



**Australian Government**

**Australian Transport Safety Bureau**



**ATSB TRANSPORT SAFETY REPORT**  
Aviation Occurrence Investigation AO-2009-004  
Final

**Operational event**  
**89 km south-east of Townsville**  
**Aerodrome, Queensland**  
**2 February 2009**  
**VH-ESH**  
**Agusta Westland AW139**





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Figure 1: Google Earth  
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### Abstract

On 2 February 2009, an Agusta Westland AW139 helicopter, registered VH-ESH, departed under the instrument flight rules from Mackay Aerodrome for Townsville Aerodrome, Queensland. The purpose of the flight was to return the helicopter to Townsville following the passage of a tropical cyclone.

Shortly after departure from Mackay, the crew were presented with an increasing number of alert messages indicating the failure of various helicopter systems. While the crew were focussed on assessing these messages, the autopilot altitude hold function disengaged, leading to a descent that was not detected by either the flight crew or air traffic services (ATS).

The helicopter descended undetected for over 6 minutes while flying towards an area of rising terrain, losing about 3,300 ft of altitude, before ATS observed the descent and alerted the crew.

The investigation determined that the helicopter sustained two independent technical problems; one associated with water and particulate ingress and a second related to the probable susceptibility of the air data system to in-flight turbulence. These failures resulted in multiple erroneous alert messages and uncommanded disengagement of the altitude hold function. The investigation also identified a number of safety factors relating to workload and task management by the crew and monitoring of the aircraft by ATS. That included the lack of an altitude deviation alert within the Australian Defence Air Traffic System (ADATS).

Following the occurrence, the helicopter manufacturer and operator, and the Civil Aviation Safety Authority (CASA) implemented a number of safety actions relating to the identified technical and operational safety issues. In addition, the manufacturer and operator of the helicopter, and CASA undertook proactive safety action in a number of cases for which no safety issues were identified.

A replacement common ATS system for ADATS and the civilian Australian Advanced Air Traffic System (TAAATS) has been announced by the Government that could be expected to include common alert functions, such as the existing cleared level adherence monitoring alert in TAAATS.

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# THE AUSTRALIAN TRANSPORT SAFETY BUREAU

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The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The Bureau is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

## **Purpose of safety investigations**

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated. The terms the ATSB uses to refer to key safety and risk concepts are set out in the next section: Terminology Used in this Report.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

## **Developing safety action**

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

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## TERMINOLOGY USED IN THIS REPORT

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**Occurrence:** accident or incident.

**Safety factor:** an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (e.g. engine failure, signal passed at danger, grounding), individual actions (e.g. errors and violations), local conditions, current risk controls and organisational influences.

**Contributing safety factor:** a safety factor that, had it not occurred or existed at the time of an occurrence, then either: (a) the occurrence would probably not have occurred; or (b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or (c) another contributing safety factor would probably not have occurred or existed.

**Other safety factor:** a safety factor identified during an occurrence investigation which did not meet the definition of contributing safety factor but was still considered to be important to communicate in an investigation report in the interests of improved transport safety.

**Other key finding:** any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which ‘saved the day’ or played an important role in reducing the risk associated with an occurrence.

**Safety issue:** a safety factor that (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operational environment at a specific point in time.

**Risk level:** The ATSB’s assessment of the risk level associated with a safety issue is noted in the Findings section of the investigation report. It reflects the risk level as it existed at the time of the occurrence. That risk level may subsequently have been reduced as a result of safety actions taken by individuals or organisations during the course of an investigation.

Safety issues are broadly classified in terms of their level of risk as follows:

- **Critical** safety issue: associated with an intolerable level of risk and generally leading to the immediate issue of a safety recommendation unless corrective safety action has already been taken.
- **Significant** safety issue: associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable. The ATSB may issue a safety recommendation or a safety advisory notice if it assesses that further safety action may be practicable.
- **Minor** safety issue: associated with a broadly acceptable level of risk, although the ATSB may sometimes issue a safety advisory notice.

**Safety action:** the steps taken or proposed to be taken by a person, organisation or agency in response to a safety issue.



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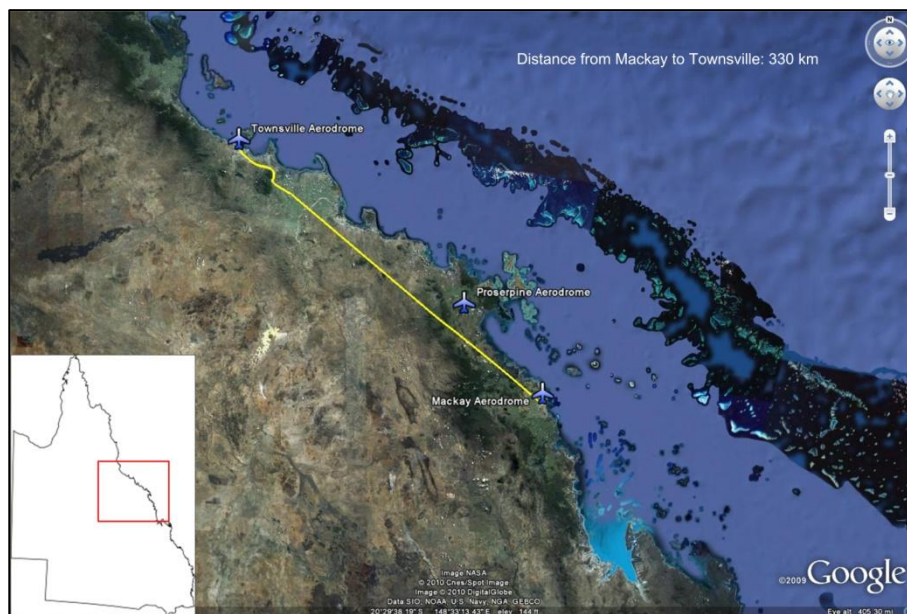
# FACTUAL INFORMATION

