB Research Report 01/2024 – SD Survey Results (Reference SS) revealed that a significant proportion (86%) of ADF aircrew respondents reported experiencing at least one SD experience during the last three years on their primary aircraft type. A noteworthy proportion of respondents (15%) rated their worst SD experience in the past 3 years as 'significant'. A further 2% (18 respondents) rated their worst SD experience as 'severe'. There were large differences based on respondents' aircraft category. For example, the majority of 'severe' SD experiences were among Rotary Wing (eight respondents) and Air Combat (seven respondents) categories.

2.17.9 Reference SS found that the most common types of SD for ADF rotary wing pilots were NVD Related Illusions, Undetected Drift, and Loss of SA. Of note, while SD experiences occurred infrequently and

65 Modified from Enclosure 9 and Reference RR.

were typically rated as 'minor' (flight safety not at risk) in their severity, a small proportion of rotary wing respondents rated their worst SD experience in the past three years as 'severe' (flight safety was at risk).

2.18 Loss of Spatial Orientation

2.18.1 The conditions and factors identified by the ASIT as likely contributing to the FP and NFP losing Spatial Orientation which led to Type I (Unrecognised) SD are detailed below:

2.18.2 **NVIS Flight Over Water (FOW)66[66].** Vision is the most critical sense for aircrew to discern their orientation. Aircrew flying at night rely on the NVIS, which send images from the reflection of visible light and near infrared light back to the pilot's eyes. The advantages of NVIS-aided visual cues over unaided visual cues are significant, but they are still inferior to day-time visual performance. As detailed in Reference TT, there are visual perception limitations and physical and environmental considerations when using NVIS. These factors are known to increase the risk of experiencing SD.

2.18.3 Visual limitations, such as contrast and visual acuity, are usually subconsciously processed by the visual perception system. Contrast is the difference in brightness or colour between two objects, or between an object and its surroundings. To be able to see an object, it needs a sufficiently high contrast to its surroundings. Visual acuity is a measure of the eye's ability to resolve visual detail. Poor contrast discrimination may manifest itself as reduced visual acuity – low contrast objects are more difficult to see than high contrast objects. Reductions in visual acuity and contrast are features of NVIS-aided vision. Degraded resolution and contrast discrimination can subtly limit visual performance.

2.18.4 Subtle limitations in visual performance or a degradation in the quality of visual cues may not be recognised until large performance deficits exist, unless a conscious effort is made to remain aware of these limitations.

2.18.5 The following are three major physical and environmental factors that can influence NVIS performance:

a. **Illumination.** Light sources come from natural illumination (such as starlight and moonlight) and artificial or 'cultural' lighting (lights from cities and vehicles etc.). Where there is limited natural or cultural lighting, night vision capability is degraded as limited information is sent to the eyes via the NVD.

b. **Terrain considerations.** Human's ability to see terrain features with NVDs is a function of the amount of light reflected by the terrain. Terrain contrast is a measure of the difference between the reflectivity of two or more surfaces. The greater the difference in contrast, the easier it is to see terrain or objects. Therefore, terrain such as water or desert, which usually have very little contrast, can be troublesome to fly over in low-light conditions. This problem is further compounded by a lack of terrain features or texture.

c. **Atmospheric effects.** Any atmospheric condition, which absorbs, scatters, or refracts illumination, either before or after it strikes the terrain, will effectively reduce the usable energy available to the NVD. This reduction, in turn, degrades the ability to see key features critical for flight. The exact amount of reduction is difficult to predict because a common factor cannot be applied to each condition.

2.18.6 FOW is particularly hazardous with NVDs due to the significantly reduced contrast, absence of features, and lack of motion cues on the NVD image. Hazy conditions over water can cause disorientation and force almost total reliance on flight instruments (Reference UU). NVD FOW must be conducted with increased reliance on instruments, as if the aircraft were in Instrument Meteorological Conditions (IMC). Because of the number of illusions that can occur, extraordinary vigilance must be maintained in the aircrew's cross-check between outside visual references and instrument references to prevent misinterpretation of the NVD scene.

66 While the analysis focused exclusively on FOW, the hazard of low contrast and poor visual acuity is not limited to this operating context. Accordingly, the ASIT draws attention to the need for hazard management activities to consider environmental conditions associated with low contrast and poor visual acuity across all operating environments.

2.18.7 The crew of BSMN 83 were flying on a night in weather that produced varied and degraded illumination levels (with limited cultural lighting and at times very little natural lighting) at low level over water. The crew would have been subjected to degraded visual acuity and contrast due to the environmental conditions on the night. In addition, as the crew were flying over water, they would have been subjected to low terrain contrast and atmospheric effects (infrared light absorbed by water).

2.18.8 DASR Specific Purpose Approval (SPA.55) Night Vision Imaging System (Reference QQQQQQ) provides additional information on NVD characteristics/limitations related to reduced FOV, visual acuity and contrast, resolution, fatigue, reduced depth perception and distance estimation accuracy, and night vision recovery.

FINDING[69] **The conduct of Low Level Flight Over Water using NVIS, in combination with periods of a degraded visual environment, increased the risk that BSMN 83's AC (FP) and CP (NFP) would be exposed to conditions inducive of Type I (Unrecognised) SD.**

2.18.9 **Attention and workload.** Attention is the cognitive process that directs information-processing resources to perceiving aspects of the environment.

2.18.10 The way in which a person applies their attention in acquiring and processing information has a fundamental impact on SA. In the context of formation flying at night, to maintain Spatial Orientation requires aircrew to consciously direct attention to visual information received from the NVIS, flight instruments (ie the instrument panel and HMSD) and other aircrew (ie verbal communication). Importantly, efforts to maintain Spatial Orientation must be balanced against maintaining broader SA requirements.

2.18.11 Attention to information is prioritised based on the salience[67] of environmental cues and how important the information is perceived to be towards achieving a goal in a specific task environment. Within the context of night formation flying, the 'goal' of maintaining position in formation requires pilots to continuously monitor and respond to visual cues from the preceding aircraft. The associated cognitive workload is increased in reduced visibility conditions due to the increased complexity and heightened attention required to detect changes in formation parameters. An increase in cognitive workload can result in a narrowing of attentional focus, where individuals concentrate on primary task (ie station keeping) while secondary tasks (ie instrument scanning) receive less attention.

2.18.12 The related phenomenon of inattentional blindness occurs when an individual does not notice visible information because their focus is directed elsewhere. Humans do not process visual information, even if presented within their FOV, unless their attention is directed towards it. In the context of using a HMSD, inattentional blindness can cause a pilot to overlook critical data even though it is clearly presented. For instance, if a pilot is preoccupied with interpreting external visual references, they may not perceive important cues displayed on the HMSD, such as altitude, pitch and the HMSD horizon line. This cognitive limitation occurs because attention is a finite resource, and when it is consumed by one task, other vital information can go unnoticed.

2.18.13 Enclosure 9 (McGrath report) also highlights the challenges aircrew experience transitioning their focus between near domain symbology to far domain external views. This inhibits the ability to maintain optimal scanning patterns between HSMD symbology and external visual references.

2.18.14 In summary, the immediate goal of maintaining station in formation, and the increased demands of operating in reduced visual conditions, likely led to the attentional focus of the FP (and likely the NFP) narrowing at the exclusion of monitoring key instruments (including HMSD symbology) or broader environmental factors necessary to maintain Spatial Orientation.

67 Salience of cues refers to the degree to which it draws attention.

FINDING[70] **It is very likely that the attentional focus of BSMN 83's AC (FP), and likely the CP (NFP), narrowed to prioritise maintaining formation position visually to the detriment of instrument scanning techniques and work cycles during challenging environmental conditions.**

2.18.15 **Misperception of visual orientation.** Humans are primed to notice inconsistences between the environment and expectations. Attentional resources are directed to resolve any conflicts or discrepancies. However, when critical information is not attended to or misinterpreted, the discrepancy will remain unrecognised.

2.18.16 Without a clear view of the horizon, it is considered very likely that the FP misperceived their visual orientation to BSMN 82. While flying in formation, the position of an outside object relative to windscreen depends on position as well as the orientation of formation aircraft. When concentrating solely on maintaining position in formation, and without meaningful outside visual orientation cues, it can be difficult to determine whether a given change in relative position or attitude results from movements in the preceding aircraft, one's own aircraft or a combination of both. In this way, in keeping BSMN 82 in the same relative position on the windscreen, the inadvertent climb and departure from formation went unrecognised by the FP and NFP (refer para 2.8.5).

FINDING[71] **It is very likely that misperception of visual orientation to BSMN 82 contributed to the inadvertent and unrecognised climb and departure from formation by the AC (FP) of BSMN 83.**

2.18.17 Effectively judging distance from an aircraft in formation is also a challenging task. This is typically achieved by estimating the size of the preceding aircraft. Misjudging distance estimation can impede the interpretation of changes in the relative position of preceding aircraft when station keeping in formation. As previously discussed, the FP misjudged their distance of BSMN 83 from BSMN 82 to be closer than the actual distance. It is very likely that this misjudgement contributed to the FP underestimating the rate and size of visual changes in their relative position to BSMN 82 and, as a result, their departure from formation parameters remaining unrecognised.

2.18.18 **Clarity of visual cues.** Reference L has a Warning[68] that states that HMSD symbology brightness levels may obscure the visual or NVD image, resulting in reduced SA. HMSD symbology intensity needs to be adjusted regularly to ensure the pilot can look through it to the visual of IIT/FLIR image. However, Reference L also states that the HMSD symbology cannot be adjusted without the removal of one hand from the flight controls, and acknowledges that this may prevent adjustment of the brightness in high workload situations. The ASIT was unable to establish the HMSD settings in use at the time of the event. Accordingly, the possibility that the HMSD symbology brightness was not set or adjusted to an optimal level, impeding the brightness and clarity of visual cues, cannot be ruled out.

2.18.19 **Misperception of pitch.** As previously stated, Spatial Orientation requires both the subconscious integration of sensory cues and the conscious interpretation of external information. Aircrew obtain information about their orientation from the:

a. visual system – which can receive information from a range of cues inside and outside the aircraft
b. vestibular system – which consists of the balance organs located in the inner ears. The semicircular canals provide information about angular or rotational accelerations in the vertical (yaw), horizontal (pitch) and longitudinal (roll) axes, and the otolith organs provide information about linear accelerations
c. somatosensory system – which includes a range of receptors in the muscles, tendons, joints and skin that sense gravity and other pressures on the body.

68 Warning is defined as: An operating procedure, practice, etc., which, if not correctly followed, could result in personal injury or loss of life. Warnings are placed immediately before the instruction to which they relate.

2.18.20 The visual system is considered to be the dominant sensory system for Spatial Orientation and generally provides about 80% of a person's raw orientation information. The remaining sensory information is provided by the vestibular and somatosensory systems, both of which are prone to misinterpretation and illusions during flight.[69] Although the visual system can overcome these limitations, the risk of SD is significantly increased if the relevant visual cues are not attended to, absent, or ambiguous.

2.18.21 It is the view of the ASIT that erroneous sensory inputs from the vestibular and somatosensory systems likely reinforced the FP and NFP's misperception of visual cues during the inadvertent climb. This impeded their ability to identify any sensory conflict in their Spatial Orientation. As a result, the subsequent actions and inactions of the FP and NFP were based on an incorrect mental model of their orientation, which was supported by multiple false sensory inputs.

2.18.22 As detailed in Enclosure 9 (McGrath report), specialist bioengineering modelling and analysis of the physical forces acting on the crew was conducted to provide an estimate of pilot perception of Spatial Orientation. Analysis concluded that during the inadvertent climb in Phase 2, the FP was likely deprived of meaningful outside visual orientation cues, and it is very likely that it would have been difficult for the FP to obtain a good estimate of the pitch angle attitude from BSMN 82 orientation. This likely led to a reliance on the vestibular and somatosensory systems to determine the body's pitch orientation.

2.18.23 The modelling indicated that these sensors failed to detect a reversal in pitch angle of the aircraft from approximately +5 degrees nose-up to about -5 degrees nose-down. Consequently, the conditions were disposed for the FP to perceive a pitch-up attitude, as opposed to the actual aircraft pitch-down attitude, leading to a loss of Spatial Orientation. Figure 36 shows the perceived orientation of the FP at the top of the climb when the FP initiated large forward longitudinal cyclic input to at or near the forward stop.

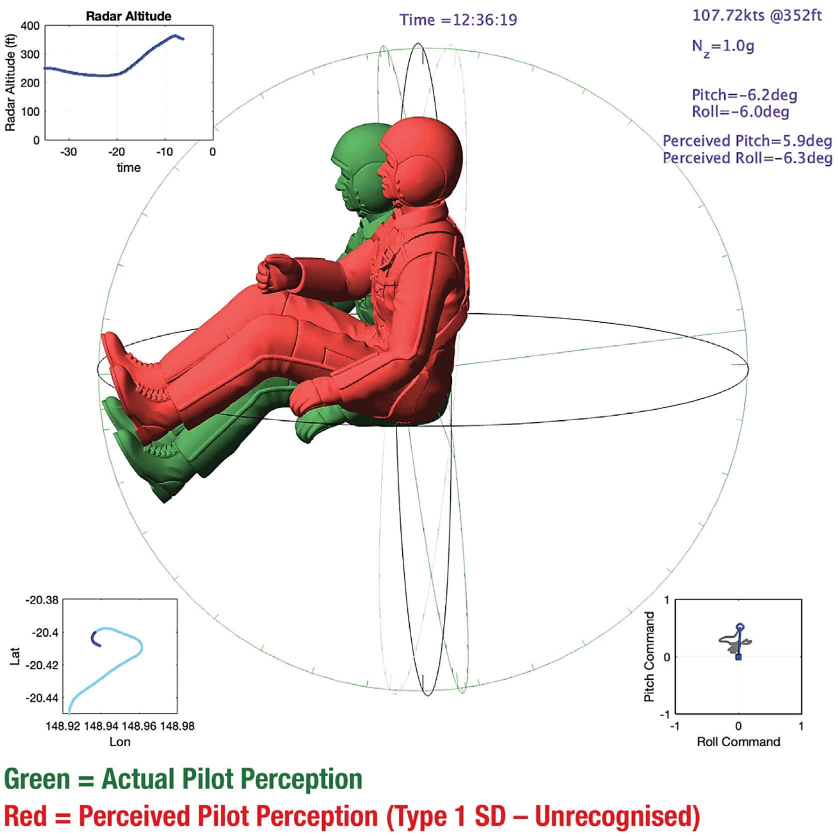

Figure 36: Pilot actual and perceived orientation at 1236:19Z[70]

69 Newman, D. G. (2007). An overview of spatial disorientation as a factor in aviation accidents and incidents (Vol. 2007). Canberra City: Australian Transport Safety Bureau

70 The red figure represents perceived pilot perception with Type 1 SD (Unrecognised).

2.18.24 The modelling of the physical forces acting on the crew during the descent (see section 2.9) indicates that the acceleration force would have resulted in an increasing positive pitch perception even though the aircraft was pitched down. The actual BSMN 83 pitch-down attitude would cause aircraft velocity to increase corresponding to a downward acceleration. As shown in Figure 37 (lower right graphic), FDR analysis indicates that at 1236:22Z the FP moved the cyclic to the maximum forward position despite the aircraft pitch being 20 degrees nose-down. The cyclic control movement is considered indicative of misperception of pitch by the FP; that is, the FP perceived pitch-up despite the aircraft being pitched down.

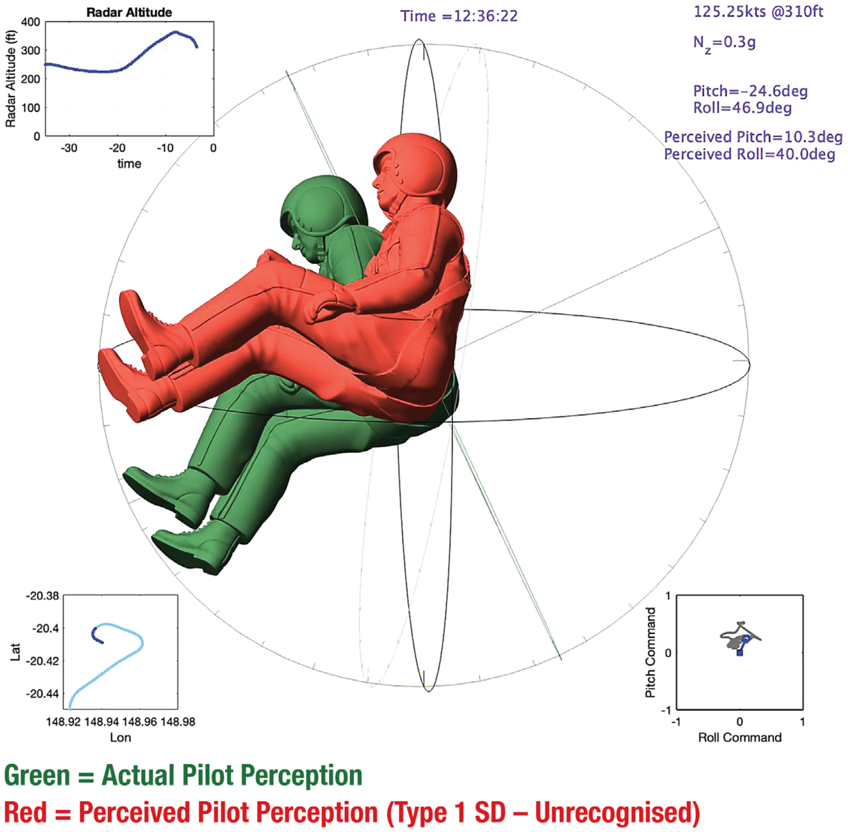

Figure 37: Pilot actual and perceived orientation at 1236:22Z - Type I SD

2.18.25 Enclosure 9 (McGrath report) concludes that the undetected pitch attitude reversal, combined with inappropriate control inputs and the absence of communication, strongly supports the occurrence of Type I SD (Unrecognised). The report noted that the FP and NFP were exposed to the same set of physical forces and were likely to have similar perception provided they are not visually referring to the instruments. The report also noted that, due to the low -level altitude, it is likely that the time needed to regain orientation by transitioning to instruments was insufficient to allow for appropriate control to prevent impact.

FINDING[72]	**Modelling indicates that it is likely that BSMN 83's pilots did not have sufficient time to transition to instruments, and then apply appropriate unusual attitude recovery controls to prevent impact after experiencing Spatial Disorientation.**

2.18.26 **Summary.** In prioritising station keeping within the formation, the pilot diverted attention away from other Spatial Orientation cues. The crew's narrowing of attention, in combination with the technique for station keeping, which required the FP to intermittently override an AFCS71[71] height hold mode, designed to keep an aircraft at pre-designated height, insufficient visual references, and NVIS equipment limitations, significantly increased the crew's vulnerability to SD. The misleading sensory inputs (visual, vestibular, and somatosensory) did not draw the crew's attention to the departure from formation parameters and created a widening gap between the perceived and actual situation. With compromised SA, the FP's attempt to re-establish visual contact with the preceding aircraft was informed by an incorrect mental model, leading to an undesired aircraft state and controlled flight into terrain.

FINDING 73	**It is more than likely that misleading sensory inputs (visual, vestibular, and somatosensory) contributed to the pilots of BSMN 83 losing spatial awareness of the departure from formation parameters and created a widening gap between the perceived and actual situation.**

FINDING 74	**It is likely that as a result of compromised Situation Awareness (SA), attempts by BSMN 83's AC (FP) to re-establish visual sight of the preceding aircraft were informed by an inaccurate mental model of Spatial Orientation, which ultimately led to an undesired aircraft state and controlled flight into terrain.**

2.18.27 The potential contribution of fatigue and NTS to the event are examined separately in the following sections.

2.19 Fatigue

2.19.1 Defence Aviation Safety Regulation (DASR) defines fatigue as a physiological state of reduced mental or physical performance capability resulting from sleep loss or extended wakefulness, circadian phase or workload (mental or physical activity) that can impair a member's alertness and ability to safely operate an asset, or perform safety related duties.

2.19.2 To establish whether fatigue may have been significant in the development of the event, it has to be shown that:

a. the crew of BSMN 83 were likely to have been fatigued at the time of the event; and

b. the actions, inactions or decisions that were causal in the event were consistent with (or vulnerable to) the effects of fatigue.

2.19.3 In focussing on the actions, inactions or decisions that were directly causal in the event, the below analysis has been limited to examining the potential influence of fatigue on the performance of the BSMN 83 AC and CP.

2.19.4 To analyse the potential contribution of fatigue, the ASIT examined a number of data sources, including self-reported sleep and fatigue histories from the aircrew of BSMN 81, 82 and 84, observations of the BSMN 83 aircrew, VFDR voice analysis, biomathematical fatigue modelling, individual leave balances, and annual *Snapshot*[72] survey results. The analysis of results was informed by *The Defence Aviation Fatigue Management Guidebook* (Reference VV) and *the Defence Aviation Non-Technical Skills Guidebook: Fundamentals for Aviation Professionals* (Reference OO).

71 To maintain station in formation, it is common for the FP to override the RHT by depressing the collective trigger in order to maintain height, line and spacing from the preceding aircraft.

72 The DFSB Snapshot survey is an annual survey administered to personnel from Air Force, Army Aviation, Fleet Air Arm and other selected elements of the ADF. The survey captures information on a broad range of issues that impact the safety, performance and overall health of participating organisations. More information is available from DFSB.

2.19.5 **Duty periods.** Army aircrew are required to operate within the endurance requirements specified in in SI(AVN) OPS 6-201 Aircrew/ Uncrewed Aircraft Systems Operator Endurance (Reference G). This includes the requirement to, unless specifically authorised, have had at least a 10 hour continuous rest period in a duty day[73] prior to commencing a flight duty period and not to plan to exceed 10 hours flying in a duty day.

2.19.6 The investigation revealed that 173 SOAS uses a duty period of 14 hours followed by a 10-hour continuous rest period as the basis of its planning for exercises. The co-ordination instructions for the Air Self-Deployment from Holsworthy to Proserpine on Mon 24 Jul 23, indicate that the planned start and end of each duty day varied. The earliest scheduled start time being 0700K and the latest finish time being 2130K, with no 173 SOAS crew exceeding a planned duty period of 14 hours. Interviews identified that, on arrival at Proserpine, the aircrew daily battle rhythm had the duty period commencing at approximately 1300K and finishing no later than 0300K. Interviews with the crews of BSMN 81, 82 and 84 indicated that all aircrew had at least a 10-hour continuous rest period prior to commencing duty periods.

INDIRECT FINDING[75]	**cheduling of aircrew duty and rest periods for Exercise TALISMAN SABRE 23 was compliant with requirements stipulated in SI(AVN) OPS 6-201 Aircrew/ Uncrewed Aircraft Systems Operator Endurance.**

2.19.7 **Sleep opportunity and time awake.** Estimates of the sleep and wake times for the BSMN 83 AC and CP are shown in Figure 3 and Figure 4.

2.19.8 The ASIT reviewed the estimated sleep and wake times (noting that these represent windows of sleep opportunity, which may be more than the actual sleep obtained) for the BSMN 83 AC and CP to assess fatigue-related risk.

2.19.9 *The Defence Aviation Fatigue Management Guidebook* (Reference VV) states that when determining an individual's fitness for flight/duty, less than 13 hours sleep in the last 48 hours and less than six hours in the last 24 hours represent thresholds associated with an increased likelihood of fatigue. Fatigue science also indicates that a person who has been continually awake more than 17 hours since their last major sleep period is more likely to be fatigued.

2.19.10 At the time of the accident, the BSMN 83 AC's estimated windows of sleep opportunity were 5 hours in the previous 24 hours and 12.5 in the previous 48 hours. Based on reports from interviewees, it is estimated that BSMN 83 AC was awake for approximately 15.5 hours at the time of the accident. The CP estimated windows of sleep opportunity were 7.5 hours in the previous 24 hours, and 12.25 hours in the previous 48 hours. Based on reports from interviewees, it was estimated that the CP was awake for approximately 14 hours at the time of the accident.

2.19.11 Based on the above analysis of estimated windows of sleep opportunity in the previous 24 hours and 48 hours, BSMN 83 AC had an increased likelihood of experiencing a level of fatigue considered sufficient to impede their fitness for commencing the duty period on the day of the event.

FINDING[76]	**Based on reduced windows of sleep opportunity, BSMN 83 AC had an increased likelihood of experiencing fatigue that was considered sufficient to impede their fitness for commencing the duty period on the day of the event.**

2.19.12 **Sleep environment.** Interviewees described the sleep environment as stretchers in tents of up to 18 people. The tents were located at an active civilian aerodrome (Proserpine – see Figure 38) and,

73 A duty day is defined as a command nominated 24-hour period.

contrary to the documented plan for the exercise, were not air-conditioned. Multiple interviewees reported interruptions to their sleep due to movements of other people in the tents who were on different sleep schedules, aircraft movements (including regular public transport and general aviation movements) and temperature and light increasing during the morning. Under these conditions, the aircrew of BSMN 81, 82 and 84 gave varying estimates of their sleep quality, which ranged from poor to good in the nights leading up to the event. While it is acknowledged that the amount of sleep and perceptions of quality of sleep will vary between individuals, fatigue science indicates that sleep obtained in such environments is typically restricted and of poorer quality[74]. Aeromedical guidance from the Institute of Aviation Medicine (IAM)[75] classifies crew rest facilities into four categories ranging from Class 1 (excellent) to Class 4 (poor). The sleep environment at Proserpine Airport was consistent with the criteria for a Class 4 rest facility indicating that its adequacy for supporting restful sleep was likely poor.

FINDING[77]	**The sleep environment for aircrew at the deployed site at Proserpine Airport was not ideally suited for restful sleep or napping.**

FINDING[78]	**It is likely that the sleep environment contributed to BSMN 83's AC and CP obtaining restricted sleep, which was of poorer quality.**

Figure 38: Camp layout at Proserpine Airport

2.19.13 **Alertness.** The aircrew of BSMN 81, 82 and 84 gave varying estimates of their degree of alertness at the time of the event. Some members reported feeling fully alert at the time of the event, despite the long duty period and field sleeping conditions, while others reported feeling tired. Variability in perceptions of alertness are considered common and arise from a mix of physiological, psychological and situational factors.

2.19.14 The crews of BSMN 81, 82 and 84 were required to sit in the aircraft for approximately two hours prior to departure from Proserpine Airport, a period characterised by low physical activity and limited cognitive stimulation. These conditions are known to contribute to reduced alertness, stress, boredom, and levels of fatigue. Sitting in the aircraft for an extended period exposed the AC and CP to conditions conducive to fatigue accumulation.

74 Sleep quality refers to the capacity of sleep to restore waking function. Good quality sleep has minimal disruption to the non-REM/REM cycle. Fragmentation of the non-REM/REM cycle by waking up, or by brief arousals that move the brain to a lighter stage of sleep without actually waking up, decreases the restorative value of sleep.

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FINDING[79] It is likely that waiting in the aircraft for approximately two hours prior to departure from Proserpine Airport exposed BSMN 83's AC and CP to conditions conducive to fatigue accumulation.

2.19.15 **VFDR voice data.** The VFDR voice data was analysed for voice/speech patterns known to be consistent with fatigue. Overall, the FP and NFP were considered to be responsive to questions and challenges and signs of slow speech patterns or speech errors were not evident in the voice recordings. Although two yawns could be heard on the ACMN's radio channel at 2126:03K and 2140:32K, there were no other obvious signs of fatigue.

2.19.16 **Fatigue modelling.** Biomathematical fatigue models (BFMs) are a tool designed to help predict personnel fatigue levels based on a scientific understanding of the factors that contribute to fatigue. The BFM SAFTE-FAST software program used by DFSB is based on research conducted by the US Army on sleep deprivation and performance at the Walter Reed Army Institute of Research. The Defence Aviation Fatigue Management Guidebook (Reference VV) provides guidance on the use and limitations of BFMs, including SAFTE-FAST.

2.19.17 SAFTE-FAST was used for a quantitative assessment of the possible contribution of fatigue to the event. The inputs into SAFTE-FAST included sleep schedules, time of day, along with ratings of sleep quality.

2.19.18 SAFTE-FAST modelling indicates that, based on the population average, both the BSMN 83 AC and the CP were exposed to an increased likelihood of fatigue considered sufficient to impede their performance at the time of the accident.

2.19.19 Among the primary outputs of SAFTE-FAST is a measure of cognitive performance referred to as Effectiveness. As detailed in Enclosure 1, an Effectiveness score of 77% was used as the threshold for assessing fatigue risk. This score is regarded as being equivalent to being awake for 18.5 hours continuously, a 30% increase in reaction time, and having a blood alcohol level of 0.05%. An Effectiveness score at or below 77% therefore constitutes a fatigue risk.

2.19.20 At the time of the accident, the AC's predicted Effectiveness score was below the fatigue-risk threshold and constituted a fatigue risk. The estimated Effectiveness score of the CP did not drop below the fatigue-risk threshold, but was close to the threshold.

2.19.21 SAFTE-FAST makes allowances for individual differences by including a band of uncertainty for measurement estimates. The error bands allow for the possibility that the BSMN 83 AC and CP were not fatigued at the time of the accident. Nevertheless, while these error bands are useful for understanding how individuals may vary in their experience of fatigue, using the population average is considered more appropriate as it provides a reliable estimate of a typical individual's fatigue and performance levels. Refer to Enclosure 1 for more detail on the SAFTE-FAST models for the BSMN 83 AC and CP.

FINDING[80] Biomathematical fatigue modelling indicates that, based on the population average, both the BSMN 83 AC and the CP were exposed to an increased likelihood of fatigue considered sufficient to impede their performance at the time of the accident.

FINDING[81] Biomathematical fatigue modelling indicates that the estimated cognitive performance of BSMN 83's AC was below the fatigue-risk threshold and constituted a fatigue risk during the key accident sequence of events.

2.19.22 **Disruptive work/sleep patterns.** In general terms, a work pattern (or pattern of daily sleeping behaviour) is considered disruptive if it impedes the opportunity to sleep by overlapping, starting or finishing, during the optimal sleep time window to which a person is acclimatised. In relation to working arrangements, the following duty periods are generally considered to be disruptive:

a. **Late finishes.** A duty period finishing in the period between 2300K and 0159K

b. **Early starts.** A duty period starting in the period between 0500K and 0659K

c. **Night duty.** A duty period encroaching on any portion of the period between 0200K and 0459K.

2.19.23 The work pattern for the BSMN 83 AC in the days immediately preceding the event included an early start (approximately 0630K on Mon 24 Jul 23[76]) and late finishes (approximately 0100K on Thu 27 Jul 23, and approximately 0100K Fri 28 Jul 23). Similarly, the CP's work patterns in the days before the event included late finishes (approximately 0230K on Thu 27 Jul 23 and approximately 0001K Fri 28 Jul 23). The night of the event was scheduled as a night duty of up to 14 hours (finishing by 0300K Sat 29 Jul 23). Disruptive patterns of work contribute to acute fatigue and cumulative fatigue over the longer-term as they restrict an individual's ability to obtain the optimal level of sleep and increase time awake. The ASIT concludes that the AC and CP were exposed to disruptive work patterns, resulting in restricted sleep and extended periods of time awake in the days immediately preceding the accident.

2.19.24 Disruptive patterns of daily sleep behaviour (regardless of their cause) are undesirable given the safety-critical operational context. See section 2.34 for further discussion.

2.19.25 Napping is a countermeasure available to mitigate acute fatigue associated with disruptive sleep schedules. Napping is a particularly valuable mitigation strategy for use prior to a night duty period. It is the view of the ASIT that the design of the duty periods in the days prior to the accidents (commencing duty at 1200 or 1300) and the available sleep environment likely impeded the opportunity for the BSMN 83 AC and CP to obtain additional sleep (through a daytime nap) prior to commencing the night mission.

FINDING 82	**It is likely that disruptive work patterns, which resulted in restricted sleep and extended periods of being awake, were conducive to BSMN 83's AC and CP experiencing elevated levels of fatigue.**

FINDING 83	**It is very likely that the scheduled start time for the duty periods in the days prior to the accident and the deployed sleep environment reduced the ability for BSMN 83's AC and CP to obtain additional sleep (through a daytime nap) prior to commencing their duty periods.**

2.19.26 **Leave balances**. Between 01 Jul 22 and 30 Jun 23, the total number of days of leave taken by the crew of BSMN 83, not including stand down periods, ranged from 29 days to 43 days. Each crewmember of BSMN 83 had taken five days of recreational leave in July 2023. As at 30 Jun 23, the accrued leave balances for the crew of BSMN 83 ranged from 27 days to 46 days and were within the organisation's leave management requirements.

2.19.27 ***Snapshot* survey results.** DFSB Technical Report 03/2024 (Enclosure 11) provides a detailed examination of 173 SOAS 2023 Snapshot survey results. Snapshot captures information on a broad range of issues that impact the safety, performance and overall health of participating organisations. 6 Avn Regt participated in Snapshot three months before the event with items capturing information about the period of time leading up to the survey's administration. The ASIT acknowledges that these two factors potentially reduce the relevance of the survey for assessing the contribution of fatigue to the event. However, it is the view of the ASIT that the availability of historical data allows projections across the gap between the survey and the time of the event. Specifically, where conditions have not

76 Based on the AC's estimated arrival time at work, not the scheduled duty start time.

changed from one year to the next it is reasonable to assume that they will not have changed in the three months following the survey.

2.19.28 DFSB Technical Report 03/2024 (Enclosure 11) compares the 2023 Snapshot survey results of 173 SOAS pilots with 6 Avn Regt and Defence Aviation. In 2023, a total of 13 pilots from 173 SOAS participated in the Snapshot survey. Analysis of 2023 data showed that, relative to the other Defence Aviation groups, 173 SOAS pilots reported higher levels of fatigue and higher exposure to factors known to be associated with fatigue. This group also reported greater vulnerability to the effects of fatigue and not getting sufficient benefit from work breaks and annual leave.

2.19.29 The results from Snapshot indicate that 173 SQN pilots saw themselves as dealing with a heavy workload, brought about by the demands of the job and staffing limitations. The data showed that the majority of 173 SOAS pilots felt they were not getting sufficient benefit from work breaks and annual leave. While it is not known if BSMN 83 pilots were among the 13 Snapshot survey respondents from 173 SOAS, it is the view of the ASIT that the Snapshot survey results demonstrate that the aircrew group as a whole had been reporting higher levels of fatigue and the organisational preconditions existed for aircrew to experience cumulative fatigue and burnout. The Snapshot survey results were consistent with information collected through interviews.

FINDING 84	**It is likely that organisational preconditions at 173 Special Operations Air Squadron (SOAS) existed for aircrew to experience cumulative fatigue and burnout.**

2.19.30 **The likelihood of fatigue.** It is the view of the ASIT that it is likely the BSMN 83 AC and the CP were experiencing a level of fatigue shown to impede their performance. Furthermore, it is the view of the ASIT that the estimated level of fatigue for the BSMN 83 AC was sufficient to constitute a risk to safety. The comparatively heightened assessment of the BSMN 83 AC's fatigue risk is based on the cumulative contribution of the following factors:

a. At the time of the accident, the BSMN 83 AC windows of sleep opportunity were 5 hours in the previous 24 hours and 12.5 hours in the previous 48 hours. These estimates indicate the BSMN 83 AC was likely experiencing a level of fatigue considered sufficient to impede their fitness for commencing the duty period on the day of the accident.

b. Within the windows of reduced sleep opportunity, the sleep environment likely contributed to the BSMN 83 AC obtaining restricted sleep that was of poorer quality.

c. Biomathematical fatigue modelling indicates that, at the time of the accident, the AC's estimated cognitive performance was below the fatigue-risk threshold and constituted a fatigue risk.

d. The BSMN 83 AC was a member of 173 SOAS aircrew, a group that was exposed to an increased risk of cumulative fatigue and burnout.

FINDING 85	**It is likely that BSMN 83's AC and CP were experiencing a level of fatigue shown to impede optimal performance.**

FINDING 86	**It is likely that the estimated level of fatigue of BSMN 83's AC was sufficient to constitute a risk to safety.**

2.19.31 **The contribution of fatigue to SD.** The ASIT was not able to establish a definitive causal link between the presence of fatigue, related performance decrements, and the accident. It is not possible to isolate the effect of fatigue from the numerous other physiological and psychological factors identified by the ASIT as having potentially contributed to the accident. Nevertheless, it is the view of the ASIT that fatigue contributed, at least in part, to the BSMN 83 AC experiencing Type 1 (Unrecognised) SD.

2.19.32 The nature of the activity being performed by the BSMN 83 AC required a high level of cognitive functioning. The key threats to safety arising from human performance factors in the context of the event are heightened levels of arousal with a consequent narrowing of attentional focus, loss of SA, loss of Spatial Orientation and impeded decision-making. Fatigue makes an individual more susceptible to these threats. Fatigue is widely acknowledged to make an individual more susceptible to SD.[77] [78]

2.19.33 It is the view of the ASIT that the actions and decisions of the BSMN 83 AC that were causal in the event were likely impacted by fatigue.

2.19.34 Based on the available information, although it is likely the BSMN 83 CP was experiencing a level of fatigue, there was insufficient evidence to establish its direct contribution to the accident.

FINDING[87]	**It is likely that BSMN 83's AC and CP were experiencing a level of fatigue that increased their susceptibility to Type I (Unrecognised) SD.**

FINDING[88]	**It is likely that actions and decisions of BSMN 83's AC (FP) considered as causal in the event were impacted by fatigue.**

INDIRECT FINDING[89]	**While it is likely that BSMN 83's CP (NFP) was experiencing a level of fatigue, there is insufficient evidence to establish the overall effect of fatigue on the CP during the key accident sequence of events.**

2.19.35 Additional fatigue management considerations. The above analysis highlights the potential for heightened levels of fatigue to be experienced within a 14-hour duty day. Specifically, the analysis emphasises that in addition to the length of a duty period, factors such as time of day, biological rhythms, time spent awake, amount of prior sleep, and sleep quality must be considered to effectively manage fatigue within a specific operating context.

2.19.36 The ASIT notes the formation crew were granted a flight and crew extension to 0500K for the emergency response. At that time, according to biomathematical fatigue modelling, it would have been very likely that the involved crews were exposed to a heightened level of fatigue, such that their performance would have been sub-optimal.

2.19.37 It is acknowledged that, when operationally necessary, such extensions are required. The ASIT did not analyse the decision-making process associated with the approval of the duty extension. The ASIT also acknowledges that the organisation's process included the evaluation of fatigue-related risk. Nevertheless, the above analysis provides an opportunity to reinforce the importance of evaluating fatigue-related factors (where possible) before extensions to duty periods are approved.

2.20 Non-Technical Skills

2.20.1 The following section analyses Non-Technical Skills (NTS) related issues that may have influenced the FP and NFP's performance during the event. The ASIT acknowledges the closure of cabin doors likely impeded the ACMNs ability to effectively contribute to the SA of the FP and NFP. This analysis is informed by Reference OO.

2.20.2 Defence Aviation Safety Regulation (DASR) defines NTS as follows:

> Those human performance skills that promote reliable and effective task performance in complex work systems. NTS encompass attributes such as the ability to recognise and manage human performance limitations, make sound decisions, communicate effectively, lead and work as a team and maintain situation awareness.

77 Newman, D. G. (2007). An overview of spatial disorientation as a factor in aviation accidents and incidents (Vol. 2007). Canberra City: Australian Transport Safety Bureau

78 LeDuc, P. A., Riley, D., Hoffman, S. M., Brock, M. E., Norman, D., & Johnson, P. A. (1999). The effects of sleep deprivation on spatial disorientation (USAARL Rep. No. 2000-09). Ft. Rucker, AL: United States Army Aeromedical Research Laboratory

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2.20.3 The ASIT emphasises that the actions, inactions and decisions of the FP and NFP that were causal in the event were likely attributable to Type I SD. As such, the following section does not seek to infer individual responsibility but to examine the possible presence and influence of NTS-related issues that may have contributed to sub-optimal team performance. Its purpose is to support accident prevention efforts. The investigation identified the following NTS-related factors that increased safety risk:

2.20.4 **Pilot monitoring.** The ASIT found that both the FP and NFP did not detect the departure from their formation position. This represents a breakdown in pilot monitoring responsibilities. Monitoring refers to the responsibility of both pilots to keep track of the aircraft's position, course, and configuration, the status of the aircraft's systems, and the actions of the other pilots in the cockpit[79]. Considerations related to monitoring are examined in Section 2.28.

FINDING 90	**BSMN 83's AC (FP) and CP (NFP) did not detect the aircraft's departure from the standard formation position, which represents a breakdown in pilot monitoring responsibilities.**

2.20.5 Workload management. As previously stated, the ASIT found that the increased demands of operating in reduced visual conditions and the technique for formation flying, likely led to the attentional focus of the FP (and likely the NFP) narrowing at the exclusion of monitoring other sources of information necessary to maintain Spatial Orientation. This finding emphasises the critical role of intra-crew SA and workload management. While SA has been discussed at the level of the individual, it is also relevant to the crew of BSMN 83 as a team. A key component of SA in a team environment is the effective management of the crew's collective workload to maintain SA across the team.

2.20.6 In high-workload situations, particularly during challenging flying conditions, effective workload management and delegation are essential for maintaining safety and performance. By distributing tasks among crewmembers, the risks associated with attentional narrowing may be mitigated by directly focusing the attention of crewmembers to specific tasks. This ensures important information is not neglected and enables the transfer of information between members of the crew to maintain high levels of SA across the team.

FINDING 91	**Management and distribution of the collective workload of BSMN 83's crew to maintain Situation Awareness(SA) was very likely sub-optimal during the key accident sequence of events.**

2.20.7 **Pilot authority gradient.** The term authority gradient is used to describe the balance of influence or power between individuals in a team. It is the view of the ASIT that a level of authority gradient was likely present between the AC and CP of BSMN 83 given their significant gap in experience. This potential presence of an authority gradient is supported by VFDR voice data analysis indicating that the AC accounted for approximately 80% of verbal communications made by the pilots during the flight. The authority gradient likely increased in response to the AC mentoring the CP during the flight and taking over control of the aircraft.

2.20.8 While the ASIT found no evidence of the authority gradient between the AC and CP directly contributing to the event, its potential influence cannot be ruled out. Authority gradients shape crew behaviour and interactions. It is widely acknowledged that, as authority gradients can lead to hesitancy and delays in voicing concerns, a less experienced CP may not feel confident in their ability to contribute meaningfully and may doubt their own judgment or capabilities. This may contribute to a CP deferring to the judgement of the more experienced AC.

79 Dismukes, R. K., & Berman, B. A. (2010). Checklists and monitoring in the cockpit: Why crucial defenses sometimes fail (NASA Technical Memorandum Report No. 2010-216396). Moffett Field, CA.

2.20.9 **Decision to close cabin doors.** The event mission had been planned and briefed to depart Proserpine Airport with the doors in the open position. At the end of Mission Orders the 6 Avn Regt Standards[80] ACMN, who was BSMN 83 RH ACMN, requested the cabin doors be closed in transit. This request was based on the anticipated rain showers and wind chill factor associated with flying with the doors open. The authorisation confirmed doors were to be closed for all four aircraft on departure, but were to be opened when the aircraft reduced airspeed by passing through the IP.

2.20.10 The MRH90 STANMAN (Reference L) states that where practicable, doors should be open with the ACMN seated to monitor the preceding aircraft. It also includes a 'caution' advising that ACMN are unable to provide formation clearances with doors closed and in their crew position. With this in mind, the ASIT considered the appropriateness of the decision to have the cabin doors closed until reaching the IP.

2.20.11 Closure of the cabin doors is a risk control designed to eliminate ACMN exposure to adverse environmental conditions. The SOP (Reference WW) identifies the planned mission flight time as the key consideration relating to the decision to keep cabin doors closed during the transit. The SOP also allows flexibility for the doors to remain closed until the IP in 'extreme environments'. The policy does not define the term 'extreme', leaving room for individual interpretation. Given the status and influence of the RSTWO within the unit, the potential influence of an authority gradient on the decision cannot be ruled out. Nevertheless, it is the view of the ASIT that the decision was not inappropriate in the given context based on the conditions and SOP/information available to the crews and authorisation officer at the time. The ASIT acknowledges that the closure of the cabin doors likely impeded the ACMNs' ability to effectively contribute to the SA of the FP and NFP. However, the decision was permissible within AVNCOMD policy. Refer to Section 2.24 (Cabin characteristics) for more information on the cabin configuration and Section 2.35 (Flying Supervision and Flight Authorisation) for more information on the flight authorisation process.

