



SPECIAL EDITION: THE HOW AND WHY
AVIATION SAFETY INVESTIGATIONS

01 2026

Spotlight



CLOSE CALLS

Investigation Special 2026

Nine expert articles exploring flight-safety incidents,
contributing factors, and their lessons for Defence aviators





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Comments, contributions, etc, are invited from readers in the interests of promoting aviation safety as widely as possible throughout Defence, and may be addressed to:

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FOREWORD

Welcome to the 2026 *Spotlight* Investigation Special, which is one of the key mechanisms through which investigation reports are communicated broadly to Defence aviation organisations and supporting enterprises. This edition includes articles about aircraft accident and serious-incident investigations conducted by the Defence Flight Safety Bureau, as well as investigations of serious incidents conducted by Defence aviation Commands.

The sequence of events leading to an accident or serious incident often begins with latent failures or conditions of organisational processes, such as management decisions associated with planning, scheduling, designing, specifying, communicating and regulating. Organisational conditions – if allowed to be transferred to the workplace –

result in or manifest through 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's or team's performance may be negatively impacted through 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.

The primary aim of investigating aviation-safety events is to improve safety-system performance and prevent recurrence of a similar event, while not apportioning blame or liability. An aviation-safety investigation is the basis for initiating actions necessary to improve aviation safety; therefore, the investigation must not only establish what happened, but 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 a risk or hazard from being realised.

I encourage commanders, managers, supervisors and operational staff to look beyond individual actions featured in the articles but, rather, to reflect upon the origins of unsafe acts, which often lie in management decisions and organisational deficiencies in: deliberate risk management; flying-management systems; orders, instructions and publications; training; flying supervision; and flight authorisation.

Very respectfully

Group Captain David Smith, CSM
Director DFSB



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F/A-18A uncommanded weapon release

ON 27 NOVEMBER 2020, a formation of two F/A-18A Hornets were conducting an air-to-ground and Red Air (simulated opposition) mission within the Delamere Air Weapons Range, Northern Territory. After one aircraft captain (AC) released his aircraft's Mk84 low-drag, high-explosive (HE) weapon, he noticed

that his Mk82 Snake Eye (SE) HE weapon was also missing. His wingman carried out a visual inspection and confirmed that both weapons were no longer loaded. The aircraft returned to RAAF Base Tindal in the Northern Territory, landing without further incident via a straight-in approach. Despite extensive searches, the missing Mk82 SE was not found.

The uncommanded release was classified as a Class B aviation-safety event because of the weapon's potential for extensive damage and loss of life, with little or no remaining risk controls. Air Commander Australia appointed an Aviation Safety Investigation Team from the Defence Flight Safety Bureau (DFSb) to investigate.

The investigation

The investigation of the event included interviews, system checks, forensic analysis of the physical bomb release unit (BRU) - BRU-32 - and downloaded data from the aircraft. The investigation found that the uncommanded release of the Mk82 SE weapon was likely due to defective hook-latch springs internal to the BRU fitted to the aircraft.

A review of previous aviation safety reports (ASRs) further identified that the BRU-32 - serial number (SNo) MQJ164 - had been involved in an uncommanded release in 2012, and a series of less-severe partial-unlock events prior to this. Investigations following the 2012 incident determined that a mechanical malfunction of the BRU-32 was likely the cause, however could not identify specific faulty components. Extensive defect and event analysis during the 2020 investigation revealed MQJ164 had a total

mean time between failures of 641 hours: 83 times the fleet average. This trend had not been identified previously, due to a lack of defect-report tracking and trending analysis at the SNo level.

A recommendation from 2012 was for the event BRU-32 (MQJ164) to be removed from service and quarantined. The investigation found that the recommendation was not actioned due to organisational communication and procedural errors. Consequently, MQJ164 was overhauled and returned to service after remaining on a shelf for two years.

Forensic teardown and inspections of MQJ164 in support of this investigation identified mechanical deficiencies similar to those highlighted in the 2012 investigations. Notably, the two hook-latch springs - which assist in holding the hook latches closed - were found to be out of tolerance, which could reduce the force required to initiate the hooks (holding the weapon) to open.

Subsequent dynamic testing of MQJ164 on a test rig resulted in the malfunction of the BRU-32 at one third of the designed load limit. Following its malfunction, the hook-latch springs were replaced with in-specification springs



An unexploded Mk82 weapon, partially buried on impact

A mechanical fault in BRU-32 MQJ164 caused the uncommanded release. Deficiencies in the hook-latch springs were the likely cause.



An F/A-18 Hornet carrying Mk82 general-purpose bombs during routine weapons training



This asset had a history of similar issues. MQJ164 was linked to a 2012 uncommanded release and multiple earlier partial unlocks.

(that is, springs that met the compression-test requirements) and the BRU-32 was retested. This resulted in MQJ164 passing the required load testing to its full designed limit. The testing therefore highlighted the criticality of hook-latch springs and elevated the deficient springs as the likely leading causal factor for the MQJ164 malfunction. In response to the findings, the squadron confirmed the serviceability of all in-service hook-latch springs before returning to HE flying operations.

Event sequence

During the taxi run before take-off on the night of the event, and in accordance with pre-take-off checklists, the AC conducted a weapons-system RACK's test¹, with no abnormalities identified.

During the next sequence, the AC identified that the Mk82 SE weapon was missing from its station 8. The second aircraft then conducted a visual inspection of the first aircraft to examine its station 8 pylon for an irregular release.

The formation returned to the Delamere range, where they informed range control and the next formation in the area of the missing weapon. The event formation unsuccessfully inspected the flight area, highway and surrounding zone for any evidence of the weapon.

The formation departed Delamere range and returned to RAAF Base Tindal via a straight-in approach to avoid any built-up areas.

Defence conducted a ground search of the Delamere range and bordering areas for the probable weapon-impact point, but all attempts to locate the weapon were unsuccessful.

BRU-32 partial unlocks

To widen the search for comparable events, the investigation team also included all prior partial-unlock and irregular-commanded release events. At the time of the investigation, there were 270 BRU-32s in service.

By reviewing prior ASRs, aviation safety occurrence reports and Systems Project Office (SPO) defect reports, the investigation team identified 15 recorded events where a BRU-32 had suffered either a partial unlock, a

hook-locking indication or an irregular release. Of these 15 events, 12 had occurred to BRU-32s with an SNo prefix of MQJ (that is, 80 per cent of previous partial-unlock BRU-32 events occurred on 36 per cent of the fleet's assets).

Armament officer and aircrew actions

All aircraft and weapons emergency-jettison electrical testing and checks were completed on the aircraft. Checks were within the 30-day prescribed currencies at the time of the event. On the afternoon of 26 November 2020, the aircraft's station 2 was loaded correctly with an Mk84 weapon and station 8 was loaded with an Mk82 SE, in accordance with published procedures. Analysis of the switch positions and pilot inputs established that all aircrew actions were also in accordance with published procedures. In particular, the air-to-ground checks were carried out in accordance with the APP 7213.006-1-TAC-300 Weapon Delivery Checklist. These included ensuring all relevant switches were made safe, as well as deselecting air-ground mode and selecting simulation mode. The pilot identified that the Mk82 SE weapon had been released after making station 8 safe. After the formation confirmed the weapon was missing, the crews appropriately notified range control,



Armament personnel prepare an F/A-18 Hornet for a training sortie by loading Mk82 bombs onto the aircraft

conducted searches, and recovered the aircraft while avoiding exposure to built-up areas.

Lessons

- The 2012 recommendation to remove BRU-32 MQJ164 from service had not been actioned, thereby allowing the same asset to feature in the 2020 uncommanded release. Safety recommendations need to be justified through investigation and tracked through Safety Management System processes.
- MQJ164 had an unknown abnormal history of partial unlocks and a significantly lower mean time between failures than the rest of the fleet. SNo-level defect-trend analysis is therefore essential for identifying faulty components.
- Extended unavailability of the spring-testing device and discrepancies in spring holdings increased the risk of undetected defects. Reliable test equipment, accurate records and robust stores management underpin weapons safety.
- MQJ164's return to service after being recommended for removal shows how breakdowns in communication and asset-quarantine processes can erode safety controls. Clear, documented information flow between units, SPOs and investigators is therefore essential.
- Incident investigations do not always produce conclusive causal factors, nor resolve all relevant issues. Similar malfunctions eight years apart demonstrate how unresolved issues can persist. Regular reviews of historical data, maintenance practices and recommendations will strengthen Defence's aviation-safety systems. ▲

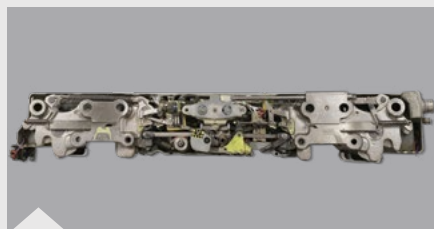
Endnote

¹A RACK's test is an inbuilt test that confirms the electrical operation of the unlock system within the bomb release unit.



Aircraft

The F/A-18A is primarily used as a counter-air-operations and air-to-ground attack platform. It can carry a wide variety of air-to-air and air-to-ground munitions.



Bomb release unit

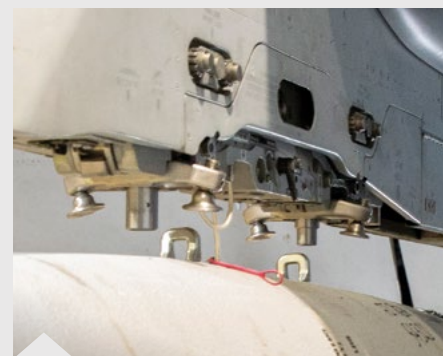
The BRU-32 ejector rack assembly is a non-jettisonable, single-carriage rack used for carrying weapons, multiple bomb racks and external fuel tanks. It is attached to the wing pylons by four bolts and is electrically integrated into the Aircraft Weapons System. The BRU-32 can carry weapons/stores of between 10 and 28 inches in diameter and weighing up to 2600 lb. Within each BRU-32 are two pairs of suspension hooks, set 14 and 30 inches apart.

Any weapons/stores suspended from the BRU-32 can be jettisoned within the aircraft's tactical-flight envelope. The BRU-32 consists of a housing assembly containing electrical and mechanical systems that facilitate inflight fusing/arming, and ejection or release of weapons/stores.



Weapon

The Mk82 low-drag general-purpose 500 lb bomb is fitted with a Mk15 SE fin assembly (designed to increase drag on the bomb, dependent on requirements) and is an air-dropped, freefall, aerodynamically streamlined, non-guided weapon. It is a high-speed, low-altitude bomb.



Weapon release

Munitions are suspended from the BRU-32 via two hooks in company with an arming lanyard attached to the BRU-32 for configuring the weapon-arm mechanism at release. For performance analysis, a Maintenance Status Data Recording System records maintenance and status events for the weapon while the weapon is loaded to the BRU-32.

During flight, aircrew use the mission computer and a digital-display interface to view weapons/stores information.



Mishandled landing and near runway over-run

ON 24 SEPTEMBER 2020, after completion of a turn manoeuvre at medium level, a solo Introductory Fighter Course (IFC) trainee pilot felt a vibration through the Hawk 127 aircraft, which dissipated with a reduction in engine power.

The trainee decided to recover the aircraft to RAAF Base Pearce, Perth, via a fixed-power straight-in approach. While positioning for the straight-in, the trainee struggled to control speed, selected gear and flaps down at a late stage and flew a very steep final approach.

Due to excess speed, the aircraft bounced hard a number of times during the landing attempt. As the aircraft drifted left of the runway centreline, the trainee pilot initiated a go-around, lifting off with 1500 ft of runway remaining. During selection of flaps up in the go-around, the airspeed reduced to within a close margin of stalling. Post-flight inspections and data analysis recovered no engine vibrations or airframe abnormalities, and the landing sequence was within the design limits of the aircraft.

Initially, this event was classified as a Class C safety incident, and an investigation was conducted by No. 79 Squadron (79SQN) but, after review, the event was reclassified as Class B. The Defence Flight Safety Bureau reviewed the final 79SQN investigation.

Emergency-handling guidance

When faced with engine mechanical damage or other engine-related problems, the aircraft captain should conduct the following actions:

- land as soon as possible (in this case, this meant at RAAF Base Gingin, which was closer)
- limit revolutions per minute (RPM) to <90 per cent
- make only essential power changes and use slow and smooth movements.

An appropriate course of action for recovery is the 'fixed-power straight-in approach', which is detailed in the IFC Hawk Training Manual. To achieve a fixed-power straight-in approach, the aircraft should be positioned for a 5 nm straight-in approach on a normal 3-degree profile. The aircraft is

progressively decelerated with airbrake, flap, and landing gear to achieve a 3-degree descent while decelerating to threshold speed.

The trainee would have been conscious of a recent RAAF Hawk catastrophic engine failure that occurred on 14 May 2019. This aircraft experienced an Adour Mk871 catastrophic engine failure during a touch-and-go take-off roll at RAAF Base Pearce. Onsite visual inspection of the engine identified damage to the low-pressure turbine, where a number of blades appeared to have been released. The fuselage of the aircraft had been punctured in one location on the left-hand side of the engine bay, and further non-penetrative damage was identified in the skin of the aircraft (Figure 1). The Mk951 engine-replacement project has re-engined the Hawk fleet and eliminates Mk871 engine risks.

