SPECIAL EDITION: THE HOW AND WHY

SUMMARISING DFSB'S RECENT INVESTIGATIONS

03 2023 EDITION

# Spotlight

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# FOREWORD

**THE *SPOTLIGHT* INVESTIGATION Special is one of the key mechanisms by which investigation reports are communicated broadly to Defence Aviation organisations and supporting enterprises. This edition of the *Spotlight* Investigation Special includes Aviation Safety Investigation Reports of serious and complex investigations completed by both the Defence Flight Safety Bureau and Defence Aviation Commands.**

The sequence of events leading to an aviation accident or serious incident often begins with latent failures or latent conditions of organisational processes, such as management decisions associated with planning, scheduling, designing, specifying, communicating and regulating. Organisational conditions can manifest in the workplace as local conditions, such as fatigue, high workload, ineffective supervision, inadequate training systems, and lack of knowledge and skills. Without detailed and robust risk-management systems and processes, an individual or team's performance may be negatively impacted through the lack of identification of hazard sources and implementation of preventative and recovery risk controls to manage organisational hazards and adverse local conditions, which ultimately sets the conditions for 'unsafe acts' – errors or violations.

Investigating aviation safety events and sharing the findings could help prevent further occurrences and enhance safety, while not apportioning blame or liability. An aviation safety investigation is the basis for initiating the actions necessary to improve aviation safety; therefore, the investigation must not only establish what happened, but also how and why it happened. It is essential that the investigation identifies, thence enables, remediation of local and systemic deficiencies and improvement of risk controls in order to prevent recurrence or to prevent a risk or hazard from being realised.

I encourage supervisors and managers to reflect upon organisational pressures placed on the workforce, analyse the suitability of organisational-level risk-management systems and processes and develop a detailed understanding of the local conditions upon which the workforce is conducting Defence Aviation operations. Ultimately, it is important to note that the origins of unsafe acts often lie in management systems and decisions, not within the individuals who performed the unsafe acts.

Very respectfully and kind regards,

**Group Captain David Smith**
**Director DFSB**

# CONTENTS

**In striking distance**
A Black Hawk hits a ship's mast twice during an exercise with ground force elements fast roping to the deck. **Page 28**

**Blinded by the light**
During a night-vision-device (NVD) recovery to HMAS *Brisbane*, aircrew experienced visual blooming, which led to an MH-60R ditching into the ocean. **Page 4**

**Flash of grey in the canopy**
Two FA/18F Super Hornets got too close in high-aspect air-combat manoeuvring. **Page 8**

**Unstable old fuel**
Degraded fuel in a vintage aircraft that had been in storage created firey consequences. **Page 12**

**Hot gun has crew over a barrel**
Intense firing from a hovering helicopter performing important training leads to an overheated barrel. **Page 18**

**Balancing safety and courtesy**
Different expectations from partner nations during an exercise led to a very close call. **Page 22**

**Zoned out**
A P-8A performing low-level passes near a frigate led to a ship control zone incursion and near-collision with an MH-60R. **Page 32**

**On the range**
Limited communication created the circumstances for a close call as a quad bike was on a range during a live-fire exercise. **Page 36**

**Unexpected failure**
Hydraulic fluid under pressure discharged from the flap drive system of a C-130J. **Page 38**

**Abnormal readings**
A poor connection in a wheel well created a fuel over-read in a Hawk 127. **Page 41**

**Lack of restraint**
An incorrectly assembled Restraint Quick Release System could have led to serious consequences for aircrew. **Page 44**

**Unrestricted**
Without a shared mental model and with limited commincation, ATCs lost separation assurance between a Dash-8 and a KC-30 while trying to clear a track for a medical evacuation helicopter.
**Page 46**

RAN crew survives, helicopter unrecoverable after CFIT

# Blinded by the light

This accident was termed by the Director Defence Flight Safety Bureau (DFSB) at the time as a case study in cumulative risk and the aggregation of latent failures. This essentially means that the accident was a result of many hazards and hidden risk-control failures in two separate systems that, when combined on that night, produced the outcome. Up front I would like to recognise and thank the investigation team members for their hard work and dedication. Detailed analysis was needed to produce the recommendations that are designed to reduce the likelihood of a similar event recurring in the ADF.

CMDR DOM COOPER, DEPUTY DIRECTOR – INVESTIGATIONS, DFSB

**A ROYAL AUSTRALIAN NAVY (RAN) helicopter was conducting a night vision device (NVD) recovery to HMAS *Brisbane* in the Philippine Sea in late 2021 when the aircrew experienced NVD blooming, lost all visual reference with the ship, and impacted the water.**

The aircrew of the MH-60R Romeo Seahawk launched for a single aided circuit on NVD on the evening of 13 October. At 150 feet during the final approach descent of the circuit, the aircrew members were subjected to an infrared (IR) illumination from the ship, which distracted them, and ultimately led to a Controlled Flight Into Terrain (CFIT). The three aircrew members successfully escaped the aircraft with only minor injuries and were recovered by HMAS *Brisbane*'s ship's boats 43 minutes after impact. The helicopter sank within minutes of hitting the water to an unrecoverable depth.

Commanding Officer HMAS *Brisbane* provided a foreword for the investigation report. 'The traumatic events of 13 October 2021 are a reminder of the inherent hazards of operating at sea … HMAS *Brisbane* and Flight 2 had the best possible outcome from a worst-case situation,' he wrote.

## The investigation

The DFSB Aviation Safety Investigation Team (ASIT) determined that this Class A aviation safety event was a genuine organisational accident. There was no singular individual action, local condition, absent risk control or organisational influence that solely caused the sequence of events that night.

Rather, many contributing factors coalesced to erode the considerable number of safeguards in place, enabling escalation to an accident. These contributing factors were grouped in the investigation report into six safety-problem categories: pre-launch considerations, actions pre-accident, CCTV IR illuminator activation, search and rescue, and safety and risk management.

## Pre-launch considerations

Before the aircraft launched for the single circuit there were a number of factors that set the pre-conditions for the accident, as identified by the ASIT.

The weather had deteriorated significantly from the forecast, and there were also a series of unplanned delays, including failure of the ship's glide slope indicator, difficulties remaining within ship-helicopter operating limits and a leaking hatch that was considered a risk to the ship's power generation. These delays led to the cancellation of the aircraft's intended mission; however, due to concerns for aircraft serviceability if left in the elements, the decision was made to launch for a single circuit to allow the aircraft to be traversed into the hangar.

Putting the aircraft into the hangar was not possible without launching due to an inability to engage the aircraft into the ship-helicopter secure and traverse system while the aircraft was on the deck. The ASIT found that this is a known capability risk and unique to the Hobart class of ship.

While waiting to launch for the single circuit, the aircrew members were subjected to their first IR illumination from a CCTV camera mounted above the helicopter control section. The aircrew requested its deactivation and the IR illuminator extinguished a short time later.

The ASIT discovered that the deactivation was a coincidence, and not the result of the aircrew members' request; however the crew did not know it at the time. This activation and deactivation set up a critical and erroneous mental model among aircrew members about the degree of control they had over their environment and was a critical factor, impacting aircrew action later.

## Actions pre-impact

While on the final approach to *Brisbane*, the aircrew again experienced an IR illumination from the same CCTV camera. This caused a significant distraction for aircrew members in flight, removing their primary visual reference with the ship through NVG.

As the same CCTV IR activation occurred pre-launch, the aircrew did not conduct an overshoot, instead elected to continue the approach and request deactivation of the IR illuminators, which was expected to occur quickly as it had before the launch. However, the illuminator remained on this time and the distraction it caused allowed an increasing aircraft rate of descent to go unnoticed, culminating in CFIT 19 seconds after the IR illuminator's activation.

Although a significant contributor to this specific accident, the distraction of the IR illuminator could be substituted with several possible 'on finals' challenges faced by aircrew.

> This set-up a critical and erroneous mental model among aircrew members about the degree of control they had over their environment …

The ASIT determined that this distraction was ineffectively mitigated due to the aircrew's preconceptions as well as a combination of sub-optimal rules, training, cognitive workload and application of non-technical skills. The combined effect of these factors impacted aircrew decision-making effectiveness in the 19 seconds from distraction to impact.

In the Aviation Safety Investigation Report (ASIR), the ASIT determined that the actions of the aircrew members would pass the substitution test; that is, given a different aircrew, subjected to the same circumstances, the ASIT could envisage the event escalating to an accident in the same way.

### CCTV IR illuminator activation

The ASIT found that both activations of the IR illuminator (pre- and post-aircraft launch) were initiated by a member in the ship's platform control room.

The member's decision to activate the IR illuminator was not made with an intent to compromise safety, but to improve the visual acuity being displayed on internal CCTV monitors. The member was not aware of the impact of IR on NVD or how this could affect flight safety.

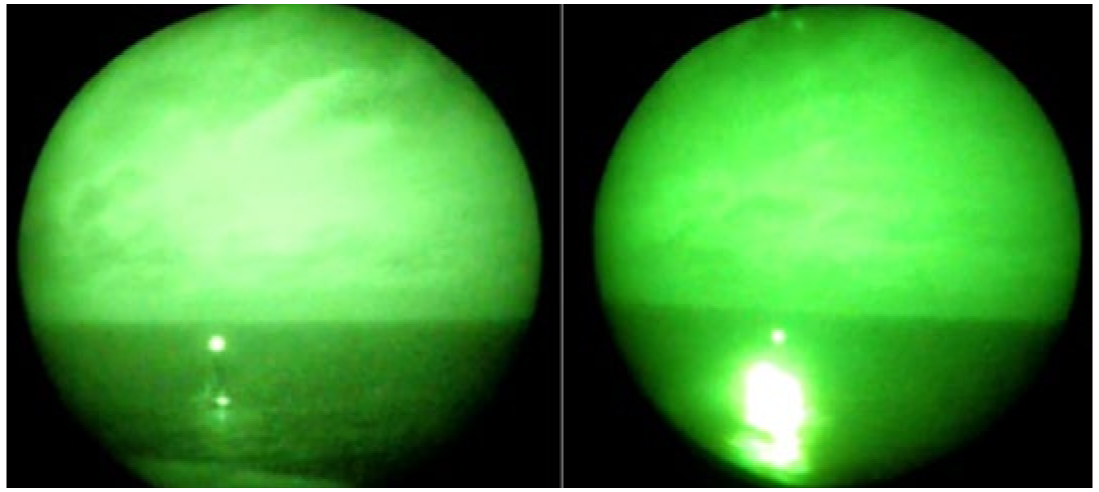
The effect of the CCTV IR illuminators was a known hazard first identified at the 2018 Hobart first of class flight trial (FOCFT) and subsequently the cause of several reported and unreported aviation-safety-related blooming events, prior to the accident.

The hazard of incompatible ship's lighting was already identified in organisational risk-management documentation; however, sub-optimally controlled.

### Search and rescue

The aircrew successfully escaped the aircraft and was rescued by *Brisbane* 43 minutes after impact. The search-and-rescue phase of the accident was, by definition, not causal and therefore not analysed to the same depth as the pre-impact factors. Although a review of this phase of the accident did identify several opportunities for safety improvements that would reduce time to rescue.

Training, doctrine and adherence to checklist guidance were elements that impacted the performance of the search and rescue. Given the weaknesses identified in Fleet-supporting doctrine and aviation emergency risk-management documentation, the ASIT considered that the actions of *Brisbane* pass the substitution test. As with the incident itself, faced with the same pre-conditions the ASIT could envisage similar



Effect of IR illuminator on NVGs

CCTV screenshot before, during and after activation of IR illuminator pre-accident

safety problems arising were this to have occurred on a different ship.

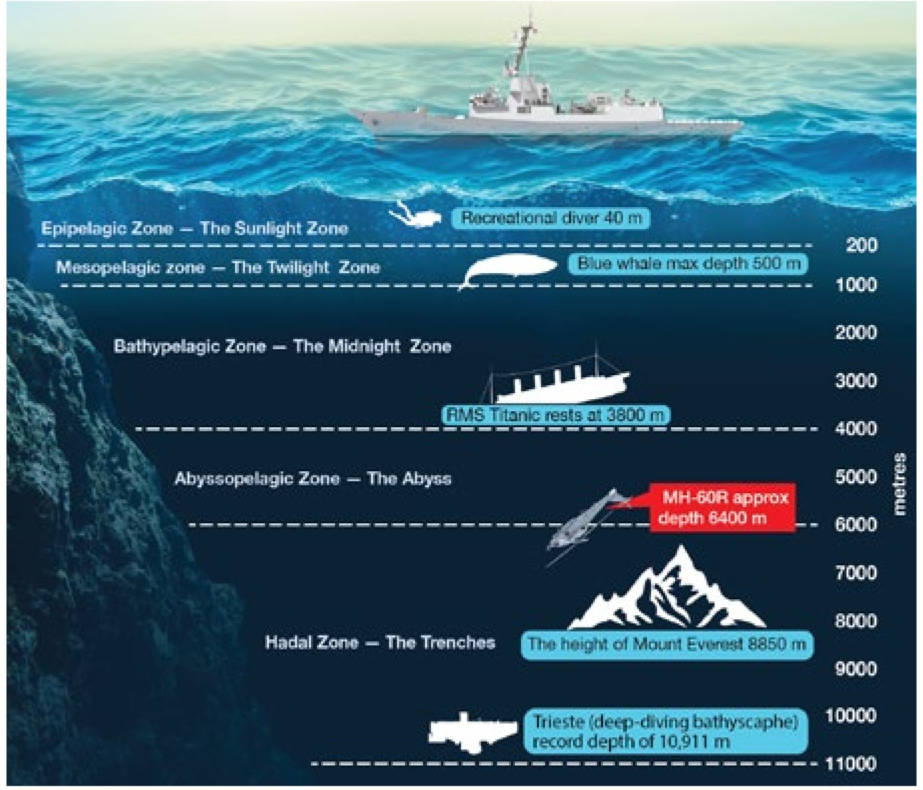
Escape training executed by the accident aircrew and the ditched helicopter response from *Brisbane* saved the lives of three ADF members. This is an overwhelmingly positive aspect of the accident but should not overshadow the opportunity to learn and improve.

As a direct result of this accident, the FAA has already taken action, using the experiences of the incident crew to improve underwater escape training for all aircrew.

### Safety and risk management

The ASIT observed two significantly different levels of safety and risk-management maturity between the aviation and Fleet documentation within Navy. These differences create the potential for structural and information gaps when operations require their systems to interface.

Overall, fleet and aviation risk-management documentation lacked depth and relied heavily on administrative controls. The review of prior aviation safety events with significant similarities to this accident also indicated deficiencies with hazard-tracking effectiveness, in particular where cross-force hazard-tracking authority functions are required.




Depth of wreckage

This accident occurred at the interface of ship-helicopter operations and spans several separate, complex, dynamic and interconnected RAN commands. The report only scratches the surface of the complexity inherent to ship-helicopter operations and is therefore intended to provide a catalyst for cross-command introspection and continued discourse on safety improvement.

The aircrew successfully escaped the aircraft and was rescued by *Brisbane* 43 minutes after impact.

# Flash of grey in the canopy

**IN LATE 2022, a formation of three F/A-18F Super Hornets were conducting a high aspect-air combat manoeuvring (HA-ACM) training mission as part of the F/A-18F Operational Conversion (OPCON) course syllabus. During the commencement of the first training serial (the 'set-up'), a near-collision occurred between Super Hornet 1 (SH1) and Super Hornet 2 (SH2). At the closest point of approach of 186 feet, neither aircrew in SH1 or SH2 was aware of the other aircraft's relative position nor proximity until they saw 'a flash of grey in the canopy'. At this point, no remaining risk controls were available to prevent a mid-air collision.**

## The event

Once established in the southern portion of the airspace, and finding an area clear of cloud suitable for the manoeuvres, the formation prepared for the first set of the Airborne Exercise (Airex).

This initial set was a demonstration of HA-ACM to be flown by SH2B (A denotes front-seat occupant, B denotes back-seat), whereby the instructor pilot (IP) would fly the aircraft and demonstrate the sequence, providing direction of attention and key-words to the trainee throughout the manoeuvres.

The set-up commenced from a reference heading of 90°. SH1A directed SH3 to 'outwards turn go', at which point SH3 began a turn through 45° to the right, accelerating to slightly over the intended airspeed start parameters of 400 kts.

After directing the outwards turn, SH1A commenced the 'ready comm', which is when the three aircraft state they are ready to begin the set-up, one after the other. SH1A then directed SH1 and SH2 to accelerate to 400 kts, prior to SH3 turning back to a heading of 90° to parallel SH1 and SH2's track.