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## History of the flight

On 2 February 2009 at 0927 Eastern Standard Time<sup>1</sup>, an Agusta Westland AW139 (AW139) helicopter, registered VH-ESH departed under the instrument flight rules (IFR) from Mackay Aerodrome, Queensland (Figure 1). The helicopter had been repositioned to Mackay the previous day from its Townsville Aerodrome base due to the threat posed by a tropical cyclone approaching the Queensland coast. The purpose of the flight was to return the helicopter to Townsville following the passage of the cyclone. On board the helicopter were the pilot seated in the front right seat, an air crew officer (ACO) seated in the front left seat and a rescue crew officer (RCO) seated in the rear cabin.

**Figure 1: Area map and helicopter flight path<sup>2</sup>**



The helicopter was parked overnight in the open at Mackay Aerodrome and was subjected to heavy rainfall for several hours. The pilot and ACO stated that prior to departure, the crew discussed the possibility of erroneous cockpit indications due to water ingress that they believed had been previously experienced by other company crews. During the departure from Mackay, the pilot and ACO observed two caution messages illuminate on the crew alerting system (CAS)<sup>3</sup> that indicated the failure of

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<sup>1</sup> The 24-hour clock is used in this report to describe the local time of day, Eastern Standard Time (EST), as particular events occurred. Eastern Standard Time was Coordinated Universal Time (UTC) + 10 hours.

<sup>2</sup> The indicated flight path was derived from Global Positioning System (GPS) data that was transmitted from the helicopter to a ground station during the occurrence flight.

<sup>3</sup> The crew alerting system (CAS) is an area of the cockpit display on which warning, caution and advisory messages are indicated to both front seat occupants. See section on *AW139 avionics system*.

the multi-purpose flight recorder (MPFR)<sup>4</sup>. On examination, the circuit breaker<sup>5</sup> associated with the MPFR was found to have activated and was unable to be reset. Following a review of the emergency checklist and consultation with a maintenance engineer via telephone, which included a discussion of previous erroneous indications believed to be associated with water ingress, the pilot elected to continue the flight to Townsville.

About 10 minutes after departure, two other caution messages relating to the avionics system briefly illuminated, followed about 1 minute later by a warning indicating a fire in the rear baggage compartment. This warning extinguished after about 20 seconds, before again illuminating briefly twice over the next 4 minutes. In response to the fire indication, the pilot and ACO again consulted the emergency checklist and the RCO inspected the rear cabin for signs of fire. No evidence of fire was present. The pilot considered diverting to the nearby Proserpine Aerodrome (Figure 1), but rejected this option due to the likelihood that the prevailing weather conditions at Proserpine were below the visual conditions required for landing. The crew again contacted the maintenance engineer to discuss the issue and following this discussion, and in the absence of signs of fire, the pilot decided to continue to Townsville. In an attempt to reduce the exposure of the helicopter to turbulence and rain, the pilot elected to climb from 6,000 ft above mean sea level (AMSL) to 8,000 ft.

At 1024 and 89 km from Townsville, while maintaining 8,000 ft with the autopilot altitude hold (ALT)<sup>6</sup> function engaged, the pilot contacted Air Traffic Services (ATS) to obtain a clearance to enter Townsville controlled airspace. At the same time, the ALT function experienced an uncommanded disengagement and the helicopter commenced a descent, undetected by either the crew or the air traffic controller. The pilot and the ACO later advised that they could not recall any indication associated with disengagement of the ALT function. At about the same time that the helicopter began descending, a large number of caution messages began to appear on the CAS. In response, the ACO accessed the emergency checklist and assisted the pilot in the assessment of the multiple caution messages.

At 1029, while the helicopter was descending through 5,300 ft, an oncoming air traffic controller for the next shift assumed control of the aircraft. At 1030, the controller observed the helicopter descending through 4,800 ft and heading towards an area of terrain approximately 4,000 ft high. In response, the controller asked the pilot whether the helicopter was being operated in visual conditions and whether he was therefore aware of the terrain ahead. The pilot replied that the helicopter was still in cloud and the controller then instructed the pilot to commence a climb to 5,500 ft<sup>7</sup> to ensure terrain clearance.

Following the ATS instruction, and while still in the process of investigating the multiple CAS caution messages, the pilot checked the altimeter and noted that the helicopter was at 4,700 ft and descending at about 600 ft/min. The pilot

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<sup>4</sup> The multi-purpose flight recorder, commonly known as a 'black box' flight recorder, records flight parameters and noises within the cockpit, including radio transmissions and conversation between the crew.