Recovery plan

The trainee held in the Pearce Training Area for nine minutes, conducting fault finding and establishing communication with the Duty Supervisor (DSUP). The

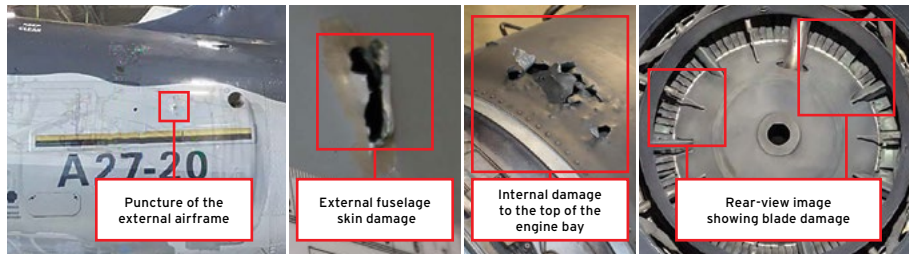


Figure 1: Catastrophic engine damage to a Hawk in 2019

final decision to conduct a fixed-power straight-in approach to RAAF Base Pearce was approved by the DSUP.

The DSUP continued to support the trainee on the approach by assessing the crosswind, and was cognisant of not adding to the stress of their situation by being overly communicative.

Although diverting to RAAF Base Gingin would have provided a track reduction of 15 nm, and runway alignment with the current 10-15 knot headwind, no discussion or consideration was made to divert, as the trainee was experiencing no vibration while the engine remained in the range of idle to 88 per cent RPM.

The trainee declared an emergency at 30 nm from base, but did not request additional airspace to be able to decelerate and manoeuvre onto finals for the runway. The trainee decelerated in the limited airspace available.

The trainee was conscious of the power range from idle to 88 per cent being available, with their primary focus for deceleration of the aircraft (while manoeuvring around the RAAF Base Pearce-Perth airspace interface) by using airbrake and flap.

In this case, RPM remained at 88 per cent until 2.2 nm from the runway, with the airspeed being 200 knots calibrated airspeed (KCAS) and altitude 1550 ft above ground level (AGL). Only then was power reduced to facilitate lowering of the undercarriage.

The aircraft's deceleration profile with 88 per cent RPM was such that a normal

approach angle - even allowing minor deviation for the fixed-power, straight-in approach - was not safely achievable.

Final approach to land

On final approach to land, the trainee became fixated on forcing the aircraft to touch down, despite significant signs that the approach profile was unsafe.

Following a prolonged deceleration (more than two minutes with 88 per cent RPM), the trainee selected the undercarriage and flaps down at 1.7 nm from the intended touchdown point, which now required a 12-degree

descent to regain a normal approach angle. The Hawk Training Manual specifies that an approach angle steeper than 7 degrees is a mandatory go-around.

The trainee descended through 1000 ft AGL with a nose-down attitude of 12 degrees at 1.1 nm from the displaced threshold (Figure 2).

The conduct of the final descent, and engine-power setting of between 76 and 83 per cent RPM, resulted in minimal deceleration, and at no point during the approach was a sustained positive angle of attack achieved (normal touchdown angle of attack is 5 degrees for all configurations).

This negative angle of attack (~2-3 degrees at touchdown) resulted in the nose wheel touching the runway prior to the main wheels and approximately 40 KCAS faster-than-normal landing speed for the aircraft weight. This resulted in initiation of the bouncing sequence



Figure 2: The approach to the runway: 1.1 nm

of up to six bounces and the trainee's subsequent decision to go around.

Figures 3 through 5 show the bounce sequence prior to the trainee's decision to go around on the sixth and final bounce.

Go-around and approach to land

The residual aircraft speed versus remaining runway braking distance rapidly eroded any chance of bringing the aircraft to a safe stop off the initial landing attempt. While it is highly undesirable for a suspected engine-damage scenario to result in reselection of maximum power, this was effectively the only action remaining available to the trainee other than ejecting during the bounce sequence.

The crosswind had exacerbated lateral movement of the aircraft during the bounce sequence, resulting in poor

directional control and inability to safely stream the parachute brake, with safe barrier engagement very unlikely.

Instead, the trainee aborted the landing attempt and conducted a go-around with the aircraft rotating with 1500 ft of runway remaining (Figure 6).

Fortunately, the engine performed as hoped and prevented the situation from worsening.

As it was unlikely to rule out heavy landing damage, the trainee should not have raised the undercarriage and flap (Figure 7). Ordinarily, a pilot would be expected to discuss this type of landing (and any potential damage to the undercarriage) with the DSUP.

During the subsequent circuit to land, the trainee failed to communicate with the DSUP to clarify what post-heavyweight-landing emergency-

checklist actions must be conducted. The trainee was left only with the hope that the undercarriage would be able to support a safe second landing.

This absence in communication could be attributed to the trainee being overwhelmed by the compounding emergency and being task focused on getting the aircraft on the ground. ▀

Recommendations

Two recommendations were made to improve aviation safety within the Hawk 127 community as a result of this incident:

1. Review the emergency-handling procedures that are taught to IFC trainees, with consideration to appropriate recovery prioritisation for engine malfunctions (real or suspected). The term 'fixed power' was replaced with 'precautionary' in the revised IFC Hawk Training Manual.
2. Review simulator training, with the focus on the precautionary straight-in approach, to reinforce the relevance of this procedure to various aircraft/engine malfunctions, actual or suspected.

Lessons

Active failures in emergency-checklist actions, communications, and aircraft handling caused this abnormal situation to compound and overwhelm the trainee pilot. The prospect of mechanical engine failure was very real at this time; a previous catastrophic failure had occurred at RAAF Base Pearce 16 months earlier and the capability was operating with additional risk-management controls. While individual decision-making in the cockpit was shaped by situational ambiguity and stress, the investigation highlighted deficiencies in engine-malfunction emergency-handling training taught to IFC trainees.

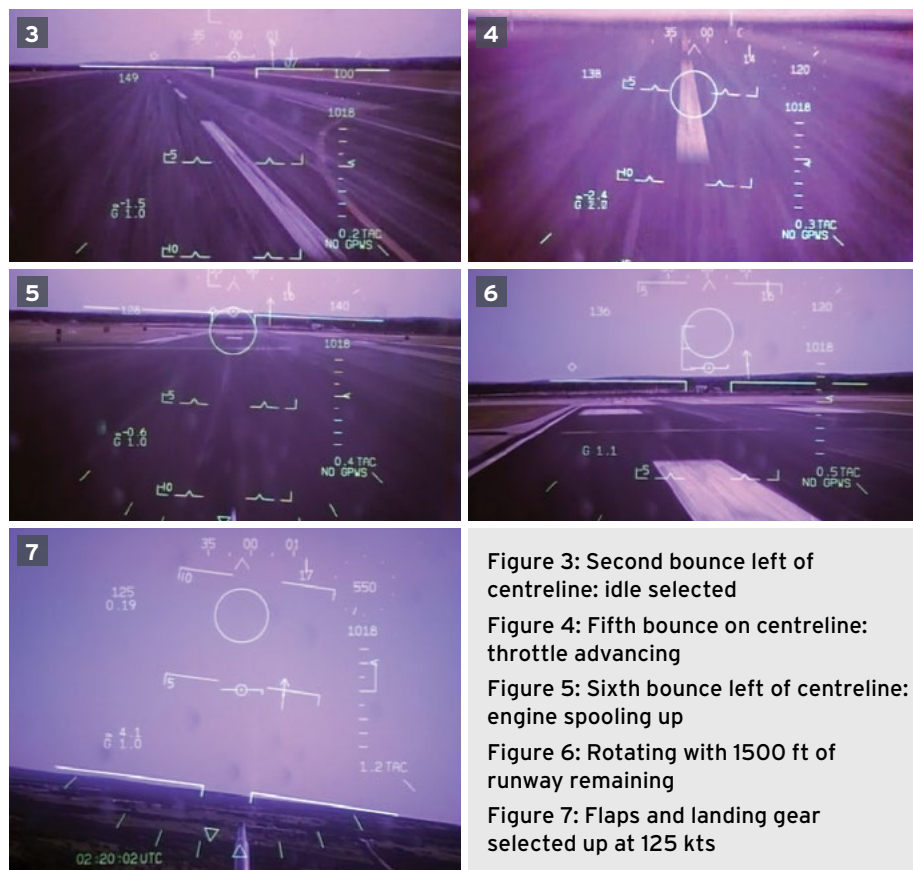


Figure 3: Second bounce left of centreline: idle selected

Figure 4: Fifth bounce on centreline: throttle advancing

Figure 5: Sixth bounce left of centreline: engine spooling up

Figure 6: Rotating with 1500 ft of runway remaining

Figure 7: Flaps and landing gear selected up at 125 kts

YOUR WORDS CAN HELP KEEP US ALL SAFE



We welcome contributions that provide meaningful insights into aviation safety and operational excellence

- case studies of recent or historical incidents, human factors in mishaps, or near-misses highlighting systemic risks
- examples of strong safety leadership, improvements in reporting culture, or perspectives from senior leaders
- retrospectives on aviation-safety evolution or analysis of past incidents and their lessons for today
- lessons from exercises and multinational operations
- policy and regulatory updates from DFSB, DASA or related bodies, or changes to safety regulations and reporting
- innovations in maintenance or operations, reviews of safety technologies, or risk management in complex environments
- best practices in safety training and simulation
- your personal reflections or experiences that have shaped your safety awareness.

Please email your article ideas to dfsb.pm@defence.gov.au

Thank you for your continued support in strengthening aviation safety across Defence



Clamping down on safety

By Major Mehdi Moussaoui

ON MONDAY 7 March 2022, a CH-47F Chinook helicopter from the 5th Aviation Regiment in Townsville, Queensland, landed at the Gold Coast Airport for a quick refuel. The helicopter was part of a contingent deployed for Operation Flood Assist 2022 in northern New South Wales. Little did anyone know at the time, after that quick stop, the helicopter was not going anywhere for a while.

While the aircraft was being refuelled, the Aircrewman Technician (AT) on board decided to conduct a check around the helicopter. Although this check was not mandated, the AT's diligence revealed a problem around the flight controls that could have led to catastrophic consequences in flight.

Sequence of events

On the day prior, Sunday 6 March 2022, the Chinook had flown from Townsville to Oakey in preparation for missions

as part of Operation Flood Assist. At Oakey, which was to be its base of operations during the deployment, the aircraft had undergone its routine After Flight and Before Flight inspections. The hazard remained undetected.

On the Monday, before departing Oakey, the aircrew completed a pre-flight inspection, with still no signs of the issue. The aircraft departed Oakey, arriving at Gallipoli Barracks, Brisbane, where it joined with a formation of three other Chinooks. The aircraft shut down and had more routine inspections, but there was still no indication of the hazard that would materialise later that day. The formation of four helicopters departed Gallipoli Barracks for Lismore, New South Wales, where it conducted troop insertions.

The formation then flew to Gold Coast Airport to refuel. While conducting an inspection on the helicopter, the AT discovered that the wheel-brake accumulator gauge cover was cracked. It quickly became apparent to the AT that the accumulator itself had dislodged from its mounting brackets



and was sitting freely on the flight-control rods in the upper-forward pylon of the Chinook. The crew assessed that the accumulator had significant potential to interfere with or jam the flight controls, potentially setting the conditions for a catastrophic outcome. The crew raised a Class B aviation

safety report, due to the perceived risk level being assessed as VERY HIGH.

On Tuesday 8 March 2022, the lead investigator from the Headquarters Army Aviation Command Aviation Safety

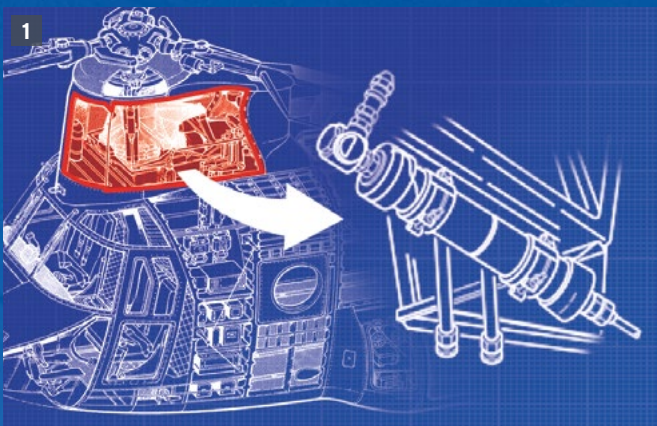


Figure 1: Installed location of the accumulator in the aircraft

Figure 2: The green area indicates where the accumulator should sit, while the red area indicates where it was found after breaking loose

Investigation Team (ASIT) began an investigation. The damaged components were removed from the helicopter and preserved for analysis. As the safety event was localised to the upper-forward-pylon area, once the necessary evidence had been gathered, the aircraft was released from investigatory quarantine and returned to maintenance.