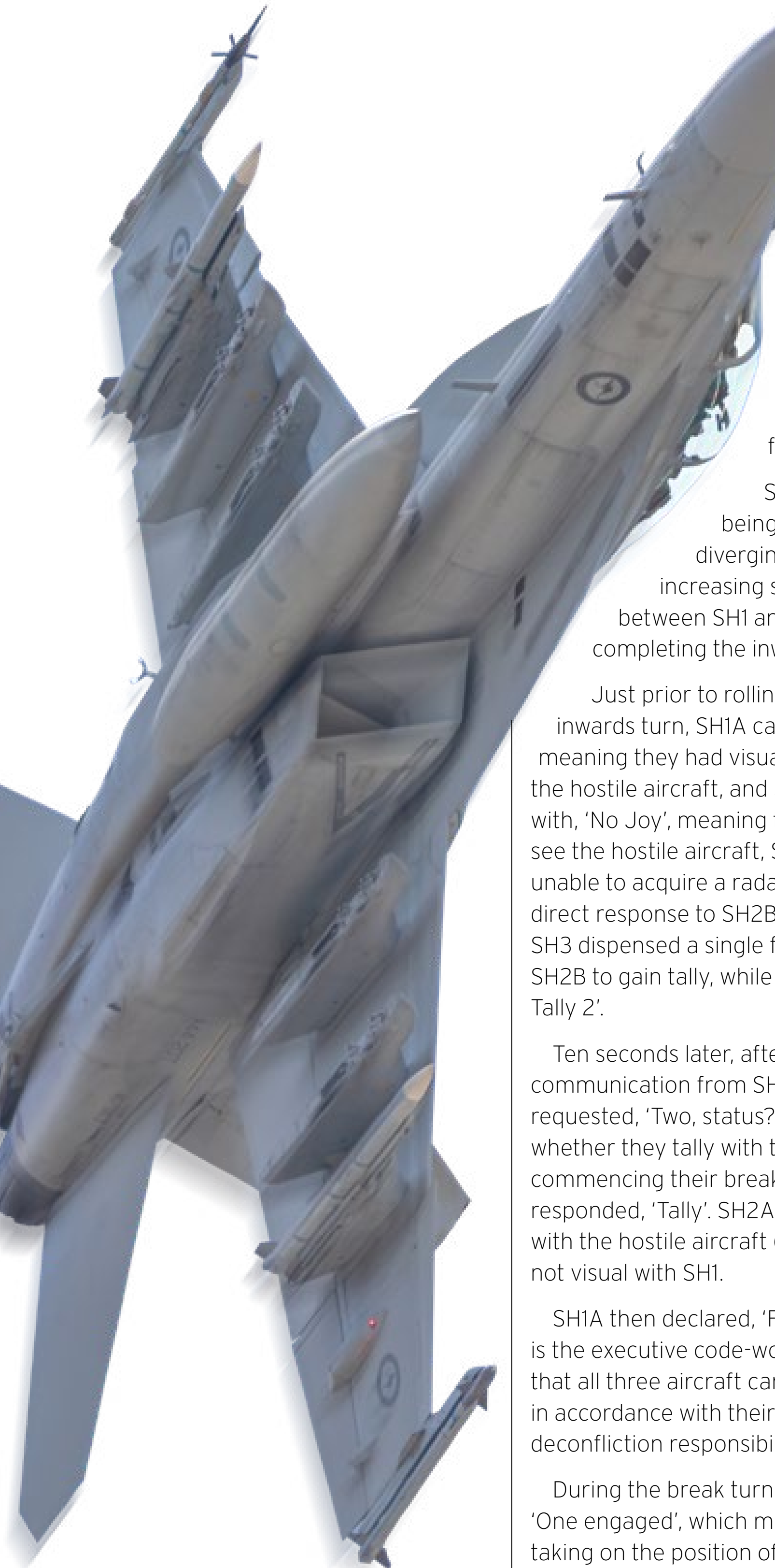
SH3 was 4.4 nm from SH1 after returning to a heading of 90° and reduced speed to below 400 kts as a result of being slightly swept forward of SH1.

With a 'wing flash' SH1A initiated the inwards turn, a brief roll in the direction of the intended turn, rapidly bringing wings back to level, at which point SH2B flew a 4G right turn through 90°, rolling out wings level heading 180°.

SH1 then commenced an inwards turn based on SH2's positioning, and simultaneously directed SH3 to commence the inwards turn. SH1 flew the turn at approximately 3G, rolling out wings level heading 170°.

SH2B recalled that their last scan to SH1's position was upon rolling out heading 180°. SH2B recalled that they noted a tactical aerial navigation system (TACAN) split range of 1.4 nm from SH1, and although being slightly wider than planned (1.2 nm), SH2B stated that

During the break turn, SH2B did not regain visual with SH1, and did not communicate to the formation that they were no longer visual with SH1.



they intended to continue the demonstration for the trainee.

SH1 reported not being aware of the diverging headings and increasing spread distance between SH1 and SH2 after completing the inwards turn.

Just prior to rolling out from the inwards turn, SH1A called, 'Tally 1', meaning they had visual reference with the hostile aircraft, and SH2B responded with, 'No Joy', meaning they could not see the hostile aircraft, SH3. SH2 was unable to acquire a radar lock on SH3. In direct response to SH2B's 'No Joy' call, SH3 dispensed a single flare to assist SH2B to gain tally, while also calling 'SH3 Tally 2'.

Ten seconds later, after no further communication from SH2B, SH1A requested, 'Two, status?', which asks whether they tally with the hostile. While commencing their break turn, SH2B responded, 'Tally'. SH2A was now tally with the hostile aircraft (SH3), but was not visual with SH1.

SH1A then declared, 'Fight's on'. This is the executive code-word indicating that all three aircraft can manoeuvre in accordance with their roles and deconfliction responsibilities.

During the break turn, SH1A stated, 'One engaged', which means SH1 is taking on the position of the engaged fighter, primarily responsible for engaging in a dog-fight with the hostile, to which SH2B responded, 'Two, Press'. This means SH2 was adopting the role of the Free Fighter, and in doing so, taking responsibility for deconfliction from both SH1 and 3.

During the break turn, SH2B did not regain visual with SH1, and did not communicate to the formation that they were no longer visual with SH1.

The trainee (SH2A) also lost visual with SH1 after the inwards turn, and did not communicate this fact to their IP as SH2B commenced the break turn.

SH2B stated over the internal communication system (ICS) to SH2A, 'Line of sight one … two'. These were key-words that implied to the trainee that SH2B was tally and visual with the other two aircraft, furthering the trainee's understanding that SH2B was tally and visual with the other two aircraft, and commenced manoeuvring into the vertical, thus departing from the 1000 ft low-altitude 'sanctuary'.

As SH1 reversed turn direction in accordance with the scripted fight with SH3, and as SH2B pulled through approximately 45° nose up, the near collision between SH1 and SH2 occurred.

The aircrew in each aircraft reported seeing a 'flash of grey' in their respective canopies. This moment of the closest point of approach was the first time any of the four aircrew were aware of their proximity to each other.

SH1A immediately stated, 'Knock it off', – meaning cease tactical manoeuvring – over the radio, with SH2 and SH3 responding in turn. SH2 continued the climb away from the last known position of SH1.

The formation then discontinued the mission, returning to Amberley without further incident.

Upon return to the training flight operations room, the formation members advised the authorising officer of a breach of the 1000 ft minimum safe distance (MSD, also known as 'the bubble') of 1000 ft. The formation then debriefed the mission using aircraft mission debrief systems ('tapes' and air combat manoeuvring instrumentation systems).

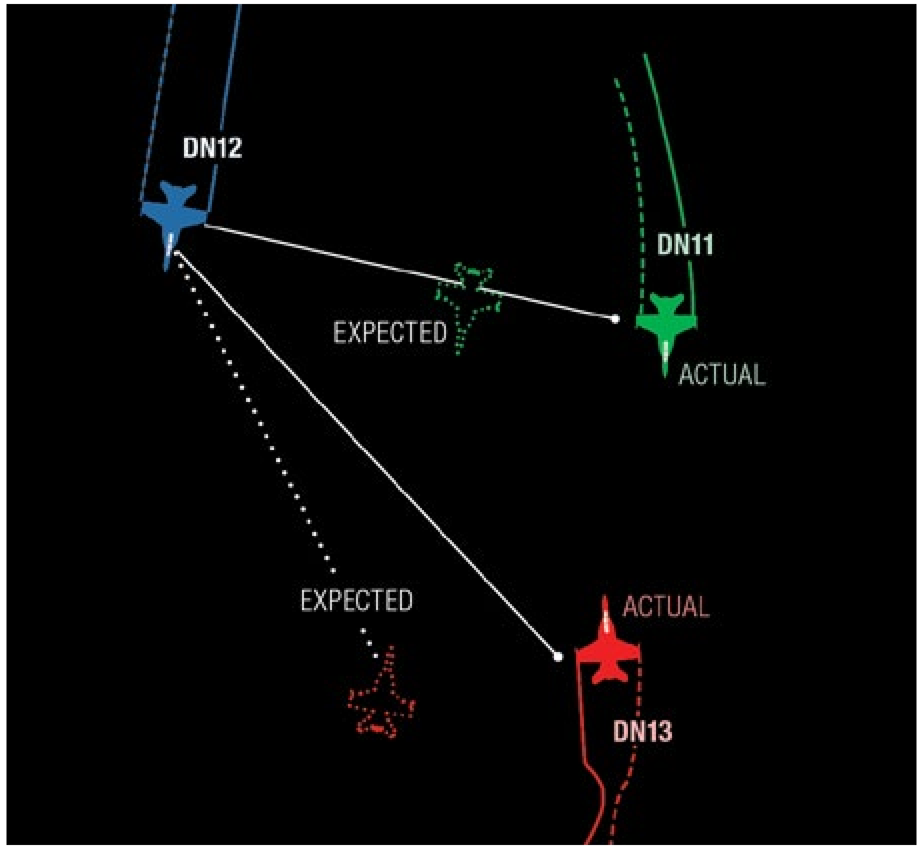
Following the mission debrief, a member raised an ASR in Sentinel and contacted the Defence Flight Safety Bureau Duty Officer to declare a Class B event.

### The investigation

The Aviation Safety Investigation Team (ASIT) identified a formally documented history of the wing's aircrew instructor workforce enduring fatigue and an unsustainable workload prior to and at the time of the event, along with contributory deficiencies in organisational learning practices and processes within the wing.

The ASIT found evidence that there were absent and failed risk controls in the organisation's workplace orders, instructions and publications (OIP), which increased reliance on training flight instructional standardisation points provided to staff members. The ASIT observed that reliance upon standardisation points, over formally documented OIP, contributed to the normalisation of workarounds and a reliance on undocumented knowledge within the training flight. This situation contributed directly to causal variation in mission execution by SH1 and SH2 from standard operating procedures (SOPs) and the mission brief.

The ASIT identified a disproportionate workload placed on the IP in SH2, whose tasking included a total of six secondary duties and senior instructional appointments in addition to their primary duties as an IP. When combined with task completion pressures to achieve a successful training mission, the IP's professional judgement and discipline were overwhelmed momentarily. Motivated to avoid the increased collective workload associated with an unsuccessful mission, the IP,




DN11 and 13 actual vs expcted positioning

as the pilot flying SH2, violated critical deconfliction rules, thus removing the final risk controls preventing a mid-air collision.

The ASIT conclusion summaries that, as is so often the case, an incident of this severity may not have occurred had any element of the interface between various actions and inactions been slightly different. As one witness stated, 'If the set-up had been correct, it probably would have worked'. However, on this occasion the variation in execution of SH1 and SH3 invalidated the assumptions upon which SH2B based their deliberate decision to deviate from their deconfliction contract. These decisions, actions and inactions occurred in the environment of local conditions that set the context of local rationality. The ASIT determined immediate time pressures, compounded by broader course-progression pressures, and a collective awareness of the workload impacts of cancelling a mission, influenced the crews' decision-making on the day.

An absence of effective guidance in procedures, which increased a reliance on subsequently ineffective standardisation (it too, was affected by the workload on the small team), enabled the contributory deviation from SOPs during the event. Underlying all of these individual actions, local conditions, and absent or ineffective risk controls, lies evidence of an organisationally accepted (and repeatedly documented) unsustainable workload for the instructional staff as well as ineffective or absent processes for ensuring organisational learning across the wing.

# Unstable old fuel

**The uncontained engine failure in-flight of heritage aircraft, De Havilland Vampire jet fighter**

**ON 21 OCTOBER 2021, during its first flight in a decade, a Number 100 Squadron Temora Flight De Havilland Vampire jet fighter experienced an uncontained engine failure. The Aviation Safety Investigation Team (ASIT) found that it was virtually certain the engine failure and subsequent fire resulted from the effects of old fuel that was thermally unstable, and very likely the product of some maintenance issues including a non-calendar-based servicing schedule.**

Built in 1951, the event aircraft was delivered to the Central Flying School, RAAF East Sale, on 22 May 1958 and subsequently transferred to Number 1 Advanced Flying Training School, RAAF Pearce. The aircraft was sold in January 1970 and exported to the United States of America.

The Temora Aviation Museum (TAM) acquired and registered the aircraft in 2001, and subsequently it was transferred to the Air Force in 2019 to remain based at Temora aerodrome, under the control of 100SQN.

Temora Heritage Flight (THF) pilots are RAAF personnel comprising current Permanent Air Force (PAF), Air Force Reserve (AFR) active reserve and Specialist Capability Officers (SCO) under the command of Commanding Officer (CO) 100SQN. Of the aircrew employed at Temora, the pilot of the event aircraft was one of only a few pilots to have flown the Vampire before it entered long-term storage, with the last flight by the same pilot, carried out on 29 November 2009. Despite the lengthy period between flights, the pilot was the most experienced person at Temora on this aircraft type and deemed the most appropriate to conduct the return-to-service maintenance-check test flight.

There is no flight data recorder or cockpit voice recorder installed on the event aircraft, nor is there a regulatory requirement to do so. The aircraft had a global positioning system (GPS) fitted in the cockpit with a memory card, however, the GPS and its memory card were not activated prior to the event flight. The ASIT interpreted the status of the flight using footage from a GoPro camera installed within the cockpit to the right of the pilot's shoulder.

In the lead-up to the event, there were periodic ground-runs that utilised a mixture of new and old fuel, the latter likely was subject to systematic ageing and oxidisation over an extended period. These runs were in accordance with original equipment manufacturer (OEM) guidelines.

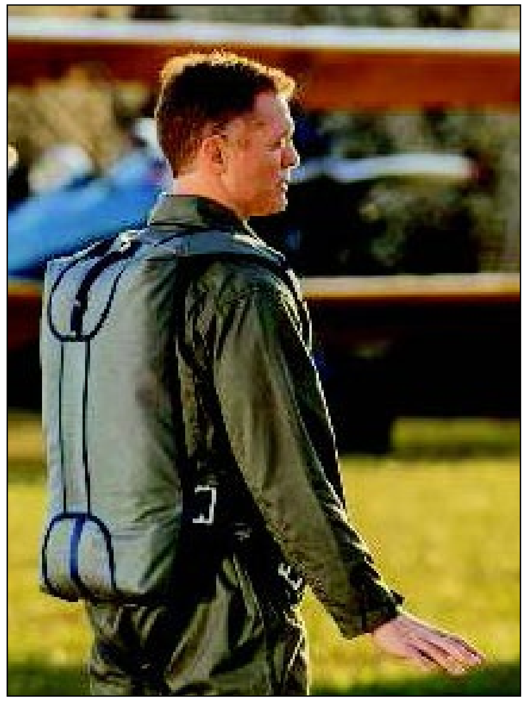
### Ejection seats and parachute

The MK3B ejection seats fitted to the aircraft have been inert since 2015 because Martin-Baker (MB) ceased support for these legacy seats. This was in response to an accident inquiry of a RAF Hawk aircraft in the United Kingdom that demonstrated the potential for liability against MB as part of the investigation. Furthermore, MB no longer supplies ejection-seat cartridges for legacy seats.

The current ejection-seat parachute was also beyond life and therefore unserviceable. Though not prescribed by Civil Aviation Safety Authority (CASA) or Australian Warbirds Association Limited (AWAL), RAAF risk-control measures mandate the need for the use of a parachute consistent with single jet-engine certification requirements when abandoning the aircraft.

The small cockpit makes manual egress in an emergency difficult, particularly when abandoning the aircraft while airborne, because

With an engine issue the likely problem, the pilot elected to conduct a precautionary forced pattern approach to the aerodrome.


Slim-back type emergency parachute

of the potential to strike the aircraft. This means the use of a parachute may not be a practical emergency risk control.

The pilot carried out wearer trials of a slim-back emergency parachute similar to the type depicted above, with the assistance of engineering staff at Temora, in an attempt to mitigate the level of risk if required to bail out from the aircraft.