<sup>5</sup> An automatically operated switch designed to protect an electrical circuit from damage due to excessive current.

<sup>6</sup> The altitude hold function maintains the helicopter at a constant barometric altitude.

<sup>7</sup> The radar-based lowest safe altitude associated with the approaching terrain.

immediately initiated a climb and established the helicopter above 5,500 ft, about 11 km before entering the region of high terrain.

During the climb, visual and aural warnings associated with the failure of the No 1 engine activated, although the engine parameter indications appeared normal and the sound level of the helicopter did not alter. This was followed soon after by the same warning indications associated with the No 2 engine. The pilot reported that shortly after these warnings activated, the helicopter climbed clear of cloud and visual contact was established with the ground through breaks in the cloud. The pilot notified ATS that the helicopter was experiencing problems with 'engine parameters' and obtained a clearance to descend visually to below 2,000 ft. Following a request by ATS, the pilot confirmed that the helicopter was still 'operations normal'.

Owing to the lower operating altitude and terrain in the vicinity, radar and radio contact was lost with the helicopter. Following several unsuccessful attempts by ATS to contact the aircraft, a distress phase (DETRESFA) was initiated. This was immediately cancelled as radar identification of the helicopter was restored. A short time later, radio contact with the pilot was also established and the helicopter continued to Townsville Aerodrome, landing at 1048.

## **Personnel information**

### **Pilot**

The pilot held an Air Transport Pilot (Helicopter) Licence that was issued in 1994. He was endorsed on the AW139 and held a Command (Multi-engined Helicopter) Instrument Rating. The pilot also held a Class 1 Aviation Medical Certificate with the requirement to have corrective reading glasses available for use during flight.

Prior to the occurrence flight, the pilot had accrued a total of 6,370.1 hours helicopter flight time, of which 92.3 hours were in AW139 helicopters. The pilot's most recent flight review was conducted on 19 September 2008 in the form of a company check flight. Additionally, the pilot's most recent Command Instrument Rating flight test, conducted on 29 August 2008, also satisfied the requirements of a flight review.

The pilot's endorsement training on the AW139 consisted of a 2-week manufacturer's theory course conducted during November and December 2007, followed by an 11.2 hour flight component conducted at the operator's Townsville base during April and May 2008. Following the completion of endorsement training, the pilot conducted an additional 10.7 flying hours in command under supervision in the AW139, prior to conducting flights as pilot in command (PIC).

Due to maintenance requirements associated with the helicopter, the pilot did not operate the AW139 for a 2-month period from 24 November 2008 until 22 January 2009. During that time he continued to operate the other helicopter type used by the company. Following this break, the pilot underwent an AW139 familiarisation flight with a company instructor and also conducted two other flights as PIC in the 10 days prior to the occurrence flight.

## Air Crew Officer

The ACO had about 22 years of experience in various aviation crew-related roles, including rescue crew officer and winch operator. He reported that he had about 3,500 hours operational experience, including about 100 hours in AW139 helicopters.

The ACO's endorsement training on the AW139 consisted of a 2-day training course delivered by the operator's senior ACO. This training covered information relating to the aircraft systems including use of the radios, Flight Management System and Primary Flight and Multi-Function Displays. The ACO also received flight training in the areas of winching and related roles.

## Aircraft information

The AW139 is a medium-sized, single main and tail rotor helicopter that is powered by two Pratt and Whitney PT6C-67C turbine engines and is equipped with retractable landing gear (Figure 2). At the time of the occurrence, the helicopter, serial number 31083, had been operated for a total of 850 hours.

**Figure 2: AW139**



## AW139 avionics system<sup>8</sup>

The AW139 was equipped with four electronic display screens, consisting of a Primary Flight Display (PFD) and Multi-function display (MFD) for each of the two front seat occupants (Figures 3 and 4). The CAS messages are displayed on

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<sup>8</sup> The United Kingdom's Air Accidents Investigation Branch investigated a similar incident involving another AW139 helicopter, registered G-CHCV that occurred on 23 December 2008. The investigation report relating to that incident, due for public release on 14 October 2010, provides additional detail of the AW139 avionics system and the testing conducted by the helicopter avionics system manufacturer referred to in the *Helicopter examination* section of this report. See <http://www.aaib.gov.uk>

each of the MFDs together with two annunciators located above each PFD/MFD pair. These annunciators illuminate for caution (yellow) and warning (red) messages respectively and may be reset by pushing the appropriate switch (Figure 4).