FINDING[92]	**Closure of the cabin doors likely impeded the ability of BSMN 83's ACMN to contribute effectively to the Situation Awareness (SA) of the AC (FP) and CP (NFP).**

INDIRECT FINDING[93]	**The decision to close the cabin doors until reaching the Initial Point was not inappropriate in the given context based on the conditions and information/procedures available to the crews and Flight Authorisation Officer.**

2.20.12 **Role clarity.** As detailed in Section 2.7.4, the AC (NFP) initiated a take-over from the CP (FP) and assumed control of the aircraft. The AC likely intervened to address a perceived developing concern of BSMN 83's position in formation. The ASIT believes that the AC's motivation in taking over was to re-establish the aircraft position in the formation, and to provide continued mentoring to the CP on station keeping, prior to handing back control to the CP. It is likely that, in anticipating the AC handing back control, in combination with receiving mentoring on station keeping, the CP's attention was directed away from NFP duties.

2.20.13 In taking over, mentoring, and delaying the return of control to the CP, it is the view of the ASIT that the AC likely obscured the clarity of their respective roles and responsibilities and impeded the crew's overall SA.

FINDING[94]	**It is likely that BSMN 83 AC (FP) taking over, mentoring, and delaying the return of control to the CP obscured the clarity of roles and responsibilities and impeded the crew's overall SA.**

80 Standards positions in a unit or Regt are responsible for maintaining standards of training and standardised execution.

2.20.14 **Crew response to loss of visual contact.** The MRH90 STANMAN details the standard terminology for use by aircrew. The term 'blind' is to be used to announce that visual contact has been lost with another friendly aircraft or ground position (opposite of visual).

2.20.15 As detailed in Phase 2, based on the analysis of the FOV of the CP (NFP), it is considered extremely likely that the CP's (NFP) query, 'Have you got them?' coincided with the CP (NFP) losing sight of BSMN 83. It is considered likely that the AC (FP) lost visual contact with BSMN 82 immediately thereafter. Without clear, assertive communication, the potential existed for the CP's (NFP) query to require interpretation by the AC (FP). Furthermore, by not immediately announcing concerns, or using standard terminology such as 'blind', the AC (FP) did not ensure that all crew were instantly aware of the developing situation. Announcing concerns immediately enables crewmembers to potentially assist an FP in regaining SA and informing corrective actions. The importance of clear and concise communication to reduce cognitive load and aid rapid decision-making cannot be overstated.

2.20.16 Analysis of the VFDR voice data revealed no explicit intra-aircraft and inter-formation communication from either the AC (FP) or the CP (NFP) that they had lost visual contact with BSMN 82.. The absence of standard terminology between the AC (FP) and (CP) NFP is considered to be a breakdown in crew communication and coordination.

2.20.17 As previously stated, it is also extremely likely that upon losing visual with BSMN 82, the FP immediately manoeuvred the aircraft in an attempt to regain sight. The MRH90 STANMAN states that, in the event that both pilots lose visual contact, the required action is to immediately initiate a break away from the formation and advise lead. The ASIT notes that the DFSB ASIR on the MRH-90 formation near collision in Nov 20 (Reference KK) found that procedures for an emergency separation of formation aircraft were not published in AVNCOMD OIP and recommended their introduction. This recommendation remained open at the time of the accident and was closed in Dec 23. Regardless, the ASIT discounted issues related to the adequacy and execution of procedures for break away or emergency separation of formation aircraft as having contributed to the event.

2.20.18 It is the view of the ASIT that the actions of the AC (FP) to quickly attempt to regain visual contact with BSMN 82, and the absence of associated standard terminology being used by the AC (FP) and CP (NFP), were likely attributable to Type I (Unrecognised) SD. The investigation found that it was very likely the AC (FP) experienced Type I (Unrecognised) SD. It was also found that it was likely the CP (NFP) also unknowingly experienced Type I (Unrecognised) SD. Type I (Unrecognised) SD involves a pilot being unaware that they are disoriented or that they have lost SA. As a result, new information is interpreted based on an incorrect mental model of the situation. In this way, it is likely that the ability of the AC (FP) and CP (NFP) to accurately interpret and respond to the sudden and unexpected loss of visual contact with BSMN 82 would have been significantly impeded.

FINDING[95]

It is likely that actions by BSMN 83's AC (FP) to attempt to regain visual sight of BSMN 82, and lack of communication by the AC (FP) and CP (NFP) following the loss of visual sight of BSMN 82, are attributed to the crew experiencing Type 1 (Unrecognised) Spatial Disorientation.

2.20.19 **Professional standards.** It is the view of the ASIT that professional standards play an indirect but essential role in accident prevention by setting clear expectations for conduct, decision-making and accountability. When individuals bypass procedures, it introduces variability and unpredictability, which can lead to errors or a reduced ability to respond effectively to sudden changes. Although discounted as having directly contributed to the event, the ASIT notes the following deviations from prescribed procedures:

a. **DH/RADALT LOW setting.** 6 Avn Regt Standing Instruction, SI(6AVN) OPS 3-209 (Reference R), states that in order to reduce the likelihood of Spatial Disorientation and CFIT, when operating below 500 ft over water at night, the low height warning system (DH/RADALT LOW) must be used to warn crew approaching minimum authorised height.

Analysis of the VFDR flight data indicates that neither the AC nor CP had a DH setting that would have warned the crew approaching the minimum authorised height of 200 ft for FOW. The ASIT assesses this unit directed risk control was ineffective and lacked detail for implementation in a standardised and practical manner. It would lead to routine alerts when flying at or near the minimum authorised height and very likely desensitise crews. This Standing Instruction was not followed by any of the BSMN formation crews.

b. **RHT hold.** SI(AVN) OPS 3-209 (Reference Q) states that aircraft shall not be flown by night over water at a height of less than 500 ft unless an automated altitude hold mode is selected. Reference R states that in order to reduce likelihood of Spatial Disorientation and CFIT, when operating below 500 ft over water at night, the AFCS RHT hold mode is to be selected at all times.

RHT hold was not selected for the segment of the FOW conducted by the CP (FP). The AC (NFP) prompted the CP (FP) to engage RHT hold during the transition to FOW. The CP (FP) declined. Neither the AC (NFP), nor the ACMN, challenged this decision, despite it being in violation of Standing Instructions. The choice to remain in TAC mode was likely due to the CP's (FP) individual preference based on previous formation experience and training, and would have been permissible IAW day formation flying standards.

c. **Hand-over/take-over.** The hand-over/take-over drill is detailed in Reference L. Approximately 20 minutes after take-off, the AC (NFP) advised the CP (FP) that they were taking over, by stating, 'Yeah, taking over.' The CP acknowledged with, 'Handing over.' The AC, as the pilot initiating the take-over, did not adhere to the requirement to announce, 'I have control.' This is the executive term for the change of aircraft control. Reference L contains a warning that the pilot who is surrendering the flight controls is not to do so until the pilot assuming control has announced, 'I have control.' The ASIT believes the non-adherence to the hand-over/take-over procedure did not affect the change of aircraft control.

d. **Emission Control (EMCON) Policy.** Mission Orders for FMP 2 specified that the flight was to be conducted in accordance with EMCON policy. This policy prohibited carriage of personal mobile phones by the crew during the mission. Evidence indicates that the AC communicated via mobile phone from the aircraft, including a video call and text messaging with family between at 2107K and 2110K, and sending a text message to a colleague at 2157K. The personal mobile phone of the RH ACMN was also not recovered from Proserpine Airport and was likely carried on board BSMN 83. The carriage of a personal mobile phone by the AC and RH ACMN was not compliant with this order.

The ASIT considered the possibility that the FP's use of their mobile phone in the cockpit for personal communications may have contributed to pilot distraction. The communication occurred pre-departure and no evidence was identified by the ASIT to indicate it impacted the pilot's focus or performance during the conduct of the mission. While, in this instance, the use of a personal communication device as a source of distraction was discounted, it is the view of the ASIT that personal communications should be avoided in the period immediately prior to commencing a mission. Such communications can inadvertently form a source of distraction and present a risk to aviation safety.

2.20.20 **Summary.** In summary, while the direct contribution of NTS factors cannot be established, the circumstances of the event emphasises the critical importance of effective communication, the management of workload, team coordination, role clarity and professional standards in accident prevention.

INDIRECT FINDING[96]	**Neither BSMN 83's AC nor the CP selected the low height warning system IAW 6 Avn Regt Standing Instructions and MRH90 STANMAN.**

INDIRECT FINDING[97]

BSMN 83's CP (FP) did not comply with the requirement to engage the Automatic Flight Control System Radar Height (RHT) hold upper mode for flight over water IAW Army Aviation Standing Instructions despite prompting by the AC (NFP).

INDIRECT FINDING[98]

BSMN 83's AC did not comply with the requirement to announce the executive, 'I have control,' as a part of the hand-over/take-over IAW MRH90 STANMAN.

OBSERVATION[99]

SMN 83's AC and RH ACMN did not comply with Emission Control policy detailed in Mission Orders by taking their mobile phones on the aircraft.

RISK CONTROLS

2.21 Risk controls scope

2.21.1 Risk controls are the measures put in place by an organisation to facilitate and assure safety performance of the system. Risk controls can be either recovery or preventative. Recovery controls detect and correct, or minimise the adverse effects of local conditions, individual and team actions and technical failures, whereas preventative controls are put in place to minimise the likelihood of those adverse effects occurring.

2.21.2 This section of the report provides more detail on the preventative risk controls such as procedures, training, equipment design, personnel management and scheduling. Additionally, recovery controls such as systems for detection, warning and recovery will be discussed.

2.21.3 The examination of risk controls by the ASIT has been purposefully constrained in its depth and scope. Given the extensive resources and detailed assessments required for the event reconstruction, the report prioritises identifying areas where enhanced scrutiny by relevant stakeholders may contribute to improved safety outcomes over an exhaustive analysis of all factors. It is the view of the ASIT that this is necessary to promote timely and concurrent safety action. By focusing on the risk controls identified by the ASIT as most pertinent to the event, the report directs targeted follow-up actions, enabling stakeholders to undertake a comprehensive review in these areas to implement or strengthen risk controls as needed.

SYSTEMS AND EQUIPMENT

2.22 TopOwl/HMSD

2.22.1 HMSD is an integrated sighting system that provides the pilots with a subset of information that is displayed on the primary flight displays without the need to scan aircraft performance parameters inside the cockpit. In March 2020, Reference XX approved the symbology upgrade from HMSDv4.00 to HMSDv5.10.

2.22.2 **MRH-90 Taipan HMSD v4.00 and v5.10 differences.** The MRH-90 Taipan HMSD system operated by the pilots of BSMN 83 on the night of the accident was of software Version 5.10 (v5.10). The difference between v5.10 and v4.00 (previous version) consisted of updates to the location and representation of symbology. *This information has been redacted due to its security classification.*

This information has been redacted due to its security classification

Figure 39: Comparison of HMSD v4.00 to v5.10

2.22.3 **MRH-90 Taipan HMSD v5.10 attitude information display disparity.** Prior to Service Release (SR) of HMSD v5.10 in 2020, Army Aviation Test and Evaluation Section (AATES) conducted testing to provide Defence with a Human Machine Interface (HMI) assessment and training gap analysis for the upgrade. The AATES Interim Flight Test Report (Reference YY) identified the HMSD pitch scale attitude altered as the pilot turned their head to either side of the aircraft despite the aircraft maintaining a constant attitude[81]. The report assessed this disparity as an UNACCEPTABLE[82] risk to flight safety. The ASIT identified that the scope of the AATES testing was limited to two flights, during the day.

81 The HMSD attitude symbology showed an ambiguity in the attitude presentation in off-axis lateral viewing and was most pronounced at 90 degrees left and right from the longitudinal axis of the nose of the aircraft.

82 The term UNACCEPTABLE as applied by AATES describes the deficiency as: prevents weapon system performing operational task or liable to cause accidents – restrictions needed to prevent occurrence are considered intolerable.

2.22.4 Subsequent to the release of the AATES Interim Flight Test Report (Reference YY), Standards Section, Aviation Branch[83], seeking to expand on the tests to broader flight regimes and environments, conducted an Operational Evaluation (OPEVAL) of the MRH-90 Taipan HMSD v5.10. The aim of the OPEVAL was to determine if the upgraded HMSD v5.10 system was suitable for safe interim use by Navy and Army aircrew. The OPEVAL assessment concluded there were deficiencies relating to attitude presentation that were UNDESIRABLE[84]; however, the HMI of the new symbology version (v5.10) was noted to be generally enhanced when compared with version 4.0. The OPEVAL recommended aircrew training should incorporate:

a. emphasis on the pitch scale animation with the respect to the Line of Sight (LOS) of the HMSD and the pitch scale reference plane

b. requirement to align LOS forward when making attitude changes using the HMSD as an attitude setting reference

c. incorporation of LOS alignment reference in unusual attitude (UA) recovery with the following warning:

WARNING: The HMSD LOS must be aligned with the longitudinal aircraft axis when conducting a UA recovery using the HMSD symbology as an attitude reference. Alternatively, use the AFCS G/A[85] mode for an automated UA recovery.[86]

2.22.5 AATES reviewed the OPEVAL (Reference ZZ), however did not change its assessment of the attitude information display looking off-axis as UNACCEPTABLE.

2.22.6 Aviation Branch reviewed the AATES Report and the OPEVAL on 20 Mar 20. Referencexx approved the symbology upgrade from HMSDv4.00 to HMSDv5.10 with the requirements outlined in the OPEVAL. A Training Implementation Plan (TIP) for the HMSD v5.10 was approved by the MRH-90 Program Director on 07 Apr 20. Extant qualified MRH-90 pilots were to complete gap training and sustainment training was conducted by AAvnTC through the Aviation Pilot MRH-90 course Learning Management Package (LMP). BSMN 83 AC and CP had completed the required gap training to conduct night-aided flight with the MRH-90 Taipan HMSD v5.10 (on 15 May 20, and 29 Oct 21 respectively).

INDIRECT FINDING[100]	**The pilots of BSMN 83 had completed the required MRH-90 Taipan HMSD v5.10 gap training.**

2.22.7 **MRH-90 Taipan HMSD v5.10 Risk Management.** The TIP and Decision Briefs seeking SR contained controls for the risks associated with the HMSD v5.10 software upgrade off-axis pitch scale attitude information display disparity. The ASIT did not find evidence of a documented hazard analysis and risk assessment process upon which preventative and recovery risk controls were developed for subsequent inclusion in aircrew OIP. Furthermore, the ASIT did not find evidence of references within AVNCOMD's Aviation Integrated and Aggregated Risk Tool (AVIART) for continual review of pitch scale attitude hazards. The following applicable warnings and comment were added to aircrew operator manuals as enduring risk controls for off-axis pitch scale attitude hazards:

a. Operator Manual MRH90 Taipan (Reference O)

WARNING: Setting aircraft attitude using the HMSD should be done only when line of sight is aligned with x-axis to prevent disorientation.

83 Aviation Branch was part of FORCOMD prior to the formation of AVNCOMD. AVNCOMD was formed in 2021 from the Aviation Branch, AAvnTC and 16 Avn Bde.

84 The term UNDESIRABLE as applied by Standards Section describes the deficiency as: could be improved to make a safer or more capable aircraft.

85 Go Around mode.

86 The modified warning placed into the MRH90 Standardisation Manual reads, 'When the flying pilot's line of sight is not aligned straight ahead (aligned with H/C forward axis), setting an aircraft attitude using HMSD v5.10 symbology will lead to spatial disorientation'.

COMMENT: The roll attitude is provided as an approximate indication and can be interpreted by the angle divergence between the Pitch Scale and the Horizon line. The angle divergence is only correct if the line of sight is aligned with the x-axis of the helicopter. The displayed divergence will reduce up to displaying no roll attitude as the line of sight moves toward the y-axis pitch divergence will be added to the roll indication. When the line of sight is aligned with the y-axis pitch will be displayed as roll.

b. Aircraft Standardisation Manual (Reference L)

WARNING: When the flying pilot's line of sight is not aligned straight ahead (aligned with H/C forward axis), setting an aircraft attitude using HMSD V5.10 symbology will lead to spatial disorientation.

2.22.8 The ASIT noted the SR Decision Briefs specified a full risk analysis would be contained in future Operational and Technical Combined Risk Matrix (OTCRM) and the issue tracked through the OTCRM to ensure effectiveness of the risk control measures. However, a review of OTCRM artefacts and its replacement – AVIART, identified no hazard analysis and risk assessment was documented.

OBSERVATION[101] **The ASIT did not find evidence that Forces Command (FORCOMD) completed or documented a deliberate and dedicated hazard analysis and risk assessment in the Operations and Technical Combined Risk Matrix (OTCRM) database to support the service release of HMSD v5.10.**

2.22.9 **HMSD v5.10 pitch scale attitude information display disparity effect on accident sequence.** The ASIT analysed the HMSD function and settings for the BSMN 83 crew on the accident flight and identified the following:

a. There were no indications on the VFDR voice data of failures or unexpected indications of the HMSD.

b. The recovered HMSD control panels for both pilots were damaged to such an extent, switch selection was unable to be determined. However, VFDR data analysis by Airbus (Reference AAA) identified the HMSD control panels were both switched ON with symbology in NORM position. The HMSD v5.10 pitch scale that displays the disparity when looking off-axis is only available to view in the NORM setting mode and in forward flight.

c. BSMN 83 FP Field of View (FOV). VFDR voice information highlighted BSMN 83 FP was station keeping off BSMN 82. VFDR flight data indicates BSMN 83, in the final 20 seconds of flight, was in a swept echelon left position before moving to a trail position on BSMN 82. BSMN 83 FP's LOS would have been aligned with the aircraft longitudinal axis or slightly offset. Therefore, any pitch scale attitude information display disparity on the HMSD would have been within 30 degrees to the right of the nose of BSMN 83.

d. Based on the attentional channelling discussed in section 2.18, it is likely that BSMN 83 FP and NFP were looking 'through' the HMSD and not responding to any HMSD pitch scale attitude display information.

2.22.10 Based on the information available to the ASIT, including the analysis conducted on wreckage, VFDR and of human performance factors, the ASIT assesses that the MRH-90 Taipan HMSD v5.10 attitude information display hazard did not directly contribute to the accident.

INDIRECT FINDING[102] **It is very unlikely that known hazards related to MRH-90 Taipan HMSD v5.10 pitch scale and attitude information contributed directly to loss of Spatial Orientation by BSMN 83's AC (FP).**

2.23 Forward Looking InfraRed

2.23.1 The Forward Looking InfraRed (FLIR) sensor is an electro-optical system installed in the nose of the MRH-90. The FLIR image is presented to the pilots via the Multi-Functional Display (MFD) in the cockpit and the HMSD display. The FLIR can be used day or night as an additional spectrum to enhance Situation Awareness.

2.23.2 The FLIR is not a primary flight aid. It is employed as a supplementary device requiring the FP to ensure a work cycle that includes aircraft flight attitude is acquired from the Flight and Navigation (FND) display. Pilot hand-over/take-over during night- aided flight requires inclusion of the FLIR and landing light, eg prior to taking over, 'My FLIR and landing light;' or after handing over, 'Your FLIR and landing light.' The FP is also required to announce, 'On FLIR,' if they have selected FLIR in HMSD LOS for greater than 10 seconds from HMSD TopOwl Image Intensifier Tubes (IIT) (Reference L).

2.23.3 The VFDR voice data indicates the crew of BSMN 83 only mention FLIR twice, during the aircraft start procedure, in reference to a 'Good test,' and immediately prior to take-off, when the AC states, 'Your FLIR.' No further commentary from the crew was recorded for the duration of the flight.

2.23.4 The MRH90 STANMAN (Reference L) contains the following CAUTION on FLIR usage during flight in rainy conditions:

> During flight in rainy conditions, interference ("flashes") can appear on the FLIR image. The interference affects part or the whole image of the FLIR. The duration and frequency of the interference can vary with the rain intensity. The interference is visible on the MFD and HMSD. Consider the use of IITs under these conditions.

2.23.5 The conditions on the night were deteriorating, and the crew made mention of flying through showers. It is almost certain, that had the pilots of BSMN 83 been using FLIR, they would have made the required calls, and would have mentioned interference had it been encountered. The ASIT therefore determined that it is very unlikely the pilots of BSMN 83 were using FLIR in the HMSD.

INDIRECT FINDING[103]	**It is very unlikely that the pilots of BSMN 83 were using FLIR in the HMSD.**

2.24 Cabin characteristics

2.24.1 **ACMN Field of Regard.** The ASIT considered the role of the ACMN in supporting Situation Awareness for the crew. In Reference BBB (2005), Aircraft Research and Development Unit (ARDU) identified that with the doors closed, the Field of Regard (FoR) of the ACMN would be reduced, resulting in increased reliance on the pilots for aircraft-to-aircraft clearances. Figure 40 shows the assessed FoR for ACMN occupying a kneeling position by the side cabin door window.

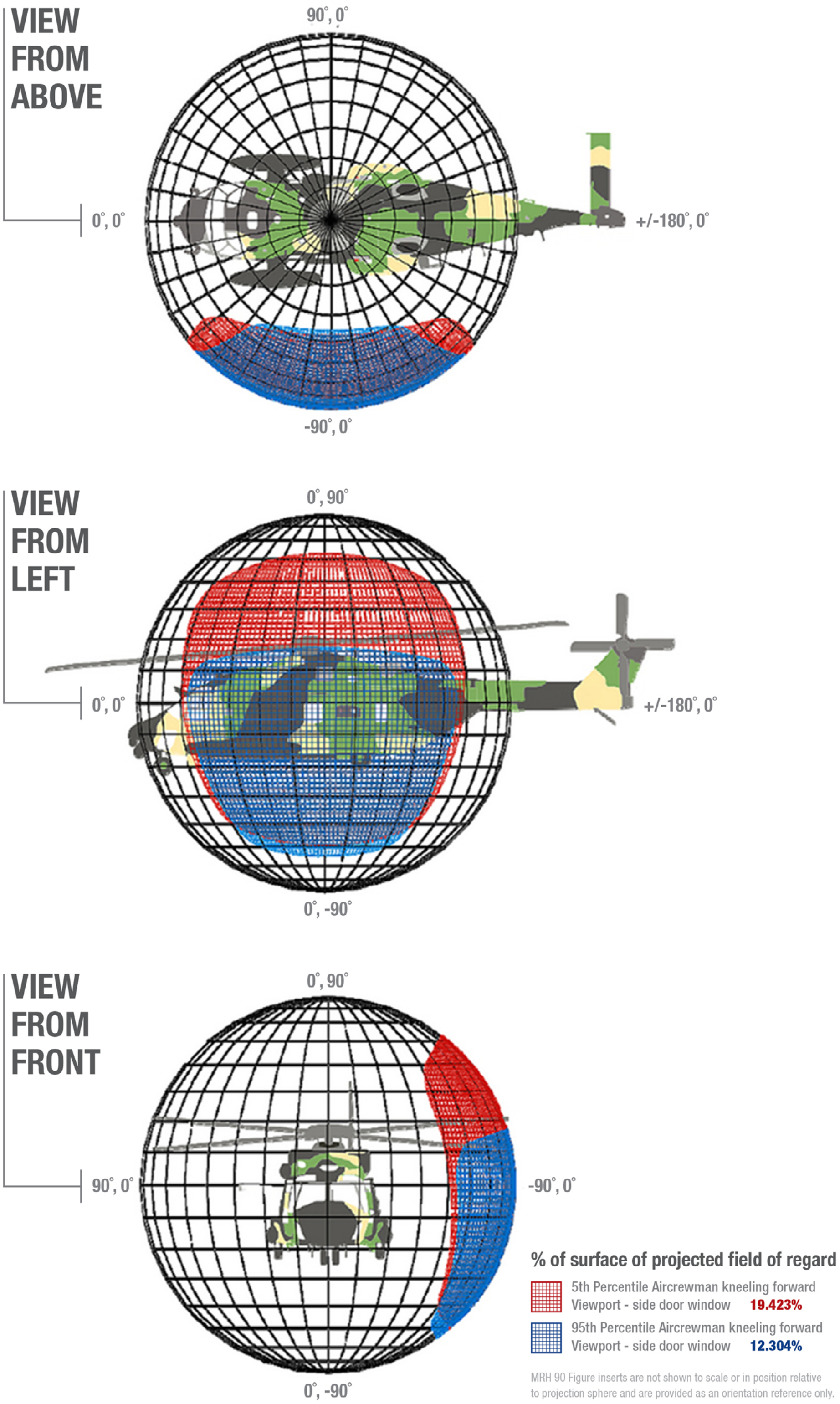

Figure 40: Projected Field of Regard of an MRH-90 aircrewman occupying a kneeling position by the side cabin door window

2.24.2 MRH-90 ACMN, in both 5 Avn Regt and 6 Avn Regt, occupy the Row 7 forward facing seats (see Figure 21) as their primary workstation. The ASIT did not identify FoR mapping for this seating position; however, assessed that the FoR would likely increase to the forward of the aircraft, and reduce to the rear of the aircraft in a forward seating position.

2.24.3 The ASIT was unable to determine the exact position of the ACMN within the cabin prior to impact. Based on the evidence that the doors needed to be opened at the IP, and that the ACMN had called, 'Clear on harness,' it is likely they were positioning themselves to open the doors. This required them to transition from seat restraints to individual restraint via the Cabin Helicopter Aircrewman Device (CHAD) harness, and prepare the Fast Roping and Extracting Device (FRED) arms for the door-opening sequence. It is considered likely that the ACMN either had 'eyes in' preparing to open the cabin doors, or if preparation was complete, then kneeling at the cabin door window.

2.24.4 **Doors closed**

2.24.5 The decision to close the aircraft cabin doors for the transit phase of the flight was made to protect the ACMN from the effects of inclement weather. The temperature during the mission was forecast to be 21 degrees. However, when considering the wind-chill factor associated with flight at planned speed of 100 KIAS, it is likely the ACMN would be exposed to temperatures of approximately 16 degrees. These calculations do not account for temperature reductions associated with rain.

2.24.6 The RH ACMN's request to keep the doors closed during the transit was likely influenced by previous flights in similar weather, and the perceived inadequacy of the cold weather clothing. The ASIT received information from squadron personnel that the in-service solution reduced effectiveness, however were not able to find evidence of safety reporting related to cold-weather clothing[87].

2.24.7 The ASIT reviewed OIP related to the door position and identified the following:

a. DASA ORO.70 (Reference CCC), SI(AVN) OPS 3-219 Carriage of Personnel on Army Aircraft (Reference DDD) states that Aircraft Captains shall ensure aircraft doors remain closed in flight to the greatest extent practicable.

b. SOP 4800 for Special Operations (Reference WW) states that for the planned mission flight time, aircraft would normally depart configured doors open and FRED Arms deployed. However, the SOP does allow flexibility for the doors to remain closed until the IP in 'extreme environments'. The ASIT was unable to find a definition for 'extreme environments' within Army Aviation OIP.

c. SOP 4400 – Aviation Mission Execution (Reference EEE) standardises procedures for the execution of Army Aviation support to conventional forces while conducting combat, combat support or combat service support missions. This SOP does not include guidance on aircraft configuration in relation to formation flight doors open/closed.

d. MRH90 STANMAN (Reference L) requires that where practicable, doors should be open with the ACMN seated to monitor the preceding aircraft, especially during formation re-joins.

2.24.8 IAW the MRH90 STANMAN (Reference L), when the doors are open (and the ACMN are on harness), the scan arcs of responsibility for the ACMN are:

a. RH ACMN. One o'clock thence right to 6 o'clock; and

b. LH ACMN. Eleven o'clock thence left to 6 o'clock.

2.24.9 When the doors are closed, the ACMN's FOV is restricted, and visual acuity is reduced due to the perspex windows. Although the 'caution' in MRH90 STANMAN (Reference L) identifies that ACMN are unable to provide formation clearances with doors closed and in their crew positions, it does not provide guidance on how the scan arcs are affected with the doors closed. Additionally, having the doors closed reduces

87 The ASIT searched the Defence Aviation Safety Reporting Database (Sentinel) and found no Aviation Safety Reports, or operational hazard reports relating to the current cold weather clothing. The ASIT searched the Report on Defective or Unsatisfactory Material (RODUM) database, and identified three related RODUMS.

both noise, and proprioceptive cues[88] that may have provided sensory cues related to airspeed changes (increased airflow into the cabin).

2.24.10 AVN COMD AVIART RM 049/23 (Reference FFF) identifies the hazard associated with the reduction in ACMN visibility when the doors are closed in flight, stating that, 'Unidentified closure rates … may result in a breakdown in aircraft separation standards if formation is conducted with doors closed.' The risk control listed to cater for operations with the doors closed in flight is that, 'MRH90 pilots and ACMN are trained on the limitations on their OTT/ROBC.'

FINDING[104]	**It is more than likely that restricted visibility while the main cabin doors were closed limited the ability of BSMN 83's ACMN to provide Situation Awareness of formation separation and clearances to the pilots.**

FINDING[105]	**MRH-90 Standard Operating Procedures and Standardisation Manuals do not restrict formation flight with the cabin doors in the closed configuration.**

FINDING[106]	**Although the MRH90 Standardisation Manual includes a caution related to a reduction in ACMN visibility when cabin doors are closed in flight, the ASIT did not find evidence that changes to formation flying technique and crew procedures, or additional risk controls, should be applied to account for the ACMN's reduced visibility.**

2.24.11 The ASIT notes that the RH ACMN provided, and was asked to provide by the pilots, station keeping advice throughout the flight. This is in contradiction to the OIP, and is suggestive that there is sufficient visual information, even with the doors closed, to provide a level of aircraft positioning advice. The ASIT did not examine whether this was a norm within the squadron.

2.24.12 Just prior to entering the turn for the hold, the RH ACMN requested permission to go 'on harness' and be notified when the aircraft was below 80 KIAS[89]. Between time 1233:04Z and 1236:17Z, it is likely that the RH ACMN's attention was divided between preparing to open the cabin doors and providing limited station keeping advice. In order to prepare the cabin and open the cabin doors, the ACMN would need to be restrained by their CHAD (as opposed to in their seats).

2.24.13 Although both the MRH90 STANMAN and AVN COMD AVIART RM 049/23 identify that having the doors closed during flight restricts the ability of the ACMN to provide any separation or clearances, they do not prohibit flight with the doors closed. Had the mission been flown IAW SOP 4800 timings, the doors would have been open prior to commencing the turn/hold, allowing the ACMN to have had a better visual picture, and they would likely have been able to provide better aircraft positioning advice, and/or identified the climb. Furthermore, the doors being already opened would have meant that the attention of the ACMN would be directed out of the aircraft, and not on the opening-door procedures inside the aircraft.

2.24.14 Nevertheless, the ASIT considers that the decision to depart with the doors closed was IAW the flexibility provisions allowed in SOP 4800, which allowed for the doors to remain closed until the IP in 'extreme environments'. Additionally, if the mission had been flown IAW SOP 4400, there would have been no limitations placed on the cabin door configuration.

88 Proprioceptive cues allow the human body to sense its position and movement in space.

89 This may have been related to the requirement for the aircraft to be below 80 KIAS for the doors to be opened. It is probable that this was the timeframe/stage of flight where doors

FINDING[107]	The Flight Lead's decision and Flight Authorisation Officer's approval for the BSMN formation to depart with the doors closed was permissible IAW the requirements of both Standing Operating Procedures 4400 and 4800.

2.25 Warning/detection systems

2.25.1 These systems provide aircrew with indications of altitude deviations include the RADALT, Altimeter, Attitude Indicator, Air Speed Indicator, Vertical Speed indicator and Decision Height. These are all visual displays and have no warnings or cautions associated with an altitude increase. The ASIT found no evidence that the aircrew would have been alerted to the climb from an on-board warning system.

OBSERVATION[108]	MRH-90 altitude and Decision Height warning system alerts are not communicated to ACMN via the internal communication system.

2.26 Collective Safety Function

2.26.1 The Collective Safety Function (CSF) is part of the AFCS which is designed to prevent the aircraft colliding with terrain. It is comprised of a series of logic gates, which, ultimately, will automatically apply power to the collective if the aircraft descends below 40 ft at a speed greater than 30 kts. There are some military flight regimes where this may result in an unfavourable outcome (for example, a system initiated climb while conducting Helicopter Insertion and Extraction), so there is the ability to inhibit the system.

2.26.2 For night FOW however, the CSF is to be left in 'NORM' and the system not inhibited (MRH90 STANMAN, Reference L). The CSF switch was found in the 'NORM' position, and there was no recording on the VFDR voice data to indicate the switch setting. However, due to impact forces, switch settings that were not lock wired could not be verified. The ASIT was therefore unable to determine the CSF switch setting for the event flight.

2.26.3 Regardless, the CSF will only function as intended when the RHT is engaged. Because the RHT had been disengaged as the aircraft approached the water (see para 2.27.5), the system would not have functioned as a recovery control. Additionally, as the RoD far exceeded the CSF parameters, it would not have been effective even if the RHT had still been engaged.

INDIRECT FINDING[109]	It is virtually certain that the Collective Safety Function (CSF) would not have aided in the prevention of the accident as the Radar Height (RHT) hold was disengaged and the aircraft rate of descent far exceeded the CSF parameters.

2.27 Radar Height (RHT) Hold

2.27.1 At the time of the accident, all four aircraft had the RHT set IAW SI(6AVN) OPS 3-209) (Reference R). However, the nature of formation flying required the FP of BSMN 83 to constantly manipulate the collective and cyclic to achieve station keeping from BSMN 82 (see section 2.14). It is almost certain the FP depressed the trim release trigger switch on the collective to make these changes, IAW taught and normal practices for formation flying.

2.27.2 SI(6AVN) OPS 3-209 (Reference R) requires RHT to be engaged when operating below 500 ft AGL over water at night. This requires FCS ATT basic mode selection and the RHT upper mode to be engaged. However, preferred practice (see section 2.29) for formation flight is to have TAC mode engaged (a basic mode that maintains an attitude datum, using a follow-up trim function where the RHT cannot be engaged. Using this mode, the FP can make constant small attitude changes to maintain station keeping, and the AFCS will automatically trim to the adjusted attitude.

2.27.3 Overriding the RHT by depressing the trim switch repeatedly, while IAW standard formation flying technique, removes the engineering risk control mandated by SI(AVN) OPS 3-209 (Reference Q) and SI(6AVN) OPS 3-209 (Reference R). The ASIT assess that the mandate in References Q and R is a reasonable risk control to prevent CFIT when operating FOW at night. However, this does not take into consideration formation flying in this flight regime. This represents a contradiction between the mandate for FOW at night, and formation flying techniques.

2.27.4 The ASIT assesses that the contradiction between the two has not been adequately considered or addressed by Army Aviation.

FINDING[110]	**Requirements prescribed in SI(6AVN) OPS 3-209 – Flight Over Water for Radar Height Hold (RHT) to remain engaged when operating below 500ft AGL over water at night conflicts with standard flying techniques to disengage and reengage RHT frequently to maintain formation position.**

2.27.5 Para 2.5.6 details the decision by the CP (FP) to remain in TAC mode when transiting to over water operations. The ASIT assesses this decision was influenced by their primacy of training in formation, and their lack of exposure to FOW at night in formation (see section 2.29). Once the AC took control of the aircraft, the RHT hold mode was engaged IAW Reference Q and R. Analysis of the VFDR flight data and subsequent simulator trials supported the assessment that the RHT hold mode had been overridden during the inadvertent climb (Phase 2). At the pushover (Phase 3), the VFDR flight data recorded a disengagement of the RHT hold mode and the TAC mode engaged. There are multiple ways to achieve this, however the ASIT assesses it is likely that the NOE/ATT mode switch on the cyclic was depressed twice by the AC (FP). The first disengages RHT hold mode and the second engages TAC mode. The ASIT was unable to determine why this occurred.

FINDING[111]	**BSMN 83's AC (FP) likely disengaged RHT hold mode and engaged TAC mode during the pushover.**

INDIRECT FINDING[112]	**The ASIT could not determine why BSMN 83's AC (FP) likely disengaged RHT and engaged TAC mode during the pushover.**

2.27.6 The ASIT reviewed Army Aviation OIP and risk artefacts related to, Formation, Night and FOW. Each flight regime is provided detailed instruction and guidance to mitigate the associated hazards. However, the ASIT found these to be siloed in their application and management. FOW (or low contrast), by night, in formation is a niche configuration, role and environment, which is not conducted frequently and is likely to expose aircrew to elevated flight safety risks. In reviewing AVNCOMD AVIART Core Risk artefacts, the ASIT assesses there is opportunity to improve how combined flight regimes are aggregated for hazard analysis and risk assessment. Furthermore, the ASIT considers that it would be appropriate for AVNCOMD to review risk based assessments which determine minimum heights for low flying commensurate with unique Configuration, Role and Operating Environment (CRE) or specific mission types. 113. Finding. AVIART does not include an aggregated Core Risk for 'Low Level, Formation Flight Over Water using NVIS'.Environment (CRE) or specific mission types.

FINDING[113]	**AVIART does not include an aggregated Core Risk for 'Low Level, Formation Flight Over Water using NVIS'.**

2.27.7 The ASIT reviewed other MRH-90 variant operator's instructions and guidance[90] and training as comparison. Review of Navy Standing Instructions (Reference GGG) and Royal New Zealand Air Force (RNZAF) Standard Operating Procedures (SOPs) (Reference HHH) identified that, in addition to setting RHT below a certain height, there is a requirement to use an adjustable height warning system (namely the DH function, see paragraph 1.7.25. This represents an additional risk control for flight over water, as evidenced by references to its use in the prevention of Spatial Disorientation over water. In addition, Navy Flying Guides for both 723 SQN and 816 SQN describe 'Coast Out' checks (which specifically call out RHT to be engaged – see para 2.5.6), altimetry requirements and crew monitoring responsibilities, providing further administrative risk controls to support safe operations over water at night.

2.27.8 A review of RNZAF SOPs identified that Operational Low Flying is a Category upgrade requirement, and also that Low Level Over Water Operations is a specifically targeted area of risk in Aviation Orders. The RNZAF SOPS require RHT to be set over water, as well as detailing specific requirements for single aircraft over water at night to include RHT, speed and heading (Navigation) modes set. This requirement means that a single aircraft would be fully coupled to the AFCS for flight over water at night. This can create significant challenges for formation flying, however, the SOPs provide comprehensive guidance on how to conduct formation flying with RHT set, and include altimetry and monitoring guidance.

2.27.9 The ASIT consider the RNZAF SOPs to represent comprehensive and clear instructions and guidance to support safe operations of formation FOW at night. In comparison, Army Aviation OIP lack of specification, and broad use of 'may' and 'should' introduce pre-conditions for a lack of standardisation. Contradiction within OIP between RHT requirements and the normalisation of overriding the RHT for formation station keeping introduces potential to degrade a key risk control for maintenance of altitude for low level flight over water. There is significant opportunity for Army Aviation to improve OIP and risk management to ensure sufficient, and appropriate instructions and guidance are provided to operators for this flight regime.

OBSERVATION[114] | **RNZAF Standard Operating Procedures represent comprehensive instructions and guidance for low level formation flight over water at night using NVIS.**

PROCEDURES, PROCESSES AND PRACTICES

2.28 Monitoring responsibilities

2.28.1 The ASIT considered the actions and inactions of the NFP in the context of the role of the NFP in Army Aviation operations, and the associated responsibilities. The term NFP and its description is consistent across AVNCOMD platforms and applicable Aircraft Standardisation Manuals.

2.28.2 Monitoring of an aircraft's performance parameters by the NFP – and addressing deviations promptly – is a well-known and recurring challenge in aviation safety. Instances where performance deviations have gone uncorrected by the NFP have been cited in previous military and civilian accident investigations, leading to a shift away from the use of the term NFP and an increased focus on the importance of monitoring duties.

2.28.3 The term NFP arguably implies a more passive role, which could affect the engagement and vigilance of the individual in this position. It is reasoned that by inadvertently conveying a passive role, the term NFP diminishes the contribution of the pilot not on the controls to the safe operation of the aircraft.

2.28.4 In 2003, the United States (US) Federal Aviation Administration (FAA) amended Advisory Circular 120-71A , Standard Operating Procedures for Flight Deck Crewmembers, and replaced the term 'pilot not

90 Primarily the Royal Australian Navy (RAN) and the Royal New Zealand Air Force (RNZAF), who operate the NH90 variant in ANVIS9 NVG configuration.

flying' with 'pilot monitoring' (PM) to convey that the pilot not flying should be actively engaged in the safe operation of the aircraft. FAA Advisory Circular 120-71B states:

> Several studies of crew performance, incidents, and accidents have identified inadequate monitoring and cross-checking as vulnerabilities for aviation safety. Effective monitoring and cross-checking can be the last barrier or line of defence against accidents because detecting an error or unsafe situation may break the chain of events leading to an accident. Conversely, when this layer of defence is absent, errors and unsafe situations may go undetected, potentially leading to adverse safety consequences. Flight crews must use monitoring to help them identify, prevent, and mitigate events that may impact safety margins. Therefore, it is imperative that operators establish operational policy and procedures on PM duties, including monitoring, and implement effective training for flight crews and instructors on the task of monitoring to help the PM expeditiously identify, prevent, and mitigate events that may impact safety margins.

2.28.5 In contrast to the term NFP, the use of the term PM emphasises active participation rather than passive support. As a result, this promotes a more alert and engaged mindset, ensuring that both pilots contribute to the safe operation of the aircraft. Consequently, the term PM has been widely adopted by civilian regulators and commercial fixed and rotary-wing operations, shifting focus toward the active role of monitoring, given its critical importance in multi-crew settings.

2.28.6 Although the term PM has been adopted by civil regulators, there is variability in the use of the term across military rotary-wing operators. The ASIT acknowledges that this variability and hesitancy may in part stem from the uniqueness of multi-crew responsibilities in the military rotary-wing environment. Specifically, concerns exist that the term PM may not fully capture the active and dynamic engagement of the NFP. This may limit the PM term's applicability without adaptation, for example, the U.S. Army has adopted the alternative term Pilot Not on the Controls (PNOC) rather than NFP and PM.

2.28.7 Notwithstanding the above concern, it remains the view of the ASIT that replacement of the term NFP with PM, or a suitable alternative term, in rotary-wing operations has the potential to enhance effective monitoring actions and encourage timely intervention in operational scenarios that warrant corrective measures.

2.28.8 The responsibilities of the NFP are detailed in Chapter 2 of the MRH90 STANMAN (Reference L). FP and NFP responsibilities are also incorporated and clearly delineated throughout MRH-90 OIP. While the policy framework provides a solid foundation for supporting safety and performance in a multi-crew setting, the investigation identified opportunities for improvement.

2.28.9 In defining individual aircrew responsibilities, the STANMAN states that, 'The NFP is responsible for monitoring aircraft performance parameters and calling when pre-briefed limits are approached during flight.' To enhance the active participation of the NFP, the scope of this responsibility should be expanded to monitoring aircraft performance parameters and calling when any limit is approached during flight, unless pre-briefed. Additionally, the responsibilities of the NFP should incorporate requirements to:

a. actively support the FP in maintaining SA and workload management
b. remain vigilant to signs of diminished FP performance such as lack of communication and attentional narrowing
c. monitor the FP for signs of SD, especially when operating in degraded visual environments
d. actively anticipate and respond to conditions that require an increased focus on monitoring duties.

2.28.10 A critical aspect of monitoring includes defining intervention steps when a deviation is identified by the NFP. Although AVNCOMD policy requires the NFP to announce when a deviation is identified, it does not explicitly address if, when or how the NFP initiates the take-over procedure in the event the FP does not correct the problem in a timely manner. While issues related to the adequacy and execution of NFP intervention protocols as having contributed to the accident were discounted, the investigation identified this as an opportunity for safety improvement. It is the view of the ASIT that AVNCOMD OIP requires updating to include structured intervention protocol, and that all pilots should be trained on policies and procedures related to NFP monitoring and intervention responsibilities. This is irrespective of whether the NFP is the AC or the CP.

INDIRECT FINDING[115]

While AVNCOMD OIP details and delineates the roles and responsibilities of the NFP, the investigation identified opportunities to improve guidance for structured intervention protocols.

TRAINING AND ASSESSMENT

2.29 Formation flying, overwater operations and night operations

2.29.1 Training pathways for the AC and the CP were reviewed, with particular focus on training and exposure to formation flying, overwater operations, night operations, and the combination. Training has been broken into three phases: basic training – ADF ab initio flying training, advanced training – rotary and platform-specific training, and operational – training and exposure gained during postings to operational units.

2.29.2 Basic training. The AC graduated from BFTS (flying CT-4 aircraft) which incorporated fixed wing formation flying into the curriculum. The AC then completed Intermediate Pilots' Course (IPC) at BFTS also flying the CT-4. IPC was an Army-specific course designed to further train flight profiles such as formation, instrument flight and low level navigation. Pilot trainees typically completed 65 hours of flight during the standard BFTS and IPC courses, graduating with a total of 115-130 flight hours. After BFTS, the AC undertook rotary training at AAvnTC, a course that averaged 104 hours flying the B-206 Kiowa.