During interview, the pilot revealed that these wearer trials had consisted of checking the seating position and ability for egress, overall fit, oxygen mounting, operation of aircraft and system controls, and the ability to move comfortably within the cockpit.

Despite the stated conduct of these trials, the ASIT was unable to identify any formal outcomes, nor any verification towards the compatibility for ongoing use of the parachute in the aircraft.

## Sequence of events

At about 10:40 and approximately 2.5 minutes into the flight, the pilot experienced a sudden jolt to the flight controls at around 7000 ft. The pilot assumed that the jolt related to a fault with the securing or locking mechanism of the undercarriage. Initially, the pilot did not comprehend the extent of the engine malfunction and subsequent damage to the aircraft. Ground personnel did not observe or alert the pilot to any damage to the aircraft.

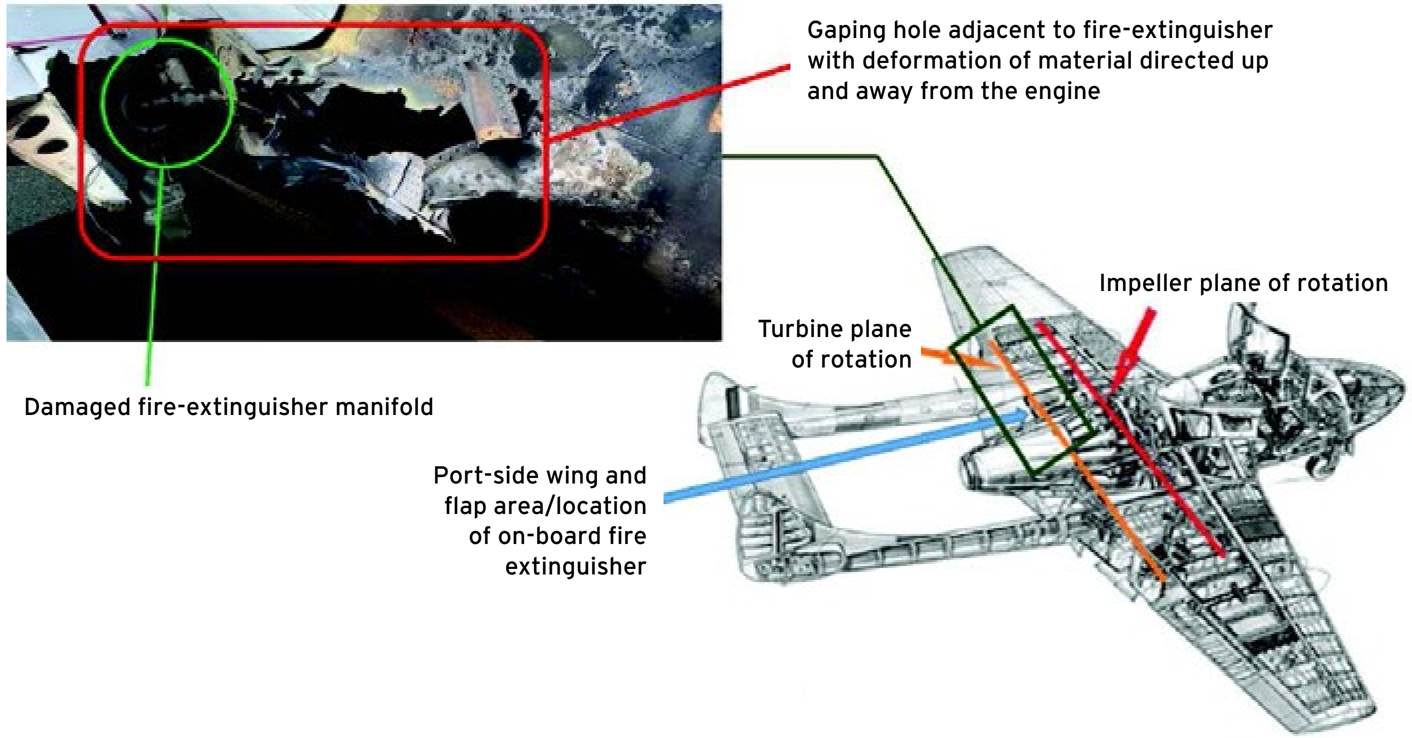
After about 10 minutes, the pilot identified a wind-back of approximately 200 RPM on the gauge. Without an obvious change in engine noise, the pilot thought that the RPM gauge may have been faulty. A momentary engine fire-light indication occurred approximately 30 seconds later, during a 180° turn back to Temora. With an engine issue the likely problem, the pilot elected to conduct a precautionary forced pattern approach to the aerodrome. On landing and coming to a halt, thick white-grey smoke engulfed the aircraft. The emergency response team arrived quickly and immediately extinguished the fire emanating from the nacelle, and they helped the pilot exit the aircraft safely.

## Fire extinguisher

The ASIT's preliminary inspection of the aircraft revealed extensive fire damage to the external engine cowlings, heat shields and upper and lower sections of the port-side wing. Significant damage was also evident on the outer port-side of the engine casing indicating the potential exit of engine components up and away from within the turbine plane of rotation.

Further inspection revealed that the fire extinguisher, normally located beneath the port-side wing-flap cavity, had separated from its manifold as did the flap itself, with both components departing the aircraft. Considering the substantial level of damage sustained by the aircraft and engine within the turbine plane of rotation, the ASIT noted the fire extinguisher's vulnerability to damage from an uncontained engine failure.

A combination of the exit of engine debris and heat escaping from the exhaust area under the wing-flap very likely caused an over-pressurisation and rupture of the fire extinguisher. Although the loss of the fire extinguisher was extremely likely not causal to the event it was considered to be a secondary effect.




## Fuel degradation

The ASIT found the level of fuel ageing and oxidisation was more likely than not a result of the aircraft having remained largely inactive during a period of long-term storage.

More than 10 years had elapsed where the aircraft had not been subject to any level of fuel quality control or inspection prior to its planned return to service in 2021.

The maintenance organisation (MO) did not have a dedicated fuel-quality-control program for the aircraft during its lengthy storage period. Further, the maintenance organisation did not recognise the high levels of contamination in the fuel system and therefore the poor condition of several components when returning the aircraft back to service.

Consequently, this allowed the fuel in the aircraft fuel tanks and wider fuel system to degrade, become stale, oxidised and acidic. Analysis of the fuel and recognition of its condition supports the conclusion that it was likely one of the causal factors contributing to inadequate combustion and eventual engine failure.

## Maintenance protocols

The technical maintenance plan (TMP) does not dictate a requirement to overhaul the engine and by extension its subassemblies other than solely by its operational usage requirements. As a result, the ASIT is of the opinion that the extended period of time that the aircraft and engine had remained dormant with no dedicated fuel-quality-control program or degree of fuel-system monitoring, necessitated a more stringent level of inspection.

The ASIT found this shortfall in information in the TMP was a potential barrier to recognising not only the extent of ageing, oxidation and contamination found throughout the fuel system but also with regard to the sub-optimal condition of several critical engine components found during later inspection. A shortfall in calendar-based maintenance information in the TMP may have unduly influenced the MO, however, the MO likely made a decision-based error when interpreting the extent of maintenance required as part of the safe return to service of the aircraft. This decision-based error is considered the primary cause for not inspecting or servicing the critical fuel-system components.

## Recommendations for ex-military aircraft

The ASIT found a lack of OEM advice and policy guidance available concerning the management considerations of fuel stored in aircraft over extended periods. As a result, there is a perceived requirement to tailor a program for 100SQN aircraft now that the Military

Gaping hole adjacent to fire extinguisher with deformation of material directed from the engine

The possibility that other heritage aircraft of 100SQN may also have similar concerns to those of the Vampire when inactive before a return to service warrants the implementation of adequate direction to prevent any possible recurrence of this event.

Air Operator – Accountable Manager (MAO-AM) is the appointed registered operator. Without any dedicated OEM procedures, maximum thresholds or even guidance in place to benchmark the requirement, then the likelihood of an event akin to that which occurred to the Vampire may still be present. This is even more likely given the lack of OEM advice and the fact that heritage aircraft fuel systems may likely contain materials not consistent with latter-day continuing airworthiness considerations.

The possibility that other heritage aircraft of 100SQN may also have similar concerns to those of the Vampire when inactive before a return to service warrants the implementation of adequate direction to prevent any possible recurrence of this event. The ASIT recognises that obtaining original replacement parts for heritage aircraft is difficult due to a global lack of spares and the ability to source components due to their age and availability.

This is very likely due to original equipment manufacturers withdrawing their aeronautical product from service long ago.

Component availability and their ongoing serviceability is critical, as is the provision of appropriate oversight to limit unnecessary degradation of components when likely subject to extended service-life intervals.

The ASIT found the heritage aircraft environment exacerbates difficulties surrounding the ongoing acquisition, storage and accountability of aeronautical product. This is due to the added responsibilities and additional considerations that exist for ageing aircraft component storage and availability.

Enhancing engineering support to the continuing airworthiness and oversight functions by Air Force will ensure that non-Defence-registered aircraft (NDRA) operate in a manner no less safe than Defence-registered aircraft.

# Hot gun has crew over a barrel

**RAN GAU-21 Barrel Failure**

By CMDR Dom Cooper
(Investigator of the incident while at FAASC)

**ON 20 JUNE 2019, a Navy MH-60R was conducting air-gunnery operations within the Eastern Australian Exercise Area (EAXA). The aircraft was fitted with an M3M (GAU-21) .50 calibre machine gun. During the firing element of the gunnery serial, the crew heard a 'bang' from the weapon, which differed from previous rounds fired. Damage was noted by the crew to the barrel of the weapon. There were nil cockpit indications of issues with the aircraft. The weapon was secured and the aircraft returned to base without further incident.**

The incident was determined to be a Class B event and a Fleet Air Arm (FAA) Aviation Safety Investigation Team (ASIT) comprising members of the Fleet Air Arm Safety Centre (FAASC) was formed.

The GAU-21 is an air-cooled weapon that operates at a fixed rate of fire and relies on the number of rounds fired (burst length) and length of time between bursts to allow for barrel cooling. There is a possibility of barrel failure if this is not carried out.

Unlike other versions of the same calibre weapon in Navy service, the barrel is not removable (allowing for a 'cold' barrel to be installed to the weapon to continue sustained firing). The helicopter's phase of flight is important as cooling is more effective in forward flight than in the hover. This weapon is also in use in the US Navy (USN) MH60-R platform.

The aircraft was conducting a gunnery serial involving the sinking of Hammerhead Unmanned Surface Vehicle Targets (USV-T) in the EAXA off the NSW coast in support of updating tactical procedures and as a training/currency opportunity for the aircrew. The incident serial was initially planned to involve two aircraft; however, following unservicabilities one aircraft was used carrying the allocated amount of ammunition for both aircraft as they planned to sink both USV-T as opposed to one.

Firing runs prior to the incident (conducted in forward flight) resulted in the disabling of one target and the damage of another. As there was an understood requirement by the crew to sink disabled USV-Ts, the firing run before the incident was carried out in the hover and involved firing just under 500 rounds in approximately four minutes. The final firing to sink the remaining target resulted in an immediate stoppage and significant damage evident to the barrel.

### The investigation

The investigation revealed that the temperature reached in the barrel exceeded the design limits leading to significant metallurgical changes. These changes, in addition to the complete erosion of the barrel rifling led to a round breaking through the side of the barrel, tearing a significant hole and exiting clear of the aircraft.

The ASIT examined four main areas, using the Defence Flight Safety Bureau SHEL model: looking at the **software**, **hardware**, **environment** and **liveware** that affected the incident. The original investigation did not use the DSAM and this will be discussed later.

**Software.** Software refers to checklists, flight manuals and procedures and, in this case,

During the firing element of the gunnery serial, the crew heard a 'bang' from the weapon.

specifically looked at the published limitations associated with operating the M3M that were available to the incident crew.

The ASIT found that there were differences between the USN M3M cooling and firing limitations used by the crew and those provided by the weapon's original equipment manufacturer (OEM), FN Herstal[1]. The limitations available to the crew were found to be less restrictive than the OEM. In addition, information in publications regarding what constitutes effective cooling of the weapon to avoid barrel damage was not available to the operating aircrew.

**Hardware.** Hardware relates to the physical aspects of the equipment – usually the aircraft – however, in this case the weapon including tools and spares.

The ASIT found that the weapon had received the appropriate scheduled maintenance and was serviceable prior to the incident sortie. The operator-level maintenance to be carried out after firing is detailed in USN and FN publications and requires the use of a bore-measurement tool to confirm the serviceability of the weapon as it checks for barrel erosion due to heating. The FAA neither possessed the tooling nor provided appropriate training to personnel to conduct these measurements. Therefore, this control to identify early signs of barrel failure due to excessive heating could not be carried out.

Thales analysis of the barrel showed that the material properties of the barrel had changed due to the excessive heat, leading to external bulging and erosion to the bore and rifling. The incident barrel was compared to one that had reached its service life, which was found not to have the same abnormalities.

**Environment.** There were no weather-related factors in this incident; however, the requirement to complete all elements of the tactical development sortie, including sinking the target, may have influenced both the amount of ammunition embarked for the sortie and the flight profiles used.

**Liveware.** Liveware consists of the crew/team actions as well as their interaction with others, including training, skills, experience and authorisations.

Deficiencies were found in the training given to MH60-R aircrew in the operation of the GAU-21 weapon system.

In the DSAM context, the ASIT determined a number of significant local conditions and failed risk controls.

**Individual actions.** The aircrew operated the weapon outside of the recommended firing schedules.

**Local conditions.** The instructions available in flight to the aircrew laid down firing limitations that were less restrictive than the manufacturer's.

The cancellation of an earlier gunnery sortie resulted in the engagement of two USV-T by one aircraft during the incident sortie.

Analysis of the barrel showed that the material properties of the barrel had changed due to the excessive heat.

The decision to engage two USV-T utilising one aircraft influenced the decision to carry and fire a significant amount of ammunition during the incident sortie.

The flying brief did not consider actions in the event a USV-T could not be sunk using the installed weapon.

The ammunition load carried for the incident sortie exceeded the post-firing inspection periodicity.

**Risk controls.** Information available to the aircrew regarding recommended firing rates/burst lengths for the GAU-21 was inconsistent.

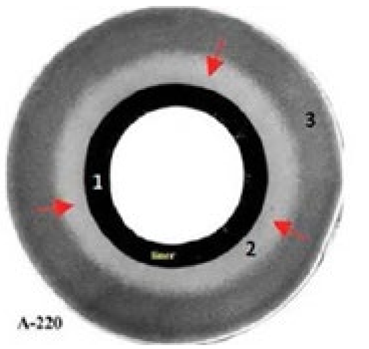
The adherence to GAU-21 firing rates and cooling times is reliant on estimations made by aircrew.

The FAA does not conduct 1200-round post-firing measurements of the GAU-21 barrels.

The FAA does not hold the test equipment to conduct the 1200-round barrel-erosion measurements.

**Organisational.** It is possible that aircrew do not receive effective training on GAU-21 firing schedules and firing limitations.

It is possible that MH-60R aircrew receive insufficient or ineffective training in regards to the possible outcomes of operating the GAU-21 outside of its recommended firing schedule and firing limitations.

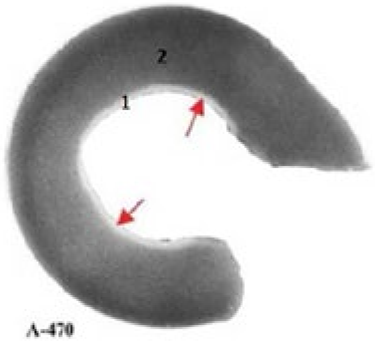



**1. Stellite Liner**

**2. Normal Material Structure**

**3. Abnormal Material Structure**

Figure 1: Barrel cross section 200 mm from chamber end.




**2.Abnormal Material Structure**

**3. Normal Material Structure**

Figure 2: Barrel cross section 470 mm from chamber end.

## Summary

The aircrew operating the weapon did not have a clear understanding, from the procedures supplied, as to how often the weapon could be fired to stay within the limitations imposed by the need to cool the barrel. The firing rate and the required cooling periods are also reliant on estimations by the aircrew rather than an accurate method of measurement.

The need to sink both targets due to the other aircraft becoming unserviceable produced the situation where there was sufficient ammunition to be fired that could take the weapon outside of the required 1200-round inspection routine. This was far in excess of 'normal' ammunition loads and therefore realised the risk brought about by the FAA not having the required tool (or providing training to aircrew) to carry out the 1200-round inspection airborne, which was mandated to check the condition of the barrel.

The report made several recommendations such as reviewing and updating operations, instructions, procedures (OIP) and adopting appropriate training for the GAU-21.