What the ASIT found, and could not find

The investigation was unable to determine when the accumulator had dislodged. However, evidence indicates that it was likely to have occurred between the helicopter departing Gallipoli Barracks and shutting down at Gold Coast Airport. The dislodged accumulator was only identified due to the AT's diligent and fortuitous thru-flight inspection, conducted beyond the scope of the Flight Crew Checklist: a credit to the AT's diligence and professionalism.

How the accumulator dislodged

Several clamps were previously approved for attaching the wheel-brake accumulator to the airframe, known as 'wide' and 'narrow' clamps. The investigation found that the accumulator

dislodged as a result of a complete failure of two wide clamps that secured the accumulator to the airframe in the forward-pylon section of the aircraft. This failure was attributed to cracking of both of the wide clamps holding the accumulator in place.

The investigation found that the cracking of the clamps was likely due to the tension and bending loads created by the mismatch between the wide clamp's geometry and the position of grooves (designed to align with the clamps) on the brake accumulator. It is likely the cracks in the clamps began months prior to the safety event; however, they would have been very difficult to detect due to the positioning of the accumulator.

The investigation

The investigation discovered that the global CH-47F aircraft fleet had experienced similar cracking. One incident had been reported to Boeing in 2018 and Boeing went on to say:

At the time of the cracking in 2018, no other customer had reported similar issues regarding issues with the subject clamp assembly. Therefore no engineering investigation was initiated for this particular event.



CH-47F Chinooks in formation during a community-engagement activity

Following the CH-47F Chinook project office raising this issue to the global community, cracked clamps were found on other aircraft, and Boeing instigated an engineering investigation.

The ASIT investigation identified that wide clamps were Boeing-approved parts up until March 2016, after which narrow clamps became the approved part to secure the wheel-brake accumulator. However, Australian CH-47F aircraft built after this date (the safety-event aircraft was built prior to this date) continued to be fitted with wide clamps. Despite the narrow clamps being the only approved clamps listed in the Australian Defence Aviation Authorisation Spares System, as it is not a Maintenance Managed Item and 'On Condition', the maintenance organisation would not become aware of this until such time as a clamp was found cracked and required replacing.

The safety event was the first-known complete failure of the clamps experienced in the Australian CH-47F fleet; however, two instances of cracking were recorded in Computer Aided Maintenance Management Version 2, dating back to September and November 2020 and found during base maintenance inspections. In both cases, defect reports were not raised, thereby nullifying an opportunity to rectify the safety issue.

The Air Force Continuing Airworthiness Manual, now renamed the Defence Continuing Airworthiness Manual, stated:

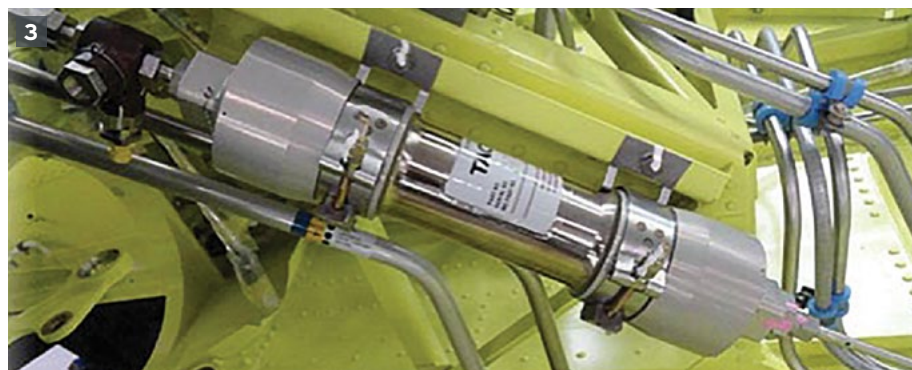


Figure 3: Accumulator mounted with non-approved wide clamps (from Service Bulletin 724-29-1018)



Figure 4: Broken brackets from A15-306 (from the ASIR)

technical reports are required to be submitted by the Maintenance Organisation (MO) to the Continuing Airworthiness Management Organisation (CAMO) whenever a failure, malfunction or defect to a component, part or other aeronautical material occurs either on or off aircraft prior to the issuance of a Certificate of Release to Service (CRS) or Authorised Release Certificate (ARC).

However, exceptions exist to this requirement for 'On Condition' items, at the discretion of the Maintenance Manager. As a result, the investigation found opportunities for improvement in defect-report training and defect-report quality monitoring by the maintenance organisation.

Actions taken by Chinook engineering organisations

As a result of this safety-event report, Cargo Helicopter Maintenance Unit released a Special Technical Instruction, which required an Australian fleet-wide inspection of the clamps. These inspections identified that of the 24 clamps fitted, 21 were the wide clamps previously identified as no longer approved by Boeing in 2016, and not approved on Australian Defence Aviation Authorisation Spares System. Of these non-approved clamps, cracking was identified in three clamps.

Boeing released a Service Bulletin to the global fleet calling for an immediate inspection of all clamps, replacing any cracked clamps with narrow clamps, and to conduct visual inspections before each flight on any wide clamps found serviceable and still fitted. Boeing further advised:

Although it is permissible to install or leave installed a suspect and uncracked Clamp, Boeing recommends removing any suspect Clamp and replacing it with an authorized Clamp as soon as authorized clamps become available. ▀



Chinook aircrew inspect the aircraft during pre-flight procedures

Recommendations

The investigation identified that the defect-reporting culture and training was not robust. The Aviation Safety Investigation Report (ASIR) recommended several actions to improve understanding of when defect reports 'should' be raised.

At an organisation-influence level, the ASIR recognised a broader issue around the clarity of defect-reporting criteria. As a result, Chapter 6 of the Defence Continuing Airworthiness Manual now provides more explicit criteria for raising defect reports.

Other findings resulted in the ASIR making recommendations for:

- improved training at the Rotary Aircraft Maintenance School on defect reporting
- updating maintenance policy to ensure changes to endorsed parts are communicated
- a review into the specifics of thru-flight inspections.

Safety message

If not for the timely and fortuitous identification of the dislodged wheel-brake accumulator by the AT, this Class B safety event could have manifested into a catastrophic aviation accident. Among other safety lessons, the investigation highlighted the importance of a robust defect-reporting system: one that relies on effective training, clear instructions, high-quality monitoring, and continual improvement. In this case, the effectiveness of the reporting system as a preventive risk control was degraded, thereby increasing the likelihood of the hazard going unnoticed and ultimately becoming dislodged among the flight controls.

The ASIR made recommendations focused on improving defect-reporting processes and culture, to identify and correct latent conditions before they become aviation-safety events.

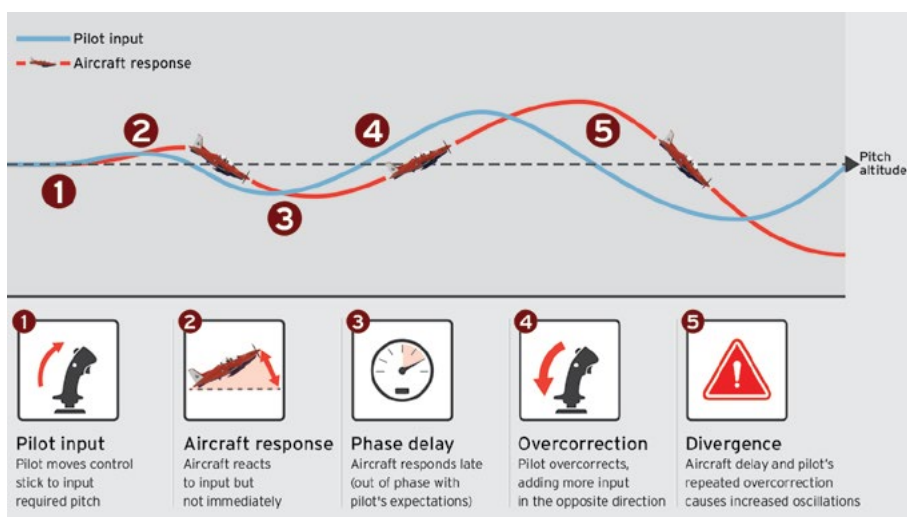


Mishandled bug-out results in near miss

ON 15 DECEMBER 2022, a formation of two PC-21s from a flying training school were performing a turning rejoin during an instructional sortie. While monitoring the student's turning rejoin technique, the qualified flying instructor (QFI) rapidly took control of the aircraft due to an excessive rate of closure on the lead aircraft. The QFI attempted to fly below and behind the lead aircraft in a commonly practised 'bug-out' manoeuvre.

During the bug-out, the QFI experienced pilot-induced oscillations (PIOs), lost visual sight of lead and subsequently performed a dynamic turn down and back towards lead without visual contact. During the dynamic turn towards lead, the two aircraft closed to 110 ft separation, which ultimately resulted in a near-collision event. There were no remaining risk controls to prevent a collision between the aircraft.

This incident was classified as a Class B aviation-safety event and, on 23 January 2023, Air Commander Australia, in



Pilot-induced oscillations driven by control delay and overcorrection

consultation with Commander Air Force Training Group, appointed the Defence Flight Safety Bureau to form an Aviation Safety Investigation Team (ASIT) to investigate the event.

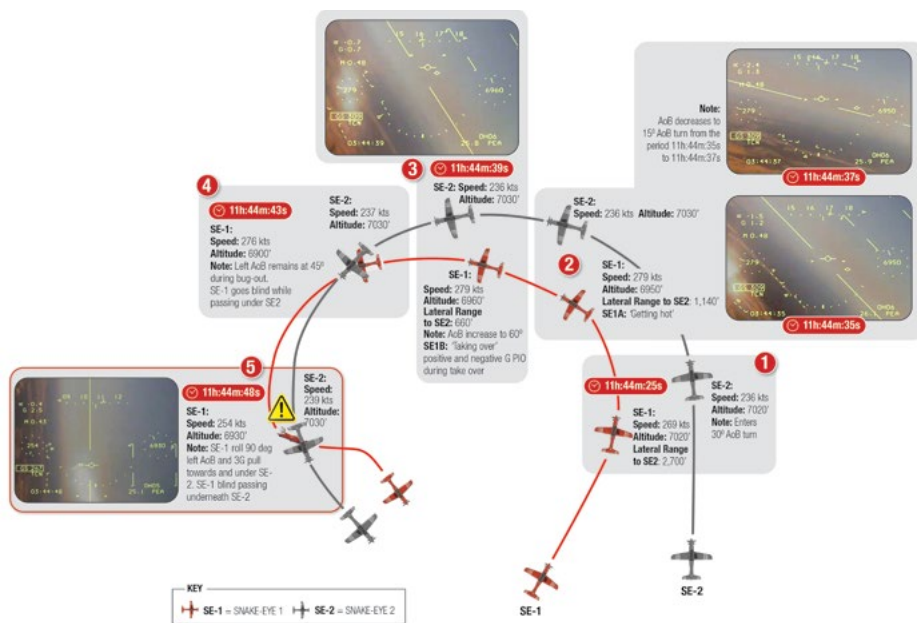
The event and investigation

The ASIT found that the incident QFI interpreted the student's control inputs to reduce the aircraft's angle of bank as the beginning of a bug-out manoeuvre.

However, the student then rapidly increased angle of bank in an attempt to regain the correct rejoin line, while also not being cognisant of excessive airspeed and rate of closure on lead. At this point in the sequence of events, the QFI's mental model was not aligned with the student's manoeuvring of the aircraft.

This resulted in the QFI rapidly taking control of the aircraft, in a dynamic situation, past the normal point where a safe rejoin was possible due to the excessive rate of closure. The QFI then experienced significant PIOs, which resulted from rapid inputs to the control column and G-forces oscillating between -3.4 G to +5.4 G. The PIOs further degraded the QFI's situation awareness (SA), and contributed to the QFI's instinctive reaction to execute a non-procedural bug-out without sight, or awareness, of the position of the lead aircraft.