2.29.3 In the period between the AC graduating from BFTS and the CP commencing pilot training, Project 5428 delivered a new ADF undergraduate pilot training system. As a result, BFTS was disbanded and Number 1 Flying Training School (1FTS) was re-established in January 2019 for pilot training on the Pilatus PC-21. Unlike BFTS, which includes IPC, the 1FTS basic training curriculum does not cover formation flying and provides Army pilots with less navigation and instrument flying experience. The CP graduated from 1FTS with 51 hours on the PC-21.

2.29.4 **Advanced training.** The AC was first exposed to rotary formation flying at Helicopter Qualification Course (HQC) on the Kiowa aircraft, by day only. This was followed by MRH-90 Initial Employment Training (IET) and ROBC, where night formation on NVD was introduced. The AC met the required Army standard for advanced training.

2.29.5 The CP's first exposure to formation flying was at HATS on the Airbus EC-135, and then at MRH-90 IET and ROBC. The CP did not complete all night formation training event[91] due to scheduling requirements[92]. The ASIT identified the LMP (Reference III) taught on the CP's course (JHS007) at the HATS Joint Helicopter School had additional formation, navigation, and instrument flying sorties included in the course. These changes addressed differences between the new 1FTS output standard and the legacy BFTS/IPC output standard, specifically targeting gaps in aviation skills and experience among Army pilots entering HATS. To maintain the Army-directed 23-week training period, Army specified a revised LMP which was implemented for later courses and removed all embarked overwater training for Army pilots[93]. The CP met the required Army standard for advanced training.

INDIRECT FINDING[116]

The PROJECT AIR 5428 Army Pilot flying training syllabus on the PC-21 at IFTS reduced exposure to fixed-wing formation, navigation and instrument flying compared to previous flying training conducted on the CT-4 at BFTS.

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91 The CP completed 1.0 hours of the 3.0 hours NVD night formation syllabus at HATS.

92 CP was required to commence MRH-90 IET in Oakey and therefore needed to complete HATS on time.

93 HATS was designed to take advantage of its locality at HMAS *Albatross*, Nowra, and Jervis Bay, as well as the experience and currency of helicopter flying instructors from multi-disciplinary backgrounds (including the Navy, Army, and Boeing Defence Australia). It uses a cost-effective platform with readily available support (SAR and ship). Foundational flying training in overwater operations was initially provided for both Navy and Army pilots at HATS.

INDIRECT FINDING[117] **The HATS flying training syllabus specified by Army removed elements of night overwater flying training in order to include additional rotary-wing navigation, instrument and formation training within a fixed course duration.**

2.29.6 **Operational.** Army Aviation is required to provide aviation support to the joint battlespace (Reference JJJ). As part of these requirements, the MRH-90 capability had tasks to conduct overwater flight and formation flights in formations greater than two aircraft (nominally four).

2.29.7 The AC had been operational since 2017, as part of 5 Avn Regt and their RNZAF unit. Both units conduct formation flying, and it forms part of the Unit Training and Assessment Plan (UTAP) that all pilots undergo.

2.29.8 The CP had been operational since 2022. The CP had flown two FOW flights at 5 Avn Regt: Water Hoisting and Deck Landing Qualification, which were awarded in June and October 2022, respectively.

2.29.9 The ASIT noted that regardless of the training pathway, Army pilots were predominately required to conduct formation flying with two aircraft[94] until they completed MRH-90 IET and ROBC, with exposure to larger formations being opportunity-based. Therefore, the CP was not required by any training plan to conduct four-aircraft formations or to fly in positions 3 or 4, and the AC was exposed to a single three/four-aircraft formation day sortie, until an operational posting. The ASIT also identified limited exposure to overwater operations training[95] for both pilots of BSMN 83.

2.29.10 The ASIT identified that the UTAPs for both 5 Avn Regt and 6 Avn Regt included formation training, however, the requirement was for a minimum of two-aircraft formation at 5 Avn Regt, and three-aircraft formation at 6 Avn Regt for 50% of the flying training. *This information has been redacted due to its security classification.* However, Flight Logbooks (from PEX) did not specify which formation position individuals had flown in. The ASIT were therefore unable to determine what experience either pilot had operating in four-aircraft formation, or their level of exposure to position 3 or 4 in formation.

2.29.11 **Special Operations Qualification Courses.** SOQC are conducted by 6 Avn Regt, and are designed to prepare crews to undertake SO tasking. The AC completed session 0042 of the SOQC AC course over the period 17 Oct 22 – 17 Mar 23. Training was completed IAW a trial LMP (Reference KKK). Of note, the AC completed the course in 21 of the 30 hours allocated. The CP completed session 0040 of the SOQC CP course over the period 12-30 Jun 23. The CP completed the course in 15.2 of the allocated 30 hours, under a draft LMP.

2.29.12 In 2022, an Operational Airworthiness (OPAW) compliance audit conducted by HQ AVNCOMD (Reference LLL), coupled with the HQ AVNCOMD ASIR Black Hawk A25-203, Sydney 2000 Main Rotor Tip Strike of Oct 20 (Reference MMM), and a review of Special Operations Aircrew Training initiated by CO 6 Avn Regt, resulted in a review of the SOQC Training Requirements Specification (TRS) and LMP (Reference NNN)[96]. The aim of the review was to remove identified deficiencies, and to ensure an effective continuum to support the generation of capability. The ASIT identified that the revised LMP for SOQC CP course reduced the number of flying hours from 30 to 18.

2.29.13 The ASIT considers it likely that the CP's SOQC was aligned with the expected changes to LMP, thus explaining the significant reduction in flying hours.

94 The HQC LMP contained one formation training sortie of 3-4 aircraft by day in 'standard Army formation'; most likely heavy left formation.

95 The HQC, IET and ROBC helicopter training courses were restricted to overland operations due to their location at Swartz Barracks, Oakey, QLD. The LMP taught for JHC007 removed all embarked overwater training for Army pilots at HATS at HMAS *Albatross*, Nowra, NSW.

96 The review was endorsed by AVNCOMD SO1 STDS, CO SAA, and CO 6 Avn Regt.

2.29.14 It is the assessment of the ASIT that differences between the AC and CP pilot training continuums did not contribute to the accident. Both pilots had met the Army standards of training for the roles they were assigned as 6 Avn Regt MRH-90 pilots, and the AC was the FP. The ASIT notes that the implementation of Air 5428 has reduced opportunities for Army pilots to experience formation prior to posting to an operational squadron. Overwater operations training was initially introduced at HATS, and subsequently removed until posting to an operational squadron. This likely shifts training burden from a standardised and resourced training system structured for initial training (under an LMP), to an operational squadron (under a UTAP) with competing operational priorities.

2.29.15 **FOW, at night, in formation**. The ASIT did not find specific training associated with the compounding complexities associated with FOW, at night, and in formation. It is the view of the ASIT that the CP's choice to not select AFCS ATT mode when transiting overwater was heavily influenced by their primarily day formation flying training and experience. Similarly, the use of the trim switch to override RHT and manage station keeping is influenced by day formation flying technique, and does not align with FOW at night RHT setting requirements.

INDIRECT FINDING[118] **The ASIT did not find evidence of a specific Training Needs Analysis or Learning Management Plan for the aggregated mission profile of 'Low Level Formation Flight Over Water using NVIS'.**

2.30 Non-Technical Skills

2.30.1 The ASIT found that while the direct contribution of NTS factors cannot be established, the circumstances of the event emphasise the critical importance of Situation Awareness, communication, decision-making, workload management and team coordination for safe operations. With this in mind, the ASIT examined the conduct of NTS training in AVNCOMD, and its effectiveness.

2.30.2 The terms NTS and Human Factors (HF) are often used interchangeably. HF refers to the broader field of study that draws together knowledge from psychology, ergonomics, medical and engineering disciplines to minimise human error and its consequences by optimising the relationships within systems between people, activities and equipment. NTS is a branch of HF that focuses on the mental, social, and personal-management abilities that complement the technical skills of workers and contribute to safe and effective performance in complex work systems.

2.30.3 NTS training provides personnel with the awareness, knowledge and skills required to manage threats and errors in their work environment more effectively. The importance and necessity of NTS training is well established across both civil and military aviation. Proficiency in both technical and Non-Technical Skills (eg decision-making, communication, SA, and leadership and management) provides the foundation for safe and efficient aviation operations. Within a crewed environment, NTS supports all aircrew to function as a team, rather than as a collection of technically competent individuals.

2.30.4 Since the introduction of NTS training there has been growing recognition of the need to move beyond classroom-based NTS training to the conduct of skills-based training incorporating active practice and individual feedback on NTS performance.

2.30.5 NTS training can support aircrew to maintain SA in complex operating environments and to respond to unpredictable events. Operating conditions that are associated with high workload, narrowing of attention, degraded visual references, and distraction are known to contribute to SD accidents in rotary wing operations[97]. It is the view of the ASIT that exposing aircrew to training scenarios that provide the opportunity to practise maintaining Spatial Orientation and SA in these settings, in combination with assessment and feedback on NTS performance, is a key area for consideration to support accident prevention efforts.

97 FLIGHTFAX: Spatial Disorientation Update. Number 131, May 2024.

2.30.6 **Army Aviation NTS Training.** In accordance with Defence Aviation Safety Regulation (DASR) and Defence Aviation Safety Manual (DASM) requirements, SI(SAF) 8-102 Human Factors and Aviation Non-Technical Skills Training (Reference OOO) requires Army aircrew to complete the DFSB Aviation NTS Foundation Course and the DFSB Aviation NTS Continuation Training (every two years). All formation aircrew of BSMN 81, 82, 83 and 84 were trained and current in NTS as per these requirements.

INDIRECT FINDING[119]	**All aircrew of BSMN 81, 82, 83 and 84 were trained and current in Non-Technical Skills training.**

2.30.7 Consistent with the DASM, SI(SAF) 8-102 specifies a related but separate requirement for all Army aircrew to move beyond classroom-based NTS training to the conduct of skills-based training incorporating practice and individual feedback on NTS performance. It requires units to integrate NTS training and/or assessment into existing simulator and/or line proficiency checks.

2.30.8 It is the view of the ASIT that the implementation of this requirement by 6 Avn Regt has only been partially satisfied. Undoubtedly, NTS is taught and reinforced during pilots' line training at 6 Avn Regt and NTS is evaluated to some extent during proficiency checks. However, NTS skills-based training and assessment has not been addressed in a holistic and structured manner and, as a result, it is difficult to confirm its effectiveness.

2.30.9 The 6 Avn Regt policy framework supporting skills-based NTS training and assessment is comparatively underdeveloped to those implemented in other Army units. By way of comparison, 5 Avn Regt, which also operated the MRH-90 at the time of the event, and 1 Avn Regt, have formally incorporated the use of the Method of Assessing Pilot Performance (MAPP) as a basis for determining if the pilot has effectively demonstrated NTS for the award of Mission Qualifications and Command Instrument Rating. As noted in SI(SAF), the DASM recommends the use of the MAPP tool for formal assessment of competencies including NTS.

2.30.10 The investigation revealed that AVNCOMD previously identified the requirement to update NTS training and assessment practices. AVNCOMD MAO-AM Directive 06/2022 (Reference PPP) was signed 10 Nov 22 and detailed the implementation of actions arising from a Class B safety event. This included the following actions related to NTS:

a. Review Standing Instructions to ensure clear guidance to the Army MAO to include assessment for NTS and the MAPP in UTAPs.

b. Develop training scenarios for all aircraft types based on real-life events that units can incorporate into their UTAP. The scenarios should be structured to enable them to be discussed as a desktop activity or conducted when flying a live aircraft or simulator.

c. Review the current NTS training system to ensure that foundation training is meeting its intent.

2.30.11 IAW AVNCOMD MAO-AM Directive 06/2022, the above actions were initially scheduled for completion by 15 Jun 23. At the time of the accident, the actions remained open. Review of the associated Sentinel record indicates that enhancement to NTS training and assessment practices would be actioned as a part of the AVNCOMD SI Modernisation Project and AVNCOMD's response to NTS regulation (ie DASR NTS) released by DASA in February 2024.

2.30.12 Overall, whether or not a more structured and holistic NTS skills-based training program would have led to different crew performance on this occasion is unknown. However, in general, a more structured and holistic approach to providing NTS skills-based training, practice and performance feedback will contribute to better safety outcomes into the future. The ASIT considers the implementation of the enhanced NTS regulatory requirements via DASR NTS, in addition to addressing the variability in NTS skills-based training and assessment within AVNCOMD, to be areas of priority to improve safety outcomes.

2.30.13 Section 2.40 examines issues related to the implementation of NTS training regulation.

INDIRECT FINDING[120] NTS skills-based training and assessment was not standardised and implemented in a structured manner across AVNCOMD flying regiments.

INDIRECT FINDING[121] IAW AVNCOMD MAO-AM Directive 06/2022, updates to AVNCOMD NTS training and assessment practices were initially scheduled for completion by June 2023 but had not been implemented before 6 Avn Regt's deployment to Ex TS23.

OBSERVATION[122] The effective implementation of DASR NTS by AVNCOMD is considered sufficient to address NTS training issues and opportunities identified in this investigation.

2.30.14 **DFSB NTS training courses.** Noting the potential contribution of NTS-related contributory factors to the accident, the ASIT considered the adequacy of NTS training courses and content provided by DFSB. A summary of DFSB NTS training is as follows:

a. **NTS Foundation Course.** The DFSB NTS Foundation Course is delivered as a part of initial training for ADF aircrew. It consists of classroom-based training that provides personnel with the theoretical background of aviation NTS and supports the development of practical knowledge relevant to skilled performance. The course covers history and development of NTS training, human performance and its limitations, error and violation, culture, decision-making, SA, communication, managing stress, managing fatigue, leading and working in teams, threat and error management and automation.

b. **NTS continuation training.** NTS continuation training is conducted periodically to promote and reinforce NTS concepts. The training has a currency period of two-years for operational personnel. DFSB, via its website, provides access to training materials to support the conduct of the training. NTS continuation training is led by a facilitator that supports guided discussion on NTS concepts and covers the topics of SA, decision-making, communication, teamwork, leadership, managing stress, managing fatigue and culture.

c. **NTS Trainer Course.** The DFSB NTS Trainer Course provides applicable personnel with the knowledge and skills to deliver the Aviation NTS Foundation Course and Aviation NTS continuation training. The course also introduces students to scenario-based training and assessment techniques to support the integration of NTS.

2.30.15 The ASIT found that while the Aviation NTS Foundation Course content is delivered in accordance with an approved Learning Management Package and its content is aligned with global aviation practices, its learning outcomes are not assessed. As such, it is not possible to determine the adequacy of the course in imparting NTS knowledge. This limitation also applies to NTS continuation training.

2.30.16 The ASIT also found that DFSB is not a member of the ADF Flying Training Advisory Group (FTAG) and that applicable elements of DFSB NTS training is not covered by FTAG. The FTAG is the steering committee for training managed under the Memorandum of Agreement between Navy, Army and Air Force regarding joint ADF pilot training. Its role is to maintain oversight and provide guidance to the Manager Joint Training for ADF flying training (CDR AFTG) regarding the Design, Develop, Implement and Evaluation phases of Rationalised Training. Activities of the FTAG include monitoring the effectiveness of the conduct of applicable training and identifying emerging training gaps and opportunities.

2.30.17 It is the view of the ASIT that the exclusion of DFSB NTS training from the scope of the FTAG governance framework represents a noteworthy gap. This gap has resulted in the effectiveness of Aviation NTS training not being considered as part of ADF pilot training managed under the Article of Appointment (Reference QQQ) and Memorandum of Agreement (Reference RRR).

INDIRECT FINDING[123] **Learning outcomes and determination of the adequacy of DFSB NTS training courses to impart NTS knowledge are not assessed formally.**

INDIRECT FINDING[124] **DFSB NTS training is not integrated within the ADF Flying Training Advisory Group (FTAG) governance framework.**

2.30.18 Section 2.40 examines organisational influences identified by the ASIT as both promoting and impeding the enhancement of skills-based NTS training approaches across Defence Aviation.

2.31 Aviation Medicine training

2.31.1 DASR MED (Reference SSS) requires Military Air Operators (MAOs) to ensure aircrew complete initial Aviation Medicine (AVMED) training prior to conducting flight operations and maintain currency through supplement or refresher training. SI(AVN) OPS (Reference TTT) directs all personnel posting to flying positions to undergo AVMED refresher training delivered by a Senior Aviation Medical Officer (SAVMO) or delegate at intervals not exceeding three years.

2.31.2 **Army Aviation AVMED initial training.** Army Aviation aircrew initial AVMED training is conducted by the Institute of Aviation Medicine (IAM). Prior to 2018, Army Aviation pilots conducted the IAM Rotary Wing Initial AVMED course. This course was archived and replaced by the IAM Pilot AVMED Initial course. The IAM Pilot AVMED initial course is delivered prior to the commencement of flying training on the PC-21 fixed-wing aircraft.

2.31.3 The IAM Pilot AVMED Initial course provides training on common hazards across all military Configuration, Role and Operating Environment (CRE) and specific hazards associated with the ab initio training platform (PC-21). The course consists of classroom-based training and demonstration. Classroom-based work outlines physiological processes involved in the perception of orientation, common types of disorientation in flight, factors leading to disorientation, and strategies and recovery actions for SD in flight. Theory lessons are supported by practical training in the Barany Chair and the Integrated Physiological Trainer (IPT).

2.31.4 IAM acknowledge the context of material delivered is not sufficient to address the specific experience with rotary wing CRE. While the hazards relevant to rotary wing pilots are addressed, the context of delivery and the practical SD training are fixed-wing centric. There is a limited focus addressing the specific context of these aeromedical hazards relevant to the rotary wing CRE.

2.31.5 Following the cessation of the IAM Rotary Wing Initial AVMED course, Army Aviation pilots do not undertake rotary wing specific AVMED training prior to operating rotary wing platforms. The AVMED refresher course or currency training, which may not occur until three years after initial AVMED training, is Army Aviation (and therefore rotary wing) specific, however, the training does not have a practical element. A DASA DAVNOPS Oversight activity conducted in 2024, issued a Level 2 finding against DASR MED (Reference SSS). The finding identified AVNCOMD as non-compliant with the Acceptable Means of Compliance (AMC) to DASR MED.05.a, which requires the MAO to ensure aircrew complete initial AVMED training appropriate to their CRE. This finding was closed by DASA DAVNOPS on 03 Mar 25, based on AVNCOMD pilots completing initial AVMED training IAW the learning requirements approved by CO IAM. Following this closure, DASA DAVNOPS immediately issued a Level 3 finding identifying AVNCOMD as partially non-compliant with DASR MED.05.d citing that 'RW aspects are delivered too early before commencing helicopter flying training for them to be relevant'. DASA noted that, while there was evidence that AVNCOMD was non-compliant with the DASR MED.05.d, it also found evidence that AVNCOMD could be managing this deficiency through two pilot crewing and completing AVMED refresher training at IAM.

INDIRECT FINDING[125]	**The Institute of Aviation Medicine initial employment of AVMED training for Army aircrew had a limited focus on specific hazards associated with ADF rotary wing operations.**

2.31.6 **Army Aviation AVMED refresher training.** IAW DASR MED (Reference SSS) requirements for refresher and/or currency training, Army Aviation aircrew undergo three-yearly AVMED refreshers, conducted by a SAVMO or delegate. DASR MED states the training should include scope and topics as defined by CO IAM. A review of the Army Aviation AVMED refresher PowerPoint presentation, which was presented to a number of 6 Avn Regt aircrew, including the BSMN 83 CP, by the Army SAVMO in February 2023, identified that the scope and topics did not address all of the IAM AVMED Refresher Course Learning Management Package (LMP) Course Learning Objectives (CLOs). A significant omission was the learning outcome addressing physiological orientation and the risk of SD. The ASIT identified that IAM did not have oversight of the Army AVMED refresher content from at least 2018 until after the accident.

INDIRECT FINDING[126]	**Army SAVMO AVMED refresher training that was delivered to a number of 6 Avn Regt aircrew in February 2023 did not include content specific to Spatial Disorientation, as required by the Institute of Aviation Medicine's AVMED Refresher LMP.**

INDIRECT FINDING[127]	**It is likely that the estimated level of fatigue of BSMN 83's AC was sufficient to constitute a risk to safety.**

2.31.7 The Air Force Interoperability Council[98] (AFIC) Information Publication on Spatial Disorientation, released in May 2020, defines the agreed minimum standards of aviation medicine training in SD required by aircrew of participating nations (Reference PP). This states that initial classroom-based training must include the following topics: orientation overview; vision (pertaining to orientation); vestibular and kinaesthetic orientation, psychology of orientation; and reinforced with ground-based demonstration. In-flight demonstration and training is suggested as a means to reinforce the education and, recognition and management of SD in flight.

2.31.8 Noting that SD was identified as a casual factor in the accident, the ASIT considers that IAM, in consultation with relevant stakeholders, should conduct a review of the efficacy of AVMED initial and refresher training in supporting the prevention of SD. The objectives of the review should address the adequacy of AVMED initial and refresher training against both the AFIC standards and best practice, as well as opportunities to strengthen IAM's involvement and oversight of externally delivered aeromedical training.

INDIRECT FINDING[128]	**The Institute of Aviation Medicine (IAM) AVMED initial and refresher training may not fully align with Air Force Interoperability Council (AFIC) standards, potentially limiting aircrew preparedness in recognising and managing Spatial Disorientation (SD).**

2.31.9 **BSMN 83 aircrew AVMED qualifications, currency and training.** At the time of the accident, the crew of BSMN 83 were qualified and current for AVMED initial and refresher training, as required by DASR MED and Army Aviation SIs (Reference TTT). The AC completed the AVMED Rotary Wing Initial

98 Originally formed in 1948 as the Air Standardisation Coordinating Committee (ASCC), changing in 2005 to the Air and Space Interoperability Council (ASIC) and recently to the Five Eyes Air Force Interoperability Council, AFIC is an international organisation which provides a framework for the air forces of Australia, Canada, New Zealand, United Kingdom and United States to work collaboratively to enhance coalition expeditionary air interoperability.

course in 2015 and the CP completed the IAM Pilot AVMED Initial course in 2022. Both courses provided foundation training in SD.

INDIRECT FINDING[129]	**The crew of BSMN 83 were qualified and current for AVMED initial employment and refresher training.**

INDIRECT FINDING[130]	**The pilots of BSMN 83 received foundational training in Spatial Disorientation.**

2.31.10 **Review of aeromedical training.** The ASIT acknowledges that AVNCOMD and IAM are taking action to address potential deficiencies in rotary wing-specific AVMED training. IAM is working with Navy Training Authority – Aviation (TA-AVN) to develop a rotary wing conversion AVMED course to implement within their LMP. The course will consist of a theory-based package building on existing knowledge of aeromedical hazards. The course will be supplemented by practical SD training using the in-situ helicopter simulators. Furthermore, under the direction of COMD AVNCOMD, IAM has assumed the role of conducting the Army Rotary Wing Refresher course.

2.31.11 **Professional Aviation Knowledge Assessment – Aeromedical Factors.** In addition to DASR training requirements, Reference L details additional aeromedical content that is to be assessed as part of dual checks and category assessments in Army Aviation. SD forms part of these assessments, with question sets drawn from the PAARM (Reference MM). The ASIT found that the PAARM includes disorientation and illusions, however does not describe the Type I (Unrecognised) form of SD, nor does it describe the means by which operators can prevent, or identify and recover from Type 1 SD. Of particular note, the PAARM describes SD only in the context of Type II SD. The lack of reference to Type I SD represents a gap in how SD is considered by Army pilots, particularly in their awareness of how to maintain Spatial Orientation, awareness of SD-producing conditions and early recognition of signs, and challenges associated with the transition from Type I to Type II SD.

INDIRECT FINDING[131]	**Lack of reference to Type I Spatial Disorientation (SD) in the Professional ADF Aviators' Reference Manual does not support ongoing knowledge checks for Army pilots to recognise and recover from Type I SD.**

2.32 Intervention training

2.32.1 Section 2.29 emphasised the importance of NFP monitoring and the need for structured intervention protocols to ensure that both pilots contribute to the safe operation of the aircraft. This necessitates the requirement for aircrew to be trained on the policies, procedures and methods related to NFP monitoring and intervention.

2.32.2 It is the view of the ASIT that such training should include how to identify signs of diminished performance in a FP, common errors in NFP monitoring, situations that are most vulnerable to FP deviations (including when little time exists to correct deviations), and intervention methods that the NFP can use to help the FP to maintain or regain SA. Training should include opportunities for the NFP to practice these methods (eg calling out deviations, levels of assertiveness).

2.32.3 In the context of this event, the ASIT believes that monitoring and intervention training is essential to provide the crew, CPs in particular, with tools or strategies to progressively resolve an unsafe situation with the AC (FP). Intervention training also incorporates a path for the NFP to assume control of the aircraft if the FP does not satisfactorily respond. One such example of an intervention tool is PACE[99], which is described in the *Defence Aviation Non-Technical Skills Guidebook: Fundamentals for Aviation Professionals.*

99 PACE: Probing, Alerting, Challenging, Emergency is a four-step progression to support team members to speak up.

2.32.4 ADF pilots are taught formal drills for hand-over/take-over procedures, as well as NTS from ab initio training courses. The ASIT found a lack of consistency in intervention training across Army Aviation, as all types except MRH-90 include intervention training in their Initial Employment Training (IET). The ASIT notes that AAvnTC submitted an Operational Hazard Report (OPHAZ) in November 2023 to review and update LMPs for intervention training. This OPHAZ remains open at the time of writing (noting that MRH-90 is no longer in service).

2.32.5 During SOQC (AC) training (two months before the accident), the AC was taught the Prompt, Prompt, Take-over model of intervention.

2.32.6 The CP conducted the SOQC (CP) training the month prior to the accident. SOQC (CP) intervention training is limited and focussed only on the critical flight sequences, such as SO approach monitoring. During the training, CPs are taught to use verbal intervention techniques (using executive words) when the aircraft is outside, or approaching, pre-determined flight parameters during an SO approach.

INDIRECT FINDING[132]	**BSMN 83's CP did not receive formal NFP intervention training during MRH-90 Initial Employment Training (IET), and received limited NFP intervention training during Special Operations Qualification Course – Co-pilot (SOQC-CP).**

2.33 Upset Prevention and Recovery Training

2.33.1 The ASIT identified that the accident was very likely attributable to Type I SD (Unrecognised). However, the influence of a surprise response on the actions of the FP could not be ruled out. With this in mind, consideration of training approaches that may assist in preparing pilots to handle unexpected events is warranted.

2.33.2 There is a general consensus that pilots may react inappropriately to unexpected in-flight situations leading up to unsafe flight conditions. It is also widely acknowledged that Type II SD (recognised), startle and surprise effects100[100] have contributed to many aircraft accidents and have been associated with inappropriate intuitive actions and hasty decision-making.

2.33.3 Upset Prevention and Recovery Training (UPRT) has been widely adopted by civilian regulators and throughout fixed-wing commercial operations to prepare pilots to handle unexpected events[101]. URPT is a type of recovery risk control that can support risk mitigation efforts associated with Type II SD (recognised), startle and surprise.

2.33.4 While UPRT is most commonly associated with fixed-wing aircraft operations, it is the view of the ASIT that its principles are equally applicable to rotary wing operations and hold the potential to enhance safety in complex and challenging flight scenarios. Unlike traditional Unusual Attitude (UA) training, UPRT adopts a broader focus on preventing and responding to unexpected scenarios. Additionally, it integrates human factors and aeromedical considerations, such as managing and responding to surprise, startle and Type II SD (Recognised).

2.33.5 It is acknowledged that ADF flying training includes robust training for UA, emergencies and abnormal situations, whether at ab initio training, or during type conversion and recurrent training. Nevertheless, the ASIT believes opportunities remain to better equip pilots to handle the emotional and physical challenges of unexpected events.

100 European Aviation Safety Authority. (2018). Research Project: Startle Effect Management. Report Number NLR-CR-2018-242

101 Refer to Civilian Aviation Safety Authority Advisory Circular 121-03 (released December 2020) for an overview of URPT.

2.33.6 As a part of the broader introduction of NTS skills-based training, the opportunity exists to provide controlled exposure to relevant simulated training scenarios (where available) that may involve a surprise and startle response. This training will improve the resilience and capacity of aircrew to deal with unexpected situations. Additionally, it is also necessary to ensure that NTS knowledge-based training incorporates the latest understanding of the effects of surprise and startle on human performance.

2.33.7 The ASIT notes that AVNCOMD has initiated a review of risk controls associated with UA and SD. The investigation team recommends that this review include opportunities to incorporate UPRT principles. Furthermore, DFSB NTS training courses require review to ensure they incorporate the latest understanding of the effects of surprise and startle on human performance.

PEOPLE MANAGEMENT, SUPERVISION AND AUTHORISATION

2.34 Fatigue

2.34.1 The ASIT identified that the actions and decisions of the AC (FP) that were causal in the event, were likely impacted by fatigue. This underscores the critical role of robust fatigue management practices in ensuring aviation safety. This section examines fatigue risk management controls related to:

a. Organisational fatigue management. Examines risk controls that were in place at the time of the accident.

b. Individual fatigue management. Examines issues related to the application of fatigue risk controls by operational personnel.

c. Fatigue management training. Examines fatigue management training received by BSMN 83 crewmembers and the adequacy of fatigue management training more broadly.

d. Implementation of fatigue management regulation. Examines AVNCOMD's implementation of Aviation Fatigue Management DASR

e. AVNCOMD fatigue management enhancements. Examines enhancements to fatigue management implemented by AVNCOMD and opportunities for improvement identified by the ASIT.

2.34.2 The analysis was informed by the Defence Aviation Fatigue Management Guidebook. Section 2.40 examines regulatory and external influences identified by the ASIT as both promoting and impeding the enhancement of fatigue management in AVNCOMD.

2.34.3 **Organisational fatigue management.** While the management of fatigue is a shared responsibility of command and individuals, the primary responsibility rests with the organisation (that is commanders and managers) who control the activities of operational personnel and the distribution of resources. Organisational responsibilities with respect to the management of fatigue include developing policies, procedures and practices that manage fatigue-related risk.

2.34.4 At the time of the event, AVNCOMD had a multi-layered policy framework for the management of aircrew fatigue-related risk. The ASIT identified the following relevant aspects of AVNCOMD fatigue management policies that were in place at the time of the accident.

a. SI(Safety) (Reference UUU). Details policy requirements and guidance for the implementation and management of the Safety Management System. Specific policy related to fatigue includes:

(1) 8-101 Risk Management requires a unit to consider a specified list of hazards, including fatigue, which is to be documented and maintained in a Risk Register. For fatigue risk management, the policy directs readers to SI(OPS) 6-201 Aircrew/Unmanned Aircraft Systems Operator Endurance (Reference G) for management and operating limits.

(2) 9-102 Annex A Noise Management contains deployment considerations and states that accommodation areas should be setup at least 100 metres from aircraft operations; the further away the better. The policy draws attention to the impact of noise on fatigue management.

(3) 3-102 Aviation Safety Committees includes the requirement for fatigue management to be discussed at all Army Aviation Safety Committee meetings.

   (4) 8-102 Human Factors and Aviation Non-Technical Skills Training includes the requirement for fatigue to be incorporated in NTS continuation training.

b. SI(SAF) SMS 15-101 – WHS Incident Management and Response (Reference VVV). Details that SI(AVN) OPS 6-201 Aircrew/Unmanned Aircraft System Operator Endurance (Reference G) governs fatigue management and reporting. The policy includes the requirement for a Fatigue Report to be submitted through Sentinel for the following:
   (1) A member completes a duty period in which they believe their own fatigue or that of others reduced the safety margin or required unplanned mitigation.
   (2) A member identifies something in their operating environment that could significantly increase their fatigue, or that of others.
   (3) Fatigue is identified as a contributing factor in an aviation safety event.

   The policy specifies that any crew duty extensions and reduced rest periods are to be tracked by raising a Duty Period Variation Report in Sentinel. It also provides a list of documents and tools to support fatigue management.

c. SI(AVN) OPS 6-201 – Aircrew/Unmanned Aerial Systems Operator Endurance (Reference G). Details requirements relating to flying hours, rest periods and processes for obtaining extensions. The policy includes reference to the DFSB Fatigue Risk Management Chart as a tool available for assessing fatigue risk.

d. SI(AVN) OPS 1-201 – Flight Authorisation (Reference WWW). Details the process for the authorisation of flights. The policy stipulates the requirements of an authorising officer, including the need to ensure fatigue is considered within the authorisation process and that aircrew are within the endurance requirements specified in SI(AVN) OPS 6-201 Aircrew/ Uncrewed Aircraft Systems Operator Endurance (Reference G).

e. SI(AVN) OPS 1-202 – Aircraft Captains (ReferencexxX). Outlines the responsibilities of the AC in planning and executing the mission and includes the requirement for the AC to confirm crewmembers are fit to undertake assigned flying duties by examining FACE considerations (fatigue, attitude, complacency and external pressures) on an individual or crew basis prior to flight. The AC is responsible for implementing additional control measures (as appropriate).

f. SI(AVN) OPS 1-204 – Supervision, Planning and Risk Management (Reference YYY). Details specific supervisory compliance requirements and includes the requirement to account for fatigue and tempo management in rostering and crew assignment. It also states that the chain-of-command should employ their supporting airworthiness staff (Standardisation Officers) to check and advise on suitability of rostering and crew assignment.

g. SI(AVN) OPS 6-102 – Medical And Dental Fitness For Flying Or Uncrewed Aircraft System Controlling Duties (Reference ZZZ). Details the condition for imposed and self-imposed Temporary Medical Unfitness and states that fatigue must be managed in accordance with the instruction.

h. SI(6AVN) OPS 6-201 (Reference AAAA) – Stipulates unit specific fatigue management requirements related to the execution of the SOQC. Outside SOQC, it states flying activities on Friday night or over weekends and public holidays require CO approval.

i. MAO Directive 01/23 Management of Safety and Operational Airworthiness within the MAO (Reference BBBB) – Details how COMD AVNCOMD executes their responsibilities as the MAO-AM. The Directive specifies the use of Commanders Critical Information Requirements (CCIRs) as a mechanism to be used by the MAO-AM to monitor the aviation safety system. CCIRs include any reporting (ASR, Sentinel Fatigue Report, Snapshot as a non-exhaustive list) that indicates fatigue as a significant organisational issue. The Directive also includes a reference to MAO Directive 03/19 – Management of Snapshot within the Army MAO.

j. MAO Directive 03/19 Management of Snapshot within the Army MAO (Reference CCCC) – Details requirements related to the receipt of Snapshot survey results. It includes the requirement for COs to produce a report identifying key hazards, including a 7-step Safety Risk Management process for each hazard, which is to be forwarded to the next higher HQ within 30 days of receipt of Snapshot.

2.34.5 It is the view of the ASIT that prescriptive limitations relating to the arrangement of duty and rest period provide the foundation of effective fatigue risk management. They form the basis upon which supervisors and individuals apply additional risk controls to actively identify and manage the fatigue-related hazards that emerge in day-to-day operations.

2.34.6 At the time of the accident, Army aircrew duty and rest limitations were prescribed in SI(AVN) OPS 6-201– Aircrew/Unmanned Aerial Systems Operator Endurance (Reference G). Relevant extracts from SI(AVN) OPS 6-201 related to flying hours and rest periods for Army aircrew are as follows:

a. Flying hours. Unless specifically authorised by the Operating Unit CO, Army aircrew shall not plan to exceed the following flying hour1[102] limitations:
   (1) 10 hours flying in a duty day
   (2) 40 hours flying in any seven-day period
   (3) 120 hours flying in any 30-day period
   (4) 1000 hours flying in any 12-month period.

b. Rest period. Commanders shall ensure that aircrew are provided the maximum rest period possible. Army aircrew shall not be authorised to act as aircrew unless:
   (1) in any duty day, they have had at least a 10-hour continuous rest period
   (2) after a period of 10 consecutive days of flying, they have a 24-hour continuous rest period free of all duties.

2.34.7 The policy included additional limitations related to the use of NVDs, time zone changes and organisational processes related to extensions.

2.34.8 The review of SI(AVN) OPS 6-201 (Reference G) found that by focusing exclusively on maximum flying hours, minimum rest before commencing a flying duty period and rest following consecutive days of flying, the policy did not adequately support commanders and supervisors in the management of fatigue-related risk factors. Specifically, the ASIT considers that the policy did not effectively address or take into account:

a. a. the impact of the length of flying and non-flying duty periods, in order to prevent acute fatigue
b. the cumulative impact of consecutive and total work periods (both flying and non-flying) over defined periods of time, in order to prevent cumulative fatigue
c. the impact of commencing duty at different times of the day
d. the impact of undertaking duties within a window of the circadian low
e. the cumulative impact of undertaking long duty hours combined with minimum rest periods
f. the impact of work schedules that cause a significant disruption of established sleep/wake pattern such as transitions between day and night duties.

2.34.9 The ASIT deemed that SI(AVN) OPS 6-201 (Reference G) was only partially effective as a fatigue management risk control. By focusing exclusively on flying hours, the policy was susceptible to misuse, as commanders and management were not required, nor prompted, to consider the interaction of factors associated with hours of work (flying and non-flying), time of day and the arrangement of duty rosters. It is the view of the ASIT that fatigue-related risk required active management prior to reaching the parameters set in the extant policy. SI(AVN) OPS 6-201 did not establish appropriate decision-points for reviewing fatigue-related risk that may have be present in a mission or schedule.

2.34.10 The ASIT acknowledges that the policy included the requirement for Commanders 'to ensure that aircrew are provided the maximum rest period possible'. However, as stated in the *Defence Aviation Fatigue Management Guidebook*, the risk with setting maximum duty time limitations is that they become de facto standard working hours, rather than upper bounds on standard working hours. It is the view of the ASIT that the policy requirement to ave at least a 10-hour continuous rest prior to commencing a flight duty period, led to the adoption of 14-hours duty periods as normal practice on

102 Flying hours refers to the period an aircraft is in operation and does not cover the period of duty-undertaken pre and post-flight.

exercises within 6 Avn Regt, irrespective of the context (eg time duty period commences and available sleep environment). The DFSB Fatigue Risk Management Chart advises that, for duty periods involving night work:

a. a. a single duty period of 12-hours or more is considered higher risk
b. two or more sequential 10-hour night duty periods is considered higher risk.

2.34.11 SI(AVN) OPS 6-201 (Reference G) afforded significant flexibility to the chain-of-command to adapt to varying operational needs. However, this flexibility can place an imbalance of responsibility on supervisors and individuals to manage fatigue at a tactical level without sufficient support from the organisation's policy framework. The emphasis on individual and supervisory management leads to variability in the application of risk controls, creates opportunities for fatigue hazards, which are inherently complex, to remain unnoticed and unresolved, and places fatigue management decisions in direct conflict with the 'can do' culture that exists across the ADF.

2.34.12 The ASIT acknowledges that the AVNCOMD framework allows for subordinate policy to be established at the unit-level to address local requirements. While SI(6AVN) OPS 6-201 (Reference G) stipulated unit-specific fatigue management requirements, these were limited to the execution of the SOQC and the requirement for CO approval for flying activities on Friday night or over weekends and public holidays.

FINDING[133] **AVNCOMD's Standing Instructions and subordinate Orders, Instructions and Publications related to aviation fatigue management did not define normal and extended duty time limitations as required by DASR AVFM.**

FINDING[134] **I(AVN) OPS 6-201 – Aircrew/Unmanned Aerial Systems Operator Endurance did not take into account the interaction of aviation fatigue factors associated with hours of work (both flying and non-flying), time of day and the arrangement of duty rosters. Additionally, the policy did not set conservative work/rest margins to support risk decision-making and command oversight.**

INDIRECT FINDING[135] **Flexibility provisions detailed in SI(AVN) OPS 6-201 – Aircrew/Unmanned Aerial Systems Operator Endurance placed an imbalance of responsibility on supervisors and individuals to manage aviation fatigue at an individual/local level without sufficient support from the organisation's policy framework. The management of fatigue at an individual/local level does not adequately support the consistent application of aviation fatigue management risk controls.**

2.34.13 The ASIT identified that AVNCOMD's fatigue management risk controls were dispersed across multiple documents and levels of policy. It is the view of the ASIT that this dispersion of policy creates challenges to ensuring a consistent understanding and application of fatigue management risk controls. It may also likely created challenges to the evaluation of their collective effectiveness in managing fatigue-related risk. It was noted that SI(SAF) SMS (Reference VVV) included references to outdated guidelines and obsolete tools. For example, SI(SAF) SMS 15-101(Reference VVV) included a link to the Prior Sleep Wake Fatigue Calculator that was replaced by the Fatigue Risk Awareness Tool in November 2020. It also included guidance on confidential fatigue reporting via Sentinel. The confidential reporting functionality in Sentinel was removed in November 2021.

INDIRECT FINDING[136]

AVNCOMD's fatigue management risk controls were dispersed across multiple documents and levels of policy, which created challenges to ensure a consistent understanding and application of fatigue management risk controls and to evaluate their collective effectiveness in managing fatigue-related risk.

2.34.14 **Individual fatigue management.** Shared responsibility under fatigue management requires that operational personnel comply with their fatigue management responsibilities established by their organisation. This includes the requirement to not fly if they are likely to be unfit to perform the task due to fatigue. In the context of the accident, despite experiencing reduced opportunity for sleep, the AC and CP did not self-identify fatigued-related concerns. The AC and CP's self-perceptions of their fatigue state are unknown.

2.34.15 In considering the responsibility of the AC and CP to self-identify and act on fatigue-related concerns, the ASIT notes the inherent difficulty individuals face in accurately self-assessing fatigue levels[103]. Compounding this issue, the pre-Flight Authorisation Brief, during which the individuals confirmed they were not fatigued using the FACE check, took place approximately seven hours before departure. It is not possible to accurately predict a future level of fatigue and how it may manifest during a duty period. Additionally, the ASIT identified evidence suggestive of a strong performance-oriented 'can do' culture within 6 Avn Regt which may have implicitly discouraged candid acknowledgment of fatigue and prioritised 'getting the job done' over individual limitations. This is consistent with the HQ AVNCOMD report summarising the outcomes of the Operational Airworthiness Compliance Audit of 6 Avn Regt during the period 04-08 Apr 22. In reviewing 6 Avn Regt's compliance with Commander Critical Information Requirements (CCIRs) – Aviation Fatigue Risk, the report stated:

> Reference NFZ[104] page 6 defines ADF leadership as "the art of positively influencing others to get the job done" This element of "...get the job done" is the pervading feeling at the Regiment.
>
> Discussion with REGT and SQN leadership noted those individuals have an understanding of Reference B[105] requirements regarding CCIR for fatigue and work periods. However, without AVNCOMD providing a standardised means to measure/track the 55hours per week; ADF ingrained (conscious/unconscious) bias to "...get the job done" appears to be evident in forging the required capability to achieve the unit's mission. To be clear, the audit team did not find any personnel stating that they had achieved the work rate milestone that required a report; they were however stating that they are constantly busy.
>
> Unit personnel self-assessed fatigue levels were communicated as probably higher than desirable (noting the unit was in the middle of a training iteration). Review of Unit historical SNAPSHOTs for the last several years appears to support an observation that fatigue may present as a problem.
>
> Unit command is conducting review of how to comply with measuring what their critical personnel work rates are; but this just adds to the daily churn and diverts them from other task/s. AVNCOMD STDS reviewed several ways of measuring work rates (contact with DFSB, DPN/DRN logs, Gate scan etc, but all were deemed to be inadequate or not available. (Finding 2.20) contributing (Findings 3.1 & 3.2).

2.34.16 In summary, the ASIT identified a number of factors, which in combination may have impeded the AC and CP self-assessing and acting on fatigue-related concerns. It is the view of the ASIT that this underscores the need for evidenced-based self-assessment tools (such as the Fatigue Risk Awareness Tool) and organisational risk controls to supplement individual fatigue management efforts.

INDIRECT FINDING[137]

It is likely that a combination of a number of factors impeded the ability of BSMN 83's AC and CP to self-assess and act on fatigue-related concerns.

103 IAM-2024-014-AG - Use of Tools and Strategies to Assess and Manage Fatigue

104 ADF-P-0 ADF Leadership; Edition 3, 2021

105 MAO Directive 01/22 – Management of Safety and Operational Airworthiness within the Military Air Operator AL1 – 01 Sep 21

2.34.17 **Fatigue management training.** Noting that potential contribution of fatigue-related issues to the accident, the ASIT investigated issues related to the conduct and adequacy of fatigue management.