Endnotes

1 Fabrique National Herstal is a firearms manufacturer based in Herstal, Belgium

# Balancing safety and courtesy

## Near-collision in the circuit area

By SQNLDR Shane Rowe

**DURING EXERCISE PITCH BLACK 2022, there was a near collision in the circuit area at RAAF Darwin involving fast jets from three foreign air forces. A pair of aircraft from partner nation A (PNA) discontinued their circuit from the base turn, passed close to another formation's aircraft (PNB) already in the base turn, and also passed close to a third formation (PNC) that was joining the circuit through initial. The PNA formation lead discontinued the approach as they had no situational awareness of PNB's position, and their wingman followed.**

### The near-collision event

The number and type of aircraft involved directly or indirectly with the event were:

- PNA – Aircraft type, General Dynamics F-16. Described as PNA1, 2, 3, 4.
- PNB – Aircraft type, Sukhoi Su-30. Described as PNB1, 2, 3, 4.
- PNC – Aircraft type, McDonnell Douglas F-15. Described as PNCx3.

The event occurred towards the conclusion of the afternoon flying wave, approximately two hours before sunset, in clear weather conditions with very good visibility.

PNB, the four-ship formation of Sukhoi Su-30s, joined the circuit visually via an initial-and-pitch. The crews pitched into the circuit and flew their normal pattern – downwind spacing approximately 2 nm from the runway, and the base turn point approximately 3 nm beyond the downwind threshold (around 4 nm diagonally from the threshold).

PNA, the four-ship formation of F-16s, was sequenced to follow PNB via the same initial-and-pitch process some 10 nm behind, which translates to around 2 minutes. ATC understood radio calls from PNA as requesting permission to pitch, and so once the tower controller had established that the fourth aircraft of PNB was past abeam of PNA formation, PNA were cleared to 'pitch now'.

PNA pitched into the circuit and flew their normal pattern – downwind spacing less than 1 nm from the runway, and the base turn point approximately 2 nm diagonally from the threshold.

At the commencement of the pitch, PNA1 was less than 8 nm from touchdown. Given the geometry of the preceding PNB circuit pattern, PNB4 was still some 3 nm from its base-turn point and 89 nm from touchdown.

PNA pilots were expecting positive control in the circuit, and so did not anticipate there would be aircraft to sight-and-follow that were not already safely in front of them. As PNA1 reached mid-to-late downwind, PNB1 and PNB2 were safely in front of them. PNA1 was unaware that PNB3 and 4 were outside PNA1's pattern and PNB3 was a similar distance from touchdown. PNA1 was able to safely follow the two aircraft sighted in front – misidentifying PNB1 and 2 as 3 and 4. It is unknown if the pilot of PNA1 had followed a PNB formation into the circuit previously during this exercise and therefore may have elected to check for other aircraft outside the PNA pattern.

The tower controller recognised the potential confliction and radioed PNA1 to identify the relative position of PNB3 and 4. PNA1 did not respond or adjust flightpath, and soon after PNA1 commenced the base turn the tower controller instructed the pilot to go-round. At the same time PNA2, behind PNA1 with a now clear picture of the disposition of PNA1, PNB3 and PNB4, also instructed the formation lead (PNA1) to go-round, though on a different radio frequency. The tower controller updated PNA1 on the location of the other aircraft and repeated the instruction to go-round.

Shortly after commencing this go-round, PNA1 transmitted, 'Request re-initial'. As the pilot of PNA1 did not know where all of the other applicable aircraft were in relation to them, their intention was to clear the circuit by the quickest means and then rejoin the normal pattern. This involved turning against the normal pattern and the expected method of going round.

The tower controller was unable to correlate this diverging picture immediately, and therefore was not able to provide clear, unambiguous guidance for PNA1 quickly enough. PNA1, now closely followed by PNA2, flew from the base turn directly towards the initial point.

The outbound turn resulted in PNA1 laterally passing within 1200 ft of PNB3, vertically separated by 500 ft, geographically quite close to the runway extended centreline. PNA1 did not see PNB3 or 4.

PNC was sequenced to follow PNB through initial some 10 nm behind. This 2-minute trail placed them between the initial point and the runway as PNA1 flew close to them in the opposite direction while clearing the circuit to reposition at the initial point. The pilot of PNA1 did not see PNCx3.

At this moment, PNB3 and 4 were still on final approach. These aircraft landed, followed by PNA3 and 4. PNA1 and 2 rejoined the circuit and landed. After the opposite direction passing of PNA1, PNC had been instructed not to join the circuit, and subsequently rejoined the circuit after PNA1 and 2.

The time interval from PNA1 pitching into the circuit until the second of the close passes with PNC, was approximately 90 seconds.

## Latent failings

### Exercise planning

The Pitch Black planning process is detailed and thorough. Over the course of several meetings, planning staff, and some personnel involved in the exercise, have the opportunity to gather information that may assist in understanding whether a particular foreign force requires extra information or briefing. This involves operational aircrew, air-traffic controllers, tactical controllers and aviation safety specialists. Each of these representatives took the opportunity to speak with the representatives of participating nations individually and collectively. There were a number of first-time participants for 2022 Pitch Black, and so PNA did not stand out. Operational aircrew planners and the air traffic controllers assumed that PNA would utilise the same domestic procedures, and that the partner nation would raise concerns in advance.

The documentation and briefings provided as a whole were based on inappropriate assumptions and therefore deficient for partner nation A, and directly contributed to the pilots' misunderstandings of local procedures.

### Foreign sponsorship

The Defence Aviation Safety Regulations require sponsorship of foreign military aircraft when participating in an exercise in Australia.

This holistic process sees the gathering of all reasonably available information from a variety of sources, to try to understand what, if any, aviation safety implications there may be in allowing a particular aircraft type flown by a particular foreign air force to participate in an exercise in Australia. It is a parallel process to the overall exercise planning, is informed by planning, and may provide information for the planning staff that isn't provided by the partner nation.

In some cases, the Defence Aviation Safety Authority's recognition of a foreign force's airworthiness system eases this task. A complete airworthiness system includes aircraft design and manufacture (engineering), aircraft servicing and repair (maintenance), and aircraft operations (piloting). Two of the three partner nations did not have this recognition.

While there may be a point where participation is approved through invitation (possibly prior to detailed planning), like all safety assessments, monitoring is ongoing and restrictions or other requirements may be imposed at any stage (perhaps following detailed planning). The safety specialist who collated the sponsorship documentation assumed that the operational planners and the air traffic controllers would unearth requirements for extra briefings or information, and so relied on 'no negative feedback' as the sponsorship was finalised.

### English-language proficiency

Shortcomings in English-language proficiency among PNA aircrew was not evident through the planning phase. All nations that were first-time participants and did not have English as their first language utilised the services of an ADF-provided translator/liaison officer. This masked the language deficiencies to some extent, as did the presence of very few of the participating aircrew members at the planning meetings.

### Documentation

All of the necessary guidance, standardisation points, domestic operations instructions and summaries were published in relevant plans, guides and procedures:

i. the *Flight Information Handbook*, and 'En Route Supplement';
ii. the 'Darwin Aerodrome Supplement';
iii. 'Terminal (Area) Procedures';
iv. the 'Pitch Black 22 Airspace Control Plan';
v. the 'Pitch Black 22 Aeronautical Information Publication Supplement';
vi. the 'Pitch Black 22 Combined Air Operations Guide'; and
vii. a local operations brief.

Some of these were briefed during the latter planning meetings and all were available prior to the commencement of the exercise. There is sufficient information in the documentation and briefings to indicate that an initial-and-pitch is a visual manoeuvre, the pilot makes the decision on when to pitch, and there is a requirement to identify and safely follow preceding traffic. Exercise planners and local air-traffic controllers expected that participants would clarify uncertainties. The documentation was suitable for aircrew whose first language was English, or had a good comprehension of the language. Also, each participant needed to read all relevant documentation or attend an in-detail briefing.

### Briefings

An air traffic controller delivered a detailed, local-area operations brief at the main planning conference prior to the exercise, and the briefing pack was available to the planning staff from all participating organisations.

Prior to commencing flying operations, all aircrew were required to attend a mass air briefing. The air traffic control (local area operations) portion of this brief was a 'lite' version of the main planning conference brief. Notably, the first slide stated: 'Assumed Knowledge – Pitch Black 2022 ACP; RAAF AIS TERMA; ERSA FAC-D; FIHA AD2 SUPP DAR; AIP SUP H89/22'. Readers will recognise these as being most of the documents listed as documentation.

The mass briefing pack listed the initial-and-pitch procedure, though not in any detail. The air-traffic-control portion of this mass brief was six minutes of a three-and-a-half hour briefing.

As with the documentation, the briefing was suitable for aircrew whose first language was English or who had a good comprehension of the language.

### Positive control in the circuit

When flying within their home country, aircrew from PNA do not make the decision on when to pitch into the circuit. This is an instruction from air traffic control – a positive control rather than the passive control procedure used in Australia and many other partner nations. Planning staff did not identify this difference, nor was it articulated or clarified by the partner nation to the Australian planning staff or air traffic controllers during the planning meetings, after having read the supplied documents, or after attending the mass briefing.

The pilot of PNA1 inappropriately sought permission to pitch, and when 'cleared to pitch' did so without sighting the preceding traffic.

## Earlier events

### Partner nation A

During the initial week of integration training there were at least two occasions where pilots from PNA did not pitch into the circuit when they should have, seemingly waiting to be cleared to do so by air traffic control, and extended upwind disrupting the flow of following traffic. Key exercise personnel knew this information but were unable to pass it back to the partner nation in a readily digestible form due to electronic communication issues.

While several partner nations had various styles of domestic phase 'infringement' during this initial training week, none of the events escalated to an adverse safety outcome, and for other partner nations the events seemed to be isolated and learnt from.

PNA, seemingly due to the language barrier, had had several non-escalating infringements, including the two mentioned above. This led the exercise director to ask the air traffic control liaison officers to formally visit PNA's detachment and deliver a further brief on Australian domestic procedures. This briefing, to the majority of PNA's aircrew, took place at the same time as the event aircrew were involved in the incident mission.

The air traffic controllers, as a group, had informally decided that it seemed less troublesome to massage their procedures and 'clear' the formations from PNA to pitch into the circuit, than to educate the pilots again and further on what should have been a simple-to-execute visual procedure.

**Partner nation B**

It had been noted that the pattern flown by PNB was large in comparison, though it had caused no noteworthy ill-effects. Pilots from various other nations (including Australia) had followed PNB into the circuit, visually identified the preceding aircraft, pitched when thought necessary, and if caught out first time then adjusted next time to safely follow. As the initial and pitch is a visual sight-and-follow procedure no formal changes were made, nor thought to be needed.

## Investigation findings

The investigation revealed two primary causal factors.

- The trigger for this incident was the decision of PNA1 to pitch into the circuit without having visual contact with the preceding traffic; this was predicated on one of multiple misunderstandings of local procedures.
- The documentation and briefings provided as a whole were based on inappropriate assumptions and therefore deficient for partner nation A, and directly contributed to the pilots' misunderstandings of local procedures.

When asked following the event, the pilot of PNA1 stated that they had seen an early version of the *Combined Air Operations Guide* prior to arriving in Australia, and an updated version after arriving, though no other documentation had been sighted and read. The only briefing received was the mass air brief. Having not read or been briefed on the other 'assumed' and therefore essential documentation the pilot had an inadequate understanding of Australian domestic-phase procedures.

Professional pride at an individual, detachment and national/cultural level probably prevented all of the necessary questions and concerns being raised by the partner nation pilots and commanders, throughout the planning phase and the initial days of the exercise.

Professional courtesy by Australian exercise staff probably prevented them from asking all of the necessary questions during planning and the start of the exercise, and possibly delayed slightly the decision to re-brief the partner nation. There will be hiccups as foreign aircrew assimilate to Australian procedures, with the vast majority of hiccups not escalating, and it seemed that understanding, comprehension and compliance was improving among all participants.

The pilot of PNA1 had a less-than-adequate understanding of procedures, could not fully comprehend the requirements or meaning of non-standard phraseology from ATC in the time available, and wasn't able to unambiguously communicate their intent or concerns in plain English.

The air traffic controllers had managed previous infringements.

The holes were aligned in most of the slices of the Swiss cheese.

## Opportunities to avoid repetition

Immediately following the event, a thorough debriefing to the aircrew from PNA was conducted by exercise staff and the local air traffic controllers.

The dimensions of the PNB pattern were brought to the attention of all aircrew participating. There were no further events of significance involving PNA for the remainder of Exercise Pitch Black 2022.

The invitation, initial planning and sponsorship processes for large-scale exercises involving foreign forces now require a more detailed examination of language proficiency. Requiring a certain standard of English might seem straightforward, but it can be a little difficult to ascertain individual participants' proficiency. Future exercise planners should consider such a requirement as part of an initial invitation. The detailed planning phase for large-scale exercises involving foreign forces now involves a more thorough querying of home-nation procedures rather than operating on the assumption that they are identical to those in Australia.

## Professional courtesy

While we have an obligation to prevent injury and harm as far as possible, it is important that we also continue to display the requisite amount of professional courtesy to foreign force professionals. Achieving this balance is our challenge.


# In striking distance

**IN EARLY 2021, a Black Hawk helicopter struck the rear mast of a ship twice during Maritime Counter Terrorism (MCT) training in Sydney Harbour. The second rotor strike occurred 20 seconds after first contact because the crew realised they were dragging a member of the Ground Force Element (GFE) still on the rope over the rails of the ship, and were positioning the aircraft to return the GFE to the deck. The crew made an emergency landing in a nearby park. No injuries were sustained.**

An Aviation Safety Investigation Team (ASIT) from Headquarters Army Aviation Command (HQ AVNCOMD Safety) investigated this Class B event, determining it was a result of latent and active failures with contributing factors spanning the breadth of the organisation.

The ASIT raised a concern in the Aviation Safety Investigation Report (ASIR) executive summary that 'previous similar occurrences in Army Aviation showed familiar themes as observed in the Black Hawk tragedy of 1996 and 2006 and most recently during Exercise VIGILANT SCIMITAR 20 (ExVS20)'.

These accidents, and a rotor-strike incident in 2017, share similar systemic issues and contributory factors with the 2021 event, including:

- deficiencies in the flight-authorisation process based on poor communication and incomplete or inconclusive information
- a lack of rehearsals or acceptance of changes to complicated missions without rehearsal
- a breakdown in Non-Technical Skills (NTS)
- inadequate risk appreciation and management.

## The event

The Black Hawk was one of two aircraft involved in Helicopter Insertion and Extraction Technique (HIET) serials on 17 February 2021. At 1405 hours, carrying a GFE comprising Army personnel and a military working dog, the aircraft approached the left-rear top deck (Landing Point 3 – LP3) and two GFE members fast roped onto the ship's deck before the main helicopter rotor blades (MRBs) struck one of the navigation lights on the rear mast.

After the first strike, the aircraft captain (AC) moved the Black Hawk away from the mast with the third GFE member still on the rope, dragging that member onto the rails at the edge of the deck. The AC then moved the Black Hawk back towards LP3 to return the member to the deck and release the ropes. At this stage, the MRBs struck the mast. The AC then departed and conducted an emergency landing at Robertson Park, Watson Bay. All four blades were damaged and rendered unserviceable.

## First strike

The initial strike on the mast's navigation light and the more significant second strike on the mast were separated by 20 seconds. The pathway to each mast strike was unique. The first was the result of the AC's plan to terminate the approach 'beside the mast', placing the edge of the rotor disc adjacent to, rather than above, the mast.

This was based on their intent to fast rope GFE as close as possible to the deck of the vessel. However, there was no common understanding that the landing point (LP3), being used for the first time that day, was of insufficient size to position the aircraft abeam the mast while maintaining the necessary lateral clearances.

This plan was the product of inexperience of the AC flying an MCT mission for the first time in command, limited access to accurate information about the vessel, compressed and under-resourced planning, and compromised supervisory processes. One of the main contributors to compromised supervision was an assumption by supervisors that the aircrew would terminate above the mast.

Mechanisms and treatment controls that may have disrupted the plan to terminate beside the mast were ineffective. Mission orders, authorisation, rehearsals, flypasts, crew coordination and mentoring did not detect the error and correct the aircraft positioning.

Having terminated at LP3, the MRBs were within the mandated 10 ft rotor clearance from the mast. This was the result of a combination of human-performance limitations in the ability of the AC and the active Aircrewman (RH ACMN) to judge the distance between the MRBs and the mast, and degraded crew coordination. Poor depth cues and a difficult visual angle severely compromised the accuracy of judging the distance to the mast.

This was the first, and only, time the crew flew to LP3. The AC and RH ACMN expected that the aircraft could fit into

This event is a reminder that assurances of safety should not be taken for granted …

LP3. These conditions, combined with the perceived pressure associated with a 'one shot' opportunity to insert the GFE, likely prioritised the RH ACMN's attention to the roping point, rather than mast clearance. Hence, the proximity to the mast was not detected until the navigation light was struck.