The ASIT found that it was highly likely the QFI experienced degraded SA and cognitive overload, due to allowing the student to manoeuvre outside the QFI's supervisory capabilities. This led to the QFI's hazardous manoeuvring despite having lost visual contact with the lead aircraft. The ASIT noted during



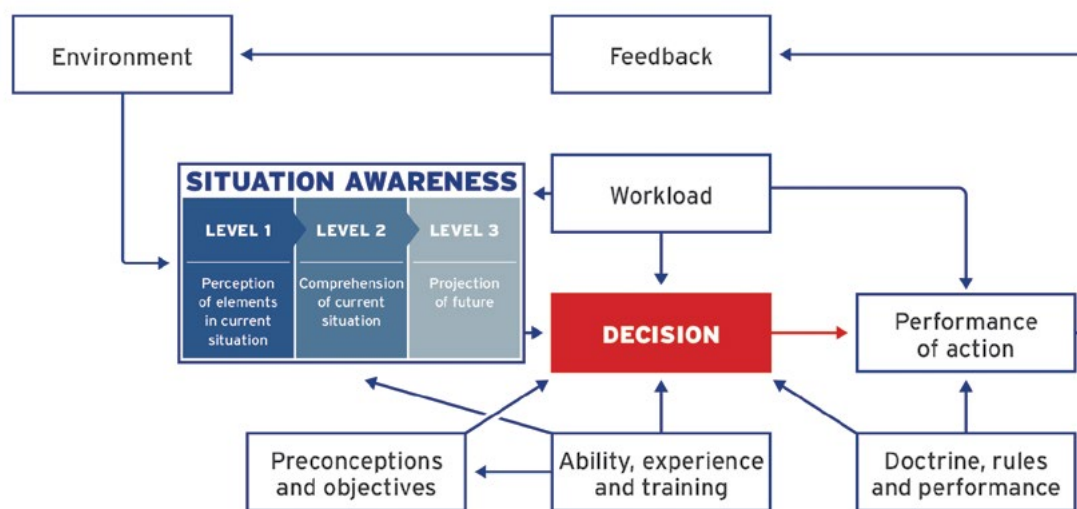
Sequence of events on 15 December 2022



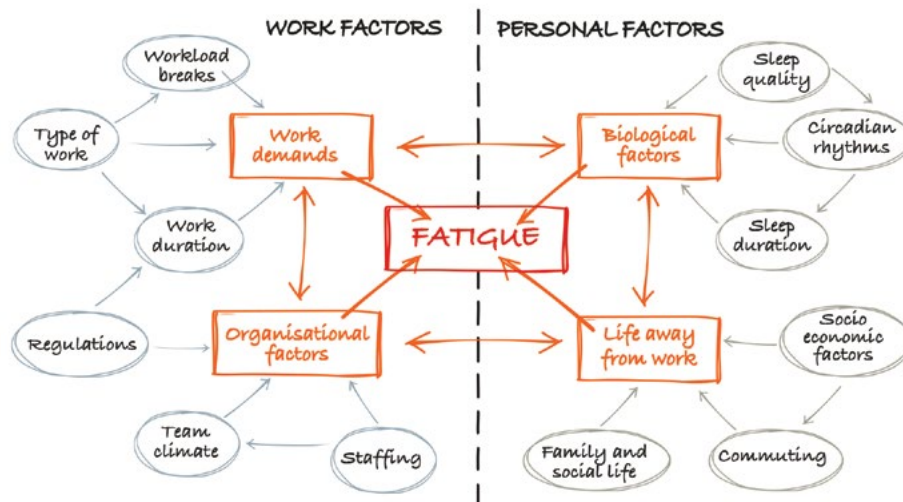
an interview that the QFI acted instinctively to increase separation by rolling inverted and away from the last-known perceived position of the lead aircraft.

The ASIT found a number of suboptimal local conditions, risk controls and organisational influences that set the preconditions for QFIs to be at risk of delayed decision-making and

High workload demands and organisational pressure created pre-conditions for aviation fatigue, burnout, and reduced supervisory oversight.



Endsley's model of situation awareness, from CASA's *Human Resource Guide for Pilots* (2012, p. 127)



Workplace and personal factors that may contribute to employee fatigue
(adapted from Hobbs, Avers and Hiles, 2011)

intervention techniques. Risks are greatest during instruction of highly dynamic manoeuvring sequences, such as was experienced by the incident QFI during this formation-rejoin instructional event.

The QFI's instinctive reaction to conduct the non-procedural bug-out manoeuvre and turn down and back towards lead was similar to that flown in a previous instructional event. Flying supervisors did not adequately identify this event as a potential weakness in the QFI's proficiency for early recognition of poor rejoin and bug-out technique.

The ASIT found that the flying school had resource constraints and organisational pressure to graduate pilots from the Pilot Training System (PTS). High workload demands on QFIs, executives, supervisors and managers resulted in suboptimal flying supervision, instructor proficiency, and fatigue monitoring.

High-workload demands on the QFI workforce created the preconditions for aviation fatigue and burnout. Organisational pressure to increase PTS graduation rates and to complete pilots' courses on schedule resulted in reduced resources and flying hours allocated

to QFI mentoring and professional development, Staff Continuation Training and upgrade programs.

Of particular note, deliberate decisions by the flight training school's executives to reduce and/or waive requirements to complete certain events from QFI category-upgrade programs, which could be considered integral to the development and standardisation of QFIs, likely contributed to lack of supervisory oversight and awareness of individual QFI proficiency and standardisation.

Finally, lack of priority for allocation of aircraft for QFI category upgrades also contributed to the situation where examiners were often not able (although



not mandated by Air Academy) to assess proficiency to instruct complex and demanding sequences, such as formation rejoins, during QFI category upgrades or annual-categorisation checks.

Ultimately, the actions of the incident QFI were not in accordance with standards and methods of airborne instructional training. QFI intervention during flying instruction is based on the dynamic nature of the event, instructor and student experience and capacity for the manoeuvre being flown. Use of key words to direct student attention to parameters and/or earlier control intervention would have likely prevented this incident. ▀

Significant findings

In accordance with the Defence Aviation Safety Analysis Model, the ASIT identified the following key contributing factors leading to this event:

- ineffective supervision of QFIs at the flying school regarding awareness of:
 - previous flying experience and proficiency levels
 - professional development, categorisation, standardisation and assessment
 - workload and fatigue
- ineffective orders, instructions and publications to identify aviation hazards and manage risks pertaining to:
 - aviation fatigue
 - non-technical skills aspects of Airborne Instructional Technique and associated common instructor and student errors
- ineffective management of aviation hazards and risks associated with organisational pressure placed upon QFIs, executives and supervisors to graduate pilots from the PTS.



Split-second confusion in the skies

ON 23 MAY 2024, the skies northeast of RAAF Base Williamtown, New South Wales, bore witness to a moment of high-speed confusion when three Hawk 127 aircraft, engaged in a routine air-combat training sortie, experienced a breakdown in separation that brought two jets within just over 1000 ft of each other: far too close for comfort in fast-jet operations.

The mission

The sortie was part of the Introductory Fighter Course: a critical phase in the development of future fast-jet pilots. The formation consisted of three aircraft: two acting as engaged fighters (Aircraft 1 and Aircraft 2), and one acting as the hostile (Aircraft 3). Their task was to conduct 'tactical intercept into

air-combat manoeuvring' in designated airspace northeast of Williamtown.

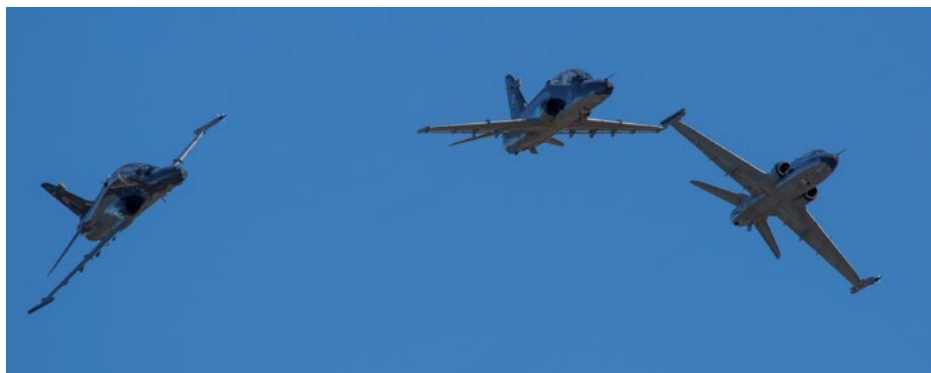
The airspace setup was complex. Noise restrictions over the town of Forster forced the formation to orient their flows north-south, compressing lateral and vertical space. Aircraft 3 (hostile) would flow from the north to south, with Aircraft 1 and Aircraft 2 flowing

from the south to north. This setup increased cognitive workload for the instructor pilots and created a more challenging environment for executing precise manoeuvres.

The breakdown

During the third flow of the sortie, the hostile aircraft executed a merge posture that deviated from the expected training picture. This subtle shift - intended to drive a learning objective - introduced ambiguity into the visual cues and mental model for the student pilot and qualified flying instructor (QFI) in Aircraft 2.

As the aircraft converged, Aircraft 1 lost sight of Aircraft 3 and, in a split-second decision, misidentified Aircraft 2 as the hostile. For several seconds, Aircraft 1 manoeuvred aggressively against his





wingman - the wrong aircraft - unaware that the real hostile was elsewhere in the fight.

The Hawk Replay System later revealed that the closest point of approach between Aircraft 1 and Aircraft 3 was just 1015 ft slant range, with 660 ft vertical separation: a margin that, in fast-jet terms, is dangerously close.

Human factors

The Aviation Safety Investigation Team (ASIT) who investigated the event identified several contributing factors. One was the delayed 'NO JOY' call from Aircraft 1: a hesitation possibly driven by pressure to complete the setup and avoid a mission re-fly. Another was the increased workload on Aircraft 2, which had to maintain separation with minimal altitude buffer, due to airspace constraints, while also supporting a student pilot in the front seat.

Interestingly, the report found that the Rules of Conduct were not violated. Instead, the incident underscored how ambiguous guidance in training documents - particularly around hostile-aircraft presentations - can lead to variability that challenges even experienced pilots.

Sequence of events

The first flow of the sortie was executed as briefed. The second flow saw Aircraft 2 go 'blind' during descent into the merge, prompting Aircraft 1 to assist over radio. In doing so, Aircraft 1 flew below the hard-deck altitude and called a knock-off before visual manoeuvring began. The aircraft then reset, thus reducing the number of available flows due to fuel, which increased time pressure.

The third flow was where the incident unfolded. The aircraft's merge posture was deliberately offset to achieve a specific

The incident was shaped less by error than by the cumulative weight of workload, uncertainty, and timing.



learning objective, but it deviated from the standard academic picture. All aircraft were visual and tally before the merge, but roles were set late due to environmental constraints.

Aircraft 1 entered the merge only 243 ft above Aircraft 2, where ideally the separation would have been 1000 ft. This reduced separation increased the workload of the latter. Both aircraft executed lead turns, but Aircraft 1 lost sight of Aircraft 2 and eased the turn.

Aircraft 3 extended slightly before turning left, resulting in a misaligned fight.

Unable to see Aircraft 3, Aircraft 1 assumed it had turned left and was now in the rear. Spotting a Hawk in a left-hand turn, Aircraft 1 misidentified Aircraft 2 as the hostile and engaged it. Meanwhile, Aircraft 2 attempted a vertical extension but lacked the energy to separate effectively.

For several seconds, Aircraft 1 fought Aircraft 2, believing it was Aircraft 3. Eventually, Aircraft 1 spotted the real hostile and switched targets. The flight continued without further incident.

Airspace and environmental constraints

The airspace northeast of Williamtown – Hotel, Whiskey and Juliet airspace – allocated for this sortie is common for No. 76 Squadron operations. However, its vertical and lateral limitations, combined with noise-sensitive areas, forced the formation into a compressed setup. Visual manoeuvring had to occur in the western portion of Hotel block to avoid noise over Forster.

These constraints likely increased cognitive workload and contributed to the late role setting and merge misalignment. The ASIT noted that such environmental factors can subtly but significantly impact decision-making and situation awareness.

Technology and training doctrine

The Hawk Replay System was instrumental in reconstructing the incident. It provided head-up display video, cockpit audio, and multifunction-displays data to map the sequence of events. The ASIT also reviewed adversary-tasking guidance from the Hawk Training Guide and Flying Instructor Training Guide.

The hostile aircraft's posture was found to have deviated from the intent

of the training doctrine, which calls for recognisable merge pictures. This deviation, while educationally motivated, introduced ambiguity that contributed to the post-merge misidentification of aircraft. ▀

Recommendations

The ASIT made two key recommendations:

1. Clarify orders, instructions and publications to better define the visual 'pictures' the hostile aircraft should present. The goal: reduce ambiguity while still achieving learning objectives.
2. Revise standard operating procedures so that the hard deck only applies during visual manoeuvring. This would reduce unnecessary knock-offs and preserve valuable training time.

These changes aim to strike a balance between realism and predictability, ensuring that training remains effective without compromising safety.

Conclusion

No one was injured. No aircraft were damaged. But the incident serves as a powerful reminder that in the world of air-combat training, even minor deviations can cascade into moments of confusion and risk.

The professionalism of the aircrew, their rapid recovery, and the transparency of the investigation reflect Air Force's commitment to continuous improvement. As fast-jet training evolves, so too must the frameworks that support it, ensuring that every sortie, no matter how routine, is flown with clarity, confidence, and safety at its core.

This incident highlights not just a moment of near miss, but a system that learns, adapts, and improves. In the unforgiving world of air combat, that is not just commendable: it is essential.

Do you know a **flight- safety crusader?**



**ROYAL
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Royal Aeronautical Society Dr Rob Lee Defence Flight Safety Award

Recognising **individual or collective efforts** that have enhanced Defence flight safety in 2026.

Nominations are open to all members of Defence aviation, including civilians, contractors, and exchange and loan personnel.

For details on the nomination process for the 2026 award, please visit the DFSB intranet site.