**Figure 3: AW139 cockpit layout**



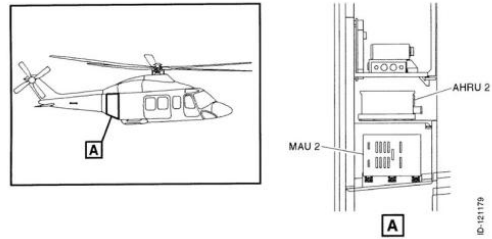
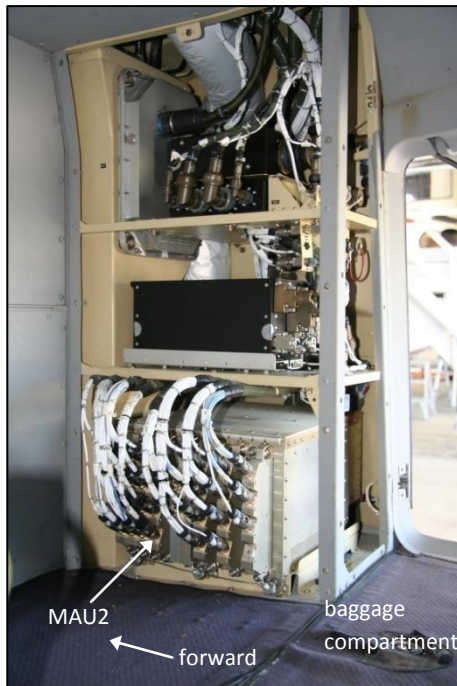
**Figure 4: Primary and multi-function flight displays**



**Modular Avionics Unit**

The avionics system in the occurrence AW139 contained two Modular Avionics Units (MAUs) located on the left (MAU1) and right (MAU2) side of the helicopter, forward of the baggage compartment (Figures 2 and 5).

**Figure 5: MAU2 location**



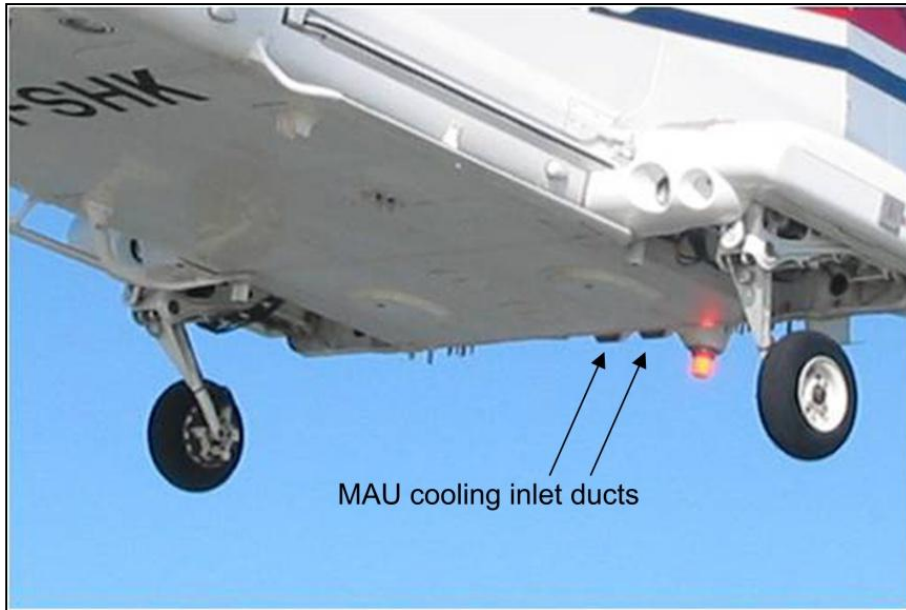
Each MAU consisted of a cabinet containing a number of slots within which several replaceable electronic modules (Figure 6) were housed.

**Figure 6: MAU module**

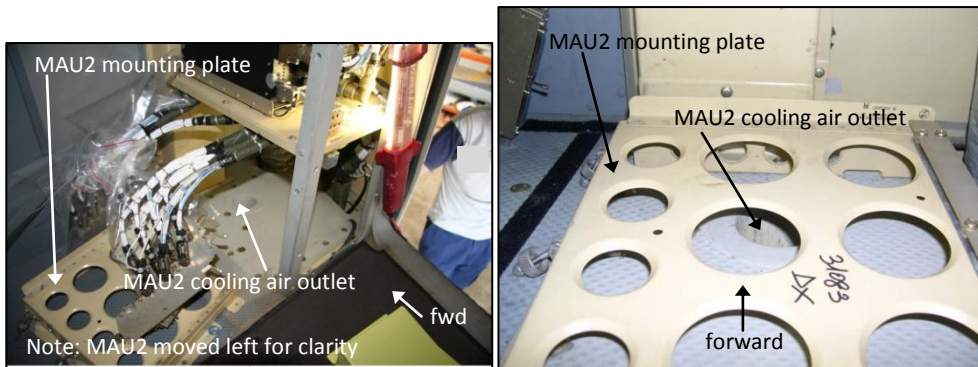


Cooling of the MAUs was achieved using outside air that was separately ducted to each MAU cabinet from two air inlets located on the underside of the fuselage (Figure 7). The cooling air was not filtered or conditioned and, in the case of MAU2 (right side) the vent was located underneath the cabinet (Figure 8).