2.34.18 As stated in the Defence Aviation Fatigue Management Guidebook, the effective management of fatigue-related risk is dependent on all personnel possessing a basic understanding of fatigue and fatigue-management concepts. For example, an understanding of the signs and behaviours that are associated with fatigue will assist personnel in identifying fatigue both within themselves and others.

2.34.19 ADF aircrew fatigue management training is incorporated within the DFSB Aviation NTS Foundation Course, DFSB Aviation NTS Continuation Course, IAM Pilot AVMED Initial Course and IAM AVMED Refresher Course. DFSB and IAM produce and promote resources to support the management of fatigue-related risk. ADF aircrew fatigue management training is often reinforced and built upon through informal training events, such as safety days, conducted by flying units.

2.34.20 Consistent with DASR and DASM requirements, SI(SAF) and SI(AVN) OPS required Army aircrew to complete the DFSB NTS and IAM AVMED courses. Furthermore, SI(AVN) OPS 2-202 identified that these qualifications constitute part of 'PEX Top 8' and should be achieved as soon as practicable during the training continuum but must be achieved prior to graduation/award of an aircrew category. The currency for these qualifications was managed IAW SI(AVN) OPS 1-103 Employment of the Patriot Excalibur System Within The Army Flight Management System (Reference DDDD) and SI(AVN) OPS 1-105 Administration of Aircrew Qualifications (Reference EEEE). A review of PEX indicated that, at the time of the accident, all formation aircrew of BSMN 81, 82, 83 and 84 were trained and current in fatigue management as per these requirements.

2.34.21 In addition to the training outlined above, in 2023 the CO of 6 Avn Regt released the Centurion Overhaul and Unit Readiness and Preparedness 2023 Administration Instruction. This instruction detailed the Mandatory Force Preservation Awareness training that all uniformed members of Army were to complete. This included Defence Fatigue Awareness training. All mandatory training was to be completed not before 01 Dec 22 and no later than the commencement of Centurion Overhaul (31 Jan 23).

INDIRECT FINDING 138	**All formation aircrew of BSMN 81, 82, 83 and 84 received and were current in aviation fatigue management training.**

INDIRECT FINDING 139	**With the exception of one crew member, the crews of BSMN 81, 82, 83 and 84 had completed, and were current in, all mandatory fatigue awareness training.**

2.34.22 The ASIT review of DFSB and IAM fatigue management training collectively provide significant information on the science of fatigue and its management. However, the review revealed some gaps in coverage and areas of overlap, which are considered indicative of a lack of training coordination between DFSB and IAM. While both DFSB and IAM training covered the basic principles of fatigue management, the training content was only partially aligned across courses and certain fatigue management resources, such as the Fatigue Risk Awareness Tool, were absent. These inconsistencies and gaps ultimately reduced the effectiveness of fatigue training delivered prior to the accident.

2.34.23 To rectify these issues and improve overall training effectiveness, the ASIT recommends that a review of the fatigue management training is conducted by DFSB and IAM, in collaboration with key stakeholders. The objectives of the review include addressing gaps in training content, aligning and/or integrating related guidance materials, examining opportunities to eliminate redundancies and ensuring that both organisations deliver complementary and consistent training.

INDIRECT FINDING[140] **A review of DFSB and IAM fatigue management training and resources revealed gaps in coverage and areas of overlap, which indicates a lack of training coordination between DFSB and IAM.**

2.34.24 **Implementation of fatigue management regulation.** DASR Aviation Fatigue Management (DASR AVFM/Reference FFFF) was released in October 2021 with a 12-month transition period. The regulation applies to aircrew, Air Traffic Controllers, Air Battle Management operators and Uncrewed Aviation System operators. DASR AVFM states that the Accountable Manager's management of fatigue must:

a. define duty limitations in accordance with the regulation
b. be integrated with the organisation's Safety Management System solution
c. be contextualised to the scope of organisational activities performed and aviation systems operated
d. be defined using benchmark information acceptable to DASA.

2.34.25 It is the view of the ASIT that while AVNCOMD employed a multi-layered approach to fatigue management, policy relating to prescriptive limitations was inconsistent with DASR AVFM (Reference FFFF) requirements. Policy relating to rostering practices was also found to be suboptimal. In accordance with DASR AVFM (Reference FFFF), the Accountable Manager must use fatigue related principles, operational knowledge and experience to define:

a. Normal duty limitations. Normal duty limitations are a set of conservative work/rest margins that under normal circumstances can support enduring and sustainable operations at a level of risk minimised So Far As Reasonably Practical (SFARP). Operation within normal duty limitations should require only limited review of other fatigue factors that may invalidate the basis of the normal duty limitations.
b. Extended duty limitations. Extended duty limitations are an expansion of the normal duty limitations that will involve additional risk management (additional risk controls and a specific 'approval to proceed'). Operations to extended duty limits should only be for defined periods, and with commensurate additional oversight of operations.

2.34.26 DASR AVFM also states that, where practicable, Accountable Managers should define rostering practices and strive to identify those common areas that will improve rostering applications through standardisation.

2.34.27 HQ AVNCOMD initiated an internal review of its fatigue management policy and practices as demonstrated by AVNCOMD MAO-AM Directive 03/2022 signed on 09 June 22 (Reference GGGG). This demonstrated that the Army MAO identified the requirement to update OIP to comply with DASR AVFM. Similarly, AVNCOMD MAO-AM Directive 04/2022 signed on 09 June 22 (Reference HHHH), provided additional detail and tasking associated with the implementation of DASR AVFM. This included a review of SI(AVN) OPS 6-201 to 'include a multilayered approach to the management of fatigue, incorporating guidance on scheduling practises and night flight duty period.'

2.34.28 IAW AVNCOMD MAO-AM Directive 04/2022, updates to SI(AVN) OPS 6-201 were to be completed by August 2022 and audited in December 2022. At the time of the accident, the required changes had not been implemented. Review of historical versions of SI(AVN) OPS 6-201 identified no changes to the prescribed duty limitation since 2010.

2.34.29 The review of fatigue management conducted by AVNCOMD culminated in the release of Special Flying Instruction (SFI) 12/2023 – Aviation Fatigue Management in December 2023. The ASIT confirmed that the development of the SFI 12/2023 commenced in July 2023, approximately nine months after the DASR AVFM transition period had ended. AVNCOMD staff cited difficulties interpreting regulatory requirements to comply with DASR AVFM and capacity constraints as contributing to its delayed implementation. There also existed an expectation that DASA would have checked on DASR

AVFM progress and compliance by the due date. It is the view of the ASIT that the lack of up-to-date policy related to prescriptive duty limitations and guidance on rostering practices contributed to an environment where fatigue-related risks were not effectively mitigated.

INDIRECT FINDING[141]	**In accordance with AVNCOMD MAO-AM Directive 04/2022, updates to SI(AVN) OPS 6-201– Aircrew/Unmanned Aerial Systems Operator Endurance were initially scheduled for completion by August 2022 but had not been implemented.**

FINDING[142]	**AVNCOMD had not completed or implemented revisions to aviation fatigue management policy in order to fully comply with DASR AVFM, which resulted in key fatigue-related risks not being mitigated effectively.**

2.34.30 **Summary of fatigue management risk controls.** In completing the analysis of fatigue management risk controls, it is important to emphasise that, at the time of the accident, AVNCOMD had a significant amount of policy to support the management of fatigue related hazards, structured fatigue training programs and ongoing monitoring of fatigue as a significant safety issue. The active monitoring of fatigue and Command commitment to fatigue management is also evident in the Minutes of the biannual Army Aviation Safety Program Conferences (AASPC) across the period from 2021 through to July 2023 with 'Tempo and Fatigue' (AASPC 02/21 and 01/22) and 'Demand/Capacity' (AASPC 02/22 and 01/23) identified as safety priorities for AVNCOMD.

2.34.31 Despite these efforts, it is the view of the ASIT that the underlying issue was not the volume of policy or the organisation's level of commitment to fatigue management, but rather the effectiveness of its key risk controls.

2.34.32 **Enhancements to fatigue management.** In response to DASR AVFM, AVNCOMD MAO-AM Directives 04/2022 and 03/2022, AVNCOMD has taken significant steps to enhance fatigue management by implementing comprehensive fatigue management policy. Special Flying Instruction (SFI) 12/2023 – Aviation Fatigue Management was released in December 2023. This policy was subsequently incorporated into SI(AVN) OPS which was released in August 2024. It is the view of the ASIT that SI(AVN) OPS 2-122 Aviation Fatigue Management satisfies DASR AVFM requirements and represents a notable advancement in the management of fatigue in Army Aviation.

2.34.33 The ASIT notes that the revised fatigue management policy allows for considerable flexibility by requiring COs, Task Group and Task Unit Commanders to specify and publish normal duty day requirements. The policy includes an example of normal duty periods, extended duty periods and recovery periods for garrison and non-garrison environments. While this flexibility fosters contextualisation, it has also led to variability in how the policy has been applied across AVNCOMD units, with different solutions being implemented for the same underlying hazard.

2.34.34 It is the view of the ASIT that there is a need for increased standardisation in the application of fatigue management practices relating to normal and extended duty and rest periods. While local contextualisation is important, a higher-level of consistency across AVNCOMD would ensure units, where appropriate to do so, are managing fatigue risks in a standardised and cohesive manner. Furthermore, strengthening this alignment would assist in establishing a common framework for monitoring fatigue risks and driving continuous improvement.

2.34.35 Additionally, AVNCOMD fatigue management policy could be further strengthened by explicitly targeting key hazard sources that contribute to fatigue in the Army Aviation operating environment. The ADF Aviation Workforce Review (AVMED-CR-2013-002) (Reference IIII), published by IAM in 2013, provided a comprehensive picture of the state of fatigue in Defence Aviation. A reduced extract from the Review describing the outcomes of focus group discussion with Army aircrew is provided below:

> The majority of participants identified a potential imbalance between workload and manning/experience levels as the primary driver of fatigue. There was also general agreement that consecutive days of night flying led to the accumulation of a sleep debt.
>
> Irregular duty/rest schedules and transition from night to day also emerged as common sources of fatigue-related risk. Such issues were reported to affect sleep as well as the ability to plan personal/social activities and had a negative impact on work/life balance.
>
> Several participants emphasised that individual flying hours and Rate of Effort were a simplistic measure of workload as it did not take into account the impact and extent of non-flying related duties.
>
> The primary consequences of fatigue identified by participants included the need to make personal sacrifices to sustain workload, increased errors, reduced job satisfaction and increased separation rates.
>
> In general terms, across the focus groups military exercises such as EX HAMEL were identified as the activities that involve the greatest exposure to fatigue-related risk.

2.34.36 The Review included suggestions that were made relating to how the management of fatigue could be improved, these included:

> Achieving a better balance between tempo, workload and manning.
>
> Implementing crew endurance policy that promotes sustainable operations.
>
> Addressing the contribution and impact of non-flying related duties on levels of fatigue.
>
> Improve shift scheduling practices (particularly the transition from night to day).
>
> Afford greater flexibility to individuals to manage their levels of fatigue including late starts and napping in the workplace.
>
> Provide appropriate facilities to encourage workplace napping/rest and the management of post duty driver fatigue.

2.34.37 The above extract is provided to highlight the historical consistency of fatigue-related hazards encountered in the Army Aviation operating context. In the context of this accident, the ASIT draws attention to disruptive schedules, cumulative fatigue, and rest facilities as present in the conditions that likely contributed to elevated levels of fatigue. By incorporating explicit policy addressing these specific sources of fatigue, AVNCOMD could further enhance its efforts to reduce fatigue-related risks and improve overall safety. Given the organisation's requirement to operate in austere environments, it is essential that related fatigue management considerations are also addressed in policy to ensure fatigue hazards are effectively managed, accounting for variations in operational contexts.

2.34.38 The ASIT further notes that the new SI(AVN) OPS Fatigue Management policy would be strengthened by detailing linkages to fatigue management risk controls contained in other policies. This will assist in providing a consolidated view of the broader procedures and processes that have been implemented to support fatigue risk management, assurance and promotion.

2.34.39 While significant fatigue management policy enhancements have been implemented, the ASIT emphasises the need to focus compliance with these policies and their effectiveness. In particular, the ASIT draws attention to DASA Oversight Assessment Report – Army Aviation Command MAO 08-12 Apr 24 (Reference JJJJ) that found non-compliance with these policies. Furthermore, Annex A to SI(AVN) OPS 1-607 Aviation Safety and Operational Airworthiness Training (published August 2024) (Reference KKKK), identified courses that enable an effective Aviation Safety Management System (ASMS) within the Army MAO. This annex identifies the Defence Fatigue Awareness eLearning course as a requirement for all AVNCOMD personnel to complete. A review of PMKeyS data indicated that (as at 14 Feb 25) approximately half of AVNCOMD personnel were yet to complete the training.

INDIRECT FINDING[143]

SI(AVN) OPS 2-122 Aviation Fatigue Management allows for considerable flexibility and contextualisation by requiring Commanders to specify and publish normal duty day requirements. However, this flexibility led to variability in how the policy was applied across AVNCOMD units, with different solutions being implemented for the same underlying hazard.

OBSERVATION[144]

The ADF Aviation Workforce Review (AVMED-CR-2013-002) published by the Institute of Aviation Medicine in 2013, provided a comprehensive picture of the state of fatigue in Defence Aviation. The review found that, and in the context of the accident, disruptive work schedules, cumulative fatigue, and aircrew rest facilities were hazard sources that contribute to fatigue in the Army Aviation operating environment.

2.35 Flying Supervision and Flight Authorisation

2.35.1 **Flight Authorisation.** Flight Authorisation is a key element of the Defence Aviation Safety Framework (DASF). Flight Authorisation is a fundamental risk control within the Flying Management System (FMS), ensuring that all flights are conducted by qualified and competent aircrew, with appropriate risk management measures in place. The requirements are detailed in DASR ORO.30 - Flight Authorisation (Reference LLLL), which states that authorisation is the final risk-control barrier before a flight is conducted to ensure risks have been eliminated or minimised SFARP.

2.35.2 IAW DASR ORO.30, a Flight Authorisation approval authority must be defined in OIP. SI(AVN) OPS 1-201 (Reference WWW) defines the Flight Authorisation approval authority as the Operating Unit CO, who may delegate this responsibility to appropriately qualified personnel (as allowed in DASR ORO.30). There were two Flight Authorisation Officers at Proserpine Airport with the appropriate authority and delegation, including self-authorisation, to authorise the mission on 28 Jul 23: they were the Officer Commanding (OC) and RSTDO. The RSTDO's crew duty limits had been reached, necessitating flight authorisation by the OC, who was AC of BSMN 84, and the designated Air Mission Commander.

2.35.3 The Flight Authorisation Officer is to provide direction to the ACs (and crew, as appropriate) IAW guidance provide in the Flight Authorisation Aide Memoire contained within SI(AVN) OPS 1-201 (Reference WWW). The authorisation brief for the mission focused on the key hazard areas for formation heights and separation. Weather and IMC conditions were addressed; however, the discussion did not cover the potential effects of the weather (including lack of horizon, low contrast conditions) on the crew.

2.35.4 The Flight Authorisation Aide Memoire within SI(AVN) OPS 1-201 (Annex A to Reference WWW) provides a structured approach to authorisation and prompts consideration of NVD/Low Illumination, however, does not specifically prompt discussion of SD as a hazard in those environments. The ASIT considers that as it is possible to predict likely pre-conditions for SD, discussion in a Flight Authorisation Brief may prompt consideration of additional risk controls. The ASIT notes that an update to Flight Authorisation OIP made post-accident (Reference MMMM / SFI 11/23 Flight Authorisation, 01 Dec 23) also does not prompt discussion of SD. The ASIT sees amendment of the Aide Memoir to explicitly include consideration of SD risk as an opportunity to enhance the Flight Authorisation framework.

2.35.5 The Flight Authorisation consideration of SD risks, in relation to degraded visual environments and varying illumination levels, was assessed to be deficient/sub-optimal. Detailed analysis of Ex TS23 Aviation Risk Management is at para 2.36.1.

FINDING[145] The Flight Authorisation Officer did not specifically discuss hazards and risk controls related to Spatial Disorientation that were likely to arise from degraded visual environments and varying illumination levels throughout the mission.

FINDING[146] Extant flight briefing and authorisation publications do not contain guidance to discuss mitigation techniques if conditions are conducive to Spatial Disorientation.

2.35.6 **Self-authorisation.** BSMN 84's AC authorised the BSMN formation mission, including self-authorising BSMN 84. Self-authorisation is permitted under DASR ORO.30 (Reference LLLL), with specific requirements, including when an independent Flight Authorisation Officer is unavailable. ORO.30(a)(3)(ii)a AMC states that the MAO must define self-authorisation criteria in OIP and that the default position should always be to obtain independent Flight Authorisation whenever practicable.

2.35.7 The ASIT reviewed AVNCOMD and 6 Avn Regt Standing Instructions for Flight Authorisation, SI(AVN) OPS 1-201 and SI(6AVN) OPS 1-201, and found that:

a. SI(AVN) OPS 1-201(Reference WWW) outlines self-authorisation restrictions but does not provide specific limitations.

b. SI(6AVN) OPS 1-201 (Reference CC) states that self-authorisation is 'empowered' without clearly maintaining the independent oversight required by DASR ORO.30.

2.35.8 Although self-authorisation has been determined as non-contributory to this accident, the ASIT has identified that AVNCOMD subordinate OIP is more permissive for self-authorisation and lacks restrictions and limits on its use, or oversight. This progressive dilution of regulatory intent from DASR to unit instructions has potentially reduced the independent safety function required by the regulation.

INDIRECT FINDING[147] Self-authorisation criteria in AVNCOMD OIP is not clearly defined and lacks independent oversight, potentially reducing the effectiveness of Flight Authorisation as a risk control.

INDIRECT FINDING[148] SI(6AVN) OPS 1-201 appears to allow self-authorisation with broader discretion than intended by DASR ORO.30.

2.35.9 **Flight Supervision.** Flying Supervision, as defined in DASR ORO.30 (Reference LLLL), ensures that risk controls within the FMS are applied effectively on a daily basis at the unit level. Flying Supervision encompasses crew selection, risk management, and mission execution oversight, ensuring that personnel are supported throughout operations.

2.35.10 Flying Supervision at Ex TS23 required consideration of a number of factors, including:

a. **Living and sleeping conditions.** AVNCOMD is required to operate in austere environments. Accommodation and facilities for 6 Avn Regt on Ex TS23 were considered 'field living', which included tent accommodation with up to 18 personnel, fresh rations only every other day (ration packs on the alternate), and limited ablutions. Tents were not segregated by shift. The accommodation was on the edge of an active civilian airfield (Proserpine Airport) and could therefore be noisy. There were members of 6 Avn Regt that had not deployed to an aviation field environment before, and were not prepared for the conditions. The ASIT found that some individuals had deployed without sleeping bags or pillows. The siting of accommodation facilities provided for 6 Avn Regt on Ex TS23 satisfied the deployed noise management requirements specified in SI(Safety) 9-102 Annex A Noise Management (Reference UUU).

b. **Flying Training and UTAP progression.** Ex TS23 provided a key opportunity for 6 Avn Regt aircrew to complete UTAP activities. On the mission on 28 Jul, BSMN 81 CP was Flight Lead for their Lead Planner UTAP event, and BSMN 84 CP was undergoing their SO Air Mission Commander UTAP event. Supervision of training was appropriately managed, and consultation with QFIs and the RSTDO was appropriate.

c. **Crewing.** The TPCOMD was responsible for crewing the mission, in consultation with the QFIs and RSTDO. Crewing for the accident event (FMP 2) had been done on 27 Jul 23, with consideration given to levels of experience in the crew. While BSMN 83 AC was a highly experienced MRH-90 operator, they were considered a 'junior' SO AC, and therefore a senior and highly experienced ACMN (the RH ACMN) was selected to provide additional experience. The ASIT notes that the FMP 2 event was considered a 'simple' extraction mission, and therefore the considerations and controls put in place were appropriate for the mission.

2.35.11 The ASIT examined SI(AVN) OPS and found no detailed description of Flying Supervisor responsibilities as they relate to the FMS. SI(AVN) OPS 0-102 Glossary (Reference NNNN) defines a Flying Supervisor only as 'aircrew delegated by the unit CO to supervise the administration of flying qualifications.' Instead, Flying Supervisor duties required for an effective FMS appear to be combined with those of the Flight Authorisation Officers, potentially reducing independent risk control effectiveness.

INDIRECT FINDING[149]	**SI(AVN) OPS does not provide a clear definition of Flying Supervisor duties within the AVNCOMD FMS.**

INDIRECT FINDING[150]	**Combining Flying Supervision and Flight Authorisation into a single function may reduce oversight effectiveness.**

2.35.12 **Prior incidents and organisational lessons.** More broadly, the ASIT considered Flying Supervision and Flight Authorisation in AVNCOMD. The ASIT reviewed previous investigations and found:

a. In November 2020, two MRH-90 Taipan helicopters nearly collided during night-aided formation operations (Reference KK). The DFSB investigation identified opportunities for Flying Supervision and Flight Authorisation improvements related to illumination levels for night-aided flight.

b. In February 2021, a Black Hawk helicopter had a rotor tip strike with a civilian vessel (HQAVNCOMD ASIR, Reference MMM). The AVNCOMD investigation identified opportunities for improving the Flight Authorisation framework, including flying supervision training requirements.

c. In March 2023, a MRH-90 Taipan helicopter ditched into Jervis Bay, NSW, due to engine failure (Reference OOOO). The DFSB investigation identified a number of sub-optimal Flying Supervision and Flight Authorisation controls, including lack of clarity of the role and responsibilities of Flying Supervisors, and the lack of documented Flying Supervision system.

2.35.13 The ASIT recognises that the DFSB ASIR (Reference OOOO) into the March 2023 ditching accident had not been completed or briefed to AVNCOMD at the time of the accident in July 2023. The sub-optimal controls were therefore still present at the time of the accident. Reference OOOO should be read in conjunction with this report for completeness of understanding of Flying Supervision and Flight Authorisation in this event context.

2.35.14 In particular, the ASIT highlights a recommendation made in Reference OOOO for the Army MAO-AM, 'to review standardisation and application of Flying Supervision and Flight Authorisation policy and procedures in order to improve clarity of, and delineation between, supervisory and authorisation roles and responsibilities within the FMS.' The analysis of Flying Supervision and Flight Authorisation for this accident reinforces the importance of this recommendation, and the need to ensure standardisation, and independent oversight of flight planning and mission execution.

2.35.15 The ASIT's review of AVNCOMD's Flying Supervision and Flight Authorisation frameworks identified a number of opportunities for safety improvement; primarily in independent oversight, alignment with the intent of the regulation, and procedural and role clarity. The ASIT considers such improvements will strengthen the FMS framework as a risk control, with supporting OIP, education and training.

INDIRECT FINDING[151]	AVNCOMD's prior incidents highlight ongoing gaps in Flying Supervision and Flight Authorisation controls.

INDIRECT FINDING[152]	Sub-optimal Flying Supervision and Flight Authorisation controls identified by the March 2023 MRH-90 ditching investigation were still present at the time of the July 2023 accident.

2.36 Exercise TALISMAN SABRE 2023 (Ex TS23) Aviation Risk Management

2.36.1 On 29 May 23, the 16 Avn Bde Ex TS23 Exercise Instruction (001/23) (Reference PPPP) directed the development of a Risk Management Plan (RMP)[106] in coordination with Regiment Standards Officers to address hazards not already covered by AVNCOMD 'Core Risks' in AVIART.

2.36.2 On 6 Mar 23, a draft AVIART 'New Risk' was raised under 6 Avn Regt – Exercise TALISMAN SABRE 2023 (AVIART Reference: 105/23) (Reference QQQQ). This RMP aimed to identify and manage aviation-specific risks for the exercise and was initially categorised as LOW for personnel safety. The exercise objective was to safely conduct foundation aviation warfighting skills at a troop-to-task group level within a multi-domain joint task force.

2.36.3 The draft RMP identified the following risk:

> High workload, reduction in normal rest cycles, and an inability to meet work and personal life commitments during activity leads to increased fatigue levels, resulting in aircraft mishandling and CFIT, causing hull loss and multiple fatalities.

2.36.4 On 18 Jul 23, the draft RMP was marked as HISTORIC, following a command assessment that existing Core Risks in AVNCOMD's AVIART, along with those identified by SOCOMD, and OIP sufficiently covered aviation risks for the exercise. These included 6 Avn Support to SO (Reference GG), 6 Avn Mixed Formation (Reference RRRR), and the Special Operations Forces (SOF) Component Risk Management Worksheet for Ex TS23 (Reference SSSS).

2.36.5 The SOF Component Risk Management Worksheet for Ex TS23 identified rotary and fixed-wing operations as hazards, with the associated risk event being multiple fatalities or injuries due to forced landings on land or water. However, this document was primarily focused on ground forces and did not specifically reference aviation-specific Core Risks such as AVIART Reference 051/22 – 6 Avn Regt SO Aviation (Reference GG), which addresses critical hazards including low-contrast terrain, overwater flight, and NVD low-light operations.

2.36.6 A Battle Worthiness Board convened at 16 Bde HQ on 19 Jul 23 confirmed that 6 Avn Regt was ready to participate in Ex TS23. This board assessed safety management as adequate, with no new hazards identified. However, additional risk management measures were implemented. CO 6 Avn Regt directed that exercise flying operations be conducted only in weather conditions no less than 'Normal'[107] and emphasised that there was no pressure to complete exercise missions if preconditions were not met or if the planning-briefing cycle was rushed. Safety remained the priority over exercise objectives.

106 As outlined in the Defence Aviation Safety Manual (DASM) (Reference A), an RMP is used to assess and manage hazards for unique tasks or activities, such as exercises, where existing policies, procedures, or risk controls may be insufficient.

107 1000 ft cloud based and 3000 m visibility with no recovery planning requirements.

2.36.7 The ASIT found that marking AVIART Reference 105/23 (Reference QQQQ) as HISTORIC was a missed opportunity to formally document and manage aviation-specific risks associated with 6 Avn Regt's deployment to Ex TS23. Relying on existing Core Risks limited the unit's ability to proactively mitigate risks, likely leaving aviation hazards such as fatigue (identified in the draft RMP) and night-aided overwater formation flight at low level unassessed in the deployment context.

2.36.8 The CO's verbal directive on risk controls highlighted Command- recognised aviation risk gaps and sought to address them informally. However, relying on verbal guidance instead of formal risk management structures exposed 6 Avn Regt to unnecessary operational risk, as neither aircrew nor Command had a complete picture of aggregate aviation-specific risks. Additionally, the absence of a dedicated RMP in AVIART as a New

Risk did not align with MAO Directive 07/21 (Reference TTTT), which required AVIART to be used as the primary tool for hazard entry and risk management.

2.36.9 The ASIT assesses that the development of a deliberate RMP for Ex TS23, formally documented in AVIART, would have accounted for the detachment's unique configuration, role and environment, and strengthened the ability of 6 Avn Regt's Flying Supervisors and Flight Authorisation Officers to leverage off pre-considered mitigations and controls. An Ex TS23 RMP would have improved risk oversight and proactive mitigation efforts, ensuring that clear, actionable controls were established, communicated, and implemented during flight planning and mission execution. The ASIT is also of the view that there are opportunities for AVNCOMD to improve knowledge and application of Deliberate Risk Management (DRM) for unique activities, exercises and deployments.

INDIRECT FINDING[153]	**6 Avn Regt's draft (unsigned) AVIART RMP 105/23 was marked as 'Historic' before Ex TS23, removing a formal record of aviation-specific risks for the deployment.**

INDIRECT FINDING[154]	**CO 6 Avn Regt relied on extant AVNCOMD AVIART Core Risks and OIP to manage Ex TS23 hazards, opting not to raise an AVIART New Risk or to formally document additional exercise risk management.**

INDIRECT FINDING[155]	**The Ex TS23 SOF Component Risk Management Worksheet did not address aviation hazards unique to 6 Avn Regt's configuration, role, and operating environment.**

INDIRECT FINDING[156]	**Although the 16 Aviation Brigade Battle Worthiness Board assessed that 6 Avn Regt's deployment to Ex TS23 did not create new hazards or risks that would require a New Risk to be documented in AVIART, CO 6 Avn Regt stipulated additional but undocumented risk controls related to weather restrictions.**

ORGANISATIONAL INFLUENCES

2.37 Organisational influences scope

2.37.1 This section of the report examines the potential influence of organisational-level influences on the accident. Organisational influences are those conditions that establish, maintain or otherwise influence the effectiveness of an organisation's risk controls.

2.37.2 To gain an understanding of the systemic factors that may have contributed to the accident, the ASIT examined influences at both internal and external levels of the organisation. The analysis of internal influences focused on the management of aviation safety within AVNCOMD as well as organisational factors that may impact the functioning of the safety system. Externally, the role of DASA was analysed, focusing on the sufficiency of regulation and oversight. This approach recognises that safety outcomes are not only influenced by AVNCOMD's internal systems and actions, but also by the broader regulatory and organisational context in which it operates.

2.37.3 The ASIT acknowledges that it is difficult to establish direct links between organisation influences and the accident. Nevertheless, it is the view of the ASIT that examining aspects of the organisational framework and its functioning, enables the identification of systemic factors that may have indirectly contributed to the accident. Ultimately, the aim of reviewing organisational influences is to identify potential vulnerabilities and gaps where safety action by relevant stakeholders is likely to enhance aviation safety.

2.37.4 The framework of organisations and accountabilities, combined with prescribed policy and regulation that contextualise and amplify statutory WHS obligations for military aviation, is called the Defence Aviation Safety Framework (DASF), shown at Figure 41. The Framework is established by the Chief of the Defence Force (CDF) and Secretary for the Department of Defence through Joint Directive 21/2021 - The Defence Aviation Safety Framework (Reference UUUU). Refer to the Defence Aviation Safety Guidebook (Reference VVVV) for an overview of the elements of the DASF.

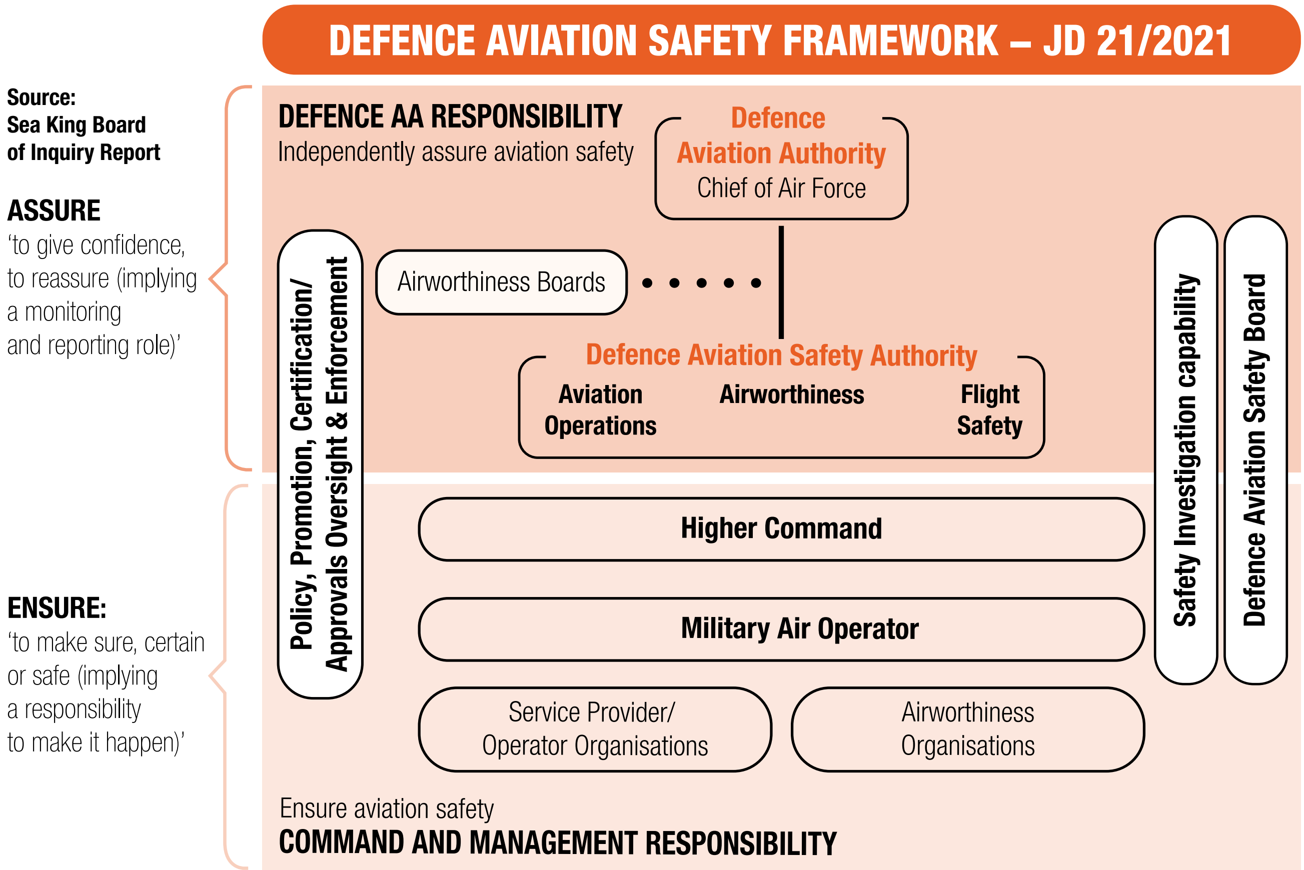

Figure 41: The Defence Aviation Safety Framework

2.37.5 While the DASF is a structured framework to assure the credibility and defensibility of aviation safety within Defence, responsibility to ensure the safety of military aviation operations and the airworthiness of aircraft rests with Command and management. Commanders and managers are accountable for ensuring aviation systems under their command or control are maintained and operated to approved standards and limitations, by competent and authorised personnel acting as members of an approved organisation.

2.37.6 The Defence Aviation Safety Program (DASP) is designed to fulfil the functions and accountabilities established by the DASF on an ongoing basis. The effectiveness of the DASP is underpinned by the suitability of, and the level of compliance with, the DASR. DASA uses the PSOE (Present, Suitable, Operating and Effective) framework, tailored for the Defence context, to assess compliance with DASR. PSOE is defined in the DASR (Reference WWWW, Volume 3, Chapter 5) as:

a. **Present (P).** There is evidence that the processes (indicators) are clearly visible and documented within the organisation's systems.

b. **Suitable (S).** There is evidence the processes (indicators) are suitable (ie regulatory compliant) for the size, nature, complexity of the organisation and the aviation safety hazard expected to be mitigated (including consideration of industry expectation for standards, codes, guidance etc.).

c. Operating (O). There is evidence that the processes (indicators) are in use and an output is being produced.

d. **Effective (E).** There is evidence that the processes outputs (indicators) are effective in achieving the desired DASR aviation safety hazard control outcome.

2.37.7 The DASR note that the assessment of 'Effectiveness' requires a thorough understanding to enable accurate assessment of whether the processes are effectively preventing realisation of that hazard. The ASIT used this framework to consider the processes implemented by AVNCOMD, and within DASA, to identify and treat hazards related to MRH-90 operations.

2.37.8 The following sections examine organisational influences related to:

a. **MRH-90 context and constraints.** Examines safety issues related to the operation and management of the MRH-90 by AVNCOMD.

b. **AVNCOMD MAO Integrated Quality and Safety Management System (iQSMS)**. Examines the structure and functioning of AVNCOMD's iQSMS at the time of the accident.

c. **DASA Regulatory Assurance.** Examines the efficacy of DASR and oversight conducted by DASA.

2.38 MRH-90 context and constraints

2.38.1 The ASIT considered a range of information that was available to DASA and Army AVNCOMD prior to the accident to examine safety-related issues for the operation and management of the MRH-90. This included Airworthiness Boards, Defence Aviation Safety – Annual Reviews, non-routine reviews of the MRH-90 capability[108], and relevant Class A and Class B safety events.

2.38.2 **Airworthiness Boards (AwB).** The Defence Aviation Authority (AA) uses independent boards of review to provide assurance that a satisfactory basis for airworthiness and aviation safety has been established and is being maintained. The review board is designed to complement the assurance activities undertaken by DASA and focuses on aspects where DASA assurance activities may provide limited confidence, particularly from a 'system of systems' perspective that examines the relationships and interaction between the separate entities that collectively ensure that aviation safety is being effectively managed.

2.38.3 12AwBs for the MRH-90 platform were conducted between 2007 and 2021. The AwBs identified maintenance complexity, technical publication deficiencies, immature logistics, and inadequate engineering support as persistent issues (ReferencexxXX). Other notable themes were the inability of the system to achieve the original planned Rate of Effort (RoE), inability to maintain aircrew currency and proficiency, and an elevated level of aggregated risk to the airworthiness and operational safety. Four Airworthiness Corrective Action Requests (ACARs) remained open at the time of the accident, dating back to the 2018 and 2020 AwBs. These ACARs related to sustainment, technical publications, maintenance challenges, and the ability of the platform to meet productivity and capability outcomes.

2.38.4 The 2017 through 2019 AwB reports (References YYYY, ZZZZ and AAAAA) were notable in their description of increasing complexity, continuing challenges with the support arrangements (described

108 Non-routine indicate reviews or assurance activities, instigated both internally (Army) or externally (DASP), that are not part of the normal DASA, QMS or SMS activities.

as both 'immature' and 'fragile'), and ongoing issues with ADF relationships with industry partners. In 2018, the Board members noted that while progress had been made, a number of notes, observations and concerns continued to be carried forward, and issued two Airworthiness Corrective Action Requests (ACARs) on maintenance complexity and technical publication system deficiencies. These ACARs remained open at the time of the accident.

2.38.5 The 2020 AwB report (Reference BBBBB) characterised the system as 'not meeting capability expectations but operating at capacity.' Of note, the Board states that they have 'diminishing confidence that risks are sufficiently known and effectively quantified, treated and accepted.' Ultimately, while the Board considered recommending the removal of the Military Type Certificate (MTC), the Board members were satisfied that appropriate risk controls were being implemented, and the system remained technically airworthy. The Board issued a further two ACARs against: the CASG sustainment system; and for modified (reduced) productivity and capability outcomes. These ACARs were also open at the time of the accident.

2.38.6 The December 2021 AwB report (Reference CCCCC) noted that low availability and serviceability had hindered aircrew experience development and supervision levels. It warned that the UH-60 Black Hawk transition to the MRH-90 Taipan at 6 Avn Regt could heighten safety and airworthiness risks. The AwB highlighted that HQ AVNCOMD and Army Aviation System Project Office (AASPO) were increasingly overstretched managing the MRH-90 at the expense of other platforms, while facing pressure to introduce new capabilities under the Battlefield Aviation Program. The report further noted that aircrew were over-burdened with secondary duties, while HQ AVNCOMD faced significant challenges managing MRH-90 operations alongside new capability transitions. Significant work had gone into understanding the aggregated risk within the MRH-90 system, and the AVNCOMD submission to the Board stated that the MRH-90 was operating at a medium level of risk to personnel safety.

2.38.7 The 2022 AwB, scheduled originally for November 2022, was delayed and then cancelled following the Government's announcement to cease MRH-90 operations following the MRH-90 fatal accident during Ex TS23. In submissions prepared for the AwB (Reference DDDDD), the MAO-AM identified the following continuing concerns for the MRH-90 capability:

a. Demand for operational capabilities and preparedness exceeded capacity across the Army Aviation enterprise.

b. Rates of Effort (RoE) continued to be less than required to deliver capability and proficiency requirements.

c. Elevated levels of risk arising from another period of transition of platforms from MRH-90 to UH-60M Black Hawk.

d. Inefficient and ineffective control of aviation risk due to the lack of maturity of AVNCOMD's integrated quality and Safety Management Systems.

2.38.8 The MAO-AM acknowledged the systemic risks stating that:

> 'I consider that systemic risk is well documented, understood and is being managed. After reviewing the various submissions and evidence presented to me, it is clear and accepted that Army is operating MRH-90 at an elevated level of risk caused by an IMPROBABLE likelihood of a CATASTROPHIC event, thus leaving the overall current risk to Personnel as MEDIUM.'

OBSERVATION 157	**The Army Aviation Military Air Operator – Accountable Manager assessed and accepted risks that MRH-90 operations were conducted at a medium level of risk to personnel safety.**

2.38.9 In the DCOMD AVNCOMD submission for the AwB, reference was made to an Operational Airworthiness Audit of 6 Avn Regt, which found key operations and safety personnel were managing multiple secondary duties. Staff officers in the Headquarters were also 'double-hatting' roles with flying and Qualified Flying Instructor (QFI) duties, significantly increasing individual workloads.

2.38.10 DCOMD AVNCOMD noted that organisational hollowness and a shortage of properly staffed and dedicated roles were identified as contributing factors in the 2021 Black Hawk rotor strike incident over Sydney Harbour. Furthermore, efforts to centralise risk management through the AVIART system were constrained by inadequate policy guidance, unfamiliarity with the system, and the overwhelming volume of risks requiring input.

2.38.11 The AwB submissions and reports describe persistent challenges to the MRH-90 capability, which have been acknowledged as part of the routine oversight and assurance activities since its introduction to service. These systemic issues were creating significant burden on Army Aviation; however, they do not appear to have been offset by significant reductions in tasking or additional resourcing. The ASIT notes a number of activities that increased workload and change management activities, including the introduction of MRH-90 to SO roles across 2019/2020, the transition from FORCOMD to the newly established Army AVNCOMD in 2021, and the transition to UH-60M in 2023. These significant changes are addressed in more detail in section 2.39.

OBSERVATION[158] **Airworthiness Boards reported persistent challenges to the MRH-90 capability since its introduction into service.**

OBSERVATION[159] **Army Aviation faced significant operational tempo, workforce pressures and platform transition challenges, increasing workload on a capability already under pressure.**

2.38.12 **Defence Aviation Safety – Annual Report (DAS-AR).** The DAS-AR is an annual report developed by DASA, which provides the Secretary of Defence and the Chief of Defence Force with a consolidated review of the performance of the DASP. DAS-ARs from FY20-21 through FY22-23 consistently reported elevated risks and operational stress within MRH-90 operations. The reports identified workload pressures on aircrew and maintenance personnel, immature logistics, and the critical need for a Flight Operations Quality Management System (QMS) to integrate airworthiness, safety, and operational oversight.

2.38.13 The FY20-21 DAS-AR (Reference EEEEE) specifically reported that unsustainable workloads had reduced MRH-90 capability for both the Army and Navy. The FY21-22 DAS-AR (Reference FFFFF) noted that concurrent platform transitions and capability acquisitions placed additional strain on the safety system and on aircrew and maintenance personnel. By FY22-23 (Reference GGGGG), AVNCOMD faced increased stress on the safety system, emphasising the urgent need for Flight Operations QMS maturation. Additionally, AVNCOMD internal assurance reports consistently identified that key supervisory and safety roles across 1 Avn Regt, 16 Avn Bde, and AAvnTC required ongoing workload prioritisation to handle competing demands effectively.

2.38.14 The DAS-ARs highlight a recurring pattern of unsustainable workloads and operational stress within MRH-90 operations, exacerbated by the concurrent platform transitions and delayed QMS development.

2.38.15 **Non-routine reviews.** The MRH-90 capability has been the subject of a number of non-routine reviews that critically examine Army Aviation and/or the MRH-90 system. These include:

a. MRH-90 Technical Review (‘The Lawson Report’), of March 2015 (Reference HHHHH)

b. The Houston Review into Army Aviation, of April 2016 (Reference IIIII)

c. Final Report – Review into MRH-90 Continuing Airworthiness Management (‘The Boughen Report’), of July 2017 (Reference JJJJJ)

d. Independent Review into MRH Sustainment and Continuing Airworthiness Management report (‘The Quaife and Gray Review’), of 2018 (Reference KKKKK)

e. An Organisational Perspective of the Airworthiness and Safety Status of the MRH-90 System, of November 2020 (Reference LLLLL)

f. MRH Capability Study ('The Yates Review'), of February 2021 (Reference MMMMM)

2.38.16 The ASIT's analysis of these non-routine reviews was not exhaustive; however, the number and frequency of reviews of the MRH-90 system is in itself indicative of a system with unresolved issues, and significant effort to identify and remediate. As the reviews referenced above are comprehensive, the ASIT did not seek to critically analyse or replicate content within this report. Collectively, the reviews describe a complex system, with recurrent issues since the introduction of service of the MRH-90. In November 2011, the Australian National Audit Office listed the MRH-90 as a 'Project of Concern'[109], which was only withdrawn from the list when the MRH-90 was retired from service in 2023. While the focus of many of these reviews was the sustainment and continuing airworthiness of the platform, in the latter years, the impact on the operational environment has also become apparent.

2.38.17 The ASIT recommends that the reviews are read in addition to this ASIR in order to gain a deep appreciation of the persistent issues affecting the MRH-90 capability.