Catastrophic engine failure



ON THE NIGHT of 22 March 2023, an MRH-90 Taipan was conducting overwater Helicopter Insertion and Extraction Technique (HIET) training in Jervis Bay, New South Wales, when it suffered a catastrophic but contained failure of its left-hand engine. The aircraft descended onto the water, briefly rose into a low hover, and then impacted the water a second time at high-G after the crew shut

down the remaining operating engine. All personnel on board were recovered, with only minor injuries, aided by prepositioned rescue vessels.

The incident

The MRH-90 crew was conducting a routine training sortie with personnel from Special Operations Command. The crew had divers suspended from two ladders beneath the aircraft, when the left-hand engine failed at 2052h

local time. The flying pilot immediately commenced boldface emergency procedures, and the aircraft began descending over the water.

In the seconds that followed, the aircraft's right-hand engine automatically entered its maximum One Engine Inoperative power rating, and the flying pilot slowly transitioned forwards in an attempt to clear the divers below¹. However, main-rotor speed began to decay as the single-engine power was insufficient to prevent the aircraft from descending towards the water. The crew attempted - but failed - to activate the Emergency Flotation System, and only one of the two diver ladders was released in time. The right-hand aircrewman, operating with night-vision goggles (NVG) in a dark cabin, was unable to locate and operate the release mechanism in time, causing the divers on that side to be dragged unexpectedly through the water.



Intended Helicopter Insertion and Extraction Technique location in Jervis Bay

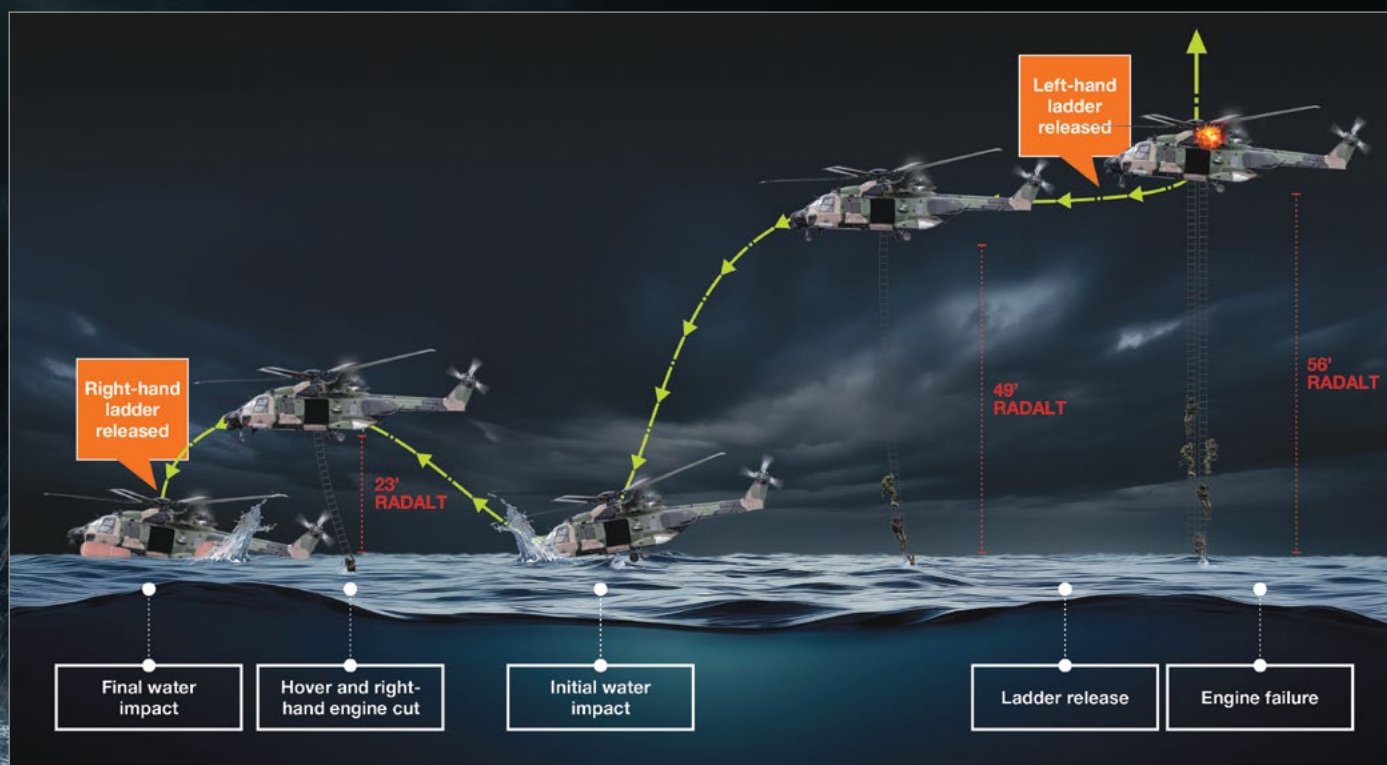


Figure 1. Aircraft flight profile following its left-engine failure

With limited visual cues and stress-induced misperceptions, the non-flying pilot believed the aircraft had settled on the water.

Unbeknown to the crew, the aircraft briefly contacted the water. The Automatic Flight Control System Hover Mode remained engaged, and the aircraft returned to a low hover at approximately 23 ft (Figure 1). With limited visual cues and stress-induced misperceptions, the non-flying pilot - now believing the aircraft was settled on the water - removed their helmet in preparation for egress.

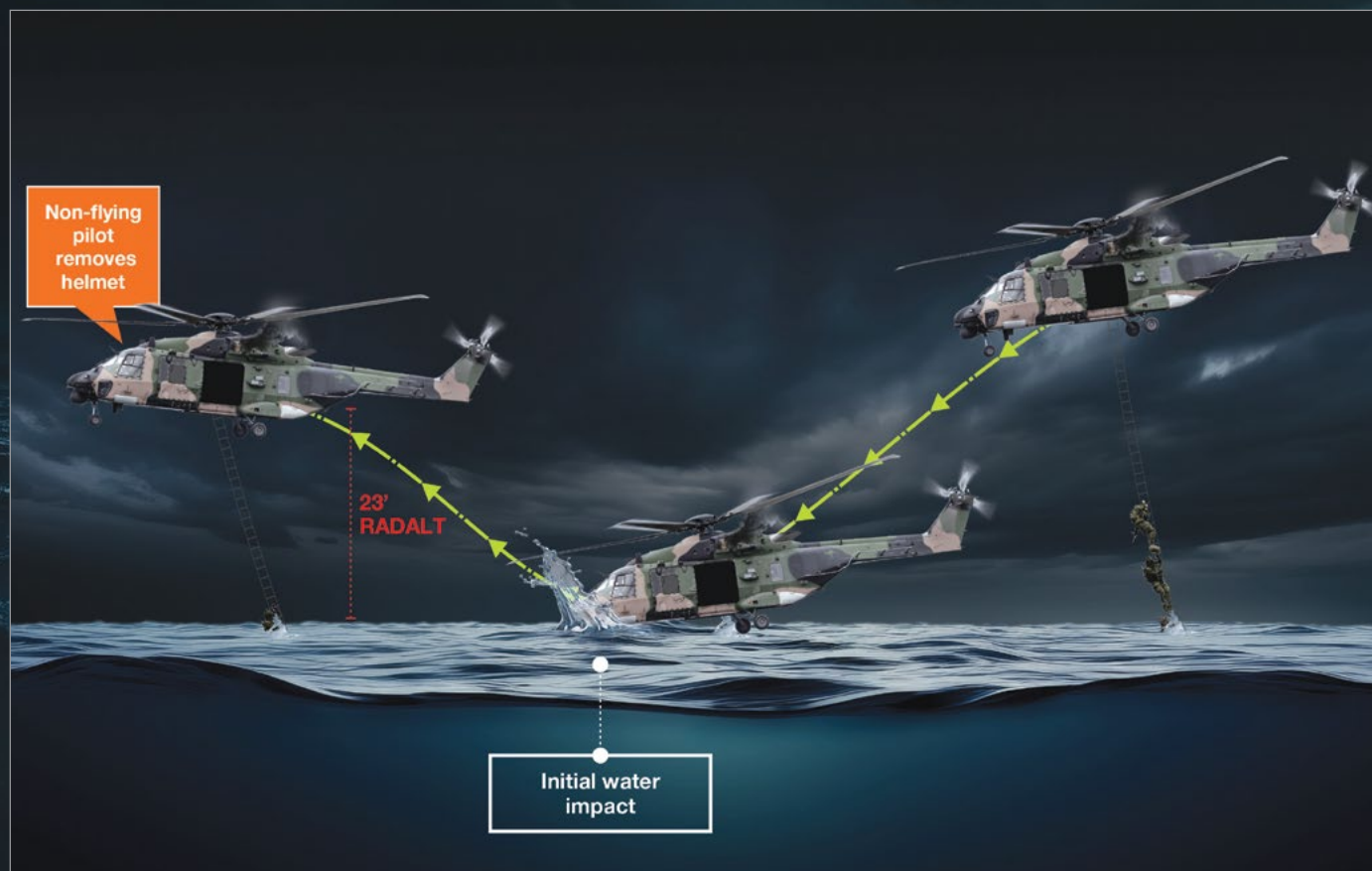
The flying pilot, having now realised the aircraft was still airborne, made the critical decision to shut down the remaining engine at approximately 19 ft, believing it safer than risking injury from uncontrolled rotor movement. The aircraft impacted the water a second time, with a force measured at 8 G. The Emergency Flotation System activated automatically and the right-hand aircrewman released the remaining ladder.

All crew and mission personnel egressed successfully. Two aircrew removed their

helmets before the rotors had fully stopped, and some exited while blades were still turning. All the divers were able to self-release and were recovered by prepositioned emergency vessels. All personnel were transported to HMAS Creswell for medical care.

What went wrong?

The root cause of the engine failure was the rupture of a single blade from the high-pressure turbine 1 (HP1) wheel in the left engine. Defence Science and Technology Group confirmed that the failure of Blade 34 from the HP1 wheel occurred due to a fatigue crack initiating beneath the blade's platform at the top of the third fir tree (Figures 2 and 3). As a consequence of this blade failure while operating at high speed, the detached Blade 34 caused secondary damage and separation of the remaining blades of the HP1 wheel (Figure 2). The blade debris then travelled



Low hover initiated by the Automatic Flight Control System (with hover mode engaged)

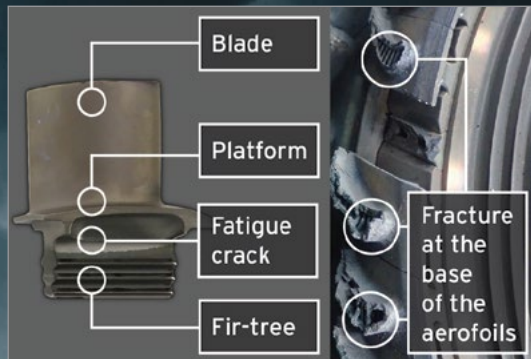


Figure 2: HP1 blade anatomy and damage

rearwards through the engine to cause extensive damage to the high-pressure turbine 2 and power turbine 1.

Although this was the first such failure experienced by an Australian MRH-90, the issue had been previously identified across the global NH90 fleet. In 2017, the engine's original-equipment manufacturer issued a service bulletin recommending - but not mandating - replacement of HP1 blades. Defence accepted the manufacturers' assessment that the design safety case remained within certification limits and chose

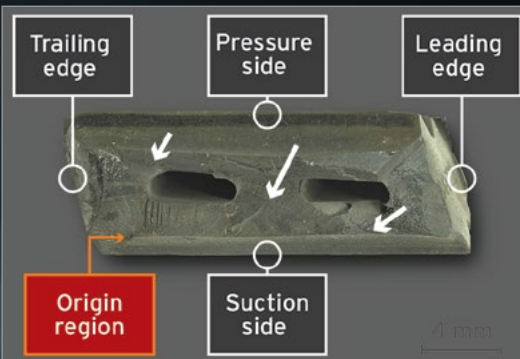


Figure 3: Blade 34 fracture surface

to replace the blades during deeper-level maintenance, initially via an 'On Condition' inspection attrition strategy, then subsequently via an accelerated engine sub-fleet modification program.

Neither of the engines on the MRH-90 had received the modified HP1 blades. Additionally, the investigation found no evidence that a formal safety-risk assessment had been conducted by the Army Military Air Operator (MAO) to assess the safety implications of such failures in overwater-hover scenarios, known as Performance Class 3 (PC3) operations².



The timely and effective emergency response and collection of evidence

Defence Science and Technology Group confirmed the failure originated from a fatigue crack beneath the blade's platform.

The emergency response in the cockpit and cabin was hampered by a series of compounding factors. The right-hand aircrewman was unable to operate the diver release mechanism due to the combined effects of surprise arising from the engine failure, and dark conditions within the aircraft cabin while operating with NVG. The crew's coordination during the emergency was inconsistent, and checklist procedures were not followed in full. Additionally, the investigation found that emergency procedures and emergency-handling guidance in the orders, instructions and publications related to aircraft ditching and emergency egress were ineffective for time-critical emergencies. These emergency actions - to be completed from numerous emergency checklists - could not be completed from the hover height where the engine failure occurred before the aircraft contacted water.