**Figure 7: MAU cooling inlets**



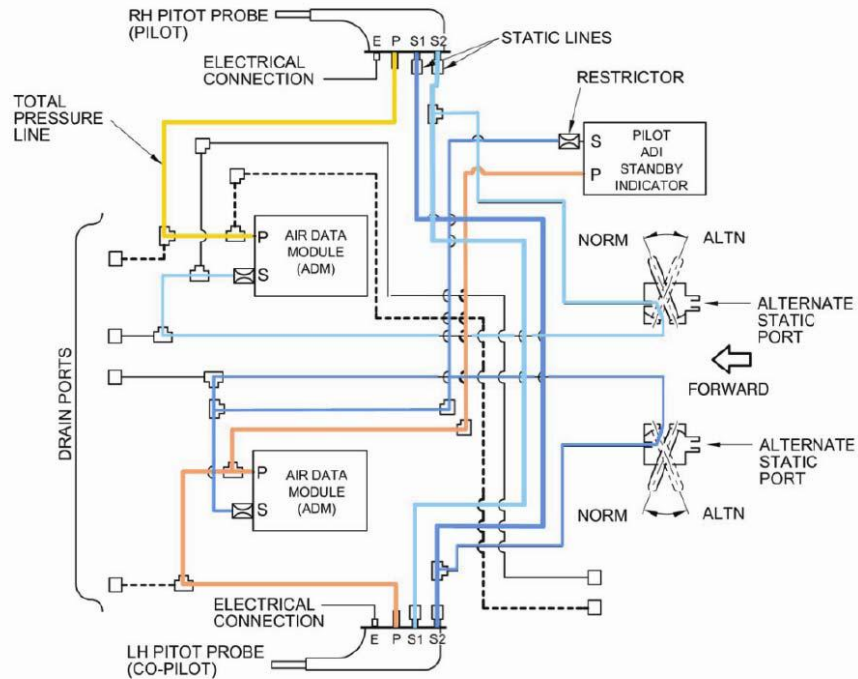
**Figure 8: MAU2 cooling outlet**



***Air data system***

The air data system is a subset of the avionics system comprising dual pitot/static probes, air data modules (ADM), outside air temperature (OAT) probes and alternate static sources (Figure 9).

**Figure 9: Air data system**

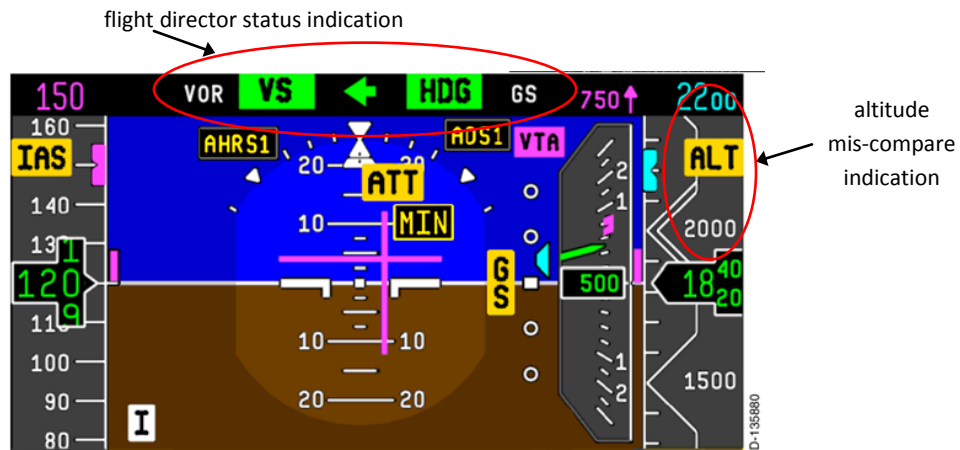


Each ADM converts the dynamic and static pressures measured by the pitot/static probes to digital signals which, together with the measured OAT values, are used by the MAUs to generate air data parameters such as airspeed, altitude and vertical speed. In the event of erratic airspeed and altimeter indications, two alternate static sources within the aircraft cabin are available to restore normal operation. In the event that the altitude generated by each of the MAUs varied by more than 150 ft, an amber altitude mis-compare alert would be displayed on both altimeters (Figure 10).

***Flight director mode change chime***

The AW139 has an automated flight system that is capable of controlling the helicopter’s movement in a number of modes, including the capture and maintenance of a defined flight path or flight parameters such as altitude or airspeed. This system, known as a flight director, incorporates a chime to identify both routine flight director mode changes to the crew and also to alert the crew of an unintended change in the automated control of the helicopter. In addition to the chime, the status of the flight director, including mode changes, is displayed on the top section of both PFDs using a combination of colour coded and flashing identifiers (Figure 10).

**Figure 10: Flight director mode information**



## Meteorological information

The Bureau of Meteorology (BoM) reported that during the period that the helicopter was positioned at Mackay, the automatic weather system located at the aerodrome recorded 64 mm of rainfall. This was consistent with the crew's observation of the weather on arrival at Mackay Aerodrome and during the evening prior to the occurrence.

The BoM also stated that weather conditions along the intended route from Mackay to Townsville were forecast to include isolated thunderstorms and scattered showers, with areas of rain that were forecast to be more widespread north of Proserpine. Scattered<sup>9</sup> cloud was forecast between 800 ft and 20,000 ft, increasing to broken cloud between 500 ft and 2,500 ft in precipitation and up to 14,000 ft in some areas. The BoM forecast also included 30 kt easterlies with frequent moderate turbulence below 9,000 ft on the sea, coast and ranges, with severe turbulence forecast within clouds associated with thunderstorms. The forecast conditions were consistent with the flight crew's observations during the flight. Additionally, the BoM analysis stated:

Conditions forecast between Mackay and Townsville, including the presence of showers, rain areas and turbulence, were consistent with conditions observed.