Despite discomfort about the proximity to the mast, the Co-Pilot (CP) did not verbalise their concerns.

**Second strike**

The second mast strike is an example of a situation worsening. After the first mast strike, the AC lost situation awareness (SA) of the GFE because he was focusing on the unfolding emergency, and moved the aircraft away from the mast with the intention of departing LP3. Conversely, the RH ACMN was unaware of the first strike because he was focusing on recovering the GFE who was being dragged over the rail.

The RH ACMN stopped the departure and called the Black Hawk back to the roping point. The AC complied, but unintentionally placed the MRBs within the minimum lateral clearance from the mast. After recovering the GFE to the deck, and dropping the rope in preparation for departure, the MRB struck the mast for the second time.

The crew did not discuss the first mast strike or the risks of another strike by returning to the roping point. The second strike was the result of ineffective communication and crew coordination, degraded individual and crew SA, and reacting to the first mast strike rather than responding to the emergency.

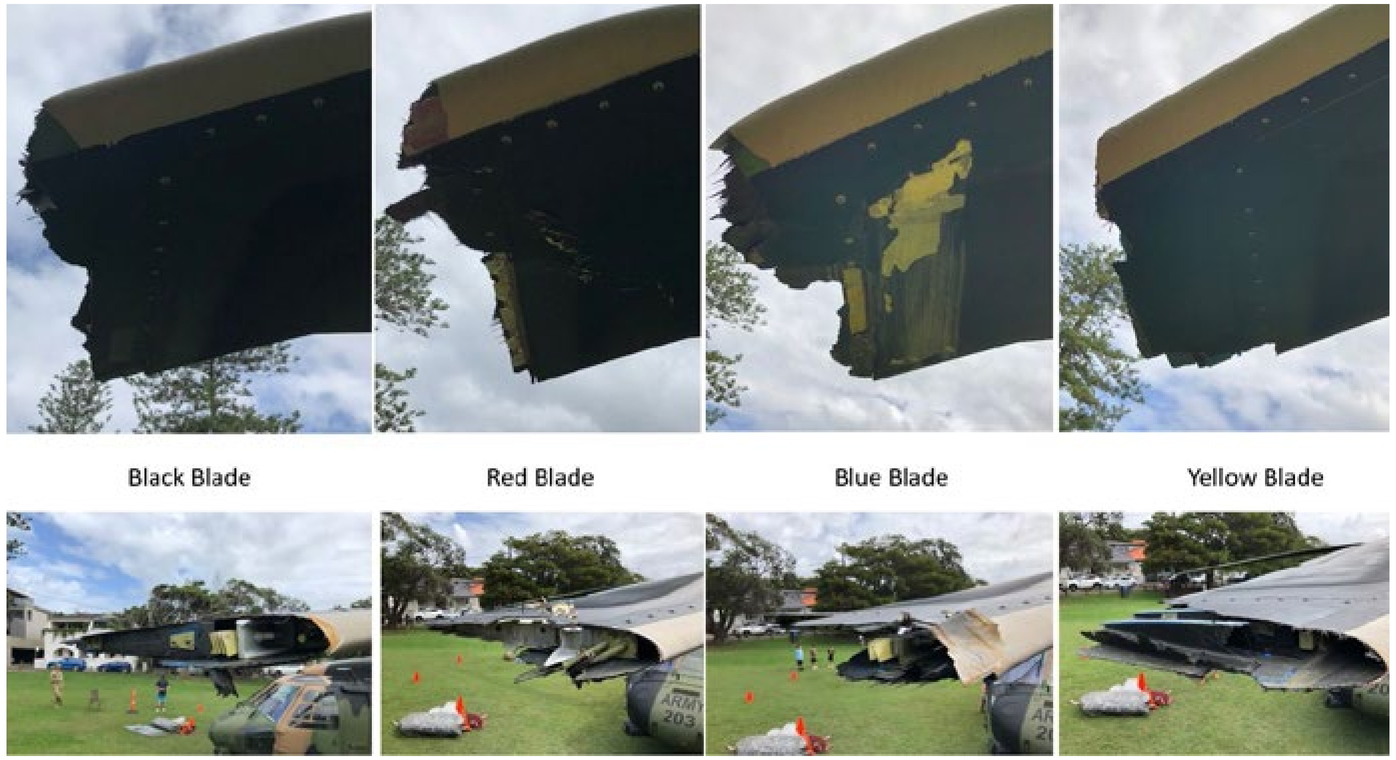
**Individual actions**

The primary contributing factor for both strikes was error of judgement by both the AC and RH ACMN. This type of error was present in two places. The planned placement of the aircraft beside the mast and the placement of the aircraft within the minimum 10 ft clearance. This first error began to formulate in the days before the activity as planning was taking place and the second error was the result of human-factors limitations relating to the visual system, information processing, divided attention, high workload, decision-making and NTS. Leading up to the second strike, the AC and ACMN were unaware of the emergencies the other was dealing with. The actions taken by each resulted in further endangering personnel aboard the aircraft and the GFE on the rope.

**Local conditions**

The ASIT assessed the errors in performance of both the AC and RH ACMN as having four related causes setting the conditions for the first strike. No measurements or schematics were taken of the vessel or mast, leading to an inadequate cognitive model of the LP, which had not been previously used. The absence of collective SA led to the AC's mental model of approaching LP3 not being challenged by any crew. NTS was sub-optimal, with minimal communication among the crew, and no-one raised the close proximity of the mast as a concern. The late arrival of the ship to the exercise area compressed the schedule, only allowing for one approach to the LP: the AC's (indeed crew's) only approach and first exposure to LP3. Additionally, the AC had not previously flown an MCT approach as aircraft captain.

After the first strike, the crew did not discuss the strike or the status of the GFE. This breakdown in NTS further exacerbated the already reduced SA for the AC and RH ACMN whose workload had increased as they handled separate emergencies. The ASIT found limited SA and degraded NTS contributed to both strikes.




Blade tip damage

**Risk controls**

The ASIT found the local conditions were further hampered by the degradation of multiple treatment controls. These controls were present and suitable but were compromised in various ways so that they were not operating effectively.

Orders, Instructions and Publications (OIP) were 'technically' being satisfied, but these controls were not meeting the intent of the OIP.

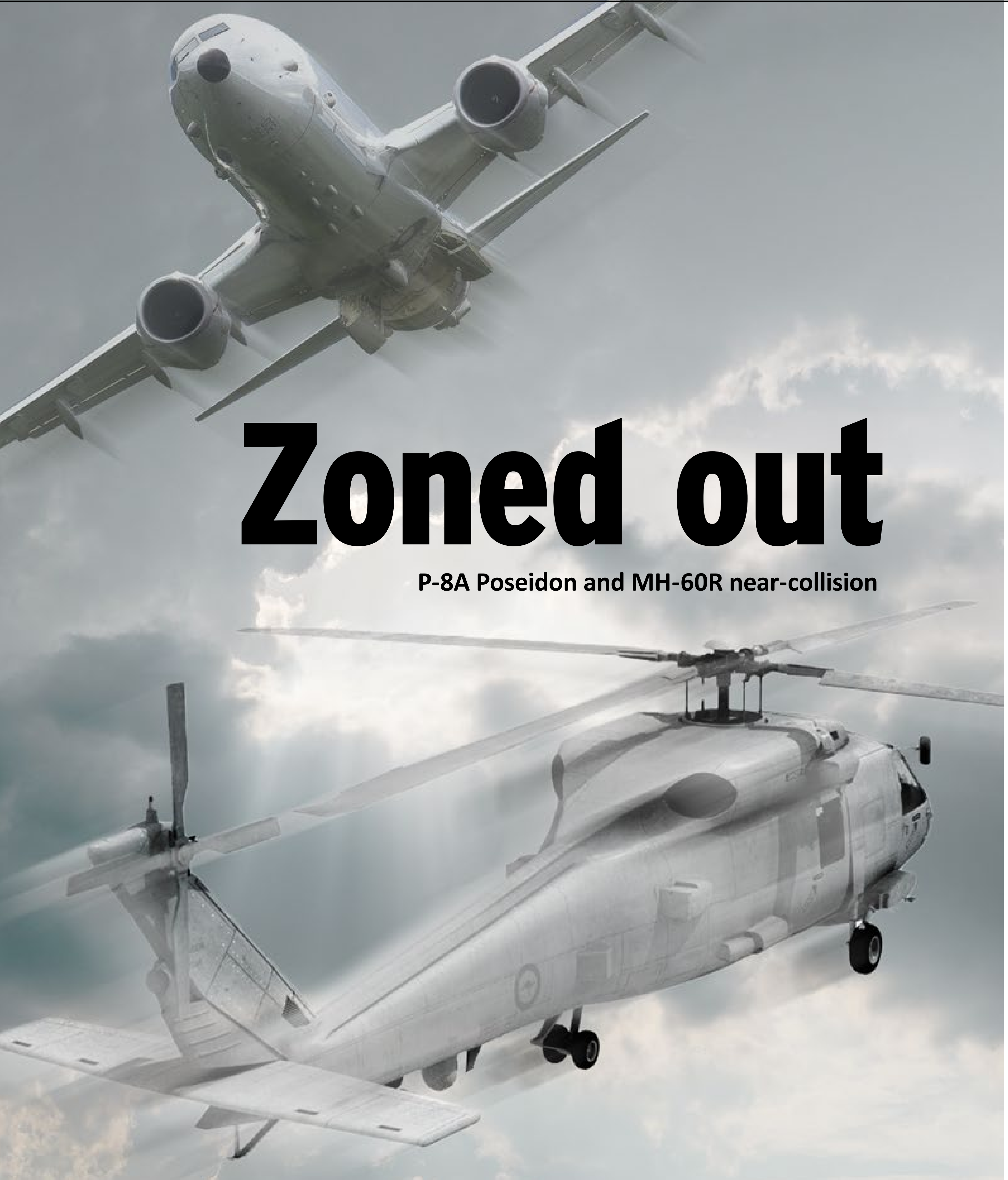
The risk-treatment controls of a flypast and venue reconnaissance were not implemented correctly, which meant the AC was missing key information that would likely have better prepared them for their first MCT approach as aircraft captain.

The absence of an aviation-only rehearsal due to the component training being a 'day only' mission did not provide the AC with any exposure to the ship prior to the exercise. The authorisation being the first special operations authorisation for this particular authorising officer and conducted remotely via phone, was influenced by the Flight Lead's (FL) assessments and considered sub-optimal.

**Organisational influences**

In this event, system strain and transition to Taipan in the special forces support role, were relevant factors. The COVID-19 pandemic and resource constraints affected experience levels and exacerbated these factors. Finally, the absence of an MCT qualification during the special operations qualification course, meant that the AC's lack of training was not recognised and adequately managed, which created a latent failure in the system.

This event is a reminder that assurances of safety should not be taken for granted and that in an environment so delicately balanced, the safety controls in an aviation system must be rigorously observed, closely supervised and routinely reviewed.



# Zoned out

## P-8A Poseidon and MH-60R near-collision

**A SIKORSKY MH-60R SEAHAWK participating in a Combined Anti-Submarine Exercise (CASEX) as part of Submarine Command Course 2022 experienced a near collision with a Boeing P-8A Poseidon shortly after its launch from an F100 Frigate in mid-2022. The P-8A, also participating in CASEX, was conducting a low-level pass, or 'brownie run'[1] to obtain photographic imagery of vessels of interest.**

Both aircraft took avoiding action 15 seconds prior to their closest point of approach before the Anti-Submarine/Anti-Surface Tactical Aircraft Controller (ASTAC) on-board the Frigate Helicopter (FFH), re-established separation. An Aviation Safety Investigation Team from the Defence Flight Safety Bureau (DFSB) investigated this Class B incident, and the resulting report forms the basis for this article.

### Planning and briefing

The minimum altitude required for the P-8A's mission was 300 feet above ground level (AGL), based on the minimum recommended altitude for employment of the MK54 MOD 0 Torpedo. The brownie run was not part of the briefing; however, the mission was nevertheless authorised to 200 ft above sea level (ASL).

Without knowing the aircraft captain's (AC) intention to conduct brownie runs, the flight authorising officer (FLTAUTHO) was not able to assess the complexity that this would add to the task. Furthermore, the FLTAUTHO was unable to assess if they were the most appropriate FLTAUTHO to authorise the flight, and was unable to provide the AC with advice on aircraft-handling techniques during the brownie runs. This also meant that the FLTAUTHO did not provide guidance to the AC on items considered corporate knowledge such as making radio contact with a vessel to ascertain the status of a ship control zone (SCZ) and radiation hazards (RADHAZ).

A SCZ is a localised airspace management area around a ship that is operating aircraft, to enable tasks, and is usually a cylinder, radius of 2 nm rising to 500 ft. Crew can communicate that the zone is active verbally over the radio and/or with the use of the Flag Hotel.

Without comprehensively briefing the crew of their intentions, the AC of the P-8A did not provide the rest of the crew with the opportunity to offer feedback regarding their current workload or the appropriateness of conducting brownie runs in the operating environment.

The P-8A's crew consisted of nine members. The crew members, who were current, began work at approximately 0900 h on the day of the event, and had achieved the minimum rest required. The MH-60R crew members were qualified and current at the time of the incident. There was no evidence that physiological factors or incapacitation affected the performance of the crew of either aircraft.

### The event

When the P-8A joined the CASEX serial, the FFH's ASTAC placed the aircraft under loose mission control. This means the AC selects their own speed, altitude, heading and tactics required to accomplish the mission and advisory safety control, and the aircraft-controlling unit (ACU) will provide adequate warnings of hazards affecting aircraft safety. The AC is responsible for the aircraft's navigation and collision avoidance. The FFH assigned the aircraft a lower altitude limit of 1000 ft ASL.

The Seahawk, having departed the F100 Frigate, was operating in the exercise area upon the arrival of the P-8A. The MH-60R was also operating under loose mission control and advisory safety control, and had an upper altitude limit of 700 ft ASL.

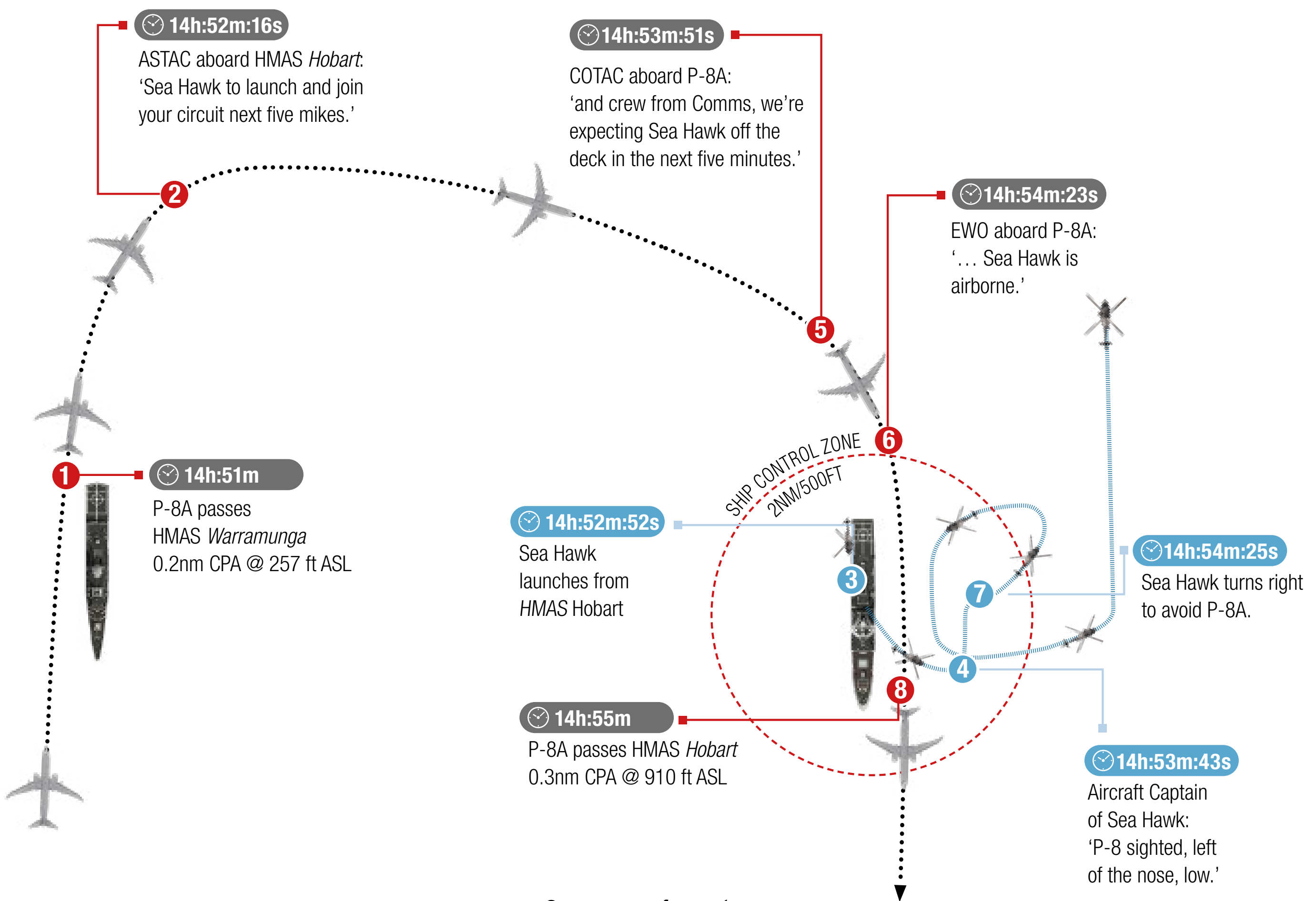
The FFH transferred control of the MH-60R to the ASTAC on-board the F11 Frigate in order to facilitate its recovery to the frigate. As part of the recovery process, the F11 Frigate made a request to the Air and Missile Defence Commander (AW), also on-board the frigate, to activate their SCZ, which the AW approved.