Both pilots developed different mental models of what was occurring, with the non-flying pilot believing the aircraft had ditched and would roll over, so removed their helmet - which was a known snagging hazard - and commenced egress in line with Helicopter Underwater Escape Training. The removal of their helmet contributed to the lack of effective crew coordination and communication to complete emergency-checklist procedures to ditch the



Fast Roping and Extraction Device

aircraft and prepare for the crew's egress. The flying pilot correctly identified the aircraft was in a low hover.

The flying pilot's suboptimal decision to shut down the remaining engine was heavily influenced by their concern for crew safety, based on previous experience with rotor-related injuries in another nation's rotary-wing force. The action of shutting down the operating engine deviated from standard emergency procedures.

The investigation found no evidence that a formal safety-risk assessment had been conducted to assess the implications of engine failure during overwater hover operations.



A Helicopter Underwater Escape Training drill





Enhanced training improves ladder release procedures

The simulator training received by the crew did not adequately replicate the unique demands of HIET in overwater PC3 scenarios. Emergency drills, egress procedures, and flotation-system training lacked realism, and the crew was not trained for the specific case in which the flotation system functioned effectively, keeping the aircraft upright.

Lessons

While individual decision-making in the cockpit was shaped by situational ambiguity and stress, the investigation highlighted deeper systemic issues. These included unclear risk documentation, inadequate simulator-based emergency training, insufficient standardisation of procedures, and poor integration of risk controls across training institutions.

The decisions made regarding the modification of engine HP1 blades and the absence of a recorded safety-risk assessment, considering the hazards of PC3 operations, left aircraft more exposed to rare but high-consequence failures. This also likely set the precondition for diminished MAO

awareness of the HP1 engine-failure mode and recovery options. While the modification would not have eliminated the hazards associated with engine failure in PC3 operations, it was an opportunity to treat a known engine-failure mode and prioritise modified engines based on PC3 exposure.

Additionally, differences in understanding and communication of risk between engineering, operations, and command elements resulted in inconsistent application of safety controls. Diver-restraint systems were not integrated into broader aircrew training, and critical drills under NVG in dark conditions were not practised to proficiency. ▲

Endnotes

¹ This was not a documented and/or trained-to procedure, but likely a good idea by the flying pilot to prevent injury to the divers below during the ditching.

² The MRH-90 Standardisation Manual defines three levels of Performance Class (PC) for the MRH-90. In the event of an engine failure:

- PC1 guarantees a safe landing is possible at all times
- PC2 guarantees safe flight except during take-off and landing
- PC3 recognises that in the event of an engine failure, a forced landing may be required.

Safety actions and recommendations

Thirteen recommendations were made to improve aviation safety within the MRH-90 community. These included:

- ensuring all MRH-90 aircraft operating in PC3 overwater regimes are equipped with modified HP1 blades
- enhancing simulator training to better replicate overwater HIET emergencies
- improving aircrew training for ladder-release procedures when using NVG
- reviewing and standardising emergency procedures and communications
- clarifying the division of responsibilities between flying supervisors and flight-authorisation authorities
- formalising risk assessments and ensuring traceability across Army MAO risk artefacts.

Two further recommendations targeted fatigue management and flying-supervision policy.

This event highlighted the importance of deeply integrated, scenario-based training and the need for proactive hazard mitigation. A rare but known technical failure escalated rapidly due to compounding procedural, environmental, and perceptual factors.

This ditching accident - which resulted in minor injuries to personnel and loss of capability - serves as a powerful reminder that even when all personnel walk away, the cost of systemic unmitigated risk must be taken seriously - before the next emergency arises.

Interested in learning more about this incident?

Readers with access to the Defence Protected Network can access the full report via Objective: <https://objcdc8/id:BP45461196>



Minutes from flameout

IN THE HIGH-STAKES WORLD of fast-jet operations, fuel is more than a number: it is a lifeline. On 24 March 2021, an F/A-18F Super Hornet on a routine training sortie came perilously close to crossing that line. The aircraft landed with just 716 pounds of fuel remaining: below the emergency fuel threshold and mere minutes from flameout (the extinguishment of the flame in its combustor, leading to loss of thrust and engine shutdown).

What began as a textbook go-around evolved into a complex emergency scenario, shaped not by technical failure alone but by human factors, organisational culture, and decision-making under pressure.

The flight

The Super Hornet was the second of two aircraft in a formation (callsign 'Cannon') returning to RAAF Amberley in Queensland after a routine air-to-ground training mission in airspace west of the base. On final approach, the pilot assessed that separation from the lead aircraft was insufficient and initiated a go-around. It was a sound decision, but what followed was anything but routine.

As the aircraft climbed away, the crew received cockpit indications that the landing gear had failed to retract. Air traffic control (ATC) confirmed the left main landing gear remained extended. The crew, consisting of a junior pilot and a highly experienced Weapons Systems

Officer (WSO), elected to hold to the west of the airfield to troubleshoot. However, they did not cancel the warning tone, creating an avoidable distraction in the cockpit that added to their cognitive load and disrupted radio communications.

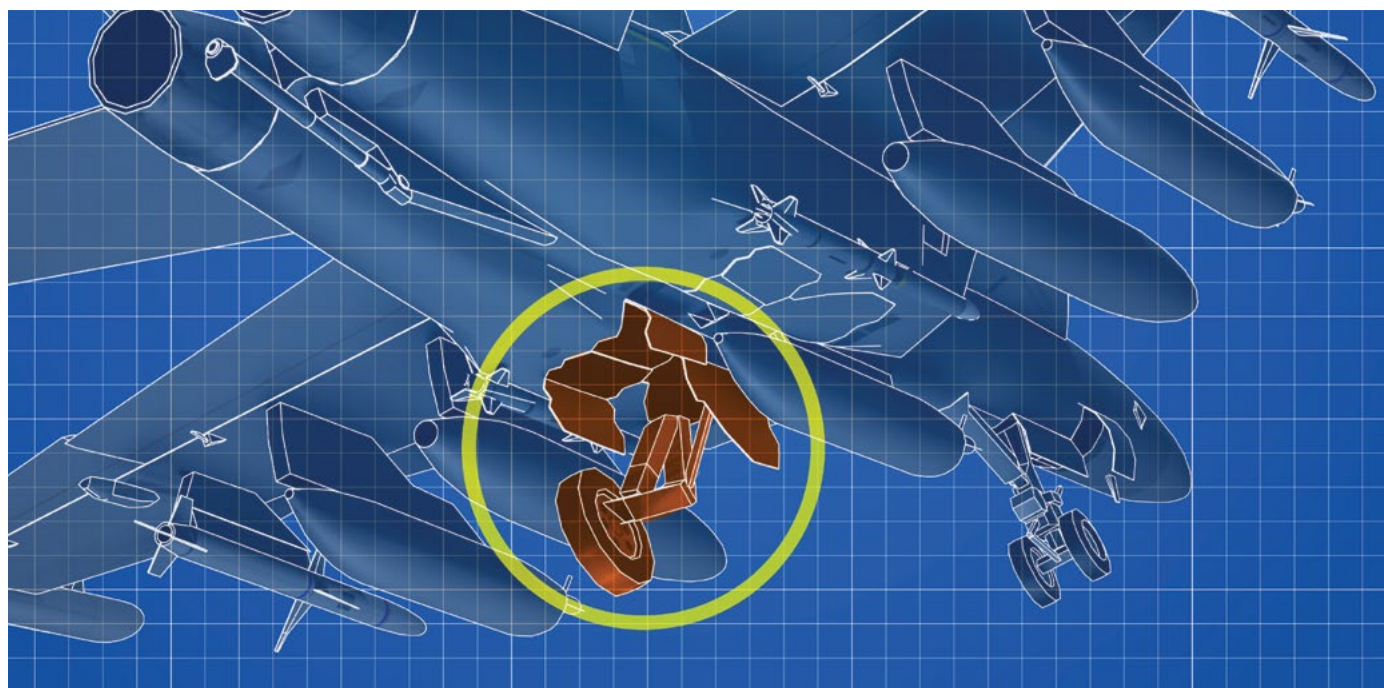
Within minutes, the crew resolved the malfunction using the NFM-500 emergency checklist. The gear was confirmed down and locked, flaps were set to full, and the aircraft was configured for landing. But instead of landing immediately, the crew then elected to hold airborne to allow a formation of four E/A-18G Growlers to land first.

It was a decision that would cost precious fuel and push the aircraft into a critical state.

The holding pattern

The crew's choice to hold for the Growler formation was made in consultation with the Duty Supervisor (DSUP), who supported the plan if fuel permitted. The WSO affirmed they had enough endurance but the investigation later revealed that this assessment was based on intuition, not data.

No tools were used to verify the Growlers' fuel state or routing. The crew assumed a direct approach, but ATC routed the formation via overhead Amberley and then 10 nm west, thereby adding significant delay. Meanwhile, the Super Hornet remained in a high-drag configuration with its gear down and flaps full, thereby burning fuel at an accelerated rate.



By the time the Super Hornet landed, it had just 716 pounds of fuel remaining in the engine-feed tanks. Investigators concluded that a second go-around would almost certainly have resulted in flameout.

The investigation

The Aviation Safety Investigation Team, appointed by Officer Commanding No. 82 Wing (82WG), approached the incident through the Defence Safety Analysis Model. The findings extended far beyond the cockpit.

While the initial technical malfunction had been handled correctly, the escalation of the event was attributed to suboptimal application of non-technical skills (NTS): a term encompassing crew coordination, communication, decision-making, and situation awareness.

The investigation found that the crew had not been adequately trained in the practical application of NTS. There was no formalised framework within 82WG for skills-based NTS training, practice, or assessment. The only requirement

was a three-yearly Crew Resource Management theory refresher, falling short of Defence Aviation Safety Manual standards.

This gap in training contributed directly to the crew's inability to reassess their plan, communicate assumptions, and manage fuel effectively under pressure.

Rank and role in decision-making

One of the most striking findings was the presence of an adverse cockpit-authority gradient. The WSO, a squadron leader and Fighter Combat Instructor, was flying with a junior pilot. Although the WSO addressed the rank difference during the crew brief, the investigation found that their actions inflight inadvertently reinforced the gradient.

The adverse cockpit-authority gradient was evident when the pilot attempted to articulate their mental model but was interrupted twice, initially by radio communication from the DSUP and then by the WSO. The WSO then took over radio communications and made decisions without consulting the pilot.

In interviews, the pilot admitted feeling it would be 'obnoxious' to question someone of higher rank and greater experience.

This dynamic undermined effective crew coordination and contributed to their failure to reassess the plan when new information (that the formation of Growlers had been re-routed) emerged.

Plan-continuation bias

The investigation identified 'plan-continuation bias' as a key contributor to the incident. After resolving the gear malfunction, the crew continued with their original plan to land after the Growlers, despite evidence that the plan was no longer viable.

Fuel levels dropped below minimum thresholds and the crew received a 'FUEL LO' caution. They discussed approaching Mayday fuel' but did not consider alternative runways, diversion options, or other contingencies.

In interviews, both crew members acknowledged realising they had 'put themselves in a corner'.

Checklist ambiguity

Another contributing factor was ambiguity in the NFM-500 emergency checklist, which instructed the crew to 'consider an arrested landing', without providing sufficient information to allow an informed consideration. The crew and DSUP interpreted this conservatively, opting for a precautionary arrested landing despite having resolved the landing-gear issue.

This decision influenced their choice to hold for the Growlers. The investigation later determined that the checklist's phrasing lacked clarity and contributed to what was likely an unnecessary escalation.

Fuel management

Throughout the event, fuel was referenced as a single number – total pounds remaining – without consideration of burn rate, configuration, or altitude. The crew did not discuss a fuel threshold for abandoning the hold, nor did they use available tools to optimise endurance.

The DSUP assumed the crew had climbed but did not confirm this with them. ATC, unaware of the aircraft's critical fuel state, continued with its planned routing for the Growlers. This

lack of shared mental models between the crew, DSUP, and ATC created the near flameout.

The crew declared 'minimum fuel', believing it conferred priority. It did not. They reached emergency fuel levels but did not declare a mayday, misunderstanding the requirement to do so.

Organisational influences

This was not an isolated incident. Of the six Class B aviation-safety reports investigated in 82WG since 2017, four – including this one – identified suboptimal NTS as a contributing factor. The investigation concluded that 82WG lacked a formalised standard for NTS proficiency and did not comply with Defence Aviation Safety Manual requirements.

Emergency simulator events were often conducted solo, without WSOs. Training scenarios focused on technical execution rather than operational decision-making. There was no framework for assessing NTS performance, and no requirement for crewed simulator events. ▣

Endnote

¹Mayday fuel refers to a defined fuel level whereby, if the crew anticipate they will land with a lower volume, they must declare a mayday.