## Helicopter examination

### Helicopter operator

Examination of the helicopter by the operator's maintenance personnel on its arrival at Townsville found evidence of significant water ingress within the baggage compartment. Water present below the baggage floor and within the tail boom area in the vicinity of the MPFR (Figure 11) was assessed as being responsible for the

<sup>9</sup> Cloud amounts are reported in oktas. An okta is a unit of sky area equal to one-eighth of total sky visible to the celestial horizon. Few = 1 to 2 oktas, scattered = 3 to 4 oktas, broken = 5 to 7 oktas and overcast = 8 oktas.

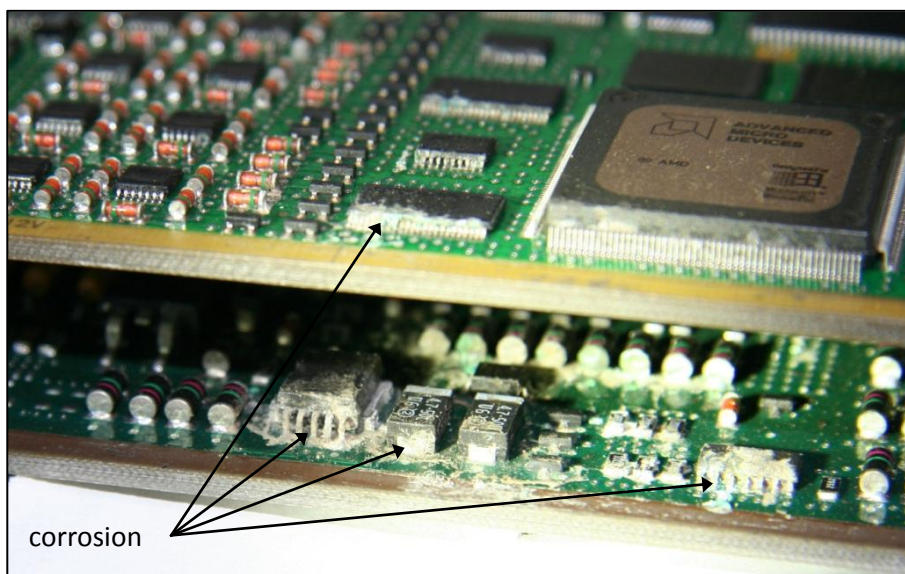
activation of the MPFR circuit breaker observed by the crew. Owing to the resultant interruption of the electrical power supply to the MPFR, no recorded information relevant to the flight, including the activation of any aural and visual warnings, was available. A second source of electronic data, primarily used to assist with fault diagnosis, was however available for analysis.

**Figure 11: AW139 tail boom**



Inspection of the two installed Modular Avionics Units (MAUs), located immediately in front of the baggage compartment, also found evidence of moisture within the right side unit (MAU2). Further detailed examination identified corrosion and contamination on a number of the electronic components located within that unit (Figure 12).

**Figure 12: Example of corroded electronic module**



The operator advised the helicopter and avionics system manufacturers of the occurrence and forwarded a number of corroded electronic modules and the

available fault history data to the avionics system manufacturer for further examination.

## **Helicopter avionics system manufacturer**

Following detailed examination of the provided electronic modules, the avionics system manufacturer advised:

The findings of the material analysis indicate the presence of corrosion and contamination that is consistent with dust and dirt being blown into the MAU2 cabinet along with high proportions of sodium and chlorine which is consistent with operation in a coastal environment.

In addition to receiving notification of this occurrence, the avionics system manufacturer was advised of a number of other instances of erroneous CAS message events, including another similar occurrence in Australia. In response, the manufacturer commenced an investigation to assess the performance of both corroded and new modules when subjected to moisture. Following that investigation, the avionics system manufacturer concluded:

Upon investigation into these events, it was discovered that a cooling vent on the aircraft was injecting foreign contaminants and moisture into the aircraft's avionics equipment located in modular avionics unit 2 (MAU2). The air intake for cooling the MAUs is located at the bottom of [the] unit. Over time this injection of moisture and contamination onto the Custom I/O 2 module and other modules located in MAU2 resulted in corrosion and contaminant build up on electronic circuits within the MAU. The corrosion and contaminants build up lead to system malfunctions associated with these aircraft incidents...Initial feedback from the field indicates this is not a problem with modules installed in the MAU1 locations as the cooling duct for this MAU does not enter the cabinet from the bottom.<sup>[10]</sup>

Following analysis of the supplied fault history data, the avionics system manufacturer concluded that the unexpected disengagement of the ALT function described by the crew was probably generated by the avionics system and not due to action by the crew.

## **Helicopter manufacturer**

In response to notification of this incident, the helicopter manufacturer conducted a number of flight and rig-based ground tests to investigate the uncommanded disengagement of the ALT mode. Those tests identified that variation between the static pressure detected by each of the two sensors fitted to the helicopter (see section on *Air data system*) was capable of disengaging the ALT mode without activation of the altitude mis-compare amber annunciator (Figure 10). The helicopter avionics system manufacturer advised that this was due to the different tolerance requirements of information provided to the flight director and crew display systems. During both flight and rig tests, the chime associated with the disengagement of the ALT mode (see section on *Flight director mode change chime*) operated. Testing also identified that selection of the alternate static source

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<sup>10</sup> Advice from the helicopter manufacturer clarified that although the cooling duct for MAU1 enters through the bottom of the cabinet, it is positioned beside the cooling air inlet screen and therefore not subject to the same moisture/particulate ingress issue.

in instances of static port obstruction could result in the uncommanded disengagement of the ALT mode, without activation of the altitude mis-compare annunciator.