2.38.18 Noteworthy aspects of the independent reviews and reports are the high level of complexity and risk associated with the continuing airworthiness of the MRH-90 platform. The reviews and reports echoed opinions expressed in other internal and DASA reporting; that the system was working, but it was using considerable resources and margins were minimal. Broadly, the reports identified ongoing issues with the organisational structure, control and oversight, workforce and ongoing maintenance and sustainment pressures.

2.38.19 The Lawson Report (Reference HHHHH) focused on airworthiness and safety of the MRH-90 capability. Lawson noted that:

> Although risks to MRH-90 airworthiness presently seem manageable in respect of both individual risks and in aggregate, this overall assessment relies heavily on the professional judgement of a number of key experienced individuals. Areas of noticeable stress and longer term concern clearly do exist across significant elements of the airworthiness management system. If not addressed, these stresses and concerns can degrade the overall safety environment by increasing the likelihood of maintenance errors, fostering the proliferation of unit-level workarounds, feeding a growing aircrew gap training liability, and increasing workload, particularly on key individuals, at the same time as the system is becoming increasingly reliant on the exercise of professional judgement to manage risk.

2.38.20 The Boughen Report (Reference JJJJJ), conducted to assess the level of risk associated with continuing airworthiness, identified a number of hazards in the MRH-90 system, related to complexity, maintenance policy, technical information management and high workloads. The review assessed the risk to continuing airworthiness to be medium to capability, and low (but not SFARP) to personnel.

2.38.21 Despite that a number of recommendations from the Boughen review were actioned, The Quaife and Gray Review (Reference KKKKK) noted that further incidents occurred in 2017, leading to a decline in confidence in the airworthiness system supporting the MRH-90. The Quaife and Gray Review was initiated to 'assess the appropriateness and continuing viability of the current MRH sustainment and continuing airworthiness models.' This review found that the fundamental system in place was capable of delivering acceptable airworthiness outcomes, but highlighted opportunities for further improvement.

2.38.22 Aligned to these reviews, the Houston report (Reference IIIII), in 2016, assessed the Army Aviation capability in response to concerns raised by the Defence AA. The review found that there was sound risk management, and that Army Aviation remained best placed to provide rotary wing aviation support to land manoeuvre, but identified deficiencies in aircraft systems (support and supplies), organisation disposition and command and control arrangements, training and inadequate facilities. The Houston report identified the MRH-90 as having sustainment challenges and risks.

109 109 The term 'Project of Concern' is used to describe an underperforming materiel acquisition project.

2.38.23 In 2020, Forces Command, Aviation Branch, Staff Officer Level 1 (SO1) AVN Psychologist conducted an evaluation of the threats to airworthiness and safety of the MRH-90 system, referred to as the 'Levey report' (Reference LLLLL). The review, which was conducted by an experienced organisational psychologist and aviation accident investigator, provided a comprehensive and challenging report of the MRH-90 capability. The Levey report identified a pressurised capability, and the potential of a 'normalised deviance' with respect to risk acceptance – a system operating at 'safe enough' level and a 'preoccupation … with the political and reputational consequences of a serious course change in the management of MRH-90, despite its obvious capability limitations and airworthiness risks.'

2.38.24 Persistent performance problems with the MRH-90 capability continued, and in 2021, an additional study was instigated (The Yates Review, Reference MMMMM) to assimilate previous reviews and recommend remediation strategies for the future of the platform. This review notes that previous reviews and the implementation of their recommendations 'appear to have generated limited success due to matters beyond the control of Australia, changes in management or changes in focus before completion.'

2.38.25 The Yates Review concluded that the MRH-90 system had not matured as expected, and enormous stressors had been placed on people, processes and systems. The Review recognised the significant work to remedy these issues, but noted that it came at a high price, and that it was unlikely the MRH-90 system would ever perform to the expected level and breadth. The review recommended three key strategies:

a. stabilise and consolidate – reduce the overheads associated with operating the strained system
b. overhaul of the support systems, with focus on a System Program Office (SPO) with greater authority, reach and capacity
c. reform of the contractual arrangements to reflect more realistic capability performance.

2.38.26 The independent reviews and associated reports described above do not form the complete breadth of reports, recommendations and studies done into the MRH-90 capability. It is clear from all, that MRH-90 issues and challenges were well documented, and that a number of remediation efforts were in progress. However, the ASIT assesses that the reports generated recommendations and implementation plans that also added pressure and workload related to governance, administration and planning to an already overstretched workforce. The Levey Report references 'clues which can indicate a management system is losing touch with operational realities,'[110] which include (but are not limited to):

a. multiple groupings attempting to deal with complex, ill-defined and prolonged tasks
b. shifting goals, roles and administrative arrangements
c. professionals who are pre-occupied because of pressure of work and for other reasons.

MRH-90 Class A and B events. The ASIT considered the number and type of aviation safety events that had occurred on the MRH-90 platform over the last fifteen years.

2.38.27 Table 6 details Class A and B events involving the MRH-90 and 6 Avn Regt for the period 2018 to 2023. The number and nature of accidents and serious incidents also provides context to the organisational pressures. It also speaks to ongoing workload to investigate and implement improvement and manage change.

110 Turner, B.A. (1994). Causes of disaster: Sloppy management. British Journal of management, Vol 5, 215-219.

TABLE 6: CLASS A AND B EVENTS INVOLVING THE MRH-90 AND 6 AVN REGT FOR THE PERIOD 2018 TO 2023

EVENT CLASS AIRCRAFT TYPE UNIT	DESCRIPTION	DATE OCCURRED	ASR
Class B MRH-90 AATES	Near miss with light twin aircraft	27 Feb 18	
Class B S-70A-9 6 Avn Regt	During the conduct of an After Flight servicing on A25-206, a tradesperson carried out an After Use inspection on the Fast Roping and Rappelling Device (FRRD), fitted internal to the Black Hawk cabin	28 Aug 18	
Class B MRH-90 808SQN	Partial Failure of Engine 2 in Flight	18 Oct 18	
Class B S-70A-9 6 Avn Regt	Rotor Overspeed whilst on the Ground	16 May 19	
Class B MRH-90 5 Avn Regt	Ex TS19 - Excessive vibration in flight	11 Jul 19	
Class B MRH-90 723 SQN	Near Miss during terrain flight operations EC135/MRH-90	28 Oct 19	
Class B MRH-90 5 Avn Regt	OP BUSHFIRE ASSIST 20-B SQN-Fire Damage to Fuselage	28 Jan 20	
Class B MRH-90 HQ FORCOMD	Maintenance Policy Overfly of MRH-90 Pintle Axle BS3 and MRH Policy Review	08 Apr 20	
Class B S-70A-9 6 Avn Regt	Near Mid Air Collision between RQ-20 UAV and S-70A-9 Black Hawk Helicopter.	23 Apr 20	
Class B MRH-90 5 Avn Regt	Ex VS20 - Multi Role Helicopter inter formation loss of separation	11 Nov 20	
Class B S-70A-9 6 Avn Regt	171 SOAS - Main Rotor Tip Strike	17 Feb 21	
Class A MRH-90 6 Avn Regt	Engine failure resulting in Ditching	22 Mar 23	
Class A MRH-90 6 Avn Regt	BSMN 83 Collision with Terrain	28 Jul 23	

2.38.28 **Summary.** The ASIT assesses that the MRH-90 and Army Aviation system as a whole were under significant strain. While the ASIT acknowledges that it can be extremely difficult in complex systems to predict exactly how and when system interactions will cause an accident, the ASIT's view is that organisational pre-conditions did exist, were well-known and documented, but remained unresolved at the time of the accident. Ultimately, this aviation accident could be considered a realisation of the known and accepted medium risk to personnel safety arising from MRH-90 operations.

INDIRECT FINDING[160]	Organisational pre-conditions for an elevated levels of safety risk to personnel arising from MRH-90 operations were understood, documented, communicated and accepted by the Military Air Operator – Accountable Manager.

2.39 AVNCOMD MAO Integrated Quality and Safety Management System (iQSMS)

2.39.1 The ASIT considered how organisational pre-conditions manifested within Army Aviation through a review of the MAO-AM directed iQSMS (Reference BBBB).

2.39.2 Prior to September 2021, Commander Forces Command was appointed by Chief of Army (CA) as the Army Aviation Military Air Operator – Accountable Manager (MAO-AM). In September 2021, all Army Aviation branches and subordinate organisations were aggregated under the command and control of Army Aviation Command (AVNCOMD). On 20 Aug 21, CA appointed COMD AVNCOMD as the Army Aviation MAO-AM. While Army's intent was for minimal impost on units and brigades, the implementation of any large organisation change will always have an impact on individuals within the organisation. A number of directives, reviews, boards, communications, documentation changes and training were required as the new MAO-AM and AVNCOMD construct were developed.

2.39.3 Key documents that describe the implementation and application of the DASR across Army Aviation are:

a. Operational Airworthiness Management Plan (OAMP), which articulates how Army airworthiness management is conducted. The OAMP is an MAO-AM Directive providing Army-wide policy of commanders and supervisors to ensure compliance with the DASP (Reference NNNNN)

b. Military Air Operator's Operations Compliance Statement (OCS) (Reference V)

c. MAO Directive 01/23 – Management of Safety and Operational Airworthiness within the Military Air Operator (Reference BBBB), which details how COMD AVNCOMD complies with policy requirements, ensures compliance with regulations and executes their responsibilities as the MAO-AM

d. Standing Instructions (Aviation) Operations (Reference OOOOO) and subordinate Brigade and Unit Standing Instructions.

2.39.4 Reference BBBB establishes the MAO-AM framework for the delivery of a safe and operationally airworthy aviation capability. The ASIT considered the framework with reference to the DASR, the DASM[111] and within the context described above.

2.39.5 **Quality Management System.** The Army MAO QMS was identified across a number of oversight and review activities as requiring attention. In the 2021 DASA audit (Reference PPPPP), a Level 2[112] finding identified that that the Army MAO lacked an effective QMS, compromising safety and capability delivery. Essential QMS elements, such as a Quality Manager (QM) role, Quality Manual, OIP management, and continuous improvement processes, were not fully addressed, resulting in non-compliance with DASR. In response, the Army MAO (Reference QQQQQ) outlined a plan to address these deficiencies by May

111 DASR SMS states that the DASM is Defence's corporate aviation SMS solution, and that entities subject to, and currently assessed against DASM are to continue to use the ASMS prescribed by the DASM.

112 DASR Level 2 Finding - Any non-compliance with the DASR requirements which lowers the safety standard and possibly hazards flight safety. 3 months to rectify.

2022, including the recruitment of an SO1 Quality and Compliance, a QMS Implementation Manager, and contractor support.

2.39.6 The newly hired QM, who commenced in November 2022, encountered persistent staffing shortages, including an 18-month vacancy in the Governance and Assurance Officer position. Shortly after assuming the role, the QM was also assigned SO1 Operational Airworthiness-A (OPAW-A) responsibilities, leading policy development on projects such as the SI Modernisation Project and AVDOCS113[113] Electronic Flight Bag. Further constraints emerged when the SO2 OPAW A retired in March 2023, leaving the QM with only a WO2 OIP Manager, who also left in November 2023.

2.39.7 The ASIT notes that the 2022 DASA audit (Reference RRRRR) noted an 'evolving' QMS that was generally well-managed, suggestive of the ongoing work to remediate. The audit report also draws attention to the magnitude and rate of organisational change, and the associated potential impact to safety and airworthiness. Internal Army documentation (AVIART DB 158/22, Reference SSSSS) recorded that the AVNCOMD QMS was 'under resourced' and 'under pressure' as of March 2022.

2.39.8 The ASIT found that the QM's focus was split between project-based improvements and routine QMS management. This, combined with persistent staffing shortfalls, and competing project priorities delayed finalisation of QMS objectives, policies, and manuals, and impacted Business As Usual tasks. At the time of the accident, QMS documentation intended to document policy, procedures and processes remained in draft.

OBSERVATION[161]

Transition of Military Air Operator accountabilities from Forces Command to Army Aviation Command, with associated organisational and chain of command changes, increased workload and complexity for personnel responsible for implementing AVNCOMD's iQSMS.

OBSERVATION[162]

Persistent staffing shortages and competing demands within the HQ AVNCOMD QMS section caused delays to implementation of QMS policy, processes and procedures aligned with regulatory requirements prescribed in DASR ARO.100(c)9 – Quality Management System.

2.39.9 A**viation Safety Management System.** In alignment with DASR Safety Management Systems, the Defence Aviation Safety Manual (DASM) describes the four major components of an ASMS as: Safety Policy and Objectives; Safety Risk Management; Safety Oversight; and Improvement and Safety Promotion. The following section examines the first three SMS components in relation to Army Aviation's implementation and management of an ASMS.

2.39.10 **Safety Policy and Objectives**. Safety Policy and Objectives are considered essential for creating an environment where safety management can be implemented effectively. It considers the management commitment to safety, the policy and objectives of the SMS and the organisational structure. Safety Policy and Objectives also encompasses safety culture.

2.39.11 Key safety appointments are listed in the Military Air Operator's (MAO) Operations Compliance Statement (OCS) (Reference V), and responsibilities are listed in the OAMP (Reference NNNNN). Army SI(SAF) (Reference UUU) further described the aviation safety management structure in Figure 42. Deputy Commander AVNCOMD (DCOMD AVNCOMD), as Director General Aviation (DG AVN), retained the appointment as the Hazard Tracking Authority (HTA) on transition from FORCOMD for all Army Aviation platforms. Director of Operational Airworthiness (DOPAW) was promulgated as the Command Aviation Safety Officer (CASO), with direct support for CASO-related responsibilities and accountabilities being provided by HQ AVNCOMD SO1 Aviation Safety.

113 Aviation Digitalised OIP Content-Management System

OFFICIAL

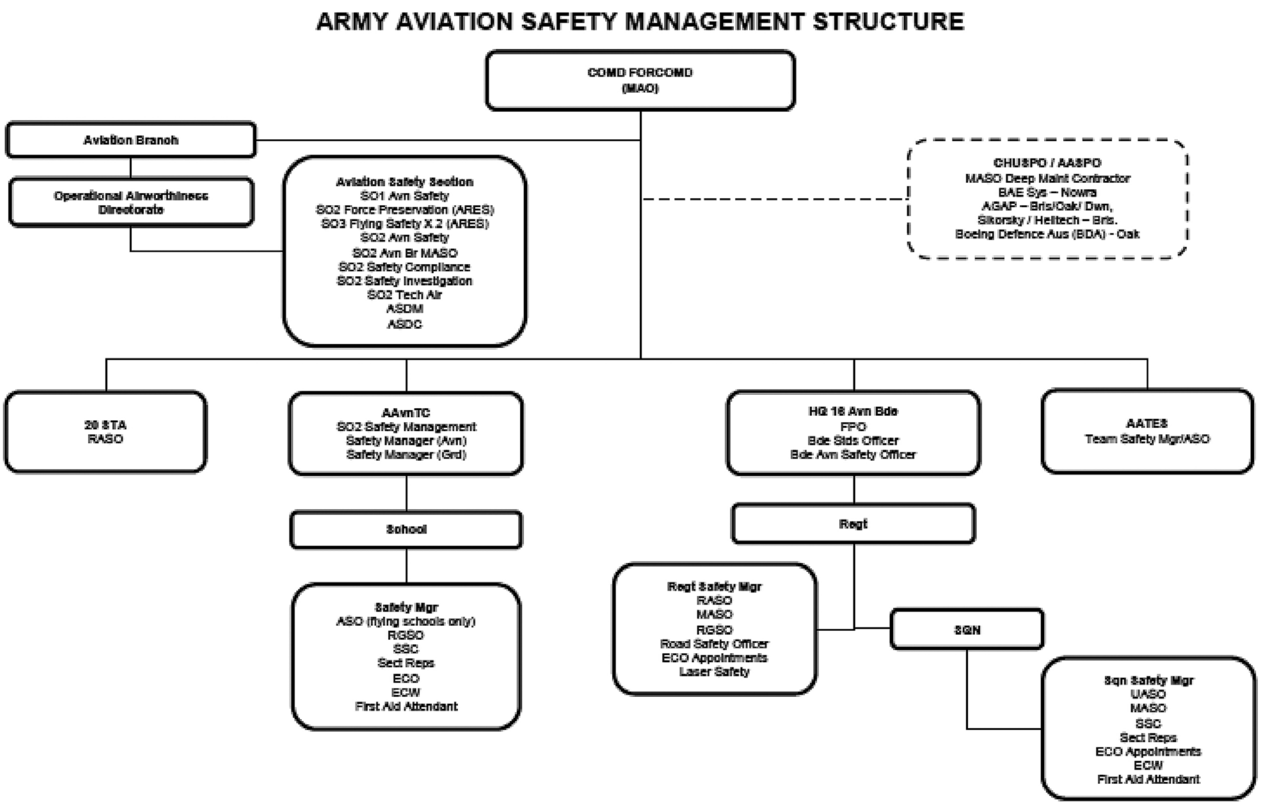

Figure 42: Army Aviation Safety Management Structure

2.39.12 Army Aviation executive staff described the DASM prescribed safety structure as unsuited to the Army context, and therefore adapted the requirements to better align. The ASIT did not review in detail the amended construct, however do make observations in the following section regarding the effectiveness, or otherwise, for some elements of the structure.

2.39.13 At the time of the accident, the ASIT identified there were:

a. prolonged vacancies in critical safety roles, creating increased workload for others through dual roles and responsibilities
b. training gaps for key personnel, including lack of ASO (Initial) and ASO (Advanced) courses as required by the DASM, reducing opportunities for key staff to be fully conversant in Defence ASMS requirements and processes
c. no recording of succession planning and competency assessments as part of the AASPC, reducing opportunities to ensure proactive training and preparation for key safety roles.

2.39.14 **Safety risk management.** A key element of an effective ASMS is the closed-loop process used for the identification, reporting, investigation, tracking, review, analysis and control of safety hazards in the workplace. Effective hazard identification forms the basis of effective risk management. A critical source of hazard identification is the reporting system; in Defence Aviation, that system is Sentinel, and a key hazard management tool is the Aviation Hazard Review Board (AHRB). These review and oversee the progress of safety related procedures and corrective actions. DASM requires AHRB to be overseen by the Hazard Tracking Authority, and held biannually. In the AVNCOMD construct, the HTA at the time of the accident was DCOMD AVNCOMD.

2.39.15 The ASIT reviewed Army Aviation documentation, and could not find evidence of the minutes of biannual AHRBs. While the Army Aviation Safety Program Conference (AASPC) (more detail in the paragraph 2.39.34) was considered by the MAO-AM (Reference TTTT) as the opportunity to review hazards and risks, the ASIT does not consider this meets the intent of the DASM AHRB requirements. One outcome of AHRBs is to review safety trends/issues arising from event reports, and to record and track to closure those ASRs. The ASIT found a steady increase of open ASRs from 2018 through to Q1 2023[114] (as depicted in Figure 43) coupled with declining closure rates over the following year. While the ASIT acknowledges that this was coincident with the establishment of AVNCOMD, it may represent a missed opportunity for Army Aviation to fully understand and assess the hazards in the system during that timeframe. The ASIT acknowledges that significant effort has gone into reducing the number of open ASRs, as evidenced in Figure 43, from mid-2023 to the present.

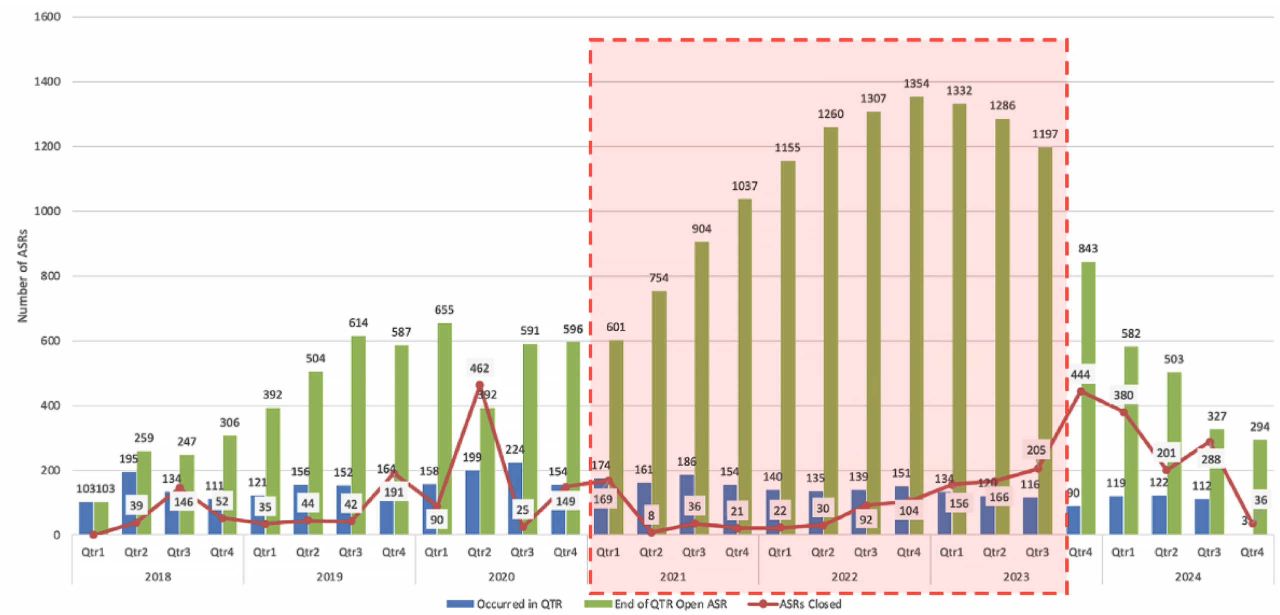

Figure 43: Total Army ASR rates for new/open/closed from 2018-2024

2.39.16 The ASIT found the absence of traditional AHRBs likely created safety oversight challenges, potentially leaving hazards unmonitored and unresolved. Without the required AHRB meetings, safety trends risked being overlooked and ASR closures were delayed, disrupting the closed-loop safety system essential for managing risks proactively. This also weakened the organisation's ability to achieve continuous improvement and organisational learning.

2.39.17 DCOMD AVNCOMD as the HTA has the potential to disconnect hazard management from operational units, slowing decision-making and limiting accountability at the unit level. In an environment already under strain, where the MRH-90 platform operated under medium safety risk and resources were stretched, the absence of AHRBs exacerbated safety governance challenges.

2.39.18 The ASIT acknowledges that the MAO-AM transferred HTA responsibilities from DCOMD AVNCOMD to COMD 16 Avn Bde, and subsequently established stand-alone AHRBs in 2024. This was reportedly recognised as a critical initiative to improve ASR closure rates and address recommendations from aviation safety investigations. It is the opinion of the ASIT that this is a positive step in ensuring hazards are considered at an appropriate level, but did not review current AHRB minutes or action items.

OBSERVATION 163	**Upon establishment of AVNCOMD, DCOMD AVNCOMD (previously DGAVN) retained the appointment as the Hazard Tracking Authority (HTA) in recognition of the unique Army Aviation organisational structure. The ASIT notes that references to each service's unique organisational structure and specific implementation requirements of the Defence ASMS were not updated in the DASM to reflect the establishment of AVNCOMD.**

114 The 'open ASR' reduction in 2020 coincides with COVID restrictions and associated reduced flying rates.

OBSERVATION[164]	The ASIT is of the view that establishment of the HTA within a Two- Star Aviation Command, vice at a level of Command directly responsible for the conduct of flying operations by the Regiments, created organisational challenges with respect to accountability and responsibility for hazard identification and analysis, and associated safety risk assessments for flying operations.

INDIRECT FINDING[165]	Prolonged vacancies, training gaps, and a lack of documented succession planning increased workload, reduced staff competency in ASMS requirements, and limited the proactive development of personnel for key safety roles.

FINDING[166]	AVNCOMD SMS policy did not clearly define the roles and responsibilities of the Hazard Tracking Authority (HTA), nor how the AVNCOMD Aviation Safety Committee Meeting (ASCM) and Aviation Hazard Review Board (AHRB) integrated within the overall construct of the Army Aviation Safety Program Conference (AASPC).

FINDING[167]	In comparison to Air Command Force Element Groups and the Fleet Air Arm, AVNCOMD's rate of closure of Aviation Safety Reports was significantly lower, which set the preconditions that actions to mitigate known and potentially latent hazards and risks were not completed in a timely and effective manner.

2.39.19 **AVNCOMD risk management framework.** AVNCOMD utilises the Aviation Integrated and Aggregated Risk Tool (AVIART) to collect and aggregate operation and technical hazard and risk in a single tool. MAO Directive 07/21 (Reference TTTT) directed the implementation of AVIART in November 2021. In the 2022 AwB submission, DCOMD AVNCOMD (the extant HTA) reported that Mission Risk Profiles (MRPs) were retired within the Army MAO to streamline risk management, as they added complexity without clarity and limited senior leaders' ability to maintain a holistic view of organisational risk. The HTA emphasised that risk management should be continuous and scalable, with only the context, hazards, controls, and acceptable risk levels differing between training and combat operations.

2.39.20 The DASM (Reference A) is the Defence-approved corporate AMC for DASR SMS (Reference PPPPPP) endorsed by Army. It requires commanders to develop Core Risk Profiles (CRPs), MRPs, and Risk Management Plans (RMPs) to ensure that risk management aligns with the complexity of operations. CRPs manage routine operational risks, MRPs address mission-specific risks, and RMPs are used for complex or unique risks that require additional controls, such as exercises. The DASM further requires Deliberate Risk Management (DRM) to ensure decisions are well-documented and aligned with operational demands.

2.39.21 The MAO Directive 07/21 (Reference TTTT) replaced CRPs with Core Risks, standard operational risks validated through OIP, reviewed biannually by the AASPC. MRPs were retired, and New Risks were introduced to manage novel or unplanned operations, equipment, or missions, aligning with RMPs. These New Risks must transition to Core Risks within 12 weeks of approval by the Risk Management Authority (RMA).

2.39.22 The ASIT assessed that AVNCOMD's framework of Core Risks and New Risks broadly meets the intent of the DASM, by aligning routine and new risks within a structured framework. However, the ASIT observes that a departure from the common standard reduces opportunities for consistency, interoperability, shared understanding and communication of risk across the whole of Defence Aviation. Noting that assessing the effectiveness (see para 2.37.6) of a process or system requires thorough understanding, the use of a separate RM framework also reduces opportunities for DASA oversight and assurance activities to identify deficiencies and opportunities for improvement.

OBSERVATION[168] AVNCOMD's structure and framework of Core Risks and New Risks within AVIART are broadly aligned with recommended guidance for risk management documentation in the Defence Aviation Safety Manual (DASM), which states that 'Commanders must produce Core Risk Profiles (CRP), Mission Risk Profiles (MRP), and Risk Management Plans (RMP) as necessary, and ensure their integration into aviation activities'.

OBSERVATION[169] The ASIT is of the view that DASR SMS and the DASM lack sufficient coherency, prescription and guidance to enable Aviation Commands to interpret and comply with regulatory requirements for risk management documentation specifically related to flying operations.

INDIRECT FINDING[170] AVNCOMD Core Risks do not represent a foundational Deliberate Risk Management (DRM) document that captures platform operation and identifies all risks associated with the conduct and support of regular, non-role specific operations.

INDIRECT FINDING[171] AVNCOMD Core Risks, which are considered the equivalent of an MRP (a DRM document that analyses hazards and risks associated with the conduct of regular operations conducted by the organisation, typically with reference to a specific role or function), do not by design leverage off a foundational DRM document that captures platform operation.

FINDING[172] AVNCOMD's structure and framework of DRM documents within AVIART sets pre-conditions to reduce the efficacy of the MAO's analysis of hazards and risks for non-role specific operations, specific roles and functions, and unique tasks/activities.

2.39.23 The ASIT acknowledges HQ AVNCOMD's significant and ongoing effort towards the development, implementation and improvement of AVAIRT as a database to record and manage hazards, risks and treatments across the Army MAO. However, the ASIT notes the following:

a. MAO-AM Directive 07/21 for the implementation of AVIART (Reference TTTT) lacks supporting guidance as to standardisation for the hierarchy and structure of CORE RISKS for common aircraft and type-specific mission profiles. The ASIT noted that in order to build an aggregated understanding of hazards and risks for specific mission types (such as Low Level, Formation, Flight Over Water using NVIS), several CORE RISKs within AVIART must be reviewed. In comparison to recommended practices contained within the DASM, the ASIT assesses that AVNCOMD would benefit from the creation of dedicated Mission Risk Profiles (MRP) for aggregated mission types. AVNCOMD staff acknowledged to the ASIT that they were in the progress of developing aggregated MRP as a function of continual improvement of the AVIART database, but this was not completed at the time of the accident.

b. In comparison to contemporary aviation Bow Tie[115] risk frameworks and taxonomy, supporting OIP for the use of AVIART does not provide standardisation of key definitions and descriptions, such as:

(1) Hazards (activity, condition or object)

(2) Top Events (loss of control of the Hazard)

(3) Threats (causes)

(4) Preventative and Recovery Controls (specific to the Top Event)

(5) Escalation Factors (that reduce the effectiveness of controls)

(6) Risk Consequences (arising from the release of the hazard)

(7) Accident Outcomes (realisation of the consequence).

2.39.24 AVIART entries generally lack clarity of the Top Event (which describes the point where there is no longer control over the Hazard). That is, the unsafe state that is not yet an accident. Clarity of Top Events within CORE RISKs would enable a more detailed understanding of Threats (direct causes of the Top Event), Preventative and Recovery Controls, Consequences and Outcomes.

2.39.25 The ASIT found several inconsistencies across AVIART entries, whereby the entry details hazards that present similar risks and consequences; however, the associated accident outcome leads to a different level of severity. For example, AVIART hazards related to NVIS Limitations and Degraded Visual Environments, which both share a similar risk of CFIT if not treated, result in a different classification of the accident outcome (critical and catastrophic respectively). Clarity of the most negative credible safety outcome is essential in order to effectively characterise risk levels.

2.39.26 AVIART entries demonstrate a lack of standardisation of the application of hazard and risk taxonomy. For example, the ASIT found numerous examples of risk and hazard descriptions that were interchangeable. For example, the Risk Decision Brief (RDB) for CRP Low Level Flight (AVIART Reference: 213/22, Reference TTTTT), defines NVD Limitations as a Risk, vice a Threat (/cause) that must be treated to prevent a Top Event (such as loss of visual reference). Redefining 'Hazard Descriptions' as 'Risk Consequence' statements that are expressed in operational terms would enable AVNCOMD to gain greater clarity of the scenario to be controlled.

2.39.27 Control descriptions often lack clarity, appear discretionary and are undocumented. For example, the following statement regarding flight authorisation could be improved by referencing which specific OIP documents the limitations and authorised controls: 'The flight authorisation process considers the risks and if necessary imposes limitations; and FLTAUTHOs are required to consider crew recency and experience especially with low illumination and apply further controls if required.'

2.39.28 Control descriptions do not reference how the organisation is to 'assure' that controls are being applied and whether they are effective. Although AVIART procedures clearly state how continuous risk monitoring and review is to be conducted through the AASPC framework, the ASIT offers that there are opportunities for HQ AVNCOMD to define policy and processes to assure that controls are standardised and being applied, while also ensuring that the effectiveness of controls is continually reviewed and assessed.

2.39.29 The ASIT assesses that AVNCOMD's approach to hazard identification and safety risk assessment, and the system of documenting risk artefacts through the AVIART database is relatively robust and mature. However, the ASIT also notes several opportunities for improvement related to alignment with contemporary aviation Bow Tie frameworks and taxonomy, and re-baselining against recommended practices for CRPs, MRPs and RMPs as prescribed within the DASM.

115 The DASM (Reference A) states that the Bow Tie is a useful tool that can be used to visualise risks and risk controls and is also referred to as a Threat Block Diagram. The Bow Tie analysis is useful for communicating what types of controls should be considered for managing certain types of hazards and to avoid a critical situation, which could lead to harmful consequences. Further reference material on Bow Tie can be found at: https://www.caa.co.uk/safety-initiatives-and-resources/working-with-industry/bowtie/#.

INDIRECT FINDING[173]	**AVNCOMD's policy for creating and documenting Core Risks in AVIART lacks standardisation of key taxonomy, definitions and description, which sets pre-conditions for inconsistent approaches to hazard analysis and safety risk assessments.**

INDIRECT FINDING[174]	**AVNCOMD's policy for creating and documenting Core Risks in AVIART does not provide guidance as to which specific roles and functions (either type-specific or non-type specific) require an aggregated Core Risk to be documented, such as for Low Level, Flight Over Water using NVIS.**

INDIRECT FINDING[175]	**Risk control descriptions within AVIART demonstrate a general lack of standardisation and specificity, references to OIP that prescribe the organisation's risk controls, and the means by which the standardisation, application and effectiveness of controls are to be assured.**

FINDING[176]	**Core Risks lack clarity of the Top Event (loss of control of the hazardous activity), threats/causes and delineation of preventative versus recovery controls, which sets pre-conditions for absent or ineffective controls.**

2.39.30 **Safety oversight and improvement.** Safety oversight and improvement requires commanders and managers to verify the performance of their organisation against required outcomes, manage change, and seek continuous improvement of the SMS. The ASIT considered the mechanisms described in MAO Directive 01/23, including AVIART as a monitoring tool, and the bi-annual AASPC.

2.39.31 The AASPC is considered the MAO-AM's formal review mechanism to discuss hazards, risk management, and safety treatments across the Operational, Maintenance, and Technical domains. In the 2022 MRH-90 AwB submission (Reference DDDDD), the MAO-AM stated that the AASPC amalgamates Aviation Safety Report (ASR) reviews (covering flying and maintenance) with input from System Project Office (SPO) safety and technical working groups.

2.39.32 The DASM (Reference A) specifies that the AASPC meets the intent of a Wing Aviation Safety Committee (WASC). The DASM mandates that a WASC evaluate the overall health of the aviation SMS, ensuring continuous improvement, safety culture, and adequacy of resources at the wing and subordinate unit levels. It also outlines requirements for trend analysis, audits, safety surveys, corrective action monitoring, and tracking the implementation of safety initiatives to ensure the ASMS remains effective and focused on fostering a generative safety culture across all aviation operations.

2.39.33 The ASIT compared minutes and presentations from AASPC against DASM requirements, and other MAO-AM constructs. The ASIT found, that while both the AASPC and WASC share the core goal of reviewing hazards, assessing risks, and driving proactive safety management, the AASPC operates at a higher strategic level. It integrates inputs across the Army Aviation enterprise, shaping strategic initiatives for operational and continuing airworthiness management. This distinction creates potential challenges in ensuring that local safety issues receive the necessary attention. The AASPC's broader scope allows it to guide enterprise-wide safety initiatives, but it may not have the same level of direct involvement in unit-level safety processes, which are critical for continuous improvement and resource adequacy evaluation.

OBSERVATION[177] The AASPC has a broader scope and agenda compared with guidance provided in the Defence Aviation Safety Manual for the conduct of Aviation Safety Committee Meetings and Aviation Hazard Review Boards.

OBSERVATION[178] The AASPC has a broader scope and agenda compared with guidance provided in the Defence Aviation Safety Manual for the conduct of Aviation Safety Committee Meetings and Aviation Hazard Review Boards.

2.39.34 **minutes and safety oversight (2021 to 2023).** The ASIT conducted a review of AASPC minutes and presentation briefs from 2021 to 2023, with focus on safety issues related to the MRH-90 system, to identify safety improvements relevant to this investigation. At the September 2022 AASPC (Reference UUUUU), the MRH-90 Taipan system was reported to be operating at medium risk to personnel, requiring disproportionate management effort. DCOMD AVNCOMD highlighted persistent organisational pressures expected to increase with multiple transitions and changes, emphasising the importance of robust foundational systems to prevent safety events. This risk assessment was communicated to the Defence Aviation Safety Board (DASB) in 2021 by the newly appointed COMD AVNCOMD (Reference VVVVV).

2.39.35 In May 2023 (Reference WWWWW), COMD AVNCOMD reaffirmed that the Taipan system remained the primary risk, consistently exposing personnel to medium risk. The flying Rate of Effort (RoE), linked to operational tempo concerns in AVIART 275/21 (ReferencexxXXX), was insufficient to maintain proficiency and workforce growth, including the development of supervisors and mentors. The ASIT was advised by AVNCOMD staff that the elimination strategy for the medium risk was to prioritise the transition to UH-60M. The ASIT did not find evidence of a Risk Management Plan to reduce the medium risk in the near term. Noting the comments in paragraph 2.39.15 regarding Army's ability to fully appreciate hazards in the context of open ASRs, it is possible that the construct of AASPC and the lack of dedicated AHRB precluded comprehensive assessment of hazards at the tactical level.

INDIRECT FINDING[179] **The ASIT is of the view that normalisation of a shared acknowledgement of the medium risk to personnel safety set organisational pre-conditions to limit ongoing analysis of which particular MRH-90 operations and roles required heightened risk awareness and proactive management to minimise risk SFARP.**

INDIRECT FINDING[180] **AVNCOMD's safety risk assessment of medium risk to personnel safety was not supported by clear articulation of which specific aspects of MRH-90 operations required heightened risk controls, Flying Supervision and Flight Authorisation to ensure that known risks were minimised SFARP.**

2.39.36 **Safety Performance Indicators (SPIs).** SPIs provide a measure of the integrity and effectiveness of SMS processes and activities. The ASIT review of the AASPC minutes and presentations did not identify consideration of SPIs or Safety Performance Targets (SPTs), rather, the AASPC focused on Key Performance Indicators (KPI). The key differentiation is a focus on compliance (KPI) versus system effectiveness in meeting safety objectives (SPI) and guiding continuous safety improvement (SPT). A DASA compliance audit in 2021 (Reference PPPPP) found that:

> KPIs are used in place of SPIs. Whether the selected KPIs are appropriate was not evaluated.
>
> 'I strongly believe their KPIs are not a suitable replacement for SPIs, but we lacked the time and understanding of their organisation to assess this fully. It would be worth revisiting in a future on-site audit.'

2.39.37 Army Aviation has, and continues to undergo significant change, including but not limited to, command construct, development and implementation of new programs, processes and OIP framework, response to routine and non-routine oversight and assurance activities, and response to Class A and B investigations. It is vital that change management strategies address both extant hazards and risk management artefacts and identify and address new risks that are introduced as part of the change.

2.39.38 SPIs and SPTs can be effective tools to ensure safety performance is continuously monitored, assessed and updated. The ASIT considers that the extant Army Aviation KPIs focus primarily on the present and suitable of PSOE considerations, but not necessarily on the effectiveness of risk controls. The ASIT observes that there are opportunities for review and improvement in AVNCOMD safety measurement strategies. The ASIT acknowledges that Army Aviation considers their KPIs meet the intent of SPIs and are suitable measures of the performance of their iQSMS. Given the criticality of understanding how well a safety system is functioning, however, especially in a complex, under-resourced system with a high rate of change, the ASIT concur with the DASA 2021 audit in that review of the current construct is warranted.

OBSERVATION[181]	**AVNCOMD's use of compliance-based Key Performance Indicators (rather than Safety Performance Indicators) as a means to measure the integrity and effectiveness of SMS processes and activities set pre-conditions to limit monitoring of the effectiveness of organisational risk controls.**

2.39.39 **Summary.** Army Aviation were clearly very aware of the persistent challenges and resultant hazards associated with continued operations of the MRH-90. The ASIT sees the breadth and pace of change, the arguably overwhelming amount of internal and external reviews, oversight activities and investigations, the introduction of new capability and the lack of resources to have created an environment where demand far exceeded capacity. Multiple airworthiness boards and reviews have stated that the MRH-90 capability was only considered airworthy and able to continue operations (albeit at an increased level of risk) because of the significant effort by key personnel, compromised operational output and with minimal safety margins.

2.39.40 The ASIT calls attention to the numerous action items that remained open at the time of the accident. While the ASIT acknowledges the body of work being undertaken at the time to remediate, the ASIT considers the demands to far outweigh the capacity of the organisation. Key known hazards, such as the action items arising from the MRH-90 Formation Loss of Separation in 2020 (DEFEV20110489), related to fatigue, NTS, formation and NVIS were overdue[116] at the time of the accident.

2.39.41 It is impossible to know if the accident would have been prevented had the action items been completed, however it is the opinion of the ASIT that implementation would have strengthened the risk controls on the night of the accident, and could have contributed to safer outcomes.

FINDING[182]	**AVNCOMD's comparatively low rate of closure of Aviation Safety Reports and extended periods of time to complete MAO-AM Directive aviation safety action items set organisational pre-conditions that key hazards and risks would not be mitigated in a timely and effective manner.**

116 MAO Directive 804/2022 Implementation of Recommendations from the ASIR into MRH-90 Formation Near Collision Townsville Field Training Area, 11 Nov 20 directed task leads to finalise action items by the due date (for all items this fell within 2022). SALUS identified that 16 items remained open at the time of the accident in mid-2023.

2.40 Defence Aviation Safety Authority (DASA)

2.40.1 DASA is responsible for the efficient implementation of the DASP. Described at the highest level, these are:

a. independent safety assurance applied by the DASA, specifically:

(1) the prescription and interpretation of aviation safety management policy, inclusive of DASR and related standards

(2) the issuance of authorisations, permits, approvals and licenses, to certify that Defence Aviation platforms, systems, organisations and personnel have shown compliance with applicable DASR

(3) ongoing oversight and enforcement activities to assure compliance with the DASR and the continued validity of authorisations issued by DASA

(4) the promotion of aviation safety through education, training, and dissemination of safety information

b. independent accident and incident investigations performed by DFSB in order to prevent recurrence and improve safety performance c. independent reviews of aviation safety coordinated by DASA on behalf of the Defence Aviation Authority.

2.40.2 DASA is led by the Director General DASA (DG DASA) and comprises of a headquarters and six functional directorates. An overview of the DASP and responsibilities of DASA directorates can be found in the Defence Aviation Safety Guidebook (Reference VVVV).

2.40.3 Directorate of Aviation Operations (DAVNOPS) is the DASA directorate responsible for the formulation and interpretation of regulations and standards for aircraft operations, including NTS and fatigue, as well as their associated oversight and enforcement.

2.40.4 DFSB is the DASA directorate responsible for the independent investigation of Defence Aviation accidents and incidents. DFSB also fosters safety awareness, knowledge and action through its research, education and promotion programs. This includes the provision of human factors guidance and tools in support of related DASR as well as maintaining key aviation safety policy, such as the Defence Aviation Safety Manual (DASM).

2.40.5 In the context of this accident, the ASIT focused on the sufficiency of Defence DASR and supporting artefacts for addressing hazards related to multi-crew aircraft operations, NTS, fatigue and SD. The ASIT also examined issues associated with the oversight of DASR AVFM as well aircraft operations regulations more broadly.

2.40.6 **Multi-crew aircraft operations.** A review of DASR and supporting regulatory artefacts identified no regulation or guidance related to roles or responsibilities of aircrew in multi-crew settings. It also revealed minimal reference to a pilot not on the aircraft's controls. A limited review of civilian airworthiness authorities by the ASIT, indicates that this is inconsistent with global aviation practices.

2.40.7 To assess this potential gap in DASR coverage, it is recommended that DASA conducts a comprehensive review of existing regulations and guidance, and benchmark against other civil and military aviation authorities' regulatory material, extant service and MAO policy. The review should determine whether regulation and guidance related to multi-crew roles, responsibilities and intervention protocols is required, and consider the benefits of adopting and defining the term pilot monitoring (PM) within DASR. By offering regulation and guidance on the duties and intervention protocols associated with multi-crew settings, DASA can promote alignment across Defence and foster effective NTS and monitoring behaviours in multi-crew settings.

INDIRECT FINDING[183]	DASR do not appear to define control outcomes related to the context and hazards related to multi-crew aircraft operations, including the differing roles and responsibilities of crewmembers.

2.40.8 **NTS training.** A review conducted by DAVNOPS identified that Defence had insufficient regulation for the effective management of NTS-related aviation safety hazards[117]. In June 2023, DG DASA endorsed a major change to NTS regulation. In August 2023, sponsored by DAVNOPS, DASA released a Notice of Proposed Amendment (NPA) 2023/002 – DASR NTS (Reference YYYYY) to enable community input into the development of the DASR NTS regulation ahead of its release.

2.40.9 In February 2024, DAVNOPS released the Comment Response Document (CRD) to NPA 2023/002 (Reference ZZZZZ), and DASR NTS was subsequently released with a transition period of 24 months.

2.40.10 The DASR NTS regulation increased the compliance obligations on the regulated community related to:

a. initial NTS knowledge-based training requirements
b. continuation NTS knowledge-based training requirements
c. NTS bridging training requirements
d. skills-based NTS training and assessment requirements
e. NTS training program management controls, including prerequisite Trainer requirements, Flying Management System (FMS) integration requirements and Safety Management System (SMS) integration requirements.