Recommendations

Following the incident, No. 1 Squadron, No. 6 Squadron, and 82WG delivered briefings on fuel endurance and decision points. A subsequent aviation-safety report suggested these lessons were well applied in a similar scenario.

The investigation team issued eight formal recommendations:

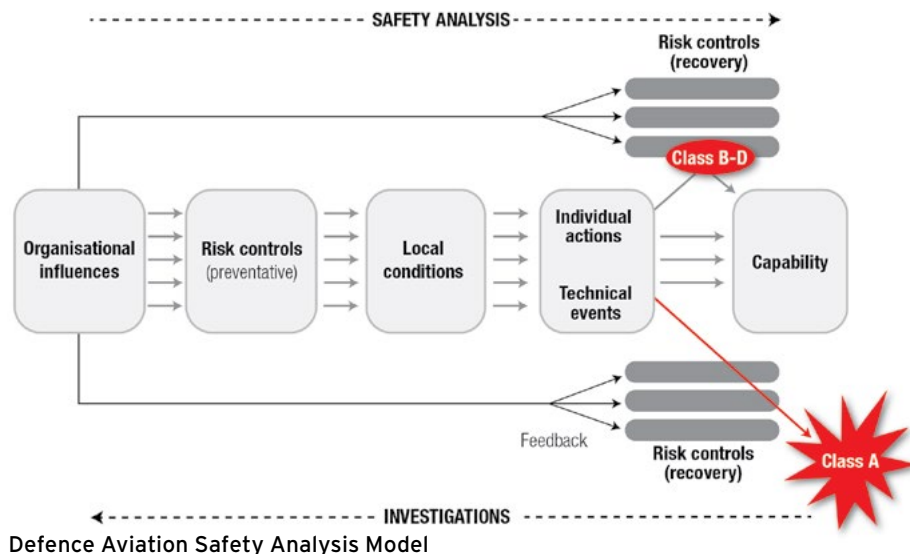
1. standardising intra-crew briefs and debriefs with NTS considerations
2. updating standard operating procedures to clarify fuel declarations and priority
3. implementing formalised NTS training and assessment
4. requiring crewed emergency simulator training every 90 days
5. teaching crews how to avoid unhealthy cockpit authority gradients
6. enhancing fuel-related training scenarios
7. building lessons from this incident into training so they are not forgotten, stressing conservative aircraft configuration, clear understanding of fuel states and terms, and what to expect from ATC
8. revising checklist language to reduce ambiguity.

Lessons

A serious accident had been averted: not by design but by timing. The aircraft landed with less than 10 minutes of fuel remaining. A second go-around would likely have ended in flameout.

The investigation revealed that technical skill alone is not enough: in fast-jet operations, where decisions unfold in seconds and margins are razor-thin, the ability to communicate, coordinate, and reassess is paramount.

This event underscored the need for structured NTS training, clear procedures, and a culture that empowers all crewmembers – regardless of rank – to speak up, challenge assumptions, and act decisively.



Beyond the envelope

ON THE MORNING of 28 May 2021, a PC-21 departed RAAF Base East Sale in Victoria for what was expected to be a standard instructional sortie. The crew consisted of a Qualified Flying Instructor (QFI) and a trainee pilot. Their mission was a Basic Navigation (BNAV) 2 exercise, part of the Phase 1 pilot-training curriculum at a flight-training school.

The sortie included navigation legs and circuits at Benalla Aerodrome, followed by a low-level navigation segment known as the Licola Navigation Exercise. The QFI intended to fly the final leg, along the route of the Macalister River, as a demonstration for the trainee. But what happened in the valley would go on to expose systemic vulnerabilities and prompt a command-led aviation-safety investigation.

Into the valley

As the aircraft descended into the Licola Valley, the QFI took control and began manoeuvring along the path of the river. The terrain demanded tight turns and rapid adjustments, and the QFI flew aggressively, banking beyond 90 degrees and pulling G-forces well above the prescribed limits. The PC-21's systems issued warnings: aural tones and amber 'G caption' on the multi-function display, indicating excessive Gs.

Then, in a moment that would define the incident, the QFI handed control to the trainee pilot. The aircraft was approaching a sharp left turn, and the QFI issued increasingly urgent commands: 'Turn left, now, now, now.' The trainee responded with a steep bank and a pitch input that resulted in a peak load of 8.4 G, exceeding the aircraft's certified structural limit of +8.0 G.

A red aerobatic aircraft is shown in a steep climb, banking sharply to the left. The aircraft's wings and tail are visible, with a blue and white circular insignia on the tail. The background is a blurred landscape of green trees and hills, suggesting high speed. The sky is a pale blue with some light clouds.

The overstress was immediate and unmistakable. The manoeuvre resulted in 8.4 G load factor overstress, as indicated on the primary flight display (PFD) G meter, activating the multi-function display (MFD) visual caution and the alerting-system aural tone. The aircraft systems displayed the PFD G meter 8.4 G digital and the analogue scale index in red. The 'OVER G' caution was activated in the MFD, and an associated aural warning tone sounded. The aircraft's Health and Usage Monitoring System (HUMS) and Mission Data Recording System recorded the event. The QFI quickly resumed control and continued flying through the valley before climbing out and returning to East Sale. No emergency was declared. No controllability check was performed. The aircraft landed via a straight-in approach.

The investigation

What the Aviation Safety Investigation Team (ASIT) uncovered was not just a single lapse in judgement, but a pattern of systemic issues that had taken root within the flying school.

The investigation revealed that the QFI had flown multiple manoeuvres exceeding +6 G before this event. These manoeuvres were not authorised within the scope of low-level flight and, in fact, constituted low-level aerobatics: strictly prohibited without specific clearance.

A standard sortie transitioned into a dynamic situation involving high workload and tight margins.

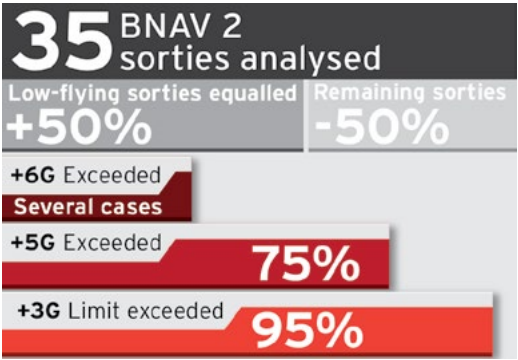


A Royal Australian Air Force PC-21 conducting a low-level training sortie

A review of multiple sorties identified trends that extended beyond a single event.

The QFI had also failed to perform a G-warm procedure: a standard safety measure for flights involving high G-forces.

More troubling was the QFI's decision to allow the trainee to fly during the low-level segment. The trainee had not been trained for low flying, had not received a brief, and was unaware of the physiological risks associated with high G. The QFI had not briefed the Flight Authorising Officer on this intent, assuming that his status as an instructor conferred implicit authority.



A culture of drift

The investigation extended beyond this single flight. Using HUMS data, they reviewed 35 BNAV 2 sorties flown between April and June 2021. The results were startling. More than half of these sorties involved low flying and, of those, 95 per cent exceeded the +3 G limit. Nearly three-quarters exceeded +5 G, and several surpassed +6 G.

This was not an isolated incident: it was evidence of a cultural drift, where deviation from authorised procedures had become routine. Low flying had become a common, informal component of BNAV sorties, despite lacking formal learning objectives or risk-management controls. Some instructors even viewed the Licola Navigation Exercise as a 'send-off' for trainees completing Phase 1, thereby adding an unofficial layer of tradition to a risky exercise.

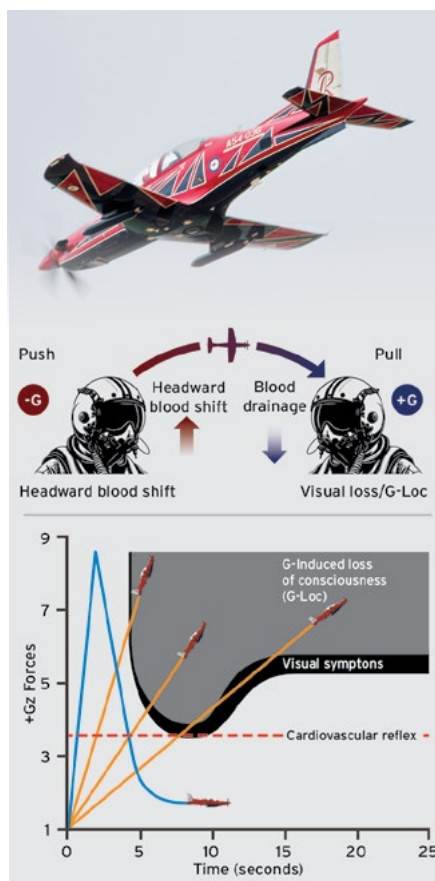
Gaps in governance

The investigation highlighted significant deficiencies in the flying-management system. Many instructors and executives lacked awareness of the PC-21's Statement of Operating Intent and Usage and the Aircraft Handling Notes, which define the aircraft's operating envelope. Risk-management plans for low flying were either absent or inadequate, and flight-authorisation briefs were often abbreviated, failing to scrutinise mission profiles.

Even post-event guidance was mishandled. Revised procedures were issued via email: a medium not authorised for operational policy.

Physiological risks and missed safeguards

The investigation team also examined the physiological risks associated with high-G flight. According to aviation-medicine publications, G-forces between +4.5 and +6 G can lead to G-induced loss of consciousness within seconds. This



Contributing factors to G-induced loss of consciousness

condition includes a period of absolute incapacitation followed by disorientation, during which a pilot is unable to control the aircraft.

The trainee pilot, who had experienced 8.4 G, reported no symptoms. However, the investigation noted that this could lead to a false sense of physiological resilience. Without proper debriefing, the trainee might conclude that he was immune to G-induced loss of consciousness: a dangerous misconception.

The absence of a G-warm procedure further compounded the risk. This standard safety measure prepares the body for high-G manoeuvres and is mandated for flights exceeding +3 G. Its omission was a critical oversight.

Post-flight response

After the overstress, the QFI contacted the Duty Executive to report the event. The Duty Executive did not provide any guidance. The QFI landed the aircraft using a normal configuration, despite recommendations to minimise configuration changes after an overstress. The QFI did not perform a controllability check, which could have identified potential damage. This response fell short of best practice and highlighted deficiencies in supervisory training. ▴

Recommendations

The investigation team issued 15 formal recommendations aimed at addressing the systemic issues. These included reviewing the use of mission-recording systems, improving HUMS-data reporting, aligning training plans with actual learning needs, and clarifying flight-authorisation boundaries.

Other recommendations focused on enhancing Crew Resource Management training, mentoring junior instructors, and standardising emergency procedures, to reduce risks as far as reasonably practicable and help to prevent future incidents.

Conclusion

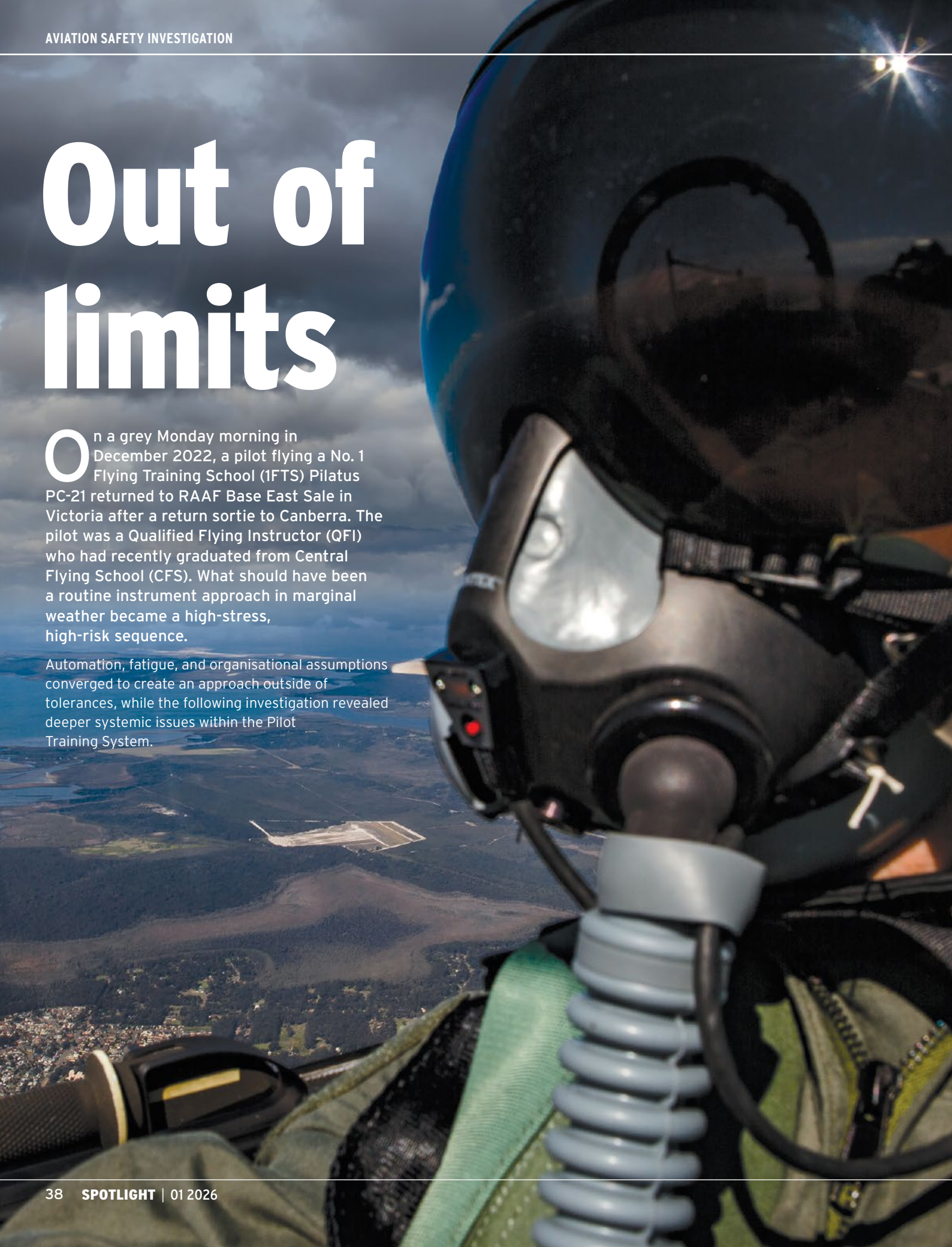
The PC-21 overstress incident in Licola Valley exposed a culture where high-performance flying had outpaced instructional discipline, informal traditions had overridden formal procedures, and systemic gaps had allowed unsafe practices to flourish.