The MH-60R landed on the F11 Frigate to conduct a rotors-turning refuel and to prepare for its next sortie. The MH-60R turned its transponder to standby shortly after landing (to stop it transmitting), as per the Post-Landing Checklist.

The AC of the P-8A asked the tactical coordinator (TACCO) 'Request brownie run'. The TACCO replied 'Yeah, if you want'. The TACCO went on to ask 'Are you flying over the top of [the FFH]? Is that your plan pilots?' to which the AC replied 'Ahh no, just while the helos umm aren't airborne, we were just going to go to two hundred feet, go past, then climb back to one thousand' before noting 'If we need to do stuff, we will cut away, don't worry'.

The P-8A proceeded to pass the FFH on its port side, aligned with the reverse of its south-easterly mean line of advance (MLA), with a closest point of approach (CPA) of 0.2 nm at 289 ft ASL. One minute later, the crew of the MH-60R completed the take-off checklist, which included selecting the aircraft's transponder to normal (to start it transmitting).

With the co-pilot (CP) now acting as the pilot flying (PF) from the left-hand seat, the P-8A passed the FFH a second time on its starboard side, aligned with the reverse of its southerly MLA. The AC




Sequence of events

During launch and recovery from a ship, the MH-60R is at its most vulnerable to collision with another aircraft, due to the requirement to blank the ship's RADAR.

of the MH-60R, unsure of the intentions of the P-8A, commenced a steep turn to the right, briefly levelling the turn before reversing to the left to follow the P-8A as they passed abeam the MH-60R.

At the same time, the MH-60R's aviation warfare officer (AvWO) called the FFH's ASTAC. The ASTAC immediately assigned the P-8A with a lower altitude limit of 1000 ft ASL, and the MH-60R with an upper altitude limit of 700 ft ASL. The P-8A proceeded to pass the F11 Frigate on its port side, aligned with its southerly MLA, with a CPA of 0.3 nm at 910 ft ASL. The captain's electronic flight bag iPad captured this.

The F11 Frigate's ASTAC called the FFH on the surface sub-surface coordinator and reporting SSCR) frequency to inform them that they would be recovering the MH-60R to the F11 Frigate and that the P-8A had flown through their SCZ.

### Orders, instructions, procedures (OIP)

The operational requirement to fly the P-8A to a minimum of 200 ft overwater is 'to conduct visual searches for survivors without raft or dye marker for the search and rescue role, rigging runs for intelligence, surveillance and reconnaissance, torpedo weapon drops for Anti-Submarine Warfare and weapon evasion for Anti-Surface Warfare'. The AFHQ Minute – *P-8A Low Flying Limits* goes on to state that 'One of the outcomes of the P-8A [operational testing and evaluation] will be to confirm the suitability of the minimum low flying heights or make recommendations to change these heights'.

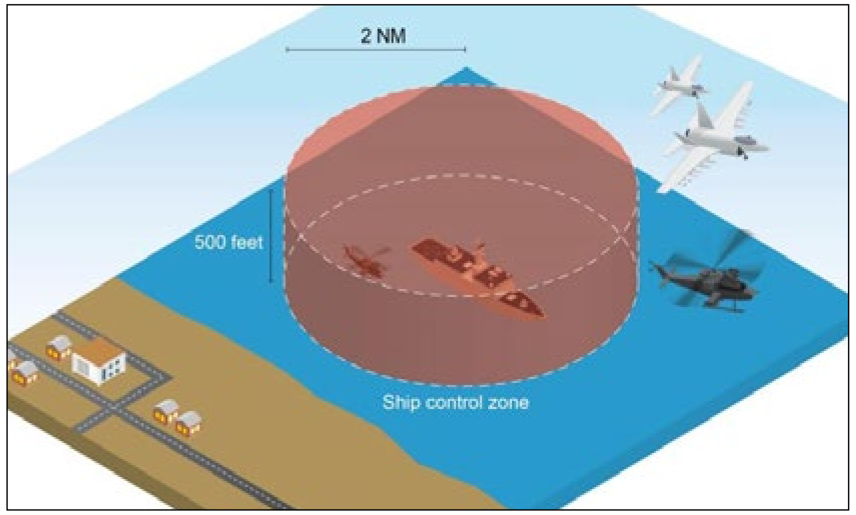
Under interview, the co-tactical coordinator of the P-8A stated, 'It's not a written procedure but there is stuff you do as a courtesy that are standard in terms of how you do brownie runs'. Royal Australian Navy (RAN) OIP regarding SCZs does not contain sufficient information regarding the activation of an SCZ, which in this case led to ambiguity as to the status of the SCZ. In addition, the MH-60R does not have a system that presents pilots with traffic awareness or alerting during critical phases of flight. Further, the reliance on voice communications and HOTEL flags does not take advantage of all of the systems available to distribute situation awareness regarding SCZ status.

The ASIT observed that the Helicopter Element Coordinator (HEC) billet at Australian Maritime Task Group (AUSMARTG) had remained vacant for some time. This left Commander AUSMARTG without a specialist safety advisor who could contribute to the planning phase for exercises and operations, and ensure that lessons learnt regarding aviation safety informed future activities. The ASIT also observed that detailed instructions for Aviation Medical Officers responding to aviation safety events are outdated and not readily accessible.

During launch and recovery from a ship, the MH-60R is at its most vulnerable to collision with another aircraft, due to the requirement to blank the ship's RADAR and keep on-board sensor systems off to protect ship's personnel from RADHAZ. However, the MH-60R does not have a system that provides the pilot with traffic awareness or alerts them in critical phases of flight, thereby degrading their ability to detect and avoid other aircraft.

### Crew composition

Under interview, the squadron commanding officer (CO) noted that they considered the pairing of the AC and CP of the P-8A was not ideal prior to the near-collision event due to the personalities of the AC and CP, and that it was their intent to reassign the members into different crews. Normally squadron crews are fixed for a six-month period, with biannual amendment, as opposed to being selected ad-hoc for each mission.




Ship's control zone

Furthermore, the squadron CO noted that an airmanship issue occurred on a sortie flown by the AC and CP of the P-8A several days before the event sortie. The squadron executive and the FLTAUTHO did not become aware of this issue until after the event.

### ASIT conclusions

Searches for ASRs showed there have been seven similar instances in the recent past – one was the subject of a *Spotlight* article in 2012.

The ASIT was of the opinion that the AC's intrinsic motivations to have fun doing brownie runs, coupled with their confidence that they could conduct another brownie run before the MH60-R was airborne was not tempered by a strong sense of what was safely achievable in the situation.

This near-collision event may appear to have occurred solely due to individual actions; namely, the ASTAC of the FFH not passing information regarding the F100 Frigate's SCZ status to the P-8A, and the AC of the P-8A conducting close-range, inappropriate low-level passes to ships. However, this investigation found that a combination of sub-optimal local conditions, risk controls, and organisational factors in the workplace, set the pre-conditions for this event to occur.

OIP do not offer sufficient support to the P-8A's close-range, low-level passes to vessels with 'corporate knowledge' the main risk control. The flying supervision system in the squadron did not take timely action upon identifying that the event crew's composition was sub-optimal, nor did the squadron executive pass its concerns regarding the crew on to flight authorisation officers. The flying authorisation brief for the P-8A's sortie was not robust, and missed the opportunity to ensure that the AC of the P-8A received adequate instructions and information to complete the flight safely.

These local conditions, failed risk controls, and organisational influences resulted in individual actions that placed two aircraft and 12 people at risk of collision, which would have had catastrophic consequences.

Endnotes

1 The name comes from the use of a 'Brownie' camera on these runs in the past.

# On the range

**Personnel inside air-to-ground gunnery safety trace during live-fire exercise**

**DURING AN EXERCISE with air-to-ground live fire in mid-2018, a quad bike was in the safety trace, and its rider was at risk. This article follows the resulting Aviation Safety Report and subsequent changes to operations, instructions, procedures (OIP).**

## The event

After a range clearance, and posting silent sentries – temporary signage – along the beach outside the northern, and southern boundaries of the safety trace, aircraft entered the airspace and conducted air-to-ground gunnery. As the aircraft were departing the airspace, they advised the range safety officer (RSO) that there was a four-wheel-drive on the beach. The RSO acknowledged the sighting and, at the end of the wave, despatched a range-control member on a quad bike to investigate the situation. The RSO advised the member that he was to conduct the search and be back at the range control (RC) complex before the next wave of aircraft activity.

Around 15 minutes later, the member contacted the RSO from the beach and reported that there was no vehicle in sight. The RSO advised the member to expedite his return to RC as the next wave of aircraft was due any moment. About 10 minutes after the member's contact with the RSO, the second wave contacted the RSO via radio and requested clearance into the airspace. The RSO assumed that the member was back within the confines of the RC complex and gave the aircraft approval to operate within the airspace.

The aircraft made a number of dry passes (passing without firing) before commencing live passes (firing rounds). At the completion of the first live pass another range control member contacted the RSO via the ground safety net and advised that the member conducting the search was not at the RC complex.

The RSO contacted the member via the ground safety net and sought his current location. The member initially reported that he was in one location. When the RSO requested a confirmation of his location, he then advised that he was located in a different position. The RSO advised him to move to a location outside of the air-to-ground gunnery safety trace.

At the completion of the second wave, the RSO conducted a verbal interview with the member who advised that at no time did he feel in danger. He informed the RSO that he was clear of the trace when the aircraft fired the first rounds. It was the view of the RSO that no safety incident had occurred as the member was outside the safety trace; however, he informed all staff that it is essential to be cognisant of correct radio procedures at all times. The RSO informed the member that in this situation he should have contacted the RSO immediately when he heard the jets in the airspace.

## The investigation

Through interviews and analysis, the investigation found some latent failings. On arrival of the second wave of aircraft, the RSO did not attempt to make contact with the member on the range area because they were confident there had been sufficient time for the member to get back before it began. The RSO could have checked the member was clear before the wave.

The arrival of the second serial should have triggered a Defence Practice Area (DPA) clearance review by the RSO. However, the RSO could not have called the member due to the radio setup on the quad bike. The rider carries a handset 'brick' in a pocket with a handheld microphone clipped to their jacket. As the rider wears a helmet and the quad bike motor is reasonably noisy, they cannot hear or manipulate the radio while riding. This radio fit does not meet the requirements of range orders for continuous two-way radio communications. Training for range staff was inadequate in that some were not aware of the requirements of range orders with regard to ground movements in the DPA. Re-currency training and exercising of staff in the handling of irregular or unusual occurrences would have raised staff awareness of their responsibilities and helped prevent complacency with operations.

Resources for range overwatch were inadequate at the weapons range. Sand dunes blocked visual surveillance of the beach, and there were no surveillance systems to maintain range overwatch.

The fundamental reason the RSO despatched a rider to investigate a suspected range intrusion was that there were no other resources to do so. Range control also has a duty of care to track its own vehicles in case of accident or misadventure. The surveillance solutions would also assist with bushfire detection and alerts, search and rescue, and video recording of vehicle/vessel registrations.

The investigation found that the RSO had not positively controlled all access to the DPA when the live weapons systems were operational. The member's failure to report his movements to the RSO was also a contributing factor.

The first-time use of silent sentries instead of manned sentries, without a corresponding change in radio procedures to compensate for the absence of humans-in-the-loop was also a factor. Inadequate training, limited surveillance and access control options, range signage and inappropriate radio for the range quad bikes also contributed to the incident.

The causal chain for this incident could have been broken at several places notably through use of the ground safety net by the RSO and the member to check personnel locations at the arrival of the second strafing serial. The lack of formalised radio procedures and training to control ground movements in the absence of manned sentries along with inadequate training, limited surveillance and access control options, range signage and radio fit of the quad bikes all contributed to the event.

## Changes on the ground and in the airwaves

The squadron has implemented several changes since the event including a revision to range orders. When silent sentries are in use, range vehicles must obtain 'clearance to proceed' at specified points within the range; follow standard routes for transit of the range; and employ standardised radiotelephony phraseology.

Another recommendation that the squadron has activated is the requirement that vehicles do not depart RC during live ordnance training without the approval of the RSO.

The use of 'silent sentries' in lieu of manned sentry positions is a pragmatic approach to managing resource constraints and has continued with re-education of range staff and minor modifications of range infrastructure and radio fit.

Although in this case there was no damage to craft or to personnel, the incident demonstrates that without adequate communication and risk controls, a routine exercise can quickly become very dangerous.

# Unexpected failure

By FLGOFF Matt Fontana

**IN SPRING 2021, personnel were conducting an engine ground run on a C-130J at RAAF Base Richmond following flap system maintenance. Four people were located within the flight station (two members operating the aircraft and two members observing), and a further two members were positioned in the cargo compartment to examine the flap drive system for leak check purposes.**

Personnel started four engines and operated them at normal speed to provide hydraulic power to carry out a leak check and functional test of the flap system. After approximately five minutes of operation, and several cycles of the flap system, the members in the cargo compartment observed hydraulic fluid under pressure discharging from the flap drive system. They alerted the members operating the aircraft, and initiated an emergency evacuation. The aircraft was shut down, and all members vacated the aircraft safely.

## Immediate actions taken

All members evacuated the aircraft. The two people in the cargo compartment who had hydraulic fluid mist exposure removed their over-shirts and washed their hands and arms with soapy water. They assessed the deluge shower was not required after removing contaminated clothing, and deeming the skin exposure as minor. All six members attended RAAF Richmond Health Centre for assessment. One member received treatment from a doctor and the remaining five personnel were released after assessment.

## Classification of the event

The event was initially classified as Class C based on the information available at the time. The aircraft was released from quarantine and towed into the hangar to allow night shift to start the clean-up and investigate the cause of the event. One of the involved members had required the application of oxygen by medical staff and a second had suffered a chemical burn to their eye. The event was immediately reclassified as Class B and the aircraft returned to quarantine until the assignment of an appropriate safety investigation team.

## Previous maintenance history

Personnel had observed hydraulic fluid leaks near the flap drive motor on two occasions in the preceding months. On both occasions, maintenance personnel conducted a leak check and certified the aircraft as serviceable; however, personnel used different maintenance job guides. In Spring 2021 the leak reoccurred resulting in further maintenance over the next few days and ultimately the replacement of the flap drive gearbox brake assembly with a new part from serviceable stock.

During night shift a few days later, personnel completed the installation of the new brake assembly and the system was pressurised using the on-board auxiliary hydraulic system with no hydraulic leaks evident. The auxiliary hydraulic system was capable of reaching the nominal system pressure of 3000 psi but could not provide sufficient flow to perform a functional test of the flap system, so the functional test was left for day shift.

## The engine run

The Engine Runner delivered a comprehensive brief covering the task, role assignments and emergency form-up point. It also took into consideration that the previous shift had applied hydraulic power to the system the night before and cycled the flaps multiple times without observing leaks. They anticipated the functional test would proceed without incident, therefore the Independent Inspector (present in the cargo compartment) wore only goggles (instead of a face shield), with gloves and general-purpose uniforms. The second observer in the cargo compartment wore no personal protective equipment (PPE) and was not wearing a headset for communication with the other members of the team.

> This event demonstrates the importance of a detailed pre-task briefing and clear understanding of emergency procedures.

The engine run and flap system functional test proceeded as planned until the Independent Inspector observed a significant misting of hydraulic oil near the flap drive motor at which point they communicated clearly with the flight deck crew, first informing them of a leak then updating the observation to 'Smoke and Fumes'.