2.40.11 Of note, the requirement to integrate NTS training into the FMS was designed to enhance the transfer of NTS knowledge and skills to operational performance and to ensure that NTS training is contextualised based on the operating context.

2.40.12 Further, the regulation requires organisations to use hazard identification processes to identify, assess and mitigate NTS related issues and considerations, and integrate into their SMS. This integration also facilitates the dissemination of NTS lessons learnt during investigation and allows for the continuous development of NTS training and its incorporation into the FMS.

2.40.13 DASR NTS represents a significant and foundational change to NTS training in Defence and, once effectively implemented, will enhance the management of NTS-related aviation safety hazards. As stated in Section 2.34, it is the view of the ASIT that AVNCOMD's implementation of DASR NTS is sufficient to address NTS training issues and opportunities identified in this investigation.

2.40.14 The ASIT acknowledges the significant body of work DFSB is undertaking to develop guidance and materials to support the regulated community in transitioning to DASR NTS. However, despite DASR NTS being released in February 2024, the supporting artefacts have not been released by DFSB. Without clear guidance and supporting artefacts, stakeholders are left uncertain about compliance expectations and may lead to inconsistent and sub-optimal implementation. To address this issue, the ASIT recommends that DFSB prioritise and expedite the development and release of guidance and products and training to support organisations in transitioning to DASR NTS.

OBSERVATION 184

DASR NTS was released in February 2024 (with a two-year transition period) and increased compliance obligations on the regulated community related to NTS knowledge-based training, NTS skills-based training and assessment, and NTS training program management controls to address NTS-related safety risks in the operating environment.

OBSERVATION 185

DFSB guidance and products to support the implementation of DASR NTS have not been released and will likely impede the implementation of the regulation.

117 Inclusive of benchmarking reviews of other civil and military aviation authorities' regulatory material, legacy MILAVREGS and OAREGS, extant Service and MAO policy, and NTS-related Defence Aviation Safety Reports.

2.40.15 **Aviation fatigue management.** Fatigue management was not regulated for any Service through the legacy Defence Aviation regulations nor the DASR when introduced in 2016. In 2019, DASA benchmarked exemplar civilian and military airworthiness authorities, identifying that it is best practice to regulate aviation fatigue management. This resulted in NPA 2019-08 – DASR AVFM (Reference AAAAAA), sponsored by DAVNOPS, being released in December 2020. The NPA proposed to introduce new DASR parts[118], AMC and Guidance Material[119] (GM) for fatigue management, accompanied by a Defence Aviation Fatigue Management Guidebook.

2.40.16 The NPA for DASR AVFM included a comprehensive plan to support a proposed two-year implementation period including:

a. mid-year 2022 transition assessments (no-findings)
b. targeted assistance based on transition assessment
c. a fortnightly consultation forum via webinars with DAVNOPS, DFSB, IAM and subject matter experts working through key issues
d. DASA Compliance assessments commencing mid-year 2023.

2.40.17 During the consultation period with the regulated community, the requirements for targeted assistance based on transition assessment and fortnightly webinars were removed from the implementation plan. DAVNOPS staff cited insufficient resources as the reason for this decision. The ASIT confirmed that the revised DASR AVFM transition plan had been endorsed by Environmental Command representatives, including AVNCOMD, before the release of the CRD.

2.40.18 DASA released CRD to NPA 2019-008 – DASR AVFM (Reference BBBBBB) in September 2021 with a revised transition plan that consisted of: a. a 12-month transition period, beginning on the date of publication of DASR AVFM, to allow the regulated community time to implement DASR AVFM, during which DASA would not enforce compliance b. that DASA would consider extensions to the transition plan on request.

2.40.19 The ASIT notes that DASA considers the need for targeted regulatory community assistance during major regulation development and consultation. However, no major operational regulation updates released since 2016 have been assessed as requiring targeted assistance – as agreed with environmental commands. Instead, in order to support the regulated community to implement major changes to DASR, DAVNOPS:

a. conducts consultation with MAO and Environmental Command staff when developing major updates to operational DASR
a. updates its existing education courses to the regulated community to incorporate changes to DASR
b. provides authoritative regulatory advice on request
c. conducts oversight and enforcement post-transition to assure compliance.

2.40.20 Notwithstanding the above, it is the view of the ASIT that, in comparison to the implementation plan proposed in the NPA, the transition plan detailed in the CRD provided significantly less support to the regulated community. It is considered likely that the absence of this support reduced the effectiveness of DASR AVFM implementation.

2.40.21 The release of DASR AVFM, in combination with DFSB supporting materials and resources, represented a significant step towards enhancing the management of fatigue-related risk in Defence Aviation. DASR AVFM moved away from the traditional approach of requiring organisations to prescribe and operate within maximum duty limitations, which had been in place for decades. While setting maximum duty limitations provided the greatest flexibility to adapt to varying operational needs, they inadvertently became de facto standards across Defence Aviation and placed the primary responsibility for the

118 DASR parts, which are outcomes-based and specify requirements for each of the specifically regulated aviation safety topics. They may include associated supporting information in the form of AMC and Guidance Material (GM).

119 GM illustrates the meaning of a requirement or provision in the DASR. It provides relevant background, context or an explanation of the policy intent underpinning the respective regulation.

day-to-day management of fatigue on supervisors and individuals. The implementation of DASR AVFM shifted the focus of fatigue management towards defining normal duty periods that establish conservative organisational limits. These limits can be extended using additional risk management and increased Command oversight commensurate to the context. It is the view of the ASIT that, at the time of the accident, AVNCOMD had yet to implement and benefit from this important change in Defence Aviation's approach to fatigue management.

2.40.22 Notwithstanding the strengths of DASR AVFM, the circumstances of this accident highlights the need to revisit regulatory obligations related to scheduling and rostering practice. The draft version of DASR AVFM included the obligation to define rostering practises as a part AVFM.30. As detailed in the CRD to NPA 2019-008, this obligation was removed during the consultation process in response to feedback from the regulated community. Scheduling and rostering practices are critical to support the effective management of fatigue-related risk by considering factors such as duty transitions, circadian alignment, consecutive night shifts and the sleep environment.

2.40.23 The ASIT considers that DASR AVFM provides the regulated community with insufficient Acceptable Means of Compliance across the Implementing Regulations and lacks clarity concerning fatigue training requirements. DASR AVFM.30 also uses the term 'normal' duty time limitations, which should be replaced with a more neutral and objective term such as 'standard' duty time limitations. Accordingly, it is the view of the ASIT that in response to this accident, as well as opportunities for improvement identified during the investigation, a review of DASR AVFM is warranted. The review should confirm the adequacy of the regulation, and assess the practical application and effectiveness of supporting materials.

2.40.24 The ASIT also draws attention to the complexity of evaluating the effectiveness of MAO fatigue management solutions and recommends that the development of targeted guidance to support oversight personnel is incorporated within the scope of this review.

FINDING[186]	The DASR AVFM transition plan implemented by DAVNOPS, which was externally consulted and documented in the Comment Response Document to DASR AVFM, provided significantly less support to the regulated community than detailed in the Notice of Proposed Amendment to DASR AVFM.

2.40.25 **Spatial Disorientation (SD).** The investigation determined that the primary cause of the accident was Spatial Disorientation, resulting in an undesired aircraft state and controlled flight into terrain.

2.40.26 In 2024, DFSB conducted a research activity to gather information on SD experienced within Defence Aviation, including SD frequency, severity and the effectiveness of SD training (see Enclosure 11).

2.40.27 The report indicates that SD remains an enduring and significant hazard to Defence Aviation safety, and that all aircrew are susceptible to experiencing SD. The report findings are consistent with SD research conducted in both civilian and foreign military settings. Furthermore, it aligns with global aviation safety data, which identifies SD as one of the leading causes of fatal aviation accidents. The DFSB research report concluded that, while the high ratings for the effectiveness of existing SD training programs are encouraging, preventative and recovery controls to minimise SD-related risks extending beyond classroom-based training vary across operational and organisational contexts.

2.40.28 Despite existing training and regulatory measures, the persistence of SD-related experiences and SD contribution to global accident rates suggests that current hazard controls may not be fully effective. This emphasises the need to monitor and continuously improve upon existing approaches to managing this critical flight safety hazard.

2.40.29 A review of DASR identified Specific Purpose Approval (SPA.55) Night Vision Imaging System (SPA.55 NVIS) as the only DASR containing material specific to the management of SD hazards.

2.40.30 In response to two previous DFSB Aviation Safety Investigation Reports (References KK and CCCCCC), DASA conducted a review of Defence NVIS regulatory material and OIP, which identified that insufficient regulatory controls existed for NVIS. DASA subsequently released NPA 2022-007 (DASR SPA.55 NVIS) (Reference DDDDDD) for regulated community comment in August 2022, followed by the CDR to NPA 2022-007 in November 2022 (Reference EEEEEE). DASR SPA.55 NVIS was released in February 2023 and, at the time of the accident, was within its nine-month transition period.

2.40.31 Noting that Type I (Unrecognised) SD was identified as the most plausible cause of the accident, the ASIT reviewed the sufficiency of DASR SPA.55 NVIS for supporting the management of SD-related hazards. The review identified that the focus of the GM is on early recognition, intervention and recovery controls. The ASIT considers this sufficient for supporting management of Type II (Recognised) SD; however does not consider the content to adequately address the hazards associated with Type I (Unrecognised) SD. The ASIT determined that enhanced focus on preventative risk controls are necessary to target the maintenance of Spatial Orientation as well as on actions to anticipate, avoid and communicate SD risk factors within operational environments. Given the SD-related risk is present across all operating environments, it is also recommended that DASR considers SD more broadly and that it is not limited to NVD operations. In addition, the ASIT considers that DASR SPA.55 may not provide the regulated community with sufficient AMC to identify the means to meet requirements of DASR SPA.55 NVIS.

2.40.32 To address these issues, the ASIT recommends that DASA conducts a comprehensive review of the effectiveness of DASR in achieving the desired SD-related regulatory hazard control outcome. The ASIT also recommends that upcoming DASA oversight activities for each MAO incorporate SD as a target area.

INDIRECT FINDING[187]	**The prevalence of SD-related experiences across Defence Aviation and SD contribution to global accident rates suggests that current hazard controls may not be fully effective.**

OBSERVATION[188]	**A review of DASR identified SPA.55 NVIS as the only DASR containing material specific to the management of SD hazards, which is limited to consideration associated with NVD operations.**

OBSERVATION[189]	**A review of DASR SPA.55 NVIS identified that the regulation does not provide sufficient AMC to identify how regulated entities may achieve the required safety outcomes and does not adequately address preventative risk controls for Type I (Unrecognised) SD.**

2.40.33 **DASA oversight and enforcement.** DAVNOPS is responsible for auditing MAO compliance with DASR on a cycle varying between 12 months and two years. The ASIT assesses that AVNCOMD was likely not compliant with DASR AVFM at the time of the accident. Furthermore, it identified that DAVNOPS had not assessed AVNCOMD's compliance with DASR AVFM.

2.40.34 DAVNOPS's last oversight of AVNCOMD MAO prior to the accident was conducted in August 2022. DAVNOPS advised that DASR AVFM was not in scope for this oversight activity as it was within the 12-month transition period. DASR AVFM was released in October 2021 with a 12-month transition period.

2.40.35 The DAVNOPS oversight approach and schedule meant that there was no opportunity for DASA to provide assurance of AVNCOMD MAO's compliance with DASR AVFM prior to the accident. The next scheduled oversight of AVNCOMD was scheduled for September 2023. This was subsequently rescheduled to April 2024. Accordingly, despite the DASR AVFM transition period ending in October

2022, DAVNOPS verification of compliance with DASR AVFM was not conducted until approximately 18 months later.

2.40.36 AVNCOMD was responsible for ensuring the timely and accurate incorporation of DASR AVFM requirements prior to the completion of the transition period. However, it is the view of the ASIT that the reliance on future oversight activities to verify compliance with DASR AVFM, in combination with the absence of transition support, created opportunities for safety gaps to emerge within AVNCOMD and remain unresolved, especially for fatigue-related risks that required timely mitigation.

FINDING 190	**The DAVNOPS oversight approach and schedule meant that there was limited opportunity for DASA to provide assurance of AVNCOMD MAO's compliance with DASR AVFM prior to the accident.**

FINDING 191	**The DAVNOPS oversight approach, which relied on future oversight activities to verify compliance with DASR AVFM, created opportunities for safety gaps to emerge within AVNCOMD and to remain unidentified and unresolved.**

2.40.37 The organisational QMS function related to the local management of the introduction of new or major updates to regulations (eg DASR AVFM) is not as effective as intended by regulation. This detracts from the effectiveness of the MAO management of tracking changed requirement implementation.

2.40.38 The ASIT notes that non-compliance with DASR AVFM was identified in a DFSB investigation involving another MAO[120]. This recurrence suggests a systemic weakness in how DASA assures MAO ongoing compliance with DASR, notwithstanding that it is intended as a periodic sampling function in each organisation.

2.40.39 As detailed in the DASP Manual[121], DASA must approve an MAO seeking to operate within the DASF against DASR for the scope and level of operations required by their organisation, before their organisation can operate. DASA may award a Military Air Operator Certificate (MAOC) when satisfied that the MAO can safely conduct flight operations. The MAOC is accompanied with an Operations Specification (OpSpec) issued by DASA. The OpSpec contains the details of the scope of operations with any specific DASA approvals, conditions or limitations.

2.40.40 Once approved, an MAO demonstrates ongoing compliance to the flight operations regulations by maintaining a suite of OIP, which record all aspects of the flying management system. As described in the DASP Manual, at the apex of this documentation suite is the maintenance of the Operations Compliance Statement (OCS). The OCS records essential information about the proposed operations and limitations and provides traceability to relevant OIP, to establish the means of compliance to each applicable flight operations regulation.

2.40.41 DASR ARO.100 states that when an MAO identifies the need for an amendment to the MAOC or accompanying OpSpec, they are to apply to DASA using the OCS as the supporting evidence. The MAO is not required to notify or seek approval from DASA for changes to the OCS that do not affect the MAOC or OpSpec. Instead, the OCS is only reviewed by DAVNOPS during periodic MAO oversight activity. As a result, any significant amendments to the evidence of compliance with DASR contained in the OCS are not assessed prior to their implementation. This approach is inconsistent with DASA's broader regulatory approach. Across airworthiness related DASR, all significant changes must be approved by DASA before they are implemented by the organisation. In this way, the evidence of the organisation's compliance with DASR is maintained on an ongoing basis.

120 Aviation Safety Investigation Report - No.2 Flying Training School; Pilatus PC-21 A54-10 and A54-11 Loss of Visual Contact Leading to Near Collision During Formation, RAAF Pearce, 15 December 2022

121 Defence Aviation Safety Program Manual, Volume 3, Chapter 5.3 Annex A - Military Air Operator

2.40.42 The ASIT considers that the reliance on verifying OCSs during periodic MAO oversight activities allows potential gaps in compliance to go unnoticed for periods of time, particularly when organisations alter their practices or do not respond to regulatory changes. This practice is inconsistent with global aviation practices, which emphasises the importance of continuous compliance verification of significant changes. Additionally, from the ASIT's perspective, this approach detracts from the effectiveness of MAO oversight activities. By focusing significant effort towards confirming sufficiency of the OCS, MAO oversight activities on-site may inadvertently be placing a reduced focus on assuring process outputs are effective in achieving the desired DASR hazard control outcome.

2.40.43 Since the implementation of DASR AVFM, DASA has incorporated a Regulatory Impact Statement (RIS) as a part of its business process for regulatory reforms. The purpose of a RIS is to assess the potential effects of proposed regulations and outline measures, including transition supports, to facilitate effective implementation and compliance. The RIS is endorsed by the Environmental Commander representatives before being presented to the Defence AA for approval prior to publishing regulations. Although the introduction of the RIS represents an improvement in DASA business processes, the systemic weakness in how DASA assures MAO ongoing compliance with aircraft operations regulations and standards remains.

INDIRECT FINDING[192] **DAVNOPS review Operations Compliance Statements during periodic MAO oversight activity. As a result, any significant amendments to the evidence of compliance with DASR contained in the OCS are not assessed prior to their implementation.**

INDIRECT FINDING[193] **The practice of verifying Operations Compliance Statements during periodic MAO oversight activities is inconsistent with DASA's broader regulatory approach and global aviation practices.**

INDIRECT FINDING[194] **DAVNOPS's approach to oversight allows potential gaps in compliance to go unnoticed for periods of time, particularly when organisations alter their practices or do not respond to regulatory changes. It also potentially detracts from the effectiveness of MAO oversight activities.**

2.40.44 **Defence aviation safety risk management.** DFSB conducts research to support the systemic safety issues across Defence Aviation, including an Annual Review of Aviation Safety Statistics. The review summarises three key sources of safety intelligence: outcomes of independent investigations conducted by DFSB; Aviation Safety Reports; and the Snapshot survey. Of note, the 2022-23 and 2021-22 reports identified insufficient application and knowledge of risk management practices as areas of safety risk and emphasised the importance of effective risk management and hazard identification processes.

2.40.45 A limited review of Defence Aviation Core and Mission Risk Profiles across MAOs highlighted inconsistent understanding and approach to identifying and managing aviation hazards, top events, preventative and recovery risk controls, consequences and outcomes, and risk levels. Risk management artefacts also vary in traceability to OIP that documents the organisation's risk controls. Risk management artefacts are critical to the ability of the HTA's organisation during investigations to identify which controls failed or were not present, and or whether 'top events' (such as 'Spatial Disorientation' or 'loss of spatial orientation') were accurately defined, analysed and risk- managed.

2.40.46 It is the view of the ASIT that the extant DASM policy and guidance, and the DFSB risk management training is likely not supporting organisations to implement effective risk management. As a result of these reviews, and in conjunction with a broader DASA program of work to revise and re-issue DASR SMS, DAVNOPS in collaboration with DFSB has undertaken to deliver a contemporary, benchmarked suite of risk management policy, guidance and training to better support the Defence Aviation community.

INDIRECT FINDING[195] DASA's extant regulatory assurance framework for Defence Aviation safety risk management is not contemporary or in alignment with global aviation standards and recommended practices, which sets the preconditions for lack of standardisation and application of aviation safety risk management by regulated organisations.

INVESTIGATION POWER AND PROTECTIONS

2.41.1 Joint Directive 21/2021 Defence Aviation Safety Framework (DASF) requires the Defence AA to establish an independent investigative capability. DASA is responsible for implementing a DASP that promotes a generative safety culture and assures the effective management of aviation safety risks.

2.41.2 A core objective of the DASP is the investigation of accidents and incidents in order to prevent recurrence and improve safety performance, in line with contemporary aviation safety conventions and ICAO standards and recommended practices. DFSB is established to independently investigate all Defence aviation accidents, select incidents of serious and or complex nature, and select systemic safety issues, in order to make recommendations for safety improvement and prevent recurrence of similar events.

2.41.3 A core principle of the promotion of a 'culture of safety' requires that incidents and occurrences are promptly reported, and facilitated by the establishment of a 'non-punitive environment'. Furthermore, appropriate measures are required to provide for the protection of such information and of those who report it.

2.41.4 In both civilian and military aviation accident investigations, obtaining information from individuals and organisations is fundamental to determining contributory and causal factors, and in order to prevent reoccurrence of similar events. However, individuals are naturally reluctant to disclose information to investigators openly if they believe that it may be disclosed and/or used punitively against them or their colleagues.

2.41.5 During the investigation, the ASIT perceived a general reluctance by individuals to openly share views and opinions and that the objectivity of organisations was influenced as a direct result of a lack of protections of disclosed information from parallel inquiries, which were likely to make punitive recommendations based upon inaction and/or non-compliance.

2.41.6 DFSB investigations are aligned with those conducted by the Australian Transport Safety Bureau (ASTB). However, unlike the ATSB, Defence has no legislative protection against the disclosure or use of information derived from DFSB aviation safety investigations for use in courts, tribunals, inquests, inquiries or other official decision-making processes.

2.41.7 ATSB investigations are conducted under the provisions of the *Tra*nsport Safety Investigation Act (TSI Act), which includes confidentiality provisions that apply to some categories of sensitive safety information. These categories include on-board recording information (which includes cockpit voice recorders) and restricted information (which includes statements obtained from a person in the course of an investigation).

2.41.8 To address DFSB's lack of legislative powers and protections, the ASIT explicitly informed individuals prior to their participation in interviews that information they shared could be subject to legal disclosure. While this approach ensured informed consent, it potentially discouraged the open flow of information.

2.41.9 Despite broad acknowledgement and a longstanding in-principle Ministerial agreement to address the lack of an adequate statutory framework for Defence Aviation accident investigations, the issue remains unresolved. This investigation underscores the importance of prioritising legislative reforms to both strengthen Defence Aviation safety and to ensure consistency in the powers and protections of Australian civil and military aviation safety investigations. Therefore, the ASIT draws attention to the need for Defence to strengthen protocols for DFSB's powers to investigate and protect safety information in order to promote a non-punitive environment and generative aviation safety culture.

OBSERVATION[196]	Defence Aviation safety investigations conducted by DFSB lack statutory powers and protections equivalent to their civilian counterparts in the Australian Transport Safety Bureau (ATSB), resulting in an ongoing risk to the effectiveness of the Defence Aviation safety investigative capability and confidence in the Defence Aviation safety system.

RECOMMENDATIONS

3.1.1 The primary aim of an aviation safety investigation is to identify and mitigate system deficiencies. Accordingly, the following recommendations for safety improvement focus on implementing or improving controls to eliminate or minimise the safety hazard or risk in order to prevent recurrence. As is often the case in complex investigations, the investigation also revealed safety issues that were not directly related to the causes and/or contributing factors of the accident but which nevertheless were identified as issues requiring recommendations for safety improvement. All recommendations are based on the best judgement of the ASIT, derived from the outcomes of the investigation and directly linked to the report's findings.

3.1.2 The ASIT developed safety recommendations aimed at mitigating the identified risk, while allowing the responsible organisations the flexibility to determine the most appropriate means of implementation. This approach recognises that the recommendation addressees are best positioned to identify and implement appropriate measures within their context. As a part of this process, the ASIT will remain engaged in assessing the extent to which planned safety actions address the identified safety issues, ensuring that meaningful and effective improvements are achieved.

3.1.3 The recommendations are grouped according to safety themes and/or specific safety issues spanning the elements of the DASP (external organisational influences), conditions within or affecting Army Aviation, and the Military Air Operator's SMS (internal organisational influences) and AVNCOMD risk controls.

Independent reviews of aviation safety	
1	**Defence Aviation Authority** to review the framework by which independent reviews of aviation safety report strategic organisational hazards in order to optimise identification and assessment of the effectiveness of critical risk controls, and articulation of required treatment plans and senior management attention to mitigate inherent and residual risks.

Issuance and retention of DASA organisational authorisations	
2	**Director General Defence Aviation Safety Authority (DG DASA)** to review policy for the issuance and retention of organisational authorisations by the Directorate of Aviation Operations (DAVNOPS) in order to improve efficacy of assessments of initial and ongoing compliance with Defence Aviation Safety Regulations (DASR) pertaining to Flight Operations and Cross-Regulatory Requirements.

Aviation Safety Management Systems and risk management	
3	**DG DASA** to review DASA's application of independent safety assurance for DASR Safety Management Systems (DASR SMS) in order to improve efficacy of interpretation and application by regulated entities of the requirements of Acceptable Means of Compliance (AMC) and Guidance Material (GM) for Hazard Identification and Safety Risk Assessment and Mitigation.
4	**DG DASA** to review DASA's application of independent safety assurance of action items developed by Aviation Commands arising from independent aviation safety investigations conducted by DFSB in order to ensure efficacy and timeliness of closure requirements for recommendations for safety improvement.
5	**Army Aviation MAO-AM** to review AVNCOMD's framework and methodology of Deliberate Risk Management (DRM) in order to improve efficacy of Hazard Identification and Safety Risk Assessment and Mitigation for Flight Operations and Cross-Regulatory Requirements, in alignment with requirements specified in DASR SMS and recommended in the Defence Aviation Safety Manual (DASM).
6	**Army Aviation MAO-AM** to consider use of 'Bow Tie' barrier risk models and nomenclature to assist hazard identification and management of risk in order to improve efficacy of DRM for Flight Operations and Cross-Regulatory Requirements.
7	**Army Aviation MAO-AM** to review policy for the roles, responsibilities and accountabilities of the Hazard Tracking Authority (HTA) in order to improve efficacy of DRM, Aviation Safety Committee Meetings, Aviation Hazard Review Boards and closure requirements for aviation safety investigations within Army Aviation's Safety Management System (SMS), in alignment with recommended practices described in the DASM.
8	**Army Aviation MAO-AM** to review the appointment, training and competency of key safety personnel in order to ensure that the implementation and maintenance of AVNCOMD's SMS is commensurate with the size of the organisation and complexity of aviation products and services.
9	**Army Aviation MAO-AM** to review AVNCOMD's SMS framework for, and application of, safety performance monitoring and measurement in order to ensure the integrity and effectiveness of SMS processes and activities.
10	**Commander 16th Aviation Brigade (COMD 16 AVN BDE)** to review policy for standardisation of Battle-Worthiness Board processes and procedures in order to improve DRM for Hazard Identification and Safety Risk Assessment and Mitigation for unique Configurations, Roles and Environments (CRE) related to activities, exercises and operational deployments.

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Quality Management System	
11	**DG DASA** to review DASA's application of independent safety assurance for DASR Authority Requirements for Air Operations (ARO).100(c)9 – Quality Management Systems (QMS) in order to improve efficacy of interpretation and application by regulated entities of the requirements of AMC and GM to implement controls to ensure Flight Operations are conducted as an approved organisation and managed to ensure aviation safety.
12	**Army Aviation MAO-AM** to review policy for the implementation and integration of QMS within AVNCOMD's SMS in order to improve consistency, continuity and compliance of safe operations through quality planning, quality assurance, quality control and quality improvement, in alignment with requirements specified in DASR ARO.100(c)9 – QMS

Non-Technical Skills	
13	**DG DASA** to review the implementation plan for and the application of independent safety assurance of DASR Non-Technical Skills (DASR NTS) in order to improve efficacy of interpretation and application by regulated entities of the requirements of AMC and GM to address NTS-related safety risks in the operating environment.
14	**Director DFSB** to review the development and provision of policy, guidance material, and education and training to support implementation for DASR NTS and DASA' s application of independent safety assurance that the regulated community will meet, and will continue to meet, requirements and constraints for DASR NTS training and assessment.
15	**Manager Joint Training (MJT)** for Australian Defence Force (ADF) Flying Training, **Commander Air Force Training Group (CDR AFTG),** to review the governance, accountabilities and framework of the ADF Flying Training Advisory Group (FTAG) in order to improve efficacy of aircrew NTS education and training, and assessment of NTS competency, as part of ADF Flying Training as defined in the Article of Appointment and Memorandum of Agreement.
16	**Army Aviation MAO-AM** to review policy for standardisation of NTS skills-based training and assessment across the 16th Aviation Brigade and subordinate Regiments in order to improve aircrew performance skills that promote reliable and effective task performance, in alignment with requirements specified in DASR NTS.

Aviation fatigue management	
17	**DG DASA** to review DASA's application of independent safety assurance of DASR Aviation Fatigue Management (AVFM) in order to improve efficacy of interpretation and application by regulated entities of the requirements of AMC and GM to minimise fatigue-related human factors errors.
18	**DASA DAVNOPS** to review DASR AVFM clauses and sub-clauses in order to improve requirements specified within AMC and GM to identify the means to meet requirements of DASR AVFM and to provide certainty as to how regulated entities may achieve the required safety outcomes.
19	**Director DFSB** to review the development and provision of aviation fatigue management policy, guidance material, and education and training in order to support DASA's application of independent safety assurance that the regulated community has met, and continues to meet, the requirements and constraints of DASR AVFM.
20	**Director DFSB** and **Commanding Officer of the Institute of Aviation Medicine (CO IAM)** to review integration and coherency of aviation fatigue management policy, guidance material, education and training in order to improve barriers and controls of risks to operations due to fatigue aspects.
21	**Army Aviation MAO-AM** to review policy for standardisation of aviation fatigue management across the 16th Aviation Brigade and subordinate Regiments in order to improve mitigation of risks to operations due to aircrew fatigue aspects, in accordance with requirements specified in DASR AVFM.

Aeromedical factors and Spatial Disorientation	
22	**DG DASA** to analyse whether the scope and applicability of the DASR Parts adequately specify requirements to mitigate aviation hazards related to aeromedical factors and Spatial Disorientation.
23	**CO IAM** to review IAM Initial and Refresher Aviation Medicine (AVMED) training continuums in order to ensure alignment with Air Force Interoperability Council (AFIC) standards and recommended practices for aeromedical factors and Spatial Disorientation training.
24	**CO IAM** to review the IAM Initial AVMED education and training syllabus provided to ab initio rotary-wing aircrew in order to improve knowledge and application of rotary-wing specific aeromedical factors and human performance limitations.
25	**CO IAM** to review requirements for IAM to assure the quality and efficacy of additional AVMED-related training conducted by Aviation Commands in order to improve standardisation of education and training and enhance aircrew knowledge of aeromedical factors and human performance limitations.

Aeromedical factors and Spatial Disorientation (cont.)	
26	**CO IAM** to review IAM reference material related to aeromedical factors and Spatial Disorientation for rotary-wing and fixed-wing operations in order to enhance aircrew knowledge to anticipate, avoid, recognise and recover from Spatial Disorientation events.
27	**Deputy Commander Fleet Air Arm (DCOMFAA),** in consultation with Royal Australian Navy - Training Authority Aviation (RAN TA-AVN), review scheduling of IAM-approved ab initio AVMED rotary-wing specific training.
28	**Army Aviation MAO-AM** to coordinate with, and seek approval, under the authority of CO IAM, for the provision of additional Army Aviation AVMED-related training in order to improve aircrew knowledge of aeromedical factors and preparedness for recognising and managing Spatial Disorientation, and to enhance aircrew performance during rotary-wing operations, in alignment with DASR Medical (MED).05 – AVMED Training.
29	**Army Aviation MAO-AM** to revise Standardisation Manuals to include reference material for aeromedical factors as authorised by CO IAM, vice reference material from the Professional ADF Aviators' Reference Manual (PAARM), in order to ensure that dual checks and category assessments reference contemporary Defence Aviation content and topics related to aeromedical factors.

Flying Supervision and Flight Authorisation	
30	**Army Aviation MAO-AM** to review policy for standardisation of, and distinction between, Flying Supervision and Flight Authorisation requirements in order to improve the independent control of Flight Planning and Mission execution, in alignment with requirements specified in DASR Organisational Requirements for Air Operations (ORO).30 – Flight Authorisation.
31	**Army Aviation MAO-AM** to review policy and practices related to Flight Authorisation and Flying Supervision, in particular, the use of self-authorisation (including restrictions and limitations) to ensure independent oversight of Flight Planning and execution, in alignment with requirements specified in DASR Organisational Requirements for Air Operations (ORO).30 – Flight Authorisation.
32	**Army Aviation MAO-AM** to review standardisation of Mission Planning and Briefing Packs, and Flight Authorisation Aide Memoirs, in order to improve the efficacy of hazard identification and risk controls to mitigate effects of environmental conditions that are conducive to Spatial Disorientation.

Low flying minimum heights, specialised equipment and altitude warning settings	
33	**Army Aviation MAO-AM** to review policy for standardisation of determining suitable minimum heights for operations over open water by night in order to ensure the safe management of low flying activities, in alignment with requirements specified in DASR SPA.05 – Flying Rules for Special Missions and Tasks, DASR SPA.20 – Low Flying and DASR SPA.55 - NVIS.
34	**Army Aviation MAO-AM** to review policy for standardisation of procedures for the use of specialised equipment and settings for altitude and decision height warning systems in order to ensure the safe management of low flying activities, in alignment with requirements specified in DASR SPA.20 – Low Flying and DASR SPA.55 - NVIS.

Night Vision Imaging Systems	
35	**DASA DAVNOPS** to review DASR Night Vision Imaging System (NVIS) clauses and sub-clauses in order to improve requirements specified within AMC and GM to identify the means to meet requirements of DASR NVIS and to provide greater certainty as to how regulated entities may achieve required safety outcomes.
36	**Army Aviation MAO-AM** to review policy for standardisation of NVIS formation procedures and limitations, inclusive of operations below ASH, LSALT or MSA and low flying, in order to ensure Aviation Safety when Night Vision Devices (NVD) are used as the primary means of vision, in alignment with requirements specified in DASR SPA.55 - NVIS.
37	**Army Aviation MAO-AM** to review policy for standardisation of procedures to assess that NVIS equipment is serviceable and correctly set up for use prior to flight, with or without a pre-flight checking facility, in alignment with requirements specified in DASR SPA.55 – NVIS.
38	**Army Aviation MAO-A**M to review policy for standardisation of procedures to conduct NVD performance checks and calibration pre-flight, or at intervals recommended by the Original Equipment Manufacturer (OEM) and as approved by the MAO, in alignment with requirements specified in DASR SPA.55 – NVIS.

Formation flying procedures and techniques	
39	**Army Aviation MAO-AM** to review policy for standardisation of procedures, based upon a risk management assessment, that address rules and requirements related to formation flying, in alignment with requirements specified in DASR SPA.05 – Flying Rules for Special Missions and Tasks.
40	**Army Aviation MAO-AM** and **DCOMFAA** to review coherency and standardisation of policy, procedures, techniques, scans, work-cycles and use of automated flight controls systems for the training and conduct of formation flying across ab initio and type-specific operational conversion courses in order to establish and maintain prerequisite qualifications and competencies for rotary-wing formation in flight regimes using NVIS and/or in Degraded Visual Environments (DVE).

Formation flying procedures and techniques (cont.)	
41	**Army Aviation MAO-AM** to review policy for the standardisation of procedures, flying techniques and crew coordination in flight regimes and operating conditions where aircrewmen are restricted or limited to contribute to the crew's Situation Awareness for maintenance of position, aircraft separation and/or collision avoidance responsibilities during formation flight.
42	**COMDT AAvnTC** to conduct a Training Needs Analysis (TNA) for the aggregated mission profiles of Low Level, Formation, Flight Over Water using NVIS and/or in DVE in order to develop Learning Management Plans (LMP) for type-specific and multi-aircraft type missions, in alignment with requirements specified in DASR SPA.20 Low Flying and DASR SPA.55 NVIS.

Pilot Monitoring vs Non-Flying Pilot	
43	**DG DASA** to analyse whether the scope and applicability of the DASR Parts adequately specify requirements to mitigate aviation hazards related to roles, responsibilities and intervention protocols for aircrew in multi-crew flight operations.
44	**Army Aviation MAO-AM** to review guidance within Standardisation Manuals for delineation of roles and responsibilities between the Flying Pilot and Non-Flying Pilot in order to improve clarity of 'pilot in control' and 'pilot monitoring' requirements and intervention protocols.

Aeronautical Life Support Equipment	
45	**Army Aviation MAO-AM** to review policy for standardisation of procedures for the management of Aeronautical Life Support Equipment (ASLE) and Continuous Charge of ALSE in order to improve aircrew training and competence, in alignment with requirements specified in DASR ORO.40 - ALSE.

Coalition and joint exercise Search and Rescue communications	
46	**Headquarters Joint Operations Command, Air and Space Operations Centre, Joint Personnel Recovery** to standardise guidance for communication plans for coalition and joint exercise participants to respond to and coordinate Search and Rescue operations.

SAFETY ACTIONS ALREADY UNDERTAKEN

4.1.1 The ASIT acknowledges that AVNCOMD implemented a significant number of safety initiatives and continuous improvement activities throughout the course of the investigation. In particular, AVNCOMD's review and analysis of preliminary reports and briefings provided by the ASIT at each of phase of the investigation resulted in improved risk controls and revised OIP for the conduct of night, formation, overwater operations and aviation fatigue management. The ASIT has not assessed whether AVNCOMD's safety actions undertaken address the recommendations made within the ASIR; however, the ASIT notes that AVNCOMD has developed and implemented a large number of actions and activities to improve aviation safety.

4.1.2 In direct response to the accident, COMD AVNCOMD issued and subsequently updated MAO-AM Directives, which detailed recommendations and associated action items to address immediate safety concerns that were likely to be causal or contributory.

4.1.3 Additionally, despite significant demands on the Army Aviation enterprise, including two MRH-90 accidents, AVNCOMD developed an overarching Army Aviation Safety Campaign Plan to support the implementation of the Battlefield Aviation Program (BAP) Integrated Program Plan (IPP), proactively addressing known and anticipated system risks to improve safety.

4.1.4 COMD AVNCOMD notified the ASIT of the following safety actions undertaken by AVNCOMD:

a. In September 2023, COMD AVNCOMD issued ARMY MAO DIRECTIVE 05/23: Implementation of Actions Following the Crash Into Water Near Lindeman Island of MRH90 Taipan A40-040 on 28 Jul 23 (Reference FFFFFF). The directive reflected the implementation of enhanced controls to improve human factors-related training and procedures for flight using Night Vision Imaging Systems (NVIS):

(1) Recommendation #1: Establish a set of enhanced controls across the Army MAO for flight under NVIS, in formation and over water IOT manage risk SFARP until the contributing factors into the accident at Ref A are understood and appropriate controls developed.

(2) Recommendation #2: Provide assurance that extant controls, as expressed in SI(AVN)OPS, SFIs, applicable Aircraft Flight and Standardisation Manuals, and subordinate OIP, are being complied with.

(3) Recommendation #3: Review Army MAO recovery controls for an aircraft crew that loses visual reference with the aircraft they are forming on.

(4) Recommendation #4: Review Army MAO recovery controls for Unusual Attitude and Spatial Disorientation during NVIS flight.during NVIS flight.

b. In October 2023, COMD AVNCOMD issued AL1 to ARMY MAO DIRECTIVE 05/23 (Reference FFFFFF) which added a fifth recommendation related to Core Risk Profiles.

(1) (Recommendation #5: Initiate a review of AVNCOMD's Core Risk Profiles related to 'Night/Low Illumination Formation Procedures' and 'Night Flight Over Water' to assess both the scope and currency of documented 'preventative' and 'recovery' risk controls for hazards such as 'loss of visual reference within the formation', 'loss of visual reference with terrain' and 'Unusual Attitudes'.

(2) A sixth action item, not specifically linked to a recommendation, was also raised to implement an independent review of Army Aviation list and support to special forces.

(3) Action Item #6: Develop terms of reference to implement an independent review of Army Aviation lift and support to special forces. The review must consider current practices by the US, UK and Canadian forces, paying particular attention to resources, training, experience of personnel and capability requirements. The review must identify where Army Aviation could improve existing methods to align with best practice as observed in US, UK and Canadian forces, particularly as it relates to night flying policy and procedures.

c. In November 2023, AVNCOMD issued SFI 07/23 – Application of Enhanced NVIS Flight Restrictions

(Reference GGGGGG), which introduced enhanced NVIS controls, as an interim measure, until AVNCOMD completed a full review of existing HQ AVN COMD orders, AAvnTC Learning Management Plans (LMPs) and Standardisation Manuals against the requirements of DASR SPA.55 NVIS.

d. AVNCOMD replaced SFI 07/23 with SFI 09/23 SPA.55 NVIS Policy Alignment (Reference HHHHHH) to ensure alignment and compliance with key regulatory requirements for:
   (1) NVIS equipment approvals
   (2) NVIS illumination levels
   (3) NVIS environmental minima
   (4) Training, qualification and currency for low illumination operations
   (5) Aviation risk management
   (6) Aviation fatigue management

e. In parallel to issuing SF1 09/23, AVNCOMD completed the following complementary safety improvement activities:
   (1) aggregated Core Risk Profiles for NVIS/DVE, FOW, Formation and Terrain Flight
   (2) provision of additional guidance for the conduct and training of 'blind' procedures
   (3) provision of additional education, training and procedures for Unusual Attitude recoveries and recognition of Spatial Disorientation
   (4) Standards Section completed compliance visits of 16th Aviation Brigade and subordinate regiments.

f. In June 2024, COMD AVNCOMD issued AL2 to ARMY MAO-AM DIRECTIVE 5/2023 (Reference FFFFFF), which added a seventh recommendation related to management of ALSE, and reported that all previous recommendations and action items were complete.
   (1) Recommendation #7: The Military Air Operator – Accountable Manager initiates a review of AVNCOMD policies and procedures for Continuous Charge of ALSE, with particular focus on:
      - Aircrew training and assessment to conduct B/F and A/F servicing of ASLE whilst under Continuous Charge.
      - Requirements for aircrew to document B/F and A/F servicing of ALSE whilst under Continuous Charge.
      - The duration of Continuous Charge for home-based operations whilst ALSE technical support is available.
      - The duration of Continuous Charge for deployed operations.

g. In May 2024, COMD AVNCOMD directed the establishment of a 'Safety Campaign Plan' in response to a wide range of demands on the Army Aviation enterprise with direct links to safe operational outcomes, such as:
   (1) force modernisation
   (2) major fleet upgrades
   (3) force disposition changes
   (4) continuous management demands
   (5) retirement of underperforming legacy systems
   (6) implementation and retirement of interim capability solutions to offset transition risks
   (7) the loss of two aircraft and four fatalities.

h. In August 2024, COMD AVNCOMD issued ARMY MAO-AM DIRECTIVE 05/2024: Implementation of the Australian Army Aviation Safety Campaign Plan (Reference IIIIII). AL1 to the directive was issued shortly thereafter. The stated aim of the Safety Campaign Plan is to provide additional support to the Army MAO-AM and HQ AVNCOMD by assisting in the prioritisation, aggregation and treatment of risks and issues as they relate to the Commanders Safety Priority List (CSPL). A key objective of the

Safety Campaign is to provide an additional assurance layer that underpins existing HQ AVNCOMD functions; particularly those associated with the Safety Management System (SMS). Central to the plan is strategic mapping of key tasks that require completion and monitoring in order to implement the Battlefield Aviation Program Integrated Program Plan (BAP IPP) while reducing overall system risk.

i. The plan identified approximately 30 tasks that directly correlate to multiple findings in this Aviation Safety Investigation Report (ASIR), while also treating previously identified issues related to SMS, PEX, aviation fatigue management, NVIS and AVMED.

j. On 11 Feb 25, COMD AVNCOMD provided the ASIT with AVNCOMD response –Draft Aviation Safety Investigation Report 6th Aviation Regiment Australian Aerospace MRH-90 Taipan A40-040, Spatial Disorientation Leading to Controlled Flight Into Terrain, Whitsunday Islands, 28 July 2023 (Reference JJJJJJ). Feedback focused primarily on providing additional context to AVNCOMD's challenges for the efficacy and safety of MRH-90 operations, significant feedback on organisational influences and safety risk management, and a comprehensive summary of 'Safety Actions Already Undertaken'. In particular, COMD AVNCOMD reiterated that the two key Army MAO-AM Directives, 05/23 and 05/24, directed relevant incident response and organisational actions. COMD AVNCOMD's response also highlighted a significant number of revisions to OIP and implementation of additional and or heightened risk controls related to findings made within the ASIR.

k. **Decision Height (DH) settings.** SFI 09/23 (Reference HHHHHH) revised wording for DH settings for flight over water. The SFI more specifically mandates: 'Crew low height warning systems (DH/RADALT LOW) must be used where fitted to warn crew of approaching terrain/water and must be set no lower than 10 percent below the minimum authorised height for transit IAW Standardisation Manual procedures.'

l. **Use of Automated Flight Control Systems (AFCS) over water.** SFI 09/23 *SPA.55 NVIS Compliance AL1* (Reference HHHHHH) updated policy on the use of aircraft AFCS modes over water.

m. **Enhanced NVIS risk controls.** In August 2023, AVNCOMD assessed compliance with DASR SPA.55 NVIS, which identified that Army Aviation was compliant with seven, partially compliant with two, but not compliant with two of the 11 NVIS regulatory requirements. Non-compliances related to requirements for an NVIS CRP and definition of 'low illumination' level. An Army Aviation NVIS/DVE CRP was created and documented in AVIART. Enhanced NVIS risk controls were published in SFI 07/23 – Enhanced NVIS Controls (Reference GGGGGG), which included additional requirements for flight in illumination levels above and below 2mlx, and included restrictions on NVIS formation over water. SFI 09/23 (Reference HHHHHH) expanded on, and replaced, SFI 07/23 with full SPA.55 NVIS compliance.

n. **Aviation fatigue management.** SFI 12/2023 (Reference KKKKKK) was published on 15 Dec 23, and was subsequently cancelled when SI(AVN) OPS 2-122 Aviation Fatigue Management (Reference LLLLLL) was released in August 2024. SI(AVN) OPS 2-122 consolidated a large number of aviation fatigue management related policy and instructions as part of a broader modernisation project for AVNCOMD's Standing Instructions.

o. **Aviation Medicine education and training.** AVNCOMD reset Aviation Medicine (AVMED) currencies for all pilots by ensuring completion of AVMED refresher courses at the IAM in order to eliminate governance issues related to LMPs and provision of refresher training by the Army Aviation SAVMO.

p. **Quality Management System.** AVNCOMD completed a modernisation project for Standing Instructions, in particular SI(AVN) Operations, in order to improve alignment and compliance with DASR. AVNCOMD is implementing an integrated Quality and Safety Management System (iQSMS), which spans operations, airworthiness and aviation safety across the layers of command and control.

q. **Aviation Safety Management Systems.** SI(AVN)OPS 3-101 – The Army MAO Aviation Safety Management System (Reference MMMMMM) was revised in Edition 6 of SI(AVN) OPS in order to improve alignment and compliance with DASR SMS. HTA roles and responsibilities were transitioned from DCOMD AVNCOMD to COMD 16 AVN BDE. Aviation Hazard Review Board (AHRB) processes were formalised within SI(AVN) OPS 3-101. AVNCOMD has significantly improved the rate of closure of actions and recommendation arising from the investigation of aviation safety events and issues. COMD AVNCOMD advised Career Management – Army of background and experience requirements for postings of key safety, standards and airworthiness roles across AVNCOMD.

r. **Aviation risk management.** Improvements to the functionality and use of AVIART, specifically the clarification of hazard review terminology and processes, are an ongoing continuous improvement activity.

s. **Flying training.** SI AVN OPS 1-501 Training and Assessment (Reference NNNNNN) revised unit pilot and aircrewman formation UTAP requirements and formation proficiency. SFI 7/23 imposed additional formation proficiency requirements for overwater, low level and low illumination operations. PEX was upgraded to provide fidelity to authorising officers for formation proficiency and recency. The Aviation Pilot - Deck Landing Qualification (DLQ) LMP (Reference OOOOOO) was updated to Version 7.0 in December 2023 to reflect contemporary post-graduation training and qualification requirements.

t. **Spatial Disorientation education and training.** COMDT AAvnTC is developing a Spatial Disorientation (SD) training package, which will include updated theory, procedures and training for Army aircrew.

u. **Non-Technical Skills education and training.** AAvnTC has developed a 'Maintenance of Spatial Orientation (MSO) training package, which includes intervention training. MAO Directive 5/23 directed action (through SFI 7/23) to review and update 'blind' drill execution and associated LMPs. SFI 9/23, which superseded SFI 7/23, included updates to SPA.55 NVIS policy and mandated additional controls for NVIS, overwater, low level formation.