Analysis of recorded flight data identified another ALT mode disengagement event involving the occurrence helicopter that occurred during turbulent flight conditions about 2 months prior to this occurrence. In that case, the helicopter descended for about 1 minute before the crew identified and recovered the 150 ft loss of altitude. The exact mechanism by which the ALT mode disengagement occurred on the occurrence helicopter could not be determined by either manufacturer; however, it was considered most likely that the static pressure system on the occurrence helicopter was sensitive to in-flight turbulence and that, with the exception of the possible disengagement of the ALT when selecting the alternate static source, fleet-wide consideration of this issue was not considered necessary.

Following the incorporation of component changes suggested by the helicopter manufacturer, the occurrence helicopter was operated on a number of test flights, in smooth flying conditions, without disengagement of the ALT function. Following the return of the helicopter to operation however, uncommanded disengagement was observed during flight in turbulent conditions. At the time of writing, the investigation of this issue by the helicopter operator was continuing.

The Australian Transport Safety Bureau (ATSB) investigation considered the feasibility of incorporating a specific warning in instances of uncommanded disengagement of the ALT function rather than the multi-role chime presently utilised. The helicopter manufacturer advised that difficulties in differentiating between a commanded or uncommanded disengagement could result in low reliability of such a warning and possible instances of false alarms.

## **Organisational and management information**

### **Air crew officer role**

With the exception of the conduct of winching activities, the ACO normally occupied the left front seat of the helicopter types in use by the operator and assisted the pilot with the management of the flight. The degree of assistance provided by the ACO was restricted, as the role of ACO was not a formally recognised flight crew position and therefore the tasks that could be performed were limited by the Civil Aviation regulatory framework.<sup>11</sup> In addition, the helicopters in use by the operator were certified to be operated by a single pilot and therefore the tasks performed by the ACO also varied depending on the degree of assistance required by individual pilots.

These considerations meant that the role of the ACO in a multi-crew context was not formalised beyond recognising that the ACO was an asset to be utilised in roles such as monitoring of the aircraft, assistance with confirmation of normal checklist actions and coordination of tasks with external emergency service agencies. To assist the ACO with these roles, the operator provided training in areas including crew resource management and, in the case of the AW139, aircraft system familiarity via a 2-day assessed endorsement on the helicopter systems combined

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<sup>11</sup> See Section 20AB of the *Civil Aviation Act 1988*.

with ongoing supervision by the pilot. The ACOs also received handling training in the area of winching and related roles.

The ACOs received limited exposure to the management of emergencies in the AW139. This was due to limits placed on the operating weight required to enable the practice of certain emergencies, restricting the crewing of the helicopter to the pilot and instructor/check pilot only.

## **Additional information**

### **Air traffic management**

Typically, an altitude monitoring alert capability is included in air traffic services (ATS) systems. For example, the Airservices Australia (Airservices) system known as the Australian Advanced Air Traffic System (TAAATS) has a cleared level adherence monitoring (CLAM) alert. That alert notifies ATS if an aircraft deviates more than 200 ft from an assigned altitude while operating between, or in the vicinity of, aerodromes.

The Australian Defence Air Traffic System (ADATS) assisted with the management by air traffic control of aircraft within the airspace associated with military and joint-user<sup>12</sup> aerodromes in Australia. The initial advice from the Department of Defence (DoD) was that ADATS had an altitude monitoring alert feature that was disabled at Townsville Aerodrome. However, after the public release of the final investigation report, the DoD advised that ADATS did not have that alert capability.

### **Automated crew alerting systems**

The way in which aircraft system alert information is displayed to flight crew has evolved with advances in aircraft flight deck design. In modern automated aircraft, crew alerts are typically displayed together in a centralised multifunction display. This is in comparison to earlier generation aircraft, where warning annunciators were typically associated and co-located with individual aircraft system panels.<sup>13</sup>

The aim of an automated crew alerting system is to support the crew in information management and decision making. For example, a crew alerting system will typically categorise alerts as either being a 'warning', a 'caution', or an 'advisory', depending on the need for immediate recognition of the problem and corrective action.

In addition, the alerting system may assist the crew by sorting failures, prioritising them, selecting only some failures for presentation, guiding the crew on what to do next, or showing the crew which systems are still operating.<sup>14</sup>

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<sup>12</sup> Joint-user aerodromes, including Townsville, accommodate both military and civil aircraft operations.

<sup>13</sup> Harris, D. (2004). *Human factors for civil flight deck design*. Aldershot, UK: Ashgate.

<sup>14</sup> Singer, G. and Dekker, S.W.A. (2000). Pilot performance during multiple failures: An empirical study of different warning systems. *Transportation Human Factors*, 2, 63-76.