Upon hearing the first message, the Book Reader proceeded to the Hydraulics Checklist. The experienced Engine Runner directed the Book Reader to the Emergency Shut Down checklist then immediately pulled all four fire handles to shut down the engines.

Reading from the Emergency Checklist, the Book Reader guided the Engine Runner through all steps successfully before exiting the aircraft.

Other maintenance staff at the time noted the calm and orderly way the team disembarked. This behaviour reflects the professionalism of the personnel involved and the quality of the brief given by the Engine Runner prior to commencing the task.

### Defective flap drive brake assembly

After the aircraft was cleaned and the flap drive system inspected, the investigating maintenance team discovered that the recently installed flap drive brake assembly had suffered a catastrophic failure during operation.

Hydraulic oil escaping under 3000 psi of pressure caused the oil to become atomised, creating a dense mist inside the cargo compartment which progressed to a significant flow of oil escaping via a small hole on the flap drive brake housing.

Flap drive brake assemblies are not the subject of any scheduled maintenance or inspections and have no applicable shelf life. The failed asset had no previous installation history; however, its military integrated logistic information system (MILIS) history showed many transfers between venues and accounts as a serviceable asset since January 2016.

The results of a defect report on the failed component revealed that a manufacturing defect had caused the cast metal casing to rupture under pressure. The defect was not visible during pre-installation inspections and only became apparent at the moment of failure.

### Communications between the flight deck and cargo compartment

Only the Independent Inspector was wearing a headset to maintain communications with the run team in the flight deck. During a normal operational check out this would be sufficient; however, during the emergency, the observing member did not have complete situational awareness.

### Insufficient PPE

The engine run team was subject to confirmation bias after both the Computer Aided Maintenance Management (CAMM2) system and the shift handover notes indicated that the system had already been pressurised the previous evening and a leak check carried out with no faults identified. Since he expected the system would not leak and would pass the functional checks, the Independent Inspector chose to wear safety glasses instead of a full face shield as is normally required for a leak check (easier headset communication was also a consideration).

The observing member at the rear of the cargo compartment did not wear any PPE because they thought they were a safe distance from the system under test.

The level of exposure to hydraulic fluid could have been minimised further had they been wearing appropriate PPE. However, a face shield would not have protected them from inhalation of the atomised vapour.

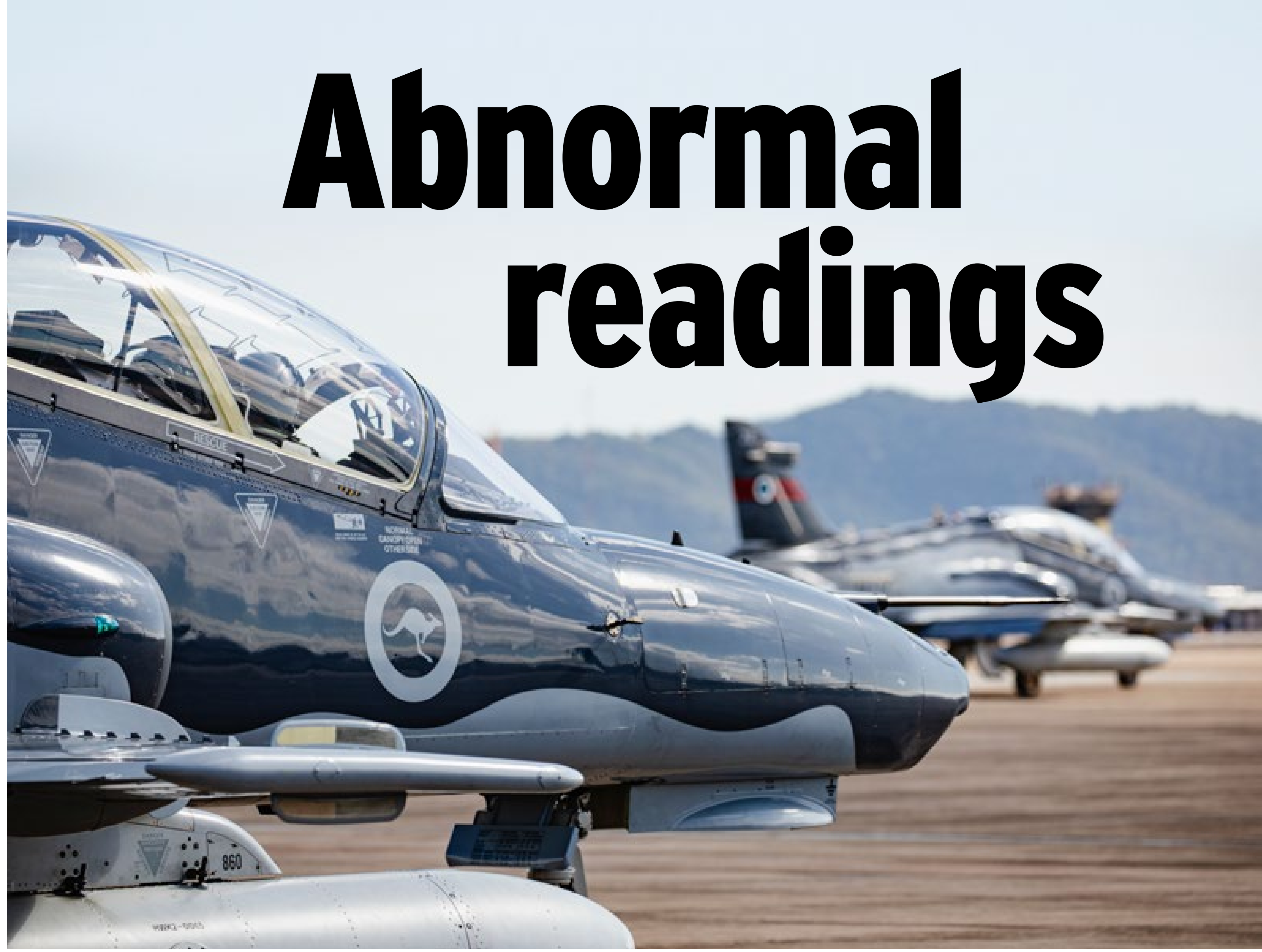
This event demonstrates the importance of a detailed pre-task briefing and clear understanding of emergency procedures.

Unexpected materiel failures may happen at any time. When performing post-maintenance functional tests near pressurised systems a leak could conceivably occur regardless of any prior maintenance. In order to minimise the risk of exposure so far as reasonably practicable, personnel should always wear PPE that is commensurate with the worst credible outcome for the task.





# Abnormal readings



By SQNLDR Craig Gee

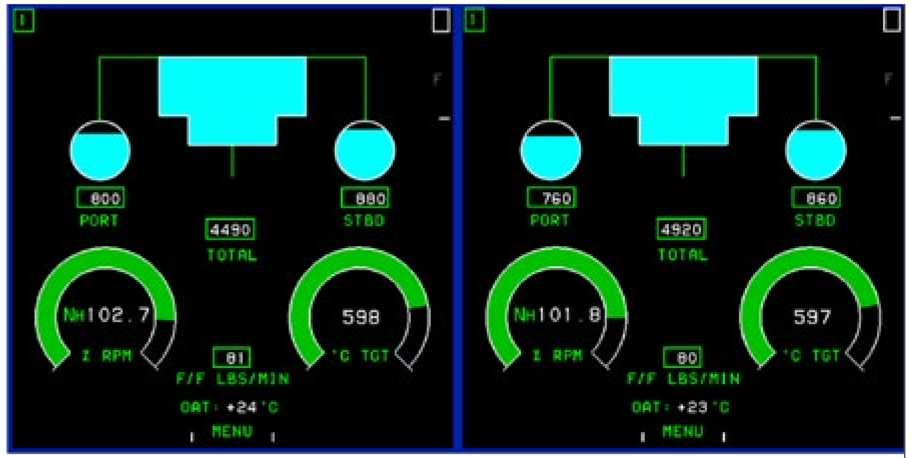
**DURING TRANSIT TO an ADF support mission on 20 March 2023, a formation of two Hawk 127 aircraft fitted with full external fuel tanks conducted a routine fuel check when approaching the exercise airspace. Post fuel check, aircrew noted a disparity of approximately 500 lbs between the two aircraft, Aircraft 1 and 52. Aircrew elected to terminate the sortie early and return to base. Further analysis of previous flights' tapes revealed that Aircraft 1's aircraft had had a very similar issue four days prior (described in more detail later on).**

### Indications

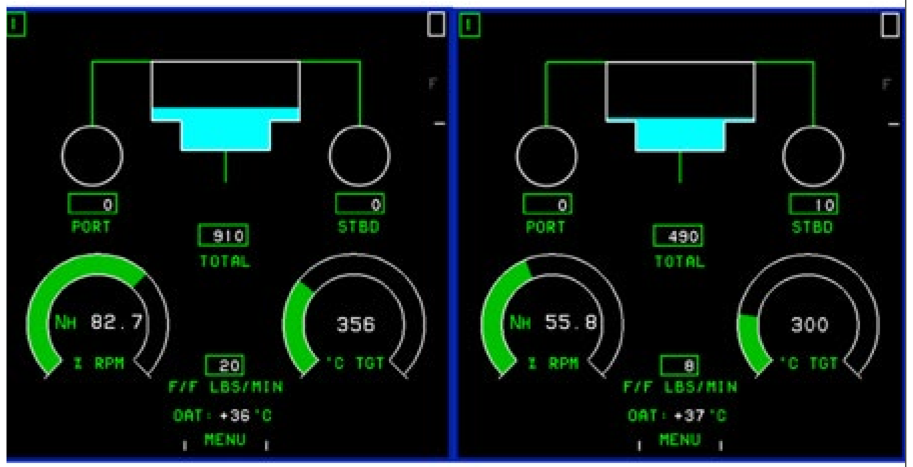
At take-off, Aircraft 1 indicated a total fuel of 4490 lbs, which is normal. Abnormally, some 20 seconds after take-off, the fuel reading rapidly increased to 4920 lbs.

As mentioned, this fuel over-read condition was identified during the routine fuel check en route to the exercise airspace. By this time, Aircraft 1 indicated 4360 lbs, whereas Aircraft 2 correctly indicated 3920 lbs. This disparity was abnormal given the simplicity of the transit and manoeuvring during the mission.

The Hawk 127 holds approximately 2800 lbs of internal fuel. Two external fuel tanks can be




Fuel reading at take-off (left) and fuel reading after take-off (right)




16 March fuel reading prior to landing (left) and during landing roll (right)

fitted each holding approximately 1000 lbs. During the fuel check, each aircraft indicated approximately 550 lbs in each external tank, a total of 1100 lbs external fuel. Adding 1100 lbs to the internal capacity of 2800 lbs leaves 3900 lbs of fuel available. Further fuel checks during the return to base confirmed the fuel disparity within the formation. Upon landing, the total fuel reading for Aircraft 1's jet indicated around 3300 lbs then rapidly reduced to around 2900 lbs before stabilising at the correct total of 3000 lbs, roughly the same fuel as Aircraft 2's jet.

### Platform fuel states

Minimum fuel in the Hawk is defined as a landing below 440 lbs. Emergency fuel equates to landing below 350 lbs. Aircraft 1's jet had had a similar fuel over-read discrepancy on 16 March when, upon landing, the total fuel indication was 920 lbs before decreasing rapidly to 480 lbs, just above minimum fuel. The crew at the time had not noticed this and it was only identified during investigation of the 20 March incident.

The possibility exists that without critical fuel analysis, aircrew could continue flying based on the indicated fuel to an extremely low fuel state, potentially even fuel starvation, given that the actual fuel quantity may be up to 500 lbs less than indicated. The low fuel state on 16 March was far less obvious because, although operating as a formation, the wingman was in a clean aircraft. In this configuration the wingman would expect considerably less fuel during routine fuel checks.

### Findings

A poor connection in the wheel well caused the inaccurate fuel reading. This connection is exposed to potential environmental damage through the ingress of contaminants.

It is likely that contamination caused the inaccurate fuel readings on these two occasions. During testing, manipulation of the associated connection revealed fuel contents variations of up to 500 lbs. To manage this there is now a mitigation strategy of additional disconnect, clean and reconnect of the wheel well connection is now part of routine servicing schedules of the Hawk 127 fleet. Since this has been implemented, no other events of this nature have been observed.

A further finding was that the total fuel appeared to fluctuate between the over-read amount of 400–500 lb and the actual, correct fuel quantity during an 'in-place' turn, which requires +3 G.

### Aircrew considerations

During the investigation, as more information emerged and the potential consequences were realised, a Class B ASR was raised. The maintenance aspects have already been discussed and procedures improved to help avoid similar incidents happening in future. The investigation also found other relevant aspects for aircrew to consider, possibly among all aircraft types.

Fuel over-read indications can lead to aircrew believing that they have more fuel than is available. This can result in being too far from an appropriate airfield when either the low-fuel indication illuminates (if the aircraft has a low-fuel warning), or recovery is initiated. This can obviously lead to fuel starvation. The key is developing techniques that can allow a fuel over-read condition to be identified.

To empower aircrew, fuel usage figures for the Hawk 127 have been developed based on in-flight and tape review. It is reasonable to assume that a Hawk 127 will consume the following amounts of fuel:

- ~250 lbs from the start of the take-off roll to 10 000 ft in a clean aircraft at SOP climb speed (most regularly used departure)
- ~300 lbs if fitted with full external fuel tanks climbing to 10,000 ft
- ~300 lbs on a Salt Ash Weapons Range (SAWR) sortie from take-off to being in the dive for a 30° low drag bombing pass
- ~350–400 lbs on a SAWR sortie from take-off to being in the dive for a 10° high-drag bombing pass, including the overfly update.

Aircrew regularly conduct a fuel check as part of their 10-minute checks at the top of climb. These figures give aircrew knowledge of what to expect during this fuel check. Air traffic control restrictions and other factors may influence this fuel figure but they will definitely assist in recognising a fuel over-read (or under-read) condition.

Additionally, action items and recommendations within No. 78 Wing documentation has been implemented. These include fuel-awareness briefs and guidance regarding 10-minute checks and what makes sense given the phase of flight, aircraft configuration, manoeuvring or throttle usage and, if applicable, other formation members.

Regardless of aircraft type, critical analysis of fuel during routine checks is of paramount

importance. It is easy to simply verbalise the indicated fuel quantity, and calculate how much fuel you are from Joker, Bingo or other fuel-significant segments of the flight without applying more thought. Further analysis may help.

Knowledge of how much fuel is consumed during regular flight regimes, how much fuel is expected at critical points (such as at the top of climb), and critical analysis of fuel states given the time between fuel checks while considering fuel flow rates can warn that something isn't quite right. This can be a difficult task during tactical manoeuvring or even domestic phases of flight in a fast jet when the cognitive workload increases.

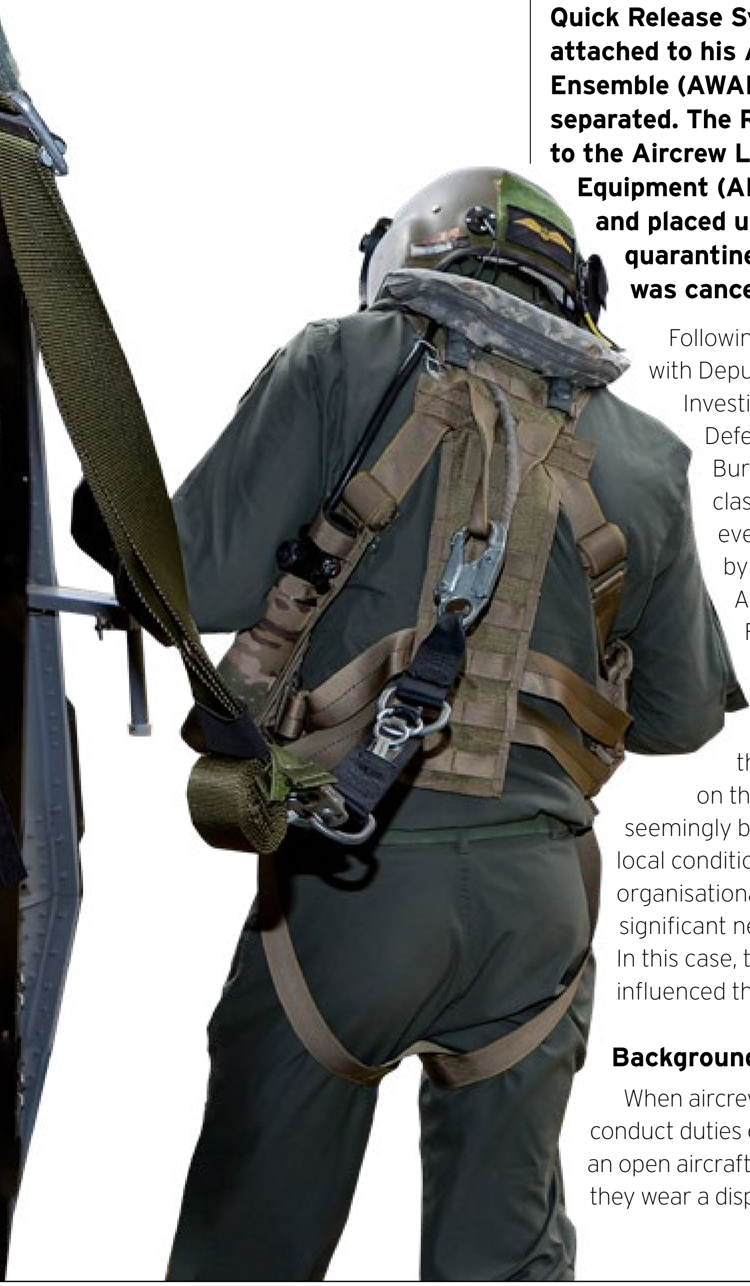
Developing techniques to help confirm how much fuel you actually have might one day prove to be extremely useful. This event also highlights the need for aircrew to improve and maintain their systems knowledge.