CONCLUSION

5.1.1 The aviation safety investigation of MRH-90 Taipan A40-040, call-sign BSMN 83, which impacted water near Lindeman Island, QLD on the night of 28 Jul 23 during Ex TS23, followed a structured process to determine the accident sequence of events. The investigation also analysed contributory factors spanning individual/crew actions, local conditions, risk controls and organisational influences in order to make recommendations for safety improvement and prevent recurrence of similar events.

5.2 The accident and primary cause

5.2.1 At approximately 2214K on 28 Jul 23, BSMN 83 departed Proserpine Airport as the third aircraft in a formation of four MRH-90 Taipan helicopters. The four BSMN aircraft were flying in a heavy left formation using NVDs in preparation for an extraction of a GFE on Lindeman Island. As per the Flight Authorisation brief, cabin doors on all formation aircraft were closed on departure at Proserpine. The ACMN were to open cabin doors as the formation progressed from the holding pattern through the IP in preparation for the approach into the LZ.

5.2.2 The CP of BSMN 83 occupied the left-hand cockpit seat and flew the aircraft from departure and for the majority of the transit, which required the CP to fly cross-cockpit in the heavy left formation. At 2233:34K, the AC, who was the NFP in the right-hand cockpit seat, took control of the aircraft from the CP as the formation passed through a rain shower, and commenced a descent into the holding pattern near the IP. The investigation found that the AC's decision to take control of the aircraft was likely in response to recognising that the CP was facing challenges to maintain formation in the varying weather and illumination conditions. It is likely that the AC intended to mentor the CP and reposition the aircraft into the correct formation position prior to handing control of the aircraft back to the CP. However, the AC retained control of the aircraft due to the challenging flying conditions.

5.2.3 At 2234:13K, the formation entered the holding pattern in the vicinity of the IP, while awaiting direction from the GFE to commence the extraction from the LZ. Although a right-hand holding pattern was briefed in Mission Orders, BSMN 81 announced and entered a left-hand holding pattern in order to avoid rain showers between and to the north of the IP and LZ.

5.2.4 The investigation found that visibility ahead of BSMN 83's flightpath in the holding pattern was variable and likely degraded. During the second turn in the holding pattern, and very likely without a discernible horizon, BSMN 83 started to climb above the datum altitude of the formation (approximately 200 ft above the water). Within a period of 14 seconds, BSMN 83 climbed from 224 ft to a maximum height of 362 ft. Of note, the AC's (FP) flying technique to adjust and maintain formation position on BSMN 82 involves the frequent overriding (dis-engagement and re-engagement) of the aircraft's AFCS RHT hold function. The investigation found that it was virtually certain the RHT hold was overridden allowing the aircraft to climb.

5.2.5 During the climb, BSMN 83's formation position also moved progressively towards a trail position on BSMN 82, which likely reduced the AC's (FP) ability to scan to BSMN 81 to assess their formation position. With the cabin doors closed, the ACMN of BSMN 83 had restricted visibility to other formation aircraft, which limited their ability to contribute effectively to the pilot's Situation Awareness. Through analysis of flight data modelling, and crew commentary, the investigation found that the actual distance of BSMN 83 to BSMN 82 was significantly further than the AC's (FP) visual assessment.. Misperception of distance to BSMN 82, combined with varying contrast and illumination conditions, and the limitations associated with using NVDs as the primary visual reference, more than likely degraded the AC's (FP) ability to differentiate individual reference features and cues to maintain formation position.

5.2.6 Analysis of cockpit voice recordings revealed that there were no internal or external crew communications for the period of the climb. There was no evidence of any other mission related issue, secondary task or distracting stimulus that may have diverted the attention of BSMN 83's pilots from maintaining the aircraft's position within the formation. In the absence of other reasonable scenarios, the investigation concluded that the inadvertent and unrecognised climb of BSMN 83 was attributable to both the AC (FP) and CP (NFP) experiencing a loss of Spatial Orientation – commonly referred to as Type I (Unrecognised) SD. Therefore, the progressive change in the aircraft's pitch attitude from 5.8 degrees nose-up to 4.7 degrees nose-down as the aircraft climbed, and the increase in airspeed from 77 KIAS to 109 KIAS, were more than likely not recognised by both pilots.

5.2.7 At 2236:13K, the CP (NFP) stated, 'Have you still got [em],' and the AC (FP) calmly responded, 'Yeah, still got [em] mate.' It is extremely likely that the CP's (NFP) question coincided with their loss of visual sight of BSMN 82. Through modelling of cockpit FOVs, the investigation found that the AC (FP) almost certainly lost visual sight of BSMN 82 immediately after responding to the CP (NFP), as BSMN 82 disappeared under the nose of BSMN 83.

5.2.8 At 2236:15K, the AC (FP) rolled the aircraft quickly to the right to 31 degrees AoB before rolling back quickly to 8 degrees left AoB. The investigation found the rolling manoeuvres were likely an attempt to regain visual sight of BSMN 82.

5.2.9 At 2236:19K, without recognising that the aircraft's pitch attitude was lowering and the airspeed was increasing, the AC (FP) applied a large forward longitudinal cyclic input at, or near, the forward stop of the cyclic's range of movement. It is likely that the AC (FP) perceived that the aircraft had not yet transitioned from a pitch-up attitude to pitch-down attitude. However, the rapid and continual application of forward cyclic pitched the aircraft's nose further down, which combined with the lack of recognition of the aircraft's increasing airspeed, resulted in a very high and unrecoverable rate of descent towards the water.

5.2.10 During the 2.5 seconds after the AC's (FP) pushover, the relative distance between BSMN 83 and BSMN 82 closed rapidly from approximately 100 metres to 50 metres, with BSMN 83 passing closely to the right of, and below BSMN 82 with right AoB. It is more than likely that the AC regained visual sight of BSMN 82 at some point after the pushover, and it is likely that the AC held cyclic input to the right to avoid a mid-air collision with BSMN 82. The AC held forward cyclic input throughout the descent, and while under control of the AC, BSMN 83 impacted the water, destroying the aircraft and fatally injuring the four crew.

5.2.11 To the extent by which the ASIT could examine the wreckage and analyse the VFDR, there was no evidence of technical failure of the aircraft or major systems. Therefore, on the basis of evidence analysed by the ASIT, the most plausible cause of the accident was Type I (Unrecognised) SD leading to CFIT.

5.2.12 As is the case with the majority of aircraft accidents, the investigation found that the accident was more than likely the result of a combination of contributing factors. These included the local conditions influencing the performance of the AC and CP of BSMN 83, limitations in some of the organisation's risk controls, organisational influences that affected the functioning of AVNCOMD's safety system, and external influences arising from Defence Aviation regulatory requirements and assurance processes. Key findings, categorised in accordance with the DSAM are shown in Figure 44. In addition, the investigation identified other factors that held the potential to increase safety risk, although there was insufficient evidence to conclude they contributed to this accident.

5.3 Local conditions

5.3.1 Local conditions are those conditions that exist in the immediate context or environment, which can have an influence on individual/team actions or technical failures. The investigation found a number of local conditions, spanning the use of aircraft systems, nature of the task, environmental conditions and human performance limitations, which in combination contributed to the accident. These are summarised below:

5.3.2 **Weather and illumination.** The investigation found that the forecast weather (cloud base and visibility) and illumination levels were within authorised limits for the mission. However, visibility degraded at times due to localised showers, which influenced BSMN 81's decision to conduct a left-hand, vice the briefed right-hand, holding pattern. As a result of the left turn in heavy left formation, it is likely that the pilots of BSMN 83 experienced an increase in workload to maintain position. As BSMN 83 exited the final left turn, it is very likely that the horizon was not discernible in the sector BSMN 83's pilots were looking, in order to maintain station. It is very likely that the rain showers and low cloud base reduced celestial illumination and the visual contrast through NVD, which impeded visual references and cues used to maintain formation on preceding aircraft.

5.3.3 **Workspace environment.** The MRH-90 cockpit is a visually restricted environment due to the windscreen pillar, the large cockpit coaming and the overhead console. The investigation found that restricted visibility towards BSMN 82 and BSMN 81 increased pilot workload, particularly when BSMN 83's CP was flying cross-cockpit in the heavy left formation position.

5.3.4 **Station keeping technique and use of RHT hold in formation flying.** The investigation found that it is common practice for ADF MRH-90 pilots to adjust and maintain position during low level, formation, flight over water using NVDs, by depressing the collective trigger switch, manoeuvring the aircraft into the correct position, and releasing trigger. This technique results in the frequent overriding of the RHT hold function of the AFCS, which increases the likelihood of introducing human error. This removes an organisational risk control designed to reduce pilot workload and prevent the aircraft descending below a pre-determined datum height when conducting low level, flight over water at night or in degraded visual environments.

5.3.5 **Instrument scan.** Night-aided formation flying requires a disciplined technique, scan and work cycle to integrate instruments and aircraft performance information, while also maintaining visual/lighting references and assessing spacing and closure. This is critical in degraded visual environments where maintaining Spatial Orientation with respect to the horizon, terrain and formation position is increasingly difficult. The investigation identified that Army Aviation OIP and flying training provided varied and non-standardised references to the integration of instrument scans within formation flying techniques and work cycles. Similarly, the ASIT found through interviews that there was variability between MRH-90 pilots in their approach and priority placed on instrument scans during night formation flying. Lack of standardisation and individual pilot flexibility with respect to night formation flying techniques, instrument scans and work cycles sets pre-conditions for varied and sub-optimal techniques and performance. The investigation found that the attentional focus of BSMN 83's AC (FP), and likely the CP (NFP), in challenging flying conditions, narrowed to prioritise maintaining formation position visually to the detriment of instrument scan.

5.3.6 **Type 1(Unrecognised) Spatial Disorientation (SD).** It is very likely that attentional narrowing of the pilots was compounded by misleading sensory inputs (visual, vestibular, and somatosensory) that did not draw their attention to the departure from formation parameters. This likely resulted in the AC (FP) and the CP (NFP) experiencing Type I (Unrecognised) SD. Gradual changes to the aircraft's pitch attitude, airspeed and altitude remained unrecognised by the pilots in BSMN 83 and created a situation in which everything felt normal, despite a worsening deviation from formation parameters as the aircraft climbed. Unaware of their loss of Spatial Orientation and SA, the AC (FP) and CP (NFP) of BSMN 83 were likely to have reduced cognitive ability to interpret and respond in a timely manner to the sudden and unexpected loss of visual sight of BSMN 82. The investigation found that once the pushover occurred, the pilots did not have sufficient time to rebuild Spatial Orientation, transition to instruments and apply appropriate UA recovery techniques to prevent the impact with water.

5.3.7 **Aviation fatigue management.** The investigation found that BSMN 83's AC and CP were likely experiencing a level of fatigue shown to impede optimal performance and increase susceptibility to Type I (Unrecognised) SD. The estimated level of fatigue of BSMN 83's AC was considered sufficient to affect their actions and decisions in the event sequence. Factors identified as contributing to fatigue included disruptive work patterns, resulting in restricted sleep and extended periods of being awake, the deployed sleep environment, and the prolonged period waiting in the aircraft prior to departure for extraction of the GFE.

5.3.8 **Non-Technical Skills (NTS).** The investigation identified a number of NTS-related issues that set pre-conditions to increase safety risk. These included:

a. BSMN 83's AC (FP) and CP (NFP) did not demonstrate awareness of the aircraft's climb and departure from the standard formation position, which likely represents a breakdown in 'Flying Pilot' and 'Pilot Monitoring/Non-Flying Pilot' responsibilities and associated crew communication and coordination.

b. Management and distribution of the collective workload of BSMN 83's crew to maintain SA was very likely suboptimal.

c. The decision and Flight Authorisation to close the formation's cabin doors likely impeded the ability of BSMN 83's ACMN to contribute effectively to the SA of the AC (FP) and the CP (NFP).

d. It was likely that after taking control of the aircraft, BSMN 83's AC directed the CP's attention away from NFP duties, which inadvertently affected the crew's overall SA.

5.3.9 **Professional standards**. It is the view of the ASIT that professional standards play an essential role in accident prevention by setting clear expectations for conduct, decision-making and accountability. Although discounted as having directly contributed to the event, the investigation revealed deviations from prescribed procedures relating to the use of the low-height warning system, engagement of the AFCS RHT hold upper-mode, execution of the hand-over/take-over procedure and the Emission Control policy.

5.4 Risk controls

5.4.1 Risk controls are the measures put in place by an organisation to facilitate and assure safe performance of the operational components of the system. The investigation identified limitations in the following risk controls:

5.4.2 **Use of RHT hold/Formation technique.** BSMN 83's AC used a common MRH-90 flying technique to depress the trim switch (thereby overriding the AFCS RHT function) to adjust and maintain the aircraft's position within the formation. The ASIT found that this technique was in alignment with standard policy, guidance and training for general formation flight, but not in alignment with more restrictive Standing Instructions for RHT to be engaged for low level, flight over water at night. The ASIT's review of OIP and risk management artefacts found that while separate formation flight regimes had detailed instruction, guidance and risk controls, they were siloed in application and management. Contradictions between OIP and taught techniques with respect to use of RHT during formation flying introduces potential to degrade a key risk control for maintenance of height during low level, formation, flight over water. The ASIT found that AVNCOMD had not adequately addressed this contradiction in OIP and training, and by not ensuring that such organisational risk controls were being applied.

5.4.3 **Cabin doors.** Although AVNCOMD policy stated that, where practicable, cabin doors should be open for formation flying, and that restricted visibility limits the ACMN's ability to provide formation clearances to the pilots when the cabin doors are closed, the crew's decision and Flight Authorisation to depart with the doors closed was permissible in accordance with OIP. The investigation found that Army Aviation did not document or standardise restrictions, additional risk control measures or changes to techniques and procedures for formation flight with the cabin doors closed.

5.4.4 **Monitoring responsibilities.** The ASIT considered the role of the NFP in Army Aviation operations and associated responsibilities. Monitoring of an aircraft's flight path and performance parameters by the NFP, and addressing deviations promptly, is a well-known and recurring challenge in aviation safety. A critical aspect of monitoring includes defining intervention protocols and steps when a NFP identifies a deviation from the aircraft's expected flight path or parameters that could affect the safe operation of the aircraft. The investigation found that, although AVNCOMD policy required the NFP to announce when a deviation was identified, it did not include a structured intervention protocol detailing if, when, or how the NFP should initiate a takeover procedure from the FP. While issues related to the adequacy and execution of NFP intervention protocols as having contributed to the accident were discounted, the investigation identified this as an opportunity for safety improvement. The investigation also highlighted potential benefits of replacing the term NFP with Pilot Monitoring (PM) in order to promote the active nature of the role, and to emphasise that both pilots contribute to the safe operation of the aircraft.

5.4.5 **Training.** The ASIT considered the training pathways for the AC and the CP, with particular focus on low level, formation, flight over water and night flying. The ASIT did not find that differences between the AC's and CP's ab initio and type-transition pilot training pathways (pre- and post-Project Air 5428 Pilot Training System) contributed to the accident. Both pilots had met the Army standards of training for the roles they were assigned as 6 Avn Regt MRH-90 pilots. The ASIT noted that implementation of Project Air 5428 has reduced opportunities for Army pilots to experience formation prior to posting to an operational squadron. Overwater operations training was initially introduced at the Helicopter Aircrew Training System, and subsequently removed until posting to an operational squadron. This likely shifts training burden from a standardised and resourced training system structured for initial training, to an operational squadron with competing priorities. The ASIT did not identify evidence indicating that Army pilots undertake dedicated training designed to address the compounding complexities associated with flight over water, at night, and in formation. The ASIT is also of the view that a lack of standardisation and flexibility of the interpretation for the use of RHT set the pre-conditions for varied application of RHT for different mission types.

5.4.6 **Aviation fatigue management.** AVNCOMD had a significant suite of policy documents to support the management of aviation fatigue-related hazards, including structured fatigue training programs and active monitoring of fatigue as a significant safety issue. Despite having a multi-layered framework, the investigation found that AVNCOMD policy relating to prescriptive limitations was only partially effective as a fatigue management risk control and was inconsistent with requirements specified in DASR AVFM. Policy relating to rostering practices was also found to be suboptimal. This contributed to an environment where fatigue-related risks were not mitigated effectively, nor were they standardised and applied across the flying regiments. While all BSMN formation aircrew received and were current in aviation fatigue management training, the investigation identified some inconsistencies and gaps in education and training delivered by DFSB and IAM.

5.4.7 **Non-Technical Skills (NTS).** The investigation found that 6 Avn Regt's policy framework supporting NTS skills-based training and assessment was comparatively under-developed to those implemented in other AVNCOMD flying Regiments. NTS skills-based training moves beyond classroom and involves exposing aircrew to training scenarios that provide the opportunity to practise NTS skills in complex operating environments, in addition to enabling assessment and feedback on NTS performance. The investigation identified that implementation of enhanced NTS regulatory requirements via DASR NTS, in addition to addressing variability in NTS skills-based training and assessment within AVNCOMD, to be areas of priority to improve safety outcomes. The investigation also identified that DFSB was not a member of the ADF FTAG. Inclusion of aviation NTS training within the scope of the FTAF will enhance the monitoring of its effectiveness.

5.4.8 **Aeromedical training.** The investigation found that the context of initial AVMED training is fixed-wing centric, with limited focus on rotary-wing specific CRE. Additionally, a review of Army aircrew AVMED refresher training delivered by the Army SAVMO found that some elements of Learning Outcomes for Aeromedical Factors and Human Performance Limitations, as prescribed by IAM, were not included. Of note, the documented training undertaken by BSMN 83's CP did not address physiological orientation and the risk of SD. The ASIT also found that IAM did not audit or independently review the delivery of Army Aviation AVMED refresher training, and therefore did not have an appropriate governance framework to identify or remediate inconsistencies or deficiencies in externally delivered AVMED Refresher training.

5.4.9 **Flying Supervision and Flight Authorisation**. Flying Supervision and Flight Authorisation for 6 Avn Regt's deployment to Ex TS23 required consideration of a range of factors, including the unique CRE of the deployed location, living and sleeping conditions, training considerations, crewing and risk management plans specific to planned mission types. The ASIT found a number of sub-optimal Flying Supervision controls, including a lack of defined policy in OIP as to the distinction between the role and responsibilities of Flying Supervisors and Flight Authorisation Officers. Flying Supervisors made appropriate decisions to allocate qualified and current crews for the BSMN formation. However, departure of one of the Troop Commanders on the day of the incident mission added complexity and workload for the remaining executives. An appropriately qualified and appointed Flight Authorisation Officer conducted Flight Authorisation for the mission. The investigation found that while the Flight Authorisation Brief covered weather considerations, it did not specifically cover hazards and risks arising from the forecast environmental conditions, such as a rain showers, variable contrast and illumination, and the potential for a lack of discernible horizon. The ASIT also found that AVNCOMD's Flight Authorisation Aide Memoir did not specifically highlight requirements to ensure that hazards and risks associated with SD were covered in the Flight Authorisation Brief.

5.4.10 **Ex TS23 Risk Management Plan.** The investigation found that in preparation for Ex TS23, 6 Avn Regt drafted an AVIART 'New Risk' which included a risk associated with 'high workload' and 'increased fatigue', resulting in 'aircraft mishandling and CFIT'. At the 16 Avn Bde pre-exercise Battle-Worthiness Board it was determined that extant AVIART Core Risks and OIP adequately covered all hazards and risks associated with 6 Avn Regt's deployment to Ex TS23, and therefore the 'New Risk' was moved to 'Historic'. The ASIT noted that CO 6 Avn Regt verbally implemented additional controls. However, the overarching Ex TS23 SOF 'Risk Worksheet' did not adequately reference specific aviation hazards and risks. The ASIT considered that the lack of an aviation-specific and documented RMP reduced the opportunity for 16 Avn Bde to assure, and 6 Avn Regt to ensure, that hazards and risks associated with the unique CRE for the deployment were considered and mitigated.

5.4.11 **Upset Prevention and Recovery Training (UPRT).** While not an identified limitation, the investigation identified UPRT as a potential training methodology to build on existing approaches to UA training.

Unlike traditional UA training, UPRT adopts a broader focus on preventing and responding to unexpected scenarios. It integrates human factors and aeromedical considerations, such as managing and responding to surprise, startle and Type II SD, and is designed to improve the resilience and capacity of aircrew to deal with unexpected situations.

5.5 Organisational influences

5.5.1 Organisational influences are those conditions that establish, maintain or otherwise influence the effectiveness of an organisation's risk controls. They include SMS processes, organisational resources, planning and communication.

5.5.2 **MRH-90 context and constraints.** As a function of the DASP, Army Aviation has been subject to a number of routine oversight activities and internal reviews. Additionally, the investigation found a number of non-routine reviews and reports related specifically to the operation and management of Army Aviation and the MRH-90 capability. These reviews were comprehensive examinations of safety and capability issues, and as such, the ASIT did not seek to critically analyse or replicate their content. The investigation noted, however, that the MRH-90 and Army Aviation system as a whole were clearly under significant strain, with a high level of complexity and risk associated with 'Initial', 'Continued' and resultant cascading effects on 'Continuing Airworthiness' of the MRH-90 platform. The reviews continued to point to complex, under-resourced systems, in both the maintenance and operational environment. The investigation found that the breadth of reviews and associated recommendations added pressure and workload to an already overstretched workforce.

5.5.3 It is difficult to predict exactly how and when complex system interactions may result in an accident, however, the investigation found that organisational pre-conditions for an elevated level of risk to airworthiness and flight safety were generally well recognised, documented and accepted. In particular, the MAO-AM clearly accepted, documented and communicated that MRH-90 operations presented a MEDIUM level of risk of safety to personnel despite significant and disproportionate efforts to minimise risk across the MRH-90 enterprise.

5.5.4 **AVNCOMD MAO Integrated Quality and Safety Management System.** The ASIT's review of the Army Aviation iQSMS identified that HQ AVNCOMD was expending significant effort to remediate known deficiencies and improve processes to demonstrate compliance with Defence Aviation QMS and SMS regulatory requirements. However, the investigation found that the breadth and pace of change management – internal and external reviews, oversight activities and investigations, transition to new aircraft types, management and retirement of aging platforms, force modernisation and introduction of new capabilities – created an environment where demands on Army Aviation often exceeded workforce capacity.

5.5.5 **Aviation risk management.** AVNCOMD has implemented a structured system to document aviation risk management artefacts using the AVIART database. However, the ASIT notes that AVNCOMD's use of 'Core Risks' and 'New Risks' to document hazard analysis and safety risk assessments varies from guidance provided in the DASM. The DASM details requirements for a cascading structure of CRPs, MRPs and RMPs. In particular, the ASIT highlights that AVIART lacks foundational CRPs to capture platform operations and identify all risks associated with the conduct and support of regular, non-role specific operations. Similarly, the ASIT highlights opportunities for safety improvement through clearly defining a framework and methodology for the aggregation of Core Risks for specific roles, functions or missions. For example, low level, formation flight over water using NVIS.

5.5.6 The investigation found that AVIART Core Risks demonstrated an inconsistent approach to hazard and risk control descriptions, a lack of standardisation of key taxonomy and references to OIP that document risk controls, and lack of reference to the means by which the standardisation, application and effectiveness of controls are to assured. Furthermore, the ASIT found that Core Risks often lack clarity of the point of loss-of-control of the hazardous activity, threats/causes and delineation of prevention versus recovery controls.

5.5.7 The investigation called attention to the numerous action items, including outcomes from Class A and Class B safety investigations, DASP oversight and assurance activities, ASRs and other internal processes, which remained open prior to Ex TS23. Of particular note, action items to close recommendations from the investigation of a near mid-air collision between two MRH-90s during Exercise VIGILANT SCIMITAR 2020 were not progressed in a timely manner. Closure of action items related to aviation fatigue management, NTS, formation and NVIS operations prior to Ex TS23 might have minimised such organisational pre-conditions highlighted within this ASIR.

5.5.8 The ASIT acknowledges that AVNCOMD has continued to implement a number of safety initiatives and continuous improvement activities. Significant effort has been directed at understanding and managing the risks associated with the conduct of night, formation, overwater operations and aviation fatigue management. The investigation draws attention to the criticality of balancing resource versus demand in this context, and the need to ensure focused and effective actions.

5.5.9 **Defence Aviation Safety Regulation (DASR).** The ASIT examined the efficacy of the DASR and supporting policy, guidance material, education and training related to key causal and contributory factors, whereby the following potential safety improvement initiatives were identified:

e. **Mulit-crew aircraft operations.** A review of DASR and supporting regulatory artefacts identified no regulation or guidance related to roles or responsibilities of aircrew in multi-crew settings. It also revealed minimal reference to a pilot not on the aircraft's controls. A limited review of civilian airworthiness authorities by the ASIT, indicates that this is inconsistent with global aviation practices.

f. **Aviation fatigue management.** Notwithstanding the strengths of DASR AVFM as an outcome-based regulation to mitigate hazards and risks related to aviation fatigue, limitations remain in regulatory obligations and guidance related to scheduling, rostering practice and fatigue training requirements. Similarly, DASR AVFM AMC lacks prescription and may lead to uncertainty in interpretation of compliance relating to how required safety outcomes can be achieved.

g. **Non-Technical Skills.** The investigation drew attention to the promulgation of DASR NTS in February 2024, which represented a significant change to NTS training to enhance the management of NTS-related aviation safety hazards across Defence Aviation. The ASIT noted that DFSB had not promulgated sufficient and contemporary supporting policy, guidance material, and education and training for the regulated community. This sets pre-conditions for inconsistent interpretation and implementation of, and by default, compliance with this major regulatory reform.

h. **Spatial Disorientation.** The investigation found that the prevalence of SD experiences by aircrew across Defence Aviation was indicative of potential weaknesses in related hazard controls, emphasising the need to monitor and continuously improve upon existing combined DASA, DFSB, IAM and AVNCOMD hazard identification and risk mitigation approaches.

5.5.10 **DASA oversight and enforcement.** The investigation identified that the regulatory oversight approach and schedule conducted by DASA's DAVNOPS limited the opportunity of the regulator of Defence Aviation to provide assurance of the Army Aviation MAO's compliance with DASR AVFM. More broadly, the investigation identified that the DAVNOPS approach, which relies on future oversight activities to verify compliance with DASR, creates opportunities for safety gaps to emerge and to remain unidentified and unresolved. This is inconsistent with DASA's broader regulatory approach and sets the pre-conditions for non-compliances to go unnoticed for periods of time, particularly when organisations alter their practices or do not respond to regulatory changes.

5.5.11 **Defence Aviation Safety risk management.** The investigation identified broad concerns relating to standardisation, knowledge and application of organisational-level aviation risk management practices across Defence Aviation, in particular with respect to the documentation of key risk artefacts for aircraft operations. The ASIT also notes that this concern is a recurring theme from previous safety investigations and research conducted by DFSB. Overall, the ASIT found that there is a general lack of coherency, standardisation and prescription spanning policy, regulations, guidance material, and education and training at various layers of the DASP to both assure and ensure the efficacy of Defence Aviation's operational risk management framework.

5.5.12 Figure 44 shows the key findings, categorised in accordance with the DSAM in order to demonstrate the linkages between the initial actions of the crew, the local conditions that influenced them, the absent or deficient risk controls and the organisational influences.

SAFETY ANALYSIS MODEL

(CONTRIBUTING FACTORS TAXONOMY)

ORGANISATIONAL INFLUENCES

Organisational characteristics

- There was a high level of complexity and risk associated with the MRH-90 platform leading to an organisation under strain

Safety management processes

- Army Aviation risk and hazard assessment varies from guidance in the DASM
- Army Aviation risk management lacked standardisation and effective assurance that risks were managed
- There was ineffective organisational learning from previous safety events and DASP oversight and assurance activities
- The breadth and depth of change associated with the AVNCOMD iQSMS and platform management exceeded workforce capacity

Regulatory influences

- DASR policy, guidance material and education and training relating to Non-Technical Skills (NTS), pilot monitoring duties, AVFM, and Spatial Disorientation (SD) are sub-optimal
- DASA regulatory oversight approach and schedule limited opportunities to provide assurance of Army Aviation MAO compliance with DASR AVFM

Other External influences

- Defence Aviation safety risk management, at various levels of the DASP was not effective at assuring the efficacy of Defence Aviation's operational risk management framework
- DFSB NTS education and training was not integrated into ADF flying training governance framework

Which was influenced by

RISK CONTROLS

People management/ supervision

- The Flight Authorisation Brief did not cover hazards and risk for a Degraded Visual Environments (DVEs), and risk relating to SD
- Lack of an aviation-specific and documented Ex TS23 Risk Management Plan reduced opportunity to ensure and assure risks associated with unique CRE for Ex TS23 were considered and mitigated
- Lack of defined policy in OIP making distinction between Flying Supervision and Flight Authorisation roles

Procedures/processes/ practices

- The commonly used technique for formation flying (overriding Radar Height (RHT) hold) is not aligned with restrictive SIs for RHT to be engaged for low level flight over water
- Army Aviation had not adequately addressed contradiction between OIP and training regarding use of RHT during formation
- Army Aviation did not adequately manage risk controls related to cabin doors closed configuration in formation flight
- AVNCOMD policy did not include a structured intervention protocol
- AVNCOMD policy relating to prescriptive limitations and rostering practices was partially effective and inconsistent with DASR AVFM

Training/assessment

- Lack of training for aggregated mission profile of low level formation flight over water
- 6 Avn Regt's policy framework for NTS skills-based training and assessment under-developed when compared to broader Army Aviation units
- DFSB and IAM fatigue management training and resources were not coordinated, and were sub-optimal, reducing effectiveness
- Aviation Medicine training had limited focus on rotary wing CRE
- IAM did not have appropriate governance framework for externally delivered AVMED training

Hampered by

LOCAL CONDITIONS

Environmental conditions

- There was a DVE due to rain showers and low illumination
- There was reduced visual contrast and lighting cues via NVD

Workspace

- The MRH-90 cockpit is a visually restricted environment
- The cabin doors were closed

Job/task factors

- The technique for formation flying requires overriding of RHT hold to maintain station
- The crew were under high workload

Personal factors

- The pilots' attentional focus were on maintaining station in DVE to the detriment of instrument scanning
- The Flying Pilot was operating with fatigue levels that increased safety risk
- The crew were subject to a loss of Situation Awareness
- The Co-pilot (Non-Flying Pilot) attentional focus on station keeping was not aligned with responsibilities of a Non-Flying Pilot to monitor aircraft performance parameters
- The pilots were subject to Type I (Unrecognised) SD
- Sub-optimal NTS increased safety risk

Was more likely because

INDIVIDUAL/ TEAM ACTION

- The aircraft climbed away from the formation altitude
- The Aircraft Captain (Flying Pilot) and the Co-pilot did not identify the deviation
- The two aircrewmen in the rear of the aircraft did not identify the deviation
- The Aircraft Captain (Flying Pilot) responded to the loss of visual contact with BSMN 82 by rolling quickly to the right, then to the left
- The Aircraft Captain (Flying Pilot) applied a large forward longitudinal cyclic input, pitching the aircraft nose-down

CONTROLLED FLIGHT INTO TERRAIN

← INVESTIGATIONS

Figure 44: DSAM Taxonomy

5.6 Safety actions already undertaken

5.6.1 The ASIT acknowledges AVNCOMD implemented a significant number of safety initiatives and continuous improvement activities throughout the course of the investigation. AVNCOMD's review and analysis of preliminary reports and briefings provided by the ASIT at each of phase of the investigation resulted in improved risk controls and revised OIP for the conduct of missions involving NVIS, DVE, formation, and low level flight over water, as well as aviation fatigue management. Additionally, COMD AVNCOMD initiated the development of an overarching Army Aviation Safety Campaign Plan to support the implementation of the BAP IPP, proactively addressing known and anticipated system risks to improve safety.

5.7 Key Recommendations

5.7.1 The investigation made a number of recommendations aimed at improving safety outcomes. These are summarised below:

a. **DASA.** Recommendations made to DG DASA relate to reviewing, benchmarking and strengthening DASR and materials related to: SD; aviation fatigue management; NVIS; crewmember roles and responsibilities; oversight processes; and the application of independent safety assurance for DASR SMS, NTS and AVFM. Recommendations made to DAVNOPS relate to improving requirements specified within DASR AVFM and NVIS AMC and GM to improve support to regulated entities. Recommendations made to DFSB relate to aviation fatigue management and NTS education and training and their incorporation into the broader ADF flying training system, and the review/release of related guidance and supporting products.

b. **AVNCOMD.** Recommendations made to Army MAO-AM relate to the SMS framework, including roles and responsibilities of key safety personnel and risk management. In addition, recommendations related to the standardisation of NTS skills-based training and assessment, formation flying rules and management of NVIS, fatigue and ALSE. Recommendations were also made in relation to standardisation of Battle Worthiness Board processes as well as standardisation of mission planning, briefing packs and the Flight Authorisation Aide Memoir to improve the identification and management of SD hazards. Recommendations were made to the Army MAO-AM and COMDT AAvnTC relating to formation flying procedures and techniques, as well as for aggregated mission profiles.

c. **IAM.** Recommendations made to CO IAM relate to initial and refresher training for fatigue, SD and rotary wing specific hazards. An additional recommendation was made to improve assurance processes for externally-delivered refresher training, and to support DFSB in reviewing aviation fatigue management training.

d. **Other.** Three recommendations were made to other Defence organisations. HQ JOC were recommended to improve the standardisation of communications during Search and Rescue operations. The Manager Joint Training for ADF Flying Training related to inclusion of NTS training and assessment in the FTAG. Fleet Air Arm, DCOMFAA was recommended to review the scheduling of AVMED rotary-wing specific training for ab initio rotary wing aircrew.

5.8 Final observations and key lessons

The ultimate aim of this ASIR is to improve aviation safety.

5.8.1 The independent investigation into the MRH-90 Taipan A40-040 accident on 28 Jul 2023 draws out critical lessons that are relevant to the broader Defence Aviation enterprise. The ASIT recommends that all individuals and organisations that support or conduct Defence Aviation operations review this report with a view to understanding and applying observations and lessons to their own activities.

5.8.2 Overall, the investigation found that the primary cause of the CFIT was Type 1 (Unrecognised) SD. The most fundamental lesson for Defence Aviation is to recognise that all aircrew are exposed to spatially disorienting effects due to the unique nature of military operations in degraded visual environments, low illumination levels or poor contrast conditions. Defence Aviation has placed a significant emphasis on training, competency and assessment to operate in such environments and conditions, and to apply UA techniques to react and recover from Type II (Recognised) SD events. However, the ASIT reached the conclusion that training, competency and assessment to promote awareness of Type I (Unrecognised) SD, such as the warning signs and indicators of decreasing SA and/or complete loss of Spatial Orientation, is a challenging and complex task. Preventative and recovery controls to minimise SD related risks must build upon extant AVMED education and training to include actions to anticipate, avoid and communicate SD risk factors within operational environments.

5.8.3 Additionally, this investigation reinforced several recurring themes observed across other major civil and military accident investigations. The ASIT draws attention to the following themes:

e. *Safety risk management is not static.* Hazards must be continually evaluated in the context of the specific operational environment. Without ongoing evaluation, organisations risk operating under incorrect assumptions, and potentially leave hazards unaddressed.

f. *Proficiency in both technical and Non-Technical Skills (eg decision-making, communication, SA, and leadership and management) provides the foundation for safe and efficient aviation operations.* This investigation emphasises the importance and necessity of investing in NTS training to equip crews to adapt, coordinate and respond effectively in dynamic and challenging operating environments.

g. *Compliance alone is insufficient.* When systems are under pressure, an organisation's focus can become increasingly on the process rather than confirming the effectiveness of the process. This investigation highlights the criticality of understanding and measuring the effectiveness of processes.

h. *Organisations and regulators must guard against the false assumption that adherence to regulations and OIP inherently equates to safe operations.* Safety risk management and the oversight of safety systems requires the effectiveness of the risk controls to be evaluated to ensure they are functioning as intended in real-world conditions.

i. *Complex systems, organisational change, and regulatory and safety governance requirements require careful balancing of resource and demand.* Action must be taken to understand and react to safety information at every level of the organisation, but with the operators at the forefront of how change is implemented.

5.8.4 Defence Aviation has long had a culture of 'can do', with high achieving and driven personnel working in challenging and complex environments. This accident has drawn attention to the fallibility of humans in complex systems, and acts as a stark reminder of the importance of the systems and processes built to support effective performance in operating environments. It should also prompt organisational reflection on the enduring aspiration to build a 'generative safety culture' – the need to maintain a persistent state of vigilance, be receptive to learning, have a willingness to respond to opportunities, and a collective commitment to enhancing aviation safety.