The aircraft's capabilities are impressive, but they must be matched by rigorous training and robust governance. The investigation concluded that the incident had been the result of individual misjudgement, organisational oversight, and a breakdown in safety culture.

Out of limits

On a grey Monday morning in December 2022, a pilot flying a No. 1 Flying Training School (1FTS) Pilatus PC-21 returned to RAAF Base East Sale in Victoria after a return sortie to Canberra. The pilot was a Qualified Flying Instructor (QFI) who had recently graduated from Central Flying School (CFS). What should have been a routine instrument approach in marginal weather became a high-stress, high-risk sequence.

Automation, fatigue, and organisational assumptions converged to create an approach outside of tolerances, while the following investigation revealed deeper systemic issues within the Pilot Training System.



The flight to and from Canberra

The pilot departed RAAF Base East Sale in a PC-21 on Friday 9 December 2022 for a Staff Continuation Training sortie to Canberra, for return on the following Monday. The pilot attended a military function over the weekend, and had been approved to carry a non-unit passenger for the flights. The outbound flight was uneventful, flown in fair weather.

On Monday 12 December, the pilot was awakened at 0300h by thunderstorms, and had broken sleep for the remainder of the night. By 0600h, the pilot reviewed the weather forecasts and Notice to Airmen reports. A meteorological information bulletin warned of severe icing between 7000 and 19 000 ft above mean sea level (AMSL) along the planned route. The East Sale weather forecast also indicated deteriorating local conditions, with rainshowers



and broken cloud above 1400 ft AMSL. Concerned about the thunderstorm activity around Canberra airport, the pilot coordinated a delayed 0930h departure time with the Flight Authorisation Officer.

The weather

The pilot flew from Canberra to East Sale under Instrument Flight Rules (IFR) at Flight Level 220 (22 000 ft), above the icing conditions. Their initial plan had been to remain clear of cloud and transit below the icing conditions slightly above the lowest safe altitude, at 8000 ft AMSL, as submitted in the flight plan. But this was impractical, with cloud and icing extending well

What began as a routine instrument approach developed into a high-stress sequence.



below the forecast level. Climbing above the cloud to avoid icing en route, the pilot then descended through icing conditions for their arrival at East Sale.

Approaching East Sale, the pilot programmed the RNAVZ (GNSS) Runway 27 approach into the Flight Management System. This approach provides lateral and barometric-aided vertical navigation, and the PC-21 autopilot is capable of following both the lateral and vertical guidance. However, as the aircraft turned onto final approach, the autopilot failed to transition from 'Capture' mode to 'Tracking' mode for the lateral navigation guidance: a known issue for the PC-21 autopilot for approaches flown using the Flight Management System. As the autopilot did not transition to Tracking mode, the system also did not automatically descend on the expected profile.

The autopilot

The PC-21 autopilot does not progress from green Vertical Glide Path-Capture (VGP-C) annunciator mode to green vertical 'Guidance' (VGP) annunciator mode unless the autopilot is tracking lateral navigation in 'Approach' mode. The PC-21 Flight Guidance Computer (FGC) had a known issue in areas of high magnetic variation, such as at East Sale (13° East variation). Where crosswind reduced the angle between the final heading (usually degrees Magnetic) and the Flight Management System approach course (True track) to less than 10°, the autopilot would engage all modes successfully. However, in light wind at high magnetic variation, or crosswind that increased the Magnetic heading-True track angle more than 10°, the autopilot might not transition from green Approach-Capture (APR-C)

annunciator mode to green Approach (APR) annunciator mode. A software fix had been developed for the Magnetic heading-True track angle issue; however, the incident aircraft was among the 20 of 25 aircraft at East Sale that had not yet been modified at the time of the incident.

The official workaround involved selecting True heading by pushing a True/Magnetic (T/M) soft key on the Primary Flight Display, waiting until the autopilot captured the approach lateral navigation, and then reverting back to Magnetic heading by again pushing the T/M soft key. This workaround had been mentioned to the pilot during a Flying Instructor Course instrument-flying brief; however, the pilot had never practised the T/M workaround procedure (the circumstances requiring the workaround

had never arisen during the pilot's airborne training).

The pilot made two errors when using the PC-21 automation for the autopilot-coupled GNSS 3D approach. Firstly, the pilot had an incomplete understanding of how to perform the T/M autopilot workaround, incorrectly selecting True heading and immediately changing back to Magnetic heading, rather than first waiting until lateral navigation capture was indicated. Secondly, the pilot misinterpreted autopilot annunciators on the Primary Flight Display by confusing the green APR-C annunciator for the VGP-C annunciator. At this stage, VGP was displayed in white, indicating vertical glide path guidance was 'armed' only, but had not locked on. Above this VGP white annunciation, 'VS' was displayed in green, signifying Vertical Speed as the active autopilot vertical mode, which is the mode normally used during descent onto the final course.

The pilot mistakenly expected the autopilot to adjust the rate of descent to follow the RNAVZ (GNSS) Runway 27 3° glide path. However, the descent continued at 700 ft per minute, the value previously selected by the pilot in VS mode. Under very strong headwind conditions, VS mode quickly resulted in the aircraft descending well below the required glide path.

The pilot then used Tactile Control Steering to override autopilot control in attempts to manually fly the aircraft back to the final course and glide path; however, these inputs were not accompanied by power adjustments. The

aircraft experienced a series of oscillations in pitch, airspeed, and glide path - with its airspeed becoming dangerously slow at one stage - and exceeding both vertical and lateral approach accuracy limits. Unable to reconcile why the autopilot would not capture the approach, the pilot eventually disconnected it and manually flew the approach.

The approach

After passing the Final Approach Fix, the pilot became task-saturated due to a number of factors: stress from the challenging weather conditions, multiple distractions from radio transmissions, and increased workload due to manual overriding of the autopilot. The pilot's flying accuracy deteriorated whenever they looked away to refer to the instrument approach chart or when responding to air traffic control.

Despite multiple exceedances of lateral and vertical tracking tolerances, the pilot continued to approach the runway. They descended to the minimum permitted altitude for the approach, and continued to fly at this level until sighting the runway.

Flying level at the 360 ft AMSL Decision Altitude (DA) for nearly one minute, scanning for visual cues, the pilot eventually sighted the runway and landed safely. However, by descending prematurely to the DA, the aircraft had been well below the intended profile: up to 125 ft below the protected obstacle-clearance surface. Fortunately, the terrain east of East Sale is relatively flat.



The pilot's recent qualification and currency did not fully reflect their exposure to Instrument Flight Rules operations nor modern cockpit systems.



The pilot's decision to continue the approach was made in the context of cumulative operational stress and task saturation.

The pilot

The pilot had more than 1500 hours' flying experience, but mostly on rotary-wing platforms, with limited exposure to high-level IFR operations, autopilot-coupled approaches and the PC-21's systems. During QFI training at CFS, the pilot had required significant additional training to complete the Flying Instructor Course (FIC), having been the subject of three training warnings and multiple remedial sorties. Notwithstanding, the pilot had graduated as a PC-21 Category D QFI with a Restricted Instrument Rating, and was soon conducting instructional sorties with pilot trainees at 1FTS.

However, the pilot had not completed the 1FTS QFI Induction Program (QIP) prior to commencing their instructor duties, and had not flown any instrument approaches since leaving CFS. The QIP had been paused after their first sortie, which was organisationally accepted to be sufficient to permit the QFI to commence general flying instructional duties. This was a common practice at 1FTS due to operational demands and workforce pressures. Had the pilot completed QIP, they could have refreshed much-needed currency and gained confidence in instrument-flying and navigation procedures.

The investigation following the incident found that the 1FTS flying supervisors approved the pilot's return flight to Canberra based on their technical currency, without fully understanding their actual capabilities. FIC training had satisfied all of the pilot's technical-skill requirements to captain and instruct on the PC-21; however, the pilot had required considerable additional resources to achieve the FIC learning objectives, and had had only limited opportunity to consolidate new skills during flying-instructor training in CFS and subsequent flying at 1FTS. The pilot had emerged from their training feeling under-confident to operate the aircraft and manage automation in all weather conditions. No formal handover or reporting from CFS had highlighted the pilot's training difficulties. Neither the pilot's end-of-course report, nor their service-flying records, contained any critical commentary. The assumption that recent FIC graduation equated to competence in all disciplines proved to be flawed.

The human element

The pilot had technically been within fatigue-management limits, but their broken sleep, anxiety about the weather conditions, and the responsibility of carrying a passenger, contributed to a reduction in their cognitive performance during the flight. During the approach, the pilot had become task-saturated due to the cumulative effects of fatigue, stress, distractions, and misunderstanding of the autopilot modes.

The pilot's decision to continue the approach, despite multiple exceedances, was likely influenced by their reluctance to prolong their exposure to the stressful conditions of the flight.

The known but undocumented issue

The PC-21 FGC issue when transitioning from Capture mode to Tracking mode, as described in this article, had been recognised by August 2020, more than two years before the incident. The PC-21 automated modes would not always function to full capacity in regions of high magnetic variation, as found in eastern Australia. The workaround had been briefed early on during the pilot's instructor training but had not been included in Aircraft Handling Notes or course materials. From an airworthiness perspective, both pre- and post-updated aircraft were deemed to be in an 'approved state' for flight. However, not including relevant information and procedures in orders, instructions and publications constituted a missed opportunity for further operational risk management. ▲

Endnote

¹Global Navigation Satellite System.

The findings

A combination of systemic shortfalls, technical issues, and human factors all contributed to this incident. The subsequent investigation found a series of organisational shortcomings, ineffective risk controls, and suboptimal conditions. The pilot, qualified but inexperienced and under prepared, had been placed in a situation that exceeded their capacity.

Missed it

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

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 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



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Aviation Safety Training Courses

ASO (I)

Aviation Safety Officer
(Initial) course

COURSE AIM

To graduate Unit ASOs,
Maintenance ASOs and Flight
Senior Maintenance Sailors.

PREREQUISITES

Personnel who are
required to perform the
duties of an ASO.

COURSE DESCRIPTION

This 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)

Aviation Safety Officer
(Advanced) course

COURSE AIM

To graduate Base, Wing, Regiment,
Fleet, Group and Command ASOs.

PREREQUISITES

ASO (I) practical and
applied experience as
an ASO
(or equivalent).

COURSE DESCRIPTION

This one-week intensive course provides theory and practical exercises in complex-incident investigation, advanced organisational safety, human factors and risk management.

NTS

Non-Technical
Skills workshop

COURSE AIM

To support collaboration, promote
consistency in approach, and
enhance effectiveness of NTS
training across Defence aviation.

PREREQUISITES

Personnel involved in
the development and
delivery of NTS training.

COURSE DESCRIPTION

NTS workshops provide an opportunity for personnel to come together to exchange ideas, share experiences, and discuss emerging issues and best practice in relation to NTS training.

AIIC

Aviation Incident
Investigator course

COURSE AIM

To develop members to support
their ASO in conducting aviation
incident-level investigations.

PREREQUISITES

Any personnel in Defence
aviation. There is no
restriction on rank, and
Defence civilians and
contractors are also
welcome to apply.

COURSE DESCRIPTION

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, and aviation safety-event investigation and reporting. Interested personnel should contact their ASO.

*Available upon request

For further details, including locations and dates, visit the DFSB intranet site or email dfsbt@resources.defence.gov.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:** relevant Wing Aviation Safety Officer, or for CSG, Staff Officer Safety HQCSG
- **Navy:** Fleet Aviation Safety Officer
- **Army:** Army Safety Section, DOPAW, AVCOMD.