Given the workload when the inaccurate fuel indications presented themselves in these missions, differing configurations among formation members and regularly fluctuating fuel totals, this anomaly was particularly difficult to identify. The lessons for aircrew, especially with regard to deeper fuel analysis, have been considerably beneficial. Well done to the aircrew members who identified and dealt with this situation before it became something much more serious.

... as more information emerged and the potential consequences were realised, a Class B ASR was raised.

# Lack of restraint

## Partial separation in a Restraint Quick Release System



**IN MID-2020, ON arrival at a flight line, in preparation for an aircrew training sortie, an aircrew instructor (AIRCREW QAI) found that the Restraint Quick Release System (RQRS) attached to his Air Warrior Aircrew Ensemble (AWAE) had partially separated. The RQRS was returned to the Aircrew Life Support Equipment (ALSE) section and placed unserviceable (in quarantine) and the sortie was cancelled.**

Following consultation with Deputy Director Safety Investigations at the Defence Flight Safety Bureau, this incident was classified as a Class B event for investigation by Headquarters-Fleet Air Arm. Commander Fleet Air Arm (COMFAA) appointed an Aviation Safety Investigation Team; this article is based on their report. Multiple seemingly benign and unrelated local conditions, risk controls and organisational influences had a significant negative safety impact. In this case, the combined with and influenced the work as done.

### Background

When aircrew are required to conduct duties out of their seat with an open aircraft doorway or hatch, they wear a dispatcher harness, which has been secured to an approved attachment point in the aircraft.

The RQRS assembly is used by all aircrew in the FAA and enables the quick release of the aircrew's dispatcher harness in the event of a crash or ditching. If such an event comes to pass and if tension were applied to the RQRS when airborne, the incorrect assembly of an RQRS could plausibly cause aircrew to fall from the aircraft.

### The event

On 4 June 2020, the Aircrew Life Support Equipment Maintainer (ALSEM1) was working alone on the day of the shift. They were distracted prior to servicing AIRCREW QAI's AWAE, by receiving a phone call that advised of a friend's death.

An unscheduled sortie required ALSEM1 transfer of a helicopter emergency egress device (HEED) bottle into an aircrew AWAE. This introduced a distraction during servicing of AIRCREW QAI's AWAE. A HEED bottle is part of the Emergency Breathing System that crew need for over-water sorties.

ALSEM2 arrived late for afternoon shift (approximately 1230), having been engaged all morning attending to a personal crisis, and commenced work with the independent inspection of AIRCREW QAI's AWAE.

AIRCREW QAI did not identify the incorrect assembly of the three metal rings associated with the RQRS. Attention was focussed on the red tac-ties, the 'figure eight' shape of the three metal rings, and general RQRS condition, due to the recent maintenance.

On arrival at the Flight Line Office, AIRCREW QAI thought their integrated restraint harness felt unusually loose. They then discovered that their RQRS had partially separated. The sortie crew were alerted and the RQRS was returned to the ALSE workshop, placed unserviceable (in quarantine), and the sortie was cancelled.

### Investigation

The investigation found that hard copies of relevant publications required for maintenance activities on ALSE equipment are not held in the ALSE workshop. ALSEM are expected to consult current online copies of publications, via the Defence Protected Network (DPN).

The primary workbench for ALSE maintenance is at the opposite end of the workshop from the DPN terminal where the relevant online publications can be accessed. The printer that members had to access to print copies of these documents was located across the road from the workshop.

The maintainer conducting the RQRS service missed a vital step. This error was a result of several contributing factors including distraction, lack of available members and pressure created by workload on the day of the incident.

The Independent Maintenance Inspector (IMI) also missed the incorrect orientation of the locking rings. All other aspects of the inspection requirements appeared to be correct, giving the impression that the entire assembly was correct. Only having three ALSEM at the squadron provides challenges for continuity of ALSE maintenance when one or more ALSEM is absent. At the time of the event, one ALSEM was absent and the two remaining ALSEM were impacted by various distractions, which contributed to the outcome.

This incident highlighted preconditions caused by organisational influences that in turn produced an erosion of extant and well-established barriers to realising negative safety events. The main organisational influence was the staffing structure of the squadron ALSE section.

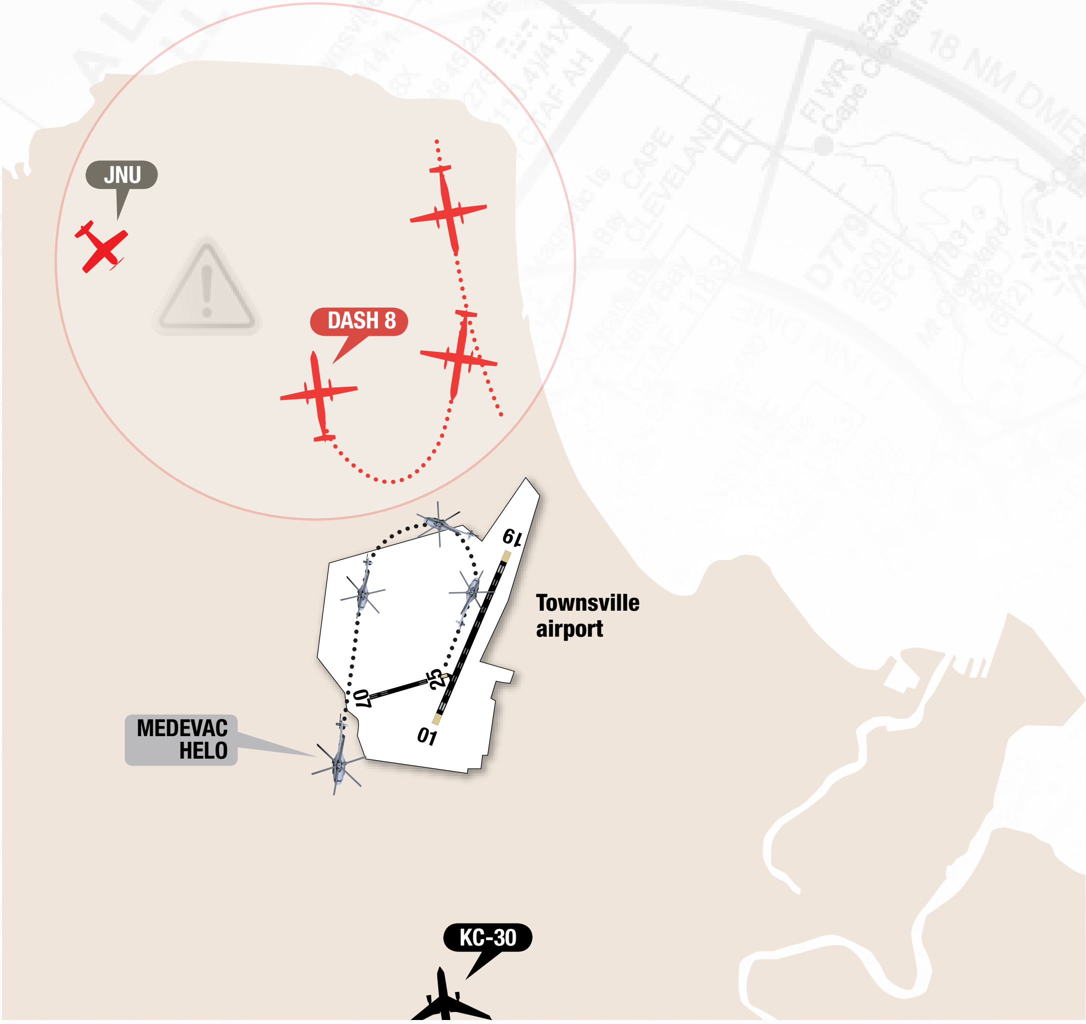
Relative to other FAA units, there was a higher workload caused both by staff numbers and a requirement for a large number of AWAE sets for the unit's training role. In addition, the shortage of HEED bottles further increased that workload as they had to be swapped between users. With sufficient HEED bottles at the squadron, the workload and attendant distraction risk associated with changing between AWAE could be reduced.

The investigation found that incorrectly reassembling the RQRS and the lack of an effective post-maintenance inspection were a direct result of distraction brought about by significant personal events on the part of both ALSEMs and, in the case of the service, the interruption for priority re-fit of HEED bottles. Importantly, without two maintainers manning the ALSE section there was no opportunity to mitigate this risk of distraction by involving another worker. The effects of this distraction was further exacerbated by a high unit rate of effort and the direct relationship with the amount of ALSE to be maintained.

While AIRCREW QAI was trained on the RQRS inspection, the training did not adequately highlight lessons learnt (in the form of Standing Instruction (Navy) (SI(NA) amendment) from a previous event, thereby contributing to the ineffective Before Flight and Acceptance inspection of the RQRS. This is noteworthy in that the SI(NA) amendment did not appear to be consistently communicated across the aircrew workforce.

The 'normal' Before Flight inspection the AIRCREW1 employed also did not cover the areas mandated in the relevant SI(NA). His Before Flight inspection was rushed to achieve the required sortie take-off time and avoid overall flying program impacts.

Increasing staffing, changing the number of HEED bottles on hand and incorporating lessons learnt listed in SI(NA) into training are all ways to mitigate the risk of a similar event happening in the future.




Note: aircraft positions are not to scale and indicative only

# Unrestricted

## Loss of separation assurance between a helicopter and Dash 8

By SQNLDR JJ Rozells

**A LOSS OF SEPARATION assurance occurred between a light aircraft and a Dash 8 on arrival from a regional airport, as the aircraft were on converging tracks with no vertical level implemented by Approach. This situation prompted an Aviation Safety Report and investigation, which forms the basis of this article.**

### The event

A Regular Public Transport, (RPT) Instrument Flight Rules (IFR) Dash 8 aircraft was taken off the Traffic Management Plan from Cairns by Air Traffic Control (ATC) and track shortened direct (DCT) to Townsville aerodrome (TL), Runway 18 (RWY 18) to solve a sequencing conflict with a KC30 (a heavy military aircraft) that was estimating slightly ahead. Sequencing the Dash 8 in front also solved delays caused by the KC30 backtracking on the runway on arrival.

Backtracking means aircraft having to turn around on the runway and taxi back along it to vacate, and in this case would require an eight-minute gap between landing of the two aircraft.

When the Dash 8 was inside 36 nm inbound to TL and on Approach (APP) frequency, a Medical Evacuation priority (MEDEVAC) helicopter (RSCU), received a clearance for Charters Towers Hospital, direct at 6000 ft above mean sea level. This direct MEDEVAC track is 5 degrees off final for RWY 18. Upon hearing this clearance the Approach Supervisor (ASPR) discussed ways to depart the helicopter and facilitate the Dash 8's arrival with the Tower Supervisor (TSPR). The supervisors came to the decision to turn the Dash 8 onto an early downwind position on arrival into the circuit behind the helicopter with 'TWR separation'. This conversation was on an unrecorded line and inaudible to APP and TWR.

This plan was not communicated to the APP or Tower (TWR) controllers. Instead, the ASPR told APP that TWR would separate the aircraft.

When TWR called to APP for departure instructions for the helicopter they did not advise that they would be separating. APP was confused by this and requested for TWR to separate, but TWR said they could not.

TWR then pressed APP for departure instructions for the helicopter, as they were attempting to get the helicopter away in front of an arriving IFR Boeing 737.

ASPR instructed APP to give 'unrestricted', as they believed TSPR would work it out. APP and ASPR then realised that this would not work, so issued a heading instruction to the arriving Dash 8 to fly to separate it from the helicopter. However when they saw the helicopter on radar and tracking outbound, they both recognised that there was diminishing radar separation.

ASPR then directed the APP controller to turn the Dash 8 away to the north-west, and out of the arrival sequence.

The ASPR then contacted the TSPR who had not been monitoring APP frequency. APP issued a heading of right onto350 back towards the north-west; however, had not projected out the path was clear of other traffic, and this heading put the aircraft in conflict with an arriving PA28R light aircraft.

APP noticed this conflict when the Dash 8 had steadied on a heading and issued a safety alert, followed by an avoiding action. During the subsequent avoiding action separation was lost and distance reduced to 2.2 nm co-altitude. The avoiding action took the Dash 8 into cloud, while it was below the lowest safe level on the Radar Terrain Clearance Chart (RTCC) on climb.

### Key points

The four ATC positions were all operating on very different mental models about what was happening, and the communication was poor between the four positions. Much of the key information passed between the supervisors on an unrecorded telephone line.

APP had not projected the flight path of the Dash 8 with other traffic when vectoring the aircraft on the directions of the ASPR to take the Dash 8 out of the sequence but simply followed the direction.

The distance between the aircraft reduced to 2.2 nm co-altitude, below the separation standard of 3 nm or 1000 ft. The Dash 8 was subsequently in an area in instrument meteorological conditions (IMC) below the safest radar vector level.

TSPR and ASPR came up with a complex plan to solve a problem, instead of the more straightforward option of removing the 'problem' aircraft out from the sequence and taking them back after the priority helicopter was clear.

This type of incident could happen when ATOs put pressure on themselves to expedite traffic. Communicating comprehensively and appropriately to all affected controllers leads to safer outcomes.

The distance between the aircraft reduced to 2.2 nm co-altitude, below the separation standard.


# Aviation Safety Training Courses

| Course | COURSE AIM: | PREREQUISITES: | COURSE DESCRIPTION: |
|---|---|---|---|
| **ASO (I)**<br>Aviation Safety Officer (Initial) Course | To graduate Unit ASOs, Maintenance ASOs and Flight Senior Maintenance Sailors. | Personnel who are required to perform the duties of an ASO. | The course is delivered as two separate weekly components (the first is online; the second is face-to-face) with a one-week break in between. The course provides theory and practical exercises in the broad topics of the Defence Aviation Safety Management System, risk management, human factors, the Defence Safety Analysis Model, safety event investigation and reporting. |
| **ASO (A)**<br>Aviation Safety Officer (Advanced) Course | To graduate Base, Wing, Regiment, Fleet, Group and Command ASOs. | ASO (I) practical and applied experience as an ASO (or equivalent). | The course provides theory and practical exercises in the broad topics of the Defence Aviation Safety Management System, human factors and risk management, and base/unit emergency response. |
| **NTS**<br>Non-Technical Skills Trainer | To graduate students with the knowledge and skills to deliver non-technical skills training. | A solid background in crew/maintenance resource management and/or human factors. | The course provides the theoretical background of aviation non-technical skills and trains students in the skills and knowledge for delivering non-technical skills training. The course also introduces students to scenario-based training and assessment techniques. |
| **AIIC**<br>Aviation Incident Investigator Course<br>*Available upon request. | To develop members to support their ASO in conducting aviation incident-level investigations. | Any personnel who are involved with Defence aviation. There is no restriction on rank, Defence civilians and contractor staff are also welcome to attend. | This one-day course provides theory (taken from the ASO(I) course) on the topics of: the Defence Aviation Safety Management System; generative safety culture; error and violation; the Defence Aviation Safety Analysis Model; aviation safety event investigation and reporting. Interested personnel should contact their ASO. |

**For further details concerning location and up-to-date course dates visit the DFSB intranet site or email dfsbet@dpe.protected.mil.au**

All courses are generally oversubscribed, nominations from individual units or candidates will not be accepted, nominations are to be forwarded with the Commanding Officer's endorsement to:

- **Air Force:** the relevant Wing Aviation Safety Officer, or for CSG, Staff Officer Safety HQCSG
- **Navy:** the Fleet Aviation Safety Officer and
- **Army:** Army Safety Section, DOPAW, AVCOMD.

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