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ANNEXES:

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B	Recommendations
C	ATSB Probabilistic Language
D	Acronyms and Glossary of Terms
E	Timeline of Events
F	Acknowledgements
G	Bushman 83 crew qualifications, experience and recency

ENCLOSURES:		
1	DFSB Biomathematical Fatigue Modelling	
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ANNEX A: FINDINGS

NUMBER	FINDING, INDIRECT FINDING OR OBSERVATION	PAGE
1	**Indirect Finding.** The crew of BSMN 83 were qualified, competent and current to perform the mission	26
2	**Indirect Finding.** It is virtually certain that A40-040 (BSMN 83) was within the approved weight and balance envelope for the mission	29
3	**Indirect Finding.** The application of Decision Height settings was inconsistent among the aircraft in the BSMN formation	34
4	**Indirect Finding.** A40-040's Voice and Flight Data Recorder (VFDR) functioned correctly and operated as designed	39
5	**Finding.** Impact forces exceeded design requirements for the aircraft	42
6	**Finding.** The accident was not survivable	42
7	**Indirect Finding.** 6 Avn Regt ALSE standardisation and application of maintenance and procedures for the management and continuous charge of ALSE was suboptimal	43
8	**Finding Impact.** forces experienced by the crew of BSMN 83 far exceeded human impact tolerances	43
9	**Indirect Finding.** There was no evidence of incapacitation of the crew of BSMN 83 prior to impact	43
10	**Indirect Finding.** BSMN 84's communication of the accident and use of operational codewords and terminology initially caused confusion with non-ADF participants as to whether this was a simulated exercise scenario or a real aviation accident	44
11	**Indirect Finding.** To the extent by which the ASIT could examine the wreckage and analyse the Voice and Flight Data Recorder (VFDR), there was no evidence of technical failure of the aircraft or major systems	50
12	**Indirect Finding.** Forecast weather and illumination conditions were within authorised limits for the mission to proceed	51
13	**Indirect Finding.** 6 Avn Regt deployed to Ex TS23 without a Hoffman 20/20 Test Set	51
14	**Indirect Finding.** It is very likely that the Helmet Mounted Sight and Displays (HMSD) of the pilots of BSMN 83 were functioning correctly throughout the mission and during the key accident sequence of events	52
15	**Indirect Finding.** BSMN 83's crew were positioned within the aircraft as follows: Aircraft Captain (AC) in the right-hand cockpit seat; Co-pilot (CP) in the left-hand cockpit seat; senior aircrewman (RH ACMN) in the right-hand side of the cabin; and the junior aircrewman (LH ACMN) in the left-hand side of the cabin	53

NUMBER	FINDING, INDIRECT FINDING OR OBSERVATION	PAGE
16	**Indirect Finding.** BSMN 83 had flown for an extended period over water below 500 feet at night without the Automatic Flight Control System Radar Height upper mode engaged	56
17	**Indirect Finding.** BSMN 83 did not conform with SI(6AVN) OPS 3-209 - Flight Over Water to engage the Automatic Flight Control System Radar Height upper mode over water when operating below 500ft at night.	56
18	**Indirect Finding.** It is very likey that BSMN 83's CP (FP) was experiencing an increased workload maintaining formation station due to BSMN 82's CP (FP) having difficulty in maintaining the same height plane as BSMN 81	58
19	**Indirect Finding.** BSMN 83's CP was required to fly cross-cockpit to maintain position in the heavy left formation	58
20	**Indirect Finding.** Cross-cockpit flying from position three in heavy left formation increases pilot workload	58
21	**Finding.** It is very likely that BSMN 83's AC (NFP) took control of the aircraft due to the increasing complexity of the situation and after the CP (FP) gained altitude above the formation	58
22	**Indirect Finding.** The transfer of control of the aircraft by BSMN 83's AC from the CP was not conducted in accordance with the MRH90 STANMAN	59
23	**Indirect Finding.** The take-over effectively transfered control to BSMN 83's AC as the FP with no ambiguity of pilot roles and responsibilities	59
24	**Indirect Finding.** BSMN 83's AC (FP) changed the flight control system to Attitude (ATT) mode and selected Radar Height (RHT) hold mode after taking control of the aircraft from the CP	61
25	**Finding.** The crew of BSMN 83 assessed their visual range to be closer than the actual range to BSMN 82	61
26	**Observation.** The ASIT could not determine the reason why the crew of BSMN 83 assessed their visual range to be closer than the actual range to BSMN 82.	61
27	**Finding.** The attention of BSMN 83's CP was very likely focused externally, to the detriment of NFP duties, as they expected to imminently resume control of the aircraft	63
28	**Finding.** It is virtually certain that the application of yaw pedal inputs by BSMN 83's AC (FP) from 1235:27Z onwards was inadvertent	63
29	**Finding.** The application of yaw pedal inputs from 1235:27Z was likely indicative that BSMN 83's AC (FP) was experiencing an increased workload due to the degrading weather conditions	64
30	**Finding.** It is extremely likely that, in responding to the operating conditions, including the degrading weather, the attention of BSMN 83's AC (FP) was exclusively focused outside the aircraft to prioritise maintaining visual sight of BSMN 82	64

NUMBER	FINDING, INDIRECT FINDING OR OBSERVATION	PAGE
31	**Finding.** It is very likely that the AC's (FP) direction of attention to the CP (NFP) of BSMN 83 towards BSMN 82 in preparation for a hand-over/take-over degraded NFP monitoring duties	64
32	**Finding.** It is virtually certain that BSMN 83's climb above the formation's datum altitude of 200 ft was inadvertent and not recognised by either the AC (FP) or CP (NFP)	65
33	**Indirect Finding.** It is very unlikely that a distraction of sufficient magnitude and duration contributed to BSMN 83's inadvertent climb	65
34	**Finding.** It is likely that BSMN 83's departure from the formation position was due to degraded crew Situation Awareness, primarily resulting from the AC's (FP) loss of Spatial Orientation	66
35	**Finding.** It is likely that the combination of a demanding technique for formation station keeping and the degraded visual environmental conditions led to increased cognitive workload and the attentional narrowing of BSMN 83's AC (FP)	66
36	**Finding.** It is likely that narrowing of attentional focus diminished the ability of the AC (FP) of BSMN 83 to maintain Spatial Orientation	66
37	**Finding.** It is very likely that misinterpretation of distance between BSMN 83 and BSMN 82, combined with low-contrast conditions, impeded the ability of BSMN 83's AC (FP) to differentiate individual reference features used for maintenance of station keeping to BSMN 82	66
38	**Finding.** It is likely that BSMN 83's formation position, which moved progressively towards the trail position on BSMN 82, reduced the AC's (FP) ability to see lighting reference features on BSMN 82 and limited their ability to incorporate BSMN 81 into their scan	67
39	**Finding.** It is very likely that BSMN 83's AC (FP) misperceived their orientation to BSMN 82 while the position of BSMN 82 remained in a relatively stable position in the windscreen during the inadvertent climb	67
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163	**Observation.** Upon establishment of AVNCOMD, DCOMD AVNCOMD (previously DGAVN) retained the appointment as the Hazard Tracking Authority (HTA) in recognition of the unique Army Aviation organisational structure. The ASIT notes that references to each service's unique organisational structure and specific implementation requirements of the Defence ASMS were not updated in the DASM to reflect the establishment of AVNCOMD	146
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194	**Indirect Finding.** DAVNOPS's approach to oversight allows potential gaps in compliance to go unnoticed for periods of time, particularly when organisations alter their practices or do not respond to regulatory changes. It also potentially detracts from the effectiveness of MAO oversight activities	159
195	**Indirect Finding.** DASA's extant regulatory assurance framework for Defence Aviation safety risk management is not contemporary or in alignment with global aviation standards and recommended practices, which sets the preconditions for lack of standardisation and application of aviation safety risk management by regulated organisations	160
196	**Observation.** Defence Aviation safety investigations conducted by DFSB lack statutory powers and protections equivalent to their civilian counterparts in the Australian Transport Safety Bureau (ATSB), resulting in an ongoing risk to the effectiveness of the Defence Aviation safety investigative capability and confidence in the Defence Aviation safety system	161

ANNEX B: RECOMMENDATIONS

DEFENCE AVIATION AUTHORITY

Number	Recommendation	Supporting Finding/ Indirect Finding/Observation
1	**Defence Aviation Authority** to review the framework by which independent reviews of aviation safety report strategic organisational hazards in order to optimise identification and assessment of the effectiveness of critical risk controls, and articulation of required treatment plans and senior management attention to mitigate inherent and residual risks.	157, 158 & 159

ARMY AVIATION MAO-AM

Number	Recommendation	Supporting Finding/ Indirect Finding/Observation
5	**Army Aviation MAO-AM** to review AVNCOMD's framework and methodology of Deliberate Risk Management (DRM) in order to improve efficacy of Hazard Identification and Safety Risk Assessment and Mitigation for Flight Operations and Cross-Regulatory Requirements, in alignment with requirements specified in DASR SMS and recommended in the Defence Aviation Safety Manual (DASM).	170, 171 & 172
6	**Army Aviation MAO-AM** to consider use of 'Bow Tie' barrier risk models and nomenclature to assist hazard identification and management of risk in order to improve efficacy of DRM for Flight Operations and Cross-Regulatory Requirements.	173, 174, 175 & 176
7	**Army Aviation MAO-AM** to review policy for the roles, responsibilities and accountabilities of the Hazard Tracking Authority (HTA) in order to improve efficacy of DRM, Aviation Safety Committee Meetings, Aviation Hazard Review Boards and closure requirements for aviation safety investigations within Army Aviation's Safety Management System (SMS), in alignment with recommended practices described in the DASM.	163, 166, & 167
8	**Army Aviation MAO-AM** to review the appointment, training and competency of key safety personnel in order to ensure that the implementation and maintenance of AVNCOMD's SMS is commensurate with the size of the organisation and complexity of aviation products and services.	165 & 169

ARMY AVIATION MAO-AM

Number	Recommendation	Supporting Finding/ Indirect Finding/Observation
9	**Army Aviation MAO-AM** to review AVNCOMD's SMS framework for, and application of, safety performance monitoring and measurement in order to ensure the integrity and effectiveness of SMS processes and activities.	161, 179, 180 & 181
12	**Army Aviation MAO-AM** to review policy for the implementation and integration of QMS within AVNCOMD's SMS in order to improve consistency, continuity and compliance of safe operations through quality planning, quality assurance, quality control and quality improvement, in alignment with requirements specified in DASR ARO.100(c)9 - QMS	162
16	**Army Aviation MAO-AM** to review policy for standardisation of NTS skills-based training and assessment across the 16th Aviation Brigade and subordinate Regiments in order to improve aircrew performance skills that promote reliable and effective task performance, in alignment with requirements specified in DASR NTS.	120
21	**Army Aviation MAO-AM** to review policy for standardisation of aviation fatigue management across the 16th Aviation Brigade and subordinate Regiments in order to improve mitigation of risks to operations due to aircrew fatigue aspects, in accordance with requirements specified in D ASR AVFM.	76, 77, 78, 82, 83, 84, 85, 86, 87, 88, 89, 133, 135, 136, 142 & 186
28	**Army Aviation MAO-AM** to coordinate with, and seek approval, under the authority of CO IAM, for the provision of additional Army Aviation AVMED-related training in order to improve aircrew knowledge of aeromedical factors and preparedness for recognising and managing Spatial Disorientation, and to enhance aircrew performance during rotary-wing operations, in alignment with DASR Medical (MED).05 - AVMED Training.	125, 126, 127 & 128
29	**Army Aviation MAO-AM** to revise Standardisation Manuals to include reference material for aeromedical factors as authorised by CO IAM, vice reference material from the Professional ADF Aviators' Reference Manual (PAARM), in order to ensure that dual checks and category assessments reference contemporary Defence Aviation content and topics related to aeromedical factors.	131

ARMY AVIATION MAO-AM

Number	Recommendation	Supporting Finding/ Indirect Finding/Observation
30	**Army Aviation MAO-AM** to review policy for standardisation of, and distinction between, Flying Supervision and Flight Authorisation requirements in order to improve the independent control of Flight Planning and Mission execution, in alignment with requirements specified in DASR Organisational Requirements for Air Operations (ORO). 30 – Flight Authorisation.	153 & 154
31	**Army Aviation MAO-AM** to review policy and practices related to Flight Authorisation and Flying Supervision, in particular, the use of self-authorisation (including restrictions and limitations) to ensure independent oversight of Flight Planning and execution, in alignment with requirements specified in DASR Organisational Requirements for Air Operations (ORO).30 – Flight Authorisation.	147 & 148
32	**Army Aviation MAO-AM** to review standardisation of Mission Planning and Briefing Packs, and Flight Authorisation Aide Memoirs, in order to improve the efficacy of hazard identification and risk controls to mitigate effects of environmental conditions that are conducive to Spatial Disorientation.	145 & 146
33	**Army Aviation MAO-AM** to review policy for standardisation of determining suitable minimum heights for operations over open water by night in order to ensure the safe management of low flying activities, in alignment with requirements specified in DASR SPA.05 – Flying Rules for Special Missions and Tasks, DASR SPA.20 – Low Flying and DASR SPA.55 - NVIS.	17, 61, 62, 63, 67 & 110
34	**Army Aviation MAO-AM** to review policy for standardisation of procedures for the use of specialised equipment and settings for altitude and decision height warning systems in order to ensure the safe management of low flying activities, in alignment with requirements specified in DASR SPA.20 – Low Flying and DASR SPA.55 - NVIS.	3 & 96
36	**Army Aviation MAO-AM** to review policy for standardisation of NVIS formation procedures and limitations, inclusive of operations below ASH, LSALT or MSA and low flying, in order to ensure Aviation Safety when Night Vision Devices (NVD) are used as the primary means of vision, in alignment with requirements specified in DASR SPA.55 - NVIS.	113, 114, 118 & 174

ARMY AVIATION MAO-AM

Number	Recommendation	Supporting Finding/ Indirect Finding/Observation
37	**Army Aviation MAO-AM** to review policy for standardisation of procedures to assess that NVIS equipment is serviceable and correctly set up for use prior to flight, with or without a pre-flight checking facility, in alignment with requirements specified in DASR SPA.55 - NVIS.	13
38	**Army Aviation MAO-AM** to review policy for standardisation of procedures to conduct NVD performance checks and calibration pre-flight, or at intervals recommended by the Original Equipment Manufacturer (OEM) and as approved by the MAO, in alignment with requirements specified in DASR SPA.55 - NVIS.	13
39	**Army Aviation MAO-AM** to review policy for standardisation of procedures, based upon a risk management assessment, that address rules and requirements related to formation flying, in alignment with requirements specified in DASR SPA.05 - Flying Rules for Special Missions and Tasks.	57, 61, 68, 105, 106, 110, 118 & 174
40	**Army Aviation MAO-AM** and DCOMFAA to review coherency and standardisation of policy, procedures, techniques, scans, work-cycles and use of automated flight controls systems for the training and conduct of formation flying across ab initio and type-specific operational conversion courses in order to establish and maintain prerequisite qualifications and competencies for rotary-wing formation in flight regimes using NVIS and/or in Degraded Visual Environments (DVE).	30, 40, 68, 97 & 110
41	**Army Aviation MAO-AM** to review policy for the standardisation of procedures, flying techniques and crew coordination in flight regimes and operating conditions where aircrewmen are restricted or limited to contribute to the crew's Situation Awareness for maintenance of position, aircraft separation and/or collision avoidance responsibilities during formation flight.	105 & 107
44	**Army Aviation MAO-AM** to review policy for standardisation of procedures for the management of Aeronautical Life Support Equipment (ASLE) and Continuous Charge of ALSE in order to improve aircrew training and competence, in alignment with requirements specified in DASR ORO.40 - ALSE.	27, 31, 43 & 116

ARMY AVIATION MAO-AM

Number	Recommendation	Supporting Finding/ Indirect Finding/Observation
45	**Army Aviation MAO-AM** to review policy for standardisation of procedures for the management of Aeronautical Life Support Equipment (ASLE) and Continuous Charge of ALSE in order to improve aircrew training and competence, in alignment with requirements specified in DASR ORO.40 - ALSE.	7

DIRECTOR GENERAL DEFENCE AVIATION SAFETY AUTHORITY (DG DASA)

Number	Recommendation	Supporting Finding/ Indirect Finding/Observation
2	**Director General Defence Aviation Safety Authority (DG DASA)** to review policy for the issuance and retention of organisational authorisations by the Directorate of Aviation Operations (DAVNOPS) in order to improve efficacy of assessments of initial and ongoing compliance with Defence Aviation Safety Regulations (DASR) pertaining to Flight Operations and Cross-Regulatory Requirements.	158, 192, 193 194, & 195
3	**DG DASA** to review DASA's application of independent safety assurance for DASR Safety Management Systems (DASR SMS) in order to improve efficacy of interpretation and application by regulated entities of the requirements of Acceptable Means of Compliance (AMC) and Guidance Material (GM) for Hazard Identification and Safety Risk Assessment and Mitigation.	160, 161, 162 , 179, & 181
4	**DG DASA** to review DASA's application of independent safety assurance of action items developed by Aviation Commands arising from independent aviation safety investigations conducted by DFSB in order to ensure efficacy and timeliness of closure requirements for recommendations for safety improvement.	171
11	DG DASA to review DASA's application of independent safety assurance for DASR Authority Requirements for Air Operations (ARO).100(c)9 - Quality Management Systems (QMS) in order to improve efficacy of interpretation and application by regulated entities of the requirements of AMC and GM to implement controls to ensure Flight Operations are conducted as an approved organisation and managed to ensure aviation safety.	160, 161, 162 & 181

DIRECTOR GENERAL DEFENCE AVIATION SAFETY AUTHORITY (DG DASA)

Number	Recommendation	Supporting Finding/ Indirect Finding/Observation
13	**DG DASA** to review the implementation plan for and the application of independent safety assurance of DASR Non-Technical Skills (DASR NTS) in order to improve efficacy of interpretation and application by regulated entities of the requirements of AMC and GM to address NTS-related safety risks in the operating environment.	121 & 191
17	**DG DAS**A to review DASA's application of independent safety assurance of DASR Aviation Fatigue Management (AVFM) in order to improve efficacy of interpretation and application by regulated entities of the requirements of AMC and GM to minimise fatigue-related human factors errors.	133, 140, 142, 186 & 190
22	**DG DAS**A to analyse whether the scope and applicability of the DASR Parts adequately specify requirements to mitigate aviation hazards related to aeromedical factors and Spatial Disorientation.	126, 131 & 187
43	**DG DASA** to analyse whether the scope and applicability of the DASR Parts adequately specify requirements to mitigate aviation hazards related to roles, responsibilities and intervention protocols for aircrew in multi-crew flight operations.	183

COMMANDER 16TH AVIATION BRIGADE (COMD 16 AVN BDE)

Number	Recommendation	Supporting Finding/ Indirect Finding/Observation
10	**Commander 16th Aviation Brigade (COMD 16 AVN BDE)** to review policy for standardisation of Battle-Worthiness Board processes and procedures in order to improve DRM for Hazard Identification and Safety Risk Assessment and Mitigation for unique Configurations, Roles and Environments (CRE) related to activities, exercises and operational deployments.	153, 154, 156, 170, 171 & 172

COMMANDER AIR FORCE TRAINING GROUP (CDR AFTG)

Number	Recommendation	Supporting Finding/ Indirect Finding/Observation
15	**Manager Joint Training (MJT)** for Australian Defence Force (ADF) Flying Training, **Commander Air Force Training Group (CDR AFTG)**, to review the governance, accountabilities and framework of the ADF Flying Training Advisory Group (FTAG) in order to improve efficacy of aircrew NTS education and training, and assessment of NTS competency, as part of ADF Flying Training as defined in the Article of Appointment and Memorandum of Agreement.	120, 123 & 124

COMMANDANT ARMY AVIATION TRAINING CENTRE (COMDT AAVNTC)

Number	Recommendation	Supporting Finding/ Indirect Finding/Observation
42	**COMDT AAvnTC** to conduct a Training Needs Analysis (TNA) for the aggregated mission profiles of Low Level, Formation, Flight Over Water using NVIS and/or in DVE in order to develop Learning Management Plans (LMP) for type-specific and multi-aircraft type missions, in alignment with requirements specified in DASR SPA.20 Low Flying and DASR SPA.55 NVIS.	118

DIRECTOR AVIATION OPERATIONS DASA (DASA DAVNOPS)

Number	Recommendation	Supporting Finding/ Indirect Finding/Observation
18	**DASA DAVNOPS** to review DASR AVFM clauses and sub-clauses in order to improve requirements specified within AMC and GM to identify the means to meet requirements of DASR AVFM and to provide certainty as to how regulated entities may achieve the required safety outcomes.	133, 140, 142, 186 & 190
35	**DASA DAVNOPS** to review DASR Night Vision Imaging System (NVIS) clauses and sub-clauses in order to improve requirements specified within AMC and GM to identify the means to meet requirements of DASR NVIS and to provide greater certainty as to how regulated entities may achieve required safety outcomes.	188 & 189

DIRECTOR DEFENCE FLIGHT SAFETY BUREAU DFSB

Number	Recommendation	Supporting Finding/ Indirect Finding/Observation
14	**Director DFSB** to review the development and provision of policy, guidance material, and education and training to support implementation for DASR NTS and DASA' s application of independent safety assurance that the regulated community will meet, and will continue to meet, requirements and constraints for DASR NTS training and assessment.	120, 123 & 185
19	**Director DFSB** to review the development and provision of aviation fatigue management policy, guidance material, and education and training in order to support DASA's application of independent safety assurance that the regulated community has met, and continues to meet, the requirements and constraints of DASR AVFM.	190 & 191
20	**Director DFSB** and **Commanding Officer of the Institute of Aviation Medicine (CO IAM)** to review integration and coherency of aviation fatigue management policy, guidance material, education and training in order to improve barriers and controls of risks to operations due to fatigue aspects.	190 & 191

COMMANDING OFFICER, INSTITUTE OF AVIATION MEDICINE (CO IAM)

Number	Recommendation	Supporting Finding/ Indirect Finding/Observation
20	**Director DFSB and Commanding Officer of the Institute of Aviation Medicine (CO IAM)** to review integration and coherency of aviation fatigue management policy, guidance material, education and training in order to improve barriers and controls of risks to operations due to fatigue aspects.	190 & 191
23	**CO IAM** to review IAM Initial and Refresher Aviation Medicine (AVMED) training continuums in order to ensure alignment with Air Force Interoperability Council (AFIC) standards and recommended practices for aeromedical factors and Spatial Disorientation training.	128
24	**CO IAM** to review the IAM Initial AVMED education and training syllabus provided to ab initio rotary-wing aircrew in order to improve knowledge and application of rotary-wing specific aeromedical factors and human performance limitations.	125, 127 & 128

COMMANDING OFFICER, INSTITUTE OF AVIATION MEDICINE (CO IAM)

Number	Recommendation	Supporting Finding/ Indirect Finding/Observation
25	**CO IAM** to review requirements for IAM to assure the quality and efficacy of additional AVMED-related training conducted by Aviation Commands in order to improve standardisation of education and training and enhance aircrew knowledge of aeromedical factors and human performance limitations.	127
26	**CO IAM** to review IAM reference material related to aeromedical factors and Spatial Disorientation for rotary-wing and fixed-wing operations in order to enhance aircrew knowledge to anticipate, avoid, recognise and recover from Spatial Disorientation events.	125, 126, 127 & 128

DEPUTY COMMANDER FLEET AIR ARM (DCOMFAA)

Number	Recommendation	Supporting Finding/ Indirect Finding/Observation
27	**Deputy Commander Fleet Air Arm (DCOMFAA)**, in consultation with Royal Australian Navy - Training Authority Aviation (RAN TA-AVN), review scheduling of IAM-approved ab initio AVMED rotary-wing specific training.	125, 126 & 127
40	**Army Aviation MAO-AM** and **DCOMFAA** to review coherency and standardisation of policy, procedures, techniques, scans, work-cycles and use of automated flight controls systems for the training and conduct of formation flying across ab initio and type-specific operational conversion courses in order to establish and maintain prerequisite qualifications and competencies for rotary-wing formation in flight regimes using NVIS and/or in Degraded Visual Environments (DVE).	30, 40, 68, 97 & 110

HEADQUARTERS JOINT OPERATIONS COMMAND, AIR AND SPACE OPERATIONS CENTRE, JOINT PERSONNEL RECOVERY

Number	Recommendation	Supporting Finding/ Indirect Finding/Observation
46	Headquarters Joint Operations Command, Air and Space Operations Centre, Joint Personnel Recovery to standardise guidance for communication plans for coalition and joint exercise participants to respond to and coordinate Search and Rescue operations.	10

ANNEX C: ATSB PROBABALISTIC LANGUAGE

1 Individuals will interpret probabilistic language differently. Therefore, it is necessary to both carefully select terminology, and properly define it. Figure C1 is the Australian Transportation Safety Bureau's (ATSB's) suggested terminology for probabilistic language. The figure defines the meanings of various words and phrases in terms of a percentage-range.

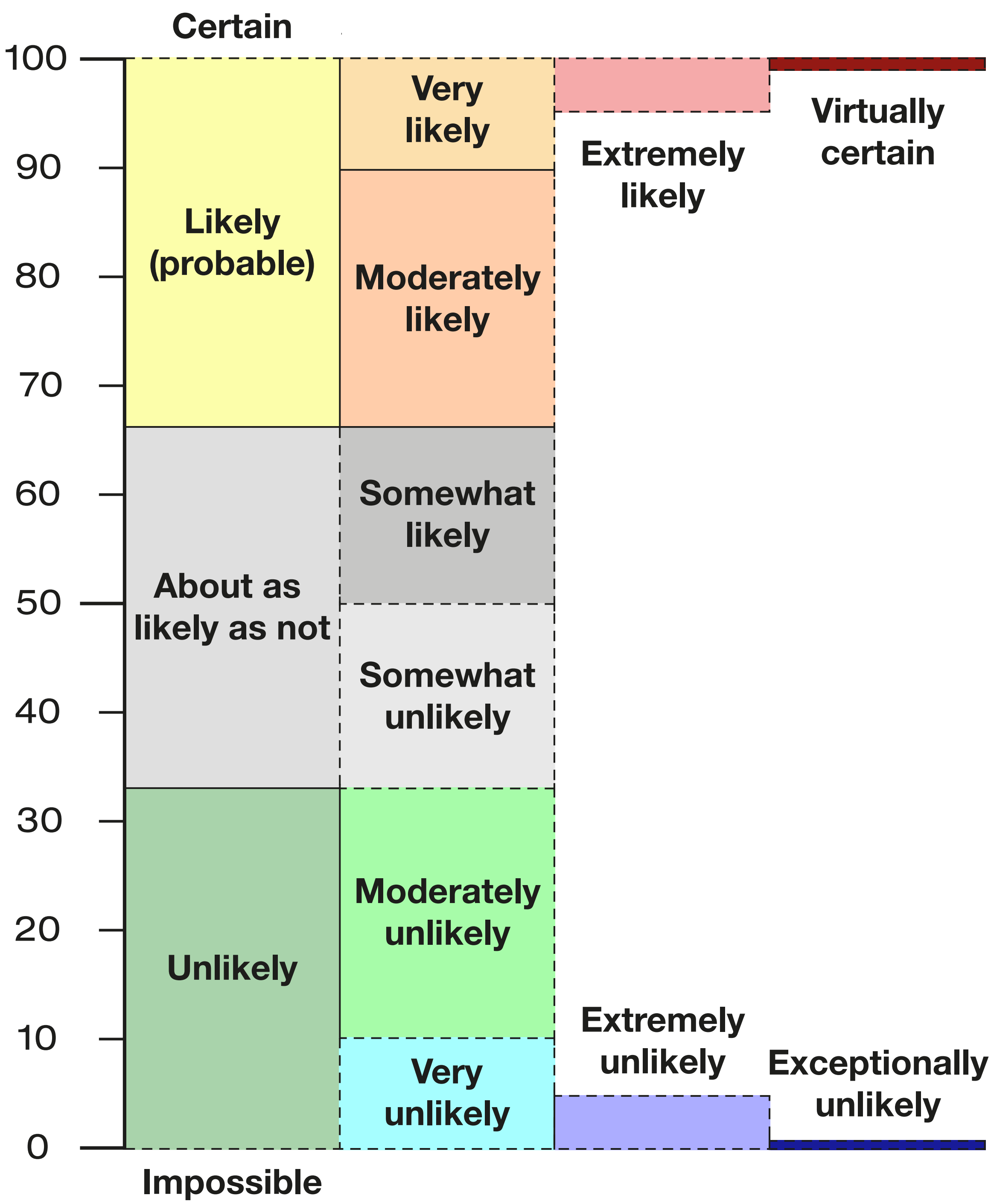


Figure C1: ATSB Probabilistic Language

ANNEX D: ACRONYMS AND GLOSSARY OF TERMS

ACRONYM	DEFINITION
1FTS	1 Flying Training School
5 Avn Regt	5th Aviation Regiment
6 Avn Regt	6th Aviation Regiment
AA	Aviation Authority
AAP	Airbus Australia Pacific
AAvnTC	Army Aviation Training Centre
AAP	Australian Air Publication
AASPC	Army Aviation Safety Program Conference
AASPO	Army Aviation Systems Program Office
AATES	Army Aviation Test and Evaluation Section
AC	Aircraft Captain
ACAR	Airworthiness Corrective Action Request
ACMN	Aircrewman / Aircrewmen
ADF	Australian Defence Force
AEO	All Engines Operating
AFCS	Automatic Flight Control System
AFIC	Air Force Interoperability Council
AGL	Above Ground Level
AHO	Above Highest Obstacle
AIT	Airbourne Instructional Technique

ACRONYM	DEFINITION
ALAP	Attitude-Lookout-Attitude-Performance
ALSLMU	Aeronautical Life Support Logistics Management Unit
ALIGN	Alignment
AMC	Acceptable Means of Compliance
AMSA	Australian Maritime Safety Authority
AMSL	Above Mean Sea Level
ANVIS	Aviators Night Vision Imaging System
AoB	Angle of Bank
APU	Auxiliary Power Unit
ARH	Armed Reconnaissance Helicopter
ARO	Authority Requirements for Air Operations
ASIR	Aviation Safety Investigation Report
ASIT	Aviation Safety Investigation Team
ASO(A)	Aviation Safety Officer (Advanced) Course
ASO(I)	Aviation Safety Officer (Initial) Course
ASR	Aviation Safety Report
ASMS	Aviation Safety Management System
ATSB	Australian Transport Safety Bureau
ATT	Attitude
AVMED	Aviation Medicine

ACRONYM	DEFINITION
AVIART	Aviation Integrated and Aggregated Risk Tool
AVN	Aviation
VNCOMD	Aviation Command
AvWO	Aviation Warfare Officer
AWSMB	Aviation Weapon System Management Board
BAP	Battlefield Aviation Program
BFM	Biomathematical Fatigue Model
BFTS	Basic Flying Training School
BH	Basic Helmet
BoM	Bureau of Meteorology
BSMN	Bushman
CAM	Cockpit Area Microphone
CAPT	Captain
CASO	Command Aviation Safety Officer
CCIR	Commanders Critical Information Requirements
CCTV	Closed-circuit television
CECG	Combined Exercise Control Group
CDR AFTG	Commander Air Force Training Group
CFIT	Controlled Flight into Terrain
CFS	Collective Safety Function
CHAD	Cabin Helicopter Aircrewman Device
CLO	Course Leaning Objective
CMD	Counter Measure Dispense
CMDS	Counter Measure Dispensing System
CO	Commanding Officer
CoE	Centre of Expertise
CoG	Centre of Gravity
COMAUSFLT	Commander Australian Fleet
COMD AVNCOMD	Commander Aviation Command
COMFAA	Commander Fleet Air Arm
COMD FORCOMD	Commander Forces Command
CP	Co-pilot
CPD	CDF (Chief of Defence Force) Preparedness Directive
CPL	Corporal
CRE	Configuration, Role and Operating Environment
CRED	Central Rappelling and Extracting Device
CRP	Core Risk Profile
CRT	Cathode Ray Tube
CSMU	Crash Survivable Memory Unit
CVR	Cockpit Voice Recorder
DACM	Director Aviation Capability Management
DAS-AR	Defence Aviation Safety - Annual Reviews

ACRONYM	DEFINITION
DASA	Defence Aviation Safety Authority
DASM	Defence Aviation Safety Manual
DASP	Defence Aviation Safety Program
DASR	Defence Aviation Safety Regulation
DAVNOPS	Directorate of Aviation Operations
DFSB	Defence Flight Safety Bureau
DG	Director General
DH	Decision Height
DMS	Display Management System
DOPAW	Director of Operational Airworthiness
DRM	Deliberate Risk Management
DSAM	Defence Aviation Safety Analysis Model
DSTG	Defence Science and Technology Group
ECC	Emergency Coordination Centre
EFB	Electronic Flight Bag
EFS	Emergency Flotation System
EMCON	Emission Control
Ex	Exercise
FAA	Federal Aviation Administration
FARP	Forward Arming and Refuelling Point
FCC	Flight Crew Checklist

ACRONYM	DEFINITION
FCS	Flight Control System
FDR	Flight Data Recorder
FEG	Force Element Group
FLIR	Forward Looking InfraRed
FMS	Flying Management System
FMP	Full Mission Profile
FoR	Field of Regard
FOW	Flight Over Water
FND	Flight Navigation Display
FOV	Field of View
FP	Flying Pilot
FP	Feet
FRED	Fast Roping and Extracting Device
FTAG	Flying Training Advisory Group
FTS	Flying Training School
G	Gravity
GFE	Ground Force Elements
H/C	Helicopter
HATS	Helicopter Aircrew Training System
HIET	Helicopter Insertion and Extraction Techniques
HMAS	His Majesty's Australian Ship

ACRONYM	DEFINITION
HMI	Human Machine Interface
HMSD	Helmet Mounted Sight and Display
hr	Hour
HTA	Hazard Tracking Authority
HQ	Headquarters
IAM	Institute of Aviation Medicine
IATA	International Air Transport Association
IAW	xx In Accordance With
ICAO	International Civil Aviation Organisation
IET	Initial Employment Training
IF	Instrument Flight
IIT	Image Intensifier Tubes
IMC	Image Intensifier Tubes
IMPS	Integrated Management Platform System
IP	Initial Point
IPC	Intermediate Pilots Course
IPP	Integrated Program Plan
IPT	Integrated Physiological Trainer
IR	Infrared
IR-APALS	Infrared-All Purpose Adhesive Light Strips
JD	Joint Directive

ACRONYM	DEFINITION
JHS	Joint Helicopter School
JOC	Joint Operations Command
JTF	Joint Task Force
K	Kilo
kg	Kilograms
kHz	Kilonewtons
KIAS	Knots Indicated Air Speed
kN	Kilonewtons
KPI	Key Performance Indicator
LED	Light-emitting Diode
LH	Left-hand
LHS	Left hand side
LPFC	Low Profile Flotation Collar
LZ	Landing Zone
LMP	Learning Management Package
LOS	Line of Sight
LT	Lieutenant
mb	Millibars
MAO	Military Air Operator
MAO-AM	Method of Assessing Pilot Performance
MAOC	Military Air Operator Certificate

ACRONYM	DEFINITION
MAPP	Method of Assessing Pilot Performance
MFD	Multi-Function Display
MLG	Main Landing Gear
mLx	mililux
ms	Millisecond
MRH	Multi Role Helicopter
MRGB	Main Rotor Gear Box
MRP	Mission Risk Profile
NATO	North Atlantic Treaty Organisation
NFH	NATO Frigate Helicopter
NFP	Non Flying Pilot
NH	NATO Helicopter
nm	Nautical Mile
NOE	Nap of Earth
NPA	NPA
NSW	NSW
NTS	Non-Technical Skills
NVD	Night Vision Devices
NVIS	Night Vision Imaging System
OC	Officer Commanding
OCS	Operations Compliance Statement
OEM	Original Equipment Manufacturer
OIP	Orders, Instructions and Publications
OPHAZ	Operational Hazard Report
OPS	Operations
OPCON	Operational Control
OPEVAL	Operational Evaluation
ORO	Organisation Requirements for Air Operations
OTCRM	Operational Technical Combined Risk Management
PAARM	Professional ADF Aviators Reference Manual
PEX	Project Excalibur
PFCS	Primary Flight Control System
PM	Pilot Monitoring
PMG	Pacific Marine Group
PSGC	Primary Survival Gear Carrier
QAI-A	Qualified Aircrewman Instructor - Category A
QFI	Qualified Flying Instructor
QLD	Queensland
QM	Quality Manager
QRP	Quick Release Pack
RAAF	Royal Australian Air Force
RADALT	Radar Altimeter

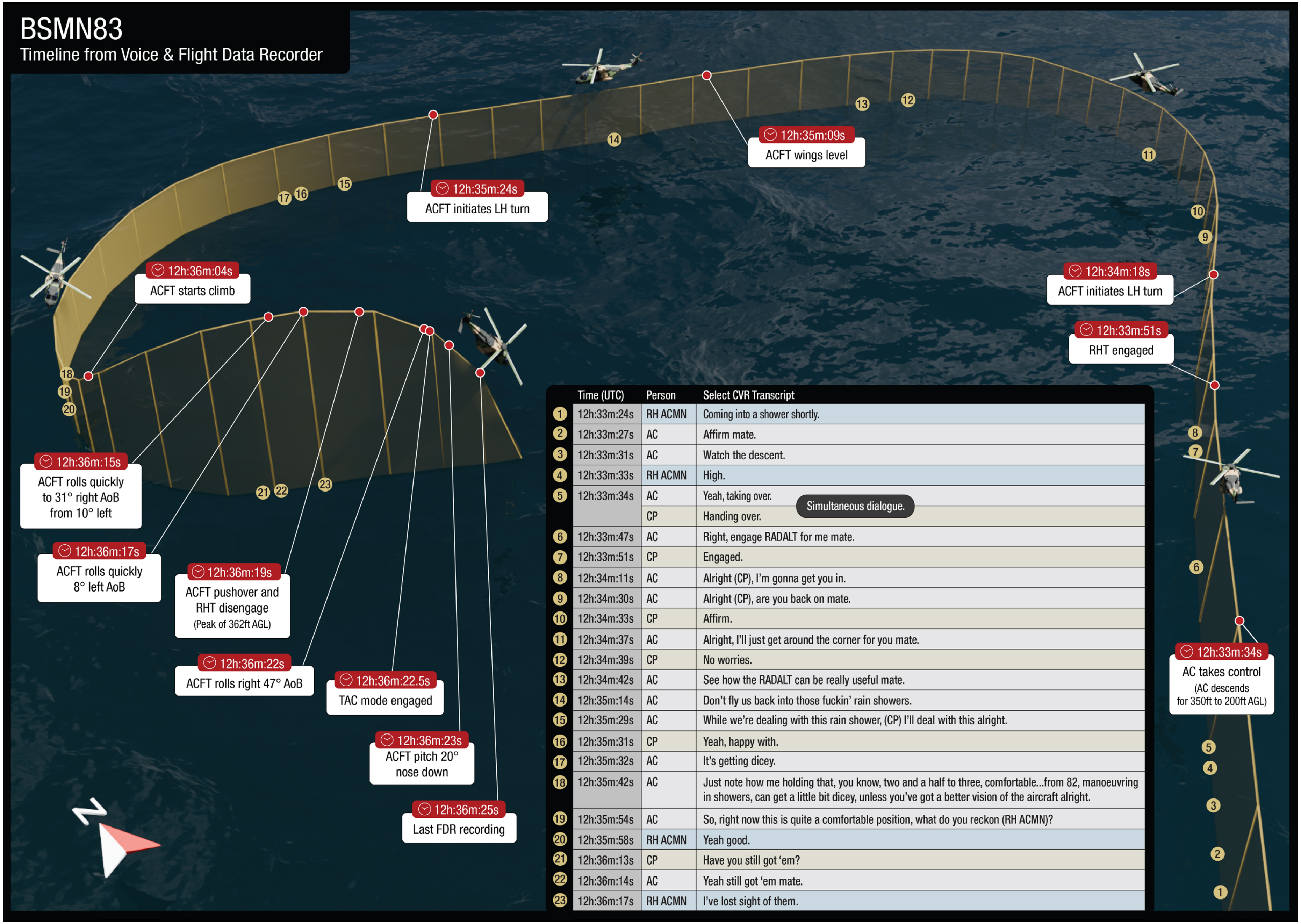
ACRONYM	DEFINITION
RADAR	Radio Detection and Ranging
RAN	Royal Australian Navy
RD	Rotor Diameter
RDB	Risk Decision Brief
REM	Rapid Eye Movement
RH	Right-hand
RHS	Right-hand side
RHT	Radar Height
RM	Risk Management
RMA	Risk Management Authority
RMP	Risk Management Plan
RNZAF	Royal New Zealand Air Force
ROBC	Regimental Officer Basic Course
RoC	Rate of Climb
ROC	Rehearsal of Concept
RoD	Rate of Descent
RSTDO	Regiment Standards Officer
RSTWO	Regiment Standardisation Warrant Officer
SA	Situation Awareness
SAA	School of Army Aviation
SAC	Scene of Action Commander

ACRONYM	DEFINITION
SAR	Search and Rescue
SAS	Stability Augmentation System
SAVMO	Senior Aviation Medical Officer
SCAS	Stability and Control Augmentation System
SD	Spatial Disorientation
SFARP	So-Far-As-Reasonably-Practicable
SI	Standing Instruction
SI(SAF)	Standing Instruction (Safety)
SLAP	Solar Lunar Almanac Prediction
SME	Subject Matter Expert
SMS	Safety Management System
SOP	Standard Operating Procedure
SO	Special Operations
SO1	Staff Officer Level 1
SO2	Staff Officer Level 2
SOAS	Special Operations Air Squadron
SOCOMD	Special Operations Command
SOF	Special Operations Forces
SOQC	Special Operations Qualification Course
SOIU	Statement of Operating Intent and Usage
SPI	Safety Performance Indicator

ACRONYM	DEFINITION
SPT	Safety Performance Target
SR	Service Release
STANMAN	Standards Manual
SQN	Squadron
TAC	Tactical
TAF	Terminal Area Forecast
TECHCON	Technical Control
TIP	Training Implementation Plan
TO/HO	Take Over/Hand Over
TOT	Time on Target
TPCOMD	Troop Commander
TRGB	Tail Rotor Gear Box
TRS	Training Requirements Specification
TS	TALISMAN SABRE
TTH	Tactical Transport Helicopter
UA	Unusual Attitude
ULB	Underwater Locator Beacon
UK	United Kingdom
UPRT	Upset Prevention and Recovery Training
US	United States of America
UTAP	Unit Training and Assessment Program

ACRONYM	DEFINITION
UTC	Coordinated Universal Time
VFDR	Voice and Flight Data Recorder
WASC	Wing Aviation Safety Committee
WHS	Work Health and Safety
WO2	Warrant Officer Class 2
Z	Zulu

ANNEX E: TIMELINE OF EVENTS – LAST 3 MINUTES



	Time (UTC)	Person	Select CVR Transcript
1	12h:33m:24s	RH ACMN	Coming into a shower shortly.
2	12h:33m:27s	AC	Affirm mate.
3	12h:33m:31s	AC	Watch the descent.
4	12h:33m:33s	RH ACMN	High.
5	12h:33m:34s	AC	Yeah, taking over. (Simultaneous dialogue.)
		CP	Handing over.
6	12h:33m:47s	AC	Right, engage RADALT for me mate.
7	12h:33m:51s	CP	Engaged.
8	12h:34m:11s	AC	Alright (CP), I'm gonna get you in.
9	12h:34m:30s	AC	Alright (CP), are you back on mate.
10	12h:34m:33s	CP	Affirm.
11	12h:34m:37s	AC	Alright, I'll just get around the corner for you mate.
12	12h:34m:39s	CP	No worries.
13	12h:34m:42s	AC	See how the RADALT can be really useful mate.
14	12h:35m:14s	AC	Don't fly us back into those fuckin' rain showers.
15	12h:35m:29s	AC	While we're dealing with this rain shower, (CP) I'll deal with this alright.
16	12h:35m:31s	CP	Yeah, happy with.
17	12h:35m:32s	AC	It's getting dicey.
18	12h:35m:42s	AC	Just note how me holding that, you know, two and a half to three, comfortable...from 82, manoeuvring in showers, can get a little bit dicey, unless you've got a better vision of the aircraft alright.
19	12h:35m:54s	AC	So, right now this is quite a comfortable position, what do you reckon (RH ACMN)?
20	12h:35m:58s	RH ACMN	Yeah good.
21	12h:36m:13s	CP	Have you still got 'em?
22	12h:36m:14s	AC	Yeah still got 'em mate.
23	12h:36m:17s	RH ACMN	I've lost sight of them.

ANNEX F: ACKNOWLEDGEMENTS

DFSB were supported during the immediate investigation activities and analysis by a number of organisations or subject matter experts. These organisations included:

- The Australian Transport Safety Bureau provided on-site VFDR retrieval, wreckage recovery and analysis support, VFDR analysis, and provided peer review of the investigation
- Defence Science and Technology Group provided technical support to the ASIT during wreckage recovery and analysis, as well as VFDR analysis
- Aviation Life Support Logistic Management Support Unit supported retrieval and analysis of Life Support Equipment
- Joint Personnel Recovery who provided on-site support to the investigation
- QLD Police for on-site, investigation, logistics, facilities and dive support
- HMAS *Huon* for on-site and dive support
- ADV Reliant for on-site support
- Pacific Marine Group Emerald who supported the recovery of wreckage
- AMSA who provided on-site and facilities support to the ASIT
- 5AVN provided support to the ASIT for wreckage identification, recovery and transport
- JOC who provided administration and logistical support to the ASIT during the site-phase
- HMAS *Harman* who provided logistical and facilities support to the ASIT
- Airbus Australia supported the ASIT with technical wreckage analysis and VFDR analysis
- NHIndustries provided VFDR analysis
- IAM conducted the Medical and Pathological investigation of BSMN 83 aircrew
- Sensatory Pty Ltd, who provided subject matter expertise on Spatial Disorientation
- Royal New Zealand Air Force Defence Aviation Safety Bureau who provided support to the ASIT
- Joint Military Police Unit, who provided technical data support to the ASIT
- Army Aviation Training Centre, who provided MRH-90 flight test pilot subject matter expertise, including simulator trials, and the recreation of flight path and control inputs
- Members of Army who provided subject matter expertise across multiple areas of the investigation

DFSB would like to formally acknowledge the support and expertise of these individuals and organisations, without which the investigation could not have been completed.

ANNEX G: BUSHMAN 83 CREW QUALIFICATIONS, EXPERIENCE & RECENCY

ITEM	AC	CP	RH ACMN	LH ACMN
Rank	CAPT	LT	WO2	CPL
Date Last medical	14-Jul-23	24-Apr-23	13-Mar-23	30-Jun-23
Category	B[122]	C[123]	QAI-A[124]	C[125]
Date Last Category Check	22-Nov-22	16-Jul-23	22-Nov-21	28-Jun-23
Date Last Instrument Rating	22-Feb-23	31-Aug-22	-	-
Special Operations (SO) Qualification	SO CAPT	SO Co-pilot	SO Instructor	SO Junior
SO Qualification Date (MRH-90)	30-Nov-22	30-Jun-23	22-Nov-21	22-Nov-22
Total Flight Hours	1731.6	576.2	3470.1	691.4
Total Flight Hours on MRH-90	1399.0	383.6	371.0	653.4
Total Captain Hours	514.0	7.4	-	-
Total Captain Hours on MRH-90	445.6	5.0	-	-
Total Hours Last 30 Days	21.3	32.2	26.7	16.7
Total Hours Last 7 Days	10.9	14.0	5.0	8.0
MRH-90 NVD Mission Command Qualification Date	16 Mar 17	-	-	-
MRH-90 NVD Mission Restricted Qualification Date	-	28 Apr 22	-	-
MRH-90 NVD Aircrewman Qualification Date	-	-	28 Sep 21	24 Sep 20

122 As per Reference H, a Category B Pilot is 'Highly Proficient – Mission Ready Captain. Competent to perform selected Brigade/Unit Training Assessment Plan (BTAP/UTAP) specified mission tasks.' Privileges include,'May mentor, training and assess aircrew on the application of technical and non-technical skills to achieve aviation mission task/s once a qualification from SI(AVN) OPS 2-105 or 2-108 is gained. May mentor and assess mission planning and execution on tasks defined by the Operating Unit CO.'

123 As per Reference H, a Category C Pilot is a 'Proficient – Mission Ready Co-pilot. Competent to perform BTAP/UTAP specified mission tasks.'

124 As per Reference I, a Category A, 'Qualified Aircrewman Instructor (QAI) has the privilege to instruct and standardise Instructors, and manage the flying standardisation system. They have been assessed as competent IAW an approved course of training to instruct AIT.'

125 As per Reference I, a Category C ACMN, 'Is competent (Proficient) to perform selected Formation/UTAP specified mission tasks, and may supervise Category D ACMN.'

ITEM	AC	CP	RH ACMN	LH ACMN
Total Hours Night Vision Devices (NVD)	373.6	120.2	1163.2	261.4
% of NVD flight v Total Flight Hours	21.6%	20.8%	33.5%	37.8%
Total Hours NVD on MRH-90	353.8	95.4	124.6	250.3
Total Hours Last 30 Days NVD	3.7	6.9	15.0	3.5
Last Night Flight (NVD)	17-Jul-23	25-Jul-23	27-Jul-23	20-Jul-23
Last Formation Flight (NVD)	30-Jun-23	30-Jun-23	27-Jul-23	27-Jun-23
Total Instructor Hours	-	-	1023.0	-
Total Instructor Hours on MRH-90	-	-	123.5	-
Total Instrument Flying (IF) Actual[126] hours on MRH-90 (aircraft and simulated)	86.6	39.8	-	-
IF Actual Hours Last 90 Days	4.3	8.4	-	-
Date Last Annual Sim Development Training	26-Jun-23	14-Sep-22	-	-

126 Instrument Flight (Actual): flying time when the aircraft cannot be controlled by reference to a visual horizon and all manoeuvres are carried out solely by reference to instruments.

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DEFENCE FLIGHT SAFETY BUREAU

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