The way in which warning information is displayed to the crew becomes particularly important in situations involving multiple alerts. Multiple warning situations can be difficult for even experienced crews to analyse and prioritise actions, and these difficulties can be exacerbated in situations of stress or high workload.<sup>15</sup>

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<sup>15</sup> Noyes, J.M. and Starr, A.F. (2000). Civil aircraft warning systems: Future directions in information management and presentation. *The International Journal of Aviation Psychology*, 10, 169-188.

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# ANALYSIS

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## Helicopter malfunctions

The first indication of a potential problem with the helicopter occurred shortly after departure from Mackay Aerodrome with the activation of crew alerting system (CAS) messages relating to failure of the multi-purpose flight recorder (MPFR). The source of the failure was later identified as water ingress, following exposure of the helicopter to heavy overnight rainfall that affected the MPFR power line and resulted in activation of the MPFR circuit breaker.

The remainder of the CAS messages experienced by the crew throughout the flight were identified by the avionics system manufacturer as spurious and originated from moisture and particulate ingress, via an external cooling vent, affecting the electronic avionics modules. Repeated exposure of the modules to moisture and particulates prior to the flight, resulted in corrosion and contamination of the electronic circuits. Subsequent moisture from operation in rain during the flight permitted the generation of multiple erroneous messages due to electrical shorting, that was exacerbated by the corroded areas of the avionics modules.

In addition to the system failures associated with moisture ingress, a second avionics system failure resulted in inadvertent disengagement of the altitude hold (ALT) function at or around the same time as the frequency of CAS messages presented to the crew significantly increased. This event, identified by the helicopter manufacturer as probably originating from sensitivity of the occurrence helicopter's static system to in-flight turbulence, resulted in the uncommanded descent of the helicopter that was not detected by either the crew or Air Traffic Services (ATS).

The helicopter manufacturer assessed that, with the exception of possible disengagement of the ALT function following selection of the alternate static sources, this issue was confined to the occurrence helicopter and fleet-wide consideration was not warranted. Despite the replacement of a number of components at the advice of the helicopter manufacturer, at the time of writing, the issue had not been resolved and further investigation by the operator, with the support of the helicopter manufacturer, was continuing.

## Operational considerations

It is probable that exposure to multiple cascading CAS messages, combined with the crew's limited experience and recency on type, resulted in a high workload and task fixation that affected their awareness of the helicopter's altitude. Owing to the failure of the MPFR, the investigation was unable to confirm if the chime associated with the disengagement of the ALT function activated in this instance. The normal operation of the chime during the subsequent flight and rig tests suggests that the chime likely activated correctly during the flight, but went unnoticed by the crew.

The lack of a formalised role for the ACO in a (non-standard) multi-crew context, particularly during the management of emergencies, combined with limited exposure to practice emergencies probably also contributed to the undetected

altitude loss. The ACO's action in assisting the pilot to assess the CAS messages, while a natural response, resulted in both the pilot and ACO conducting the same task at the expense of monitoring the overall performance of the helicopter. Given the ACO's familiarity with the flight display screens, it is likely that, had there been a formalised requirement for the ACO to monitor the key instrument indications, the inadvertent descent would have been detected at some point prior to the ATS alert.

The absence of altitude deviation alerting within the Australian Defence Air Traffic System increased the risk of undetected altitude variation. In this instance, such an alert would have assisted the initial air traffic controller to identify the inadvertent descent and prevented the significant, undetected loss of altitude. The detection of the unintended descent by the oncoming controller resulted in the restoration of safe operation and potentially prevented the helicopter colliding with terrain.

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## FINDINGS

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From the evidence available, the following findings are made with respect to the operational event that occurred 89 km south-east of Townsville, Queensland on 2 February 2009 and involved Agusta Westland AW139 helicopter, registration VH-ESH. They should not be read as apportioning blame or liability to any particular organisation or individual.

### Contributing safety factors

- The design and relative positioning of the external air vent and avionics modules permitted the ingress of moisture and particulates that led to corrosion and contamination of electronic avionics components, and the generation of multiple erroneous crew alerting system messages due to electrical shorting. [*Significant safety issue*]
- The crew experienced a high level of workload and probable fixated attention during the assessment and actioning of the multiple crew alerting system messages, which led to the failure to detect the inadvertent disengagement of the altitude function, and subsequent loss of altitude.
- Probable sensitivity of the occurrence helicopter's Air Data System to turbulence and minor airflow differences resulted in the inadvertent disengagement of the altitude hold function, permitting the helicopter to descend.
- The inadvertent descent was not detected by Air Traffic Services prior to the loss of significant altitude.
- The lack of formalised procedures in place requiring the air crew officer to monitor key instrument indications probably contributed to the undetected altitude loss. [*Minor safety issue*]
- The absence of an altitude deviation alert within the Australian Defence Air Traffic System increased the risk of undetected altitude variation and contributed to the significant loss of altitude. [*Minor safety issue*]

### Other safety factors

- Interruption of electrical power to the multi-purpose flight recorder due to moisture ingress removed an important source of information used by the flight crew to identify safety issues. [*Minor safety issue*]

### Other key finding

- Detection of the unintended descent of the helicopter by Air Traffic Services resulted in the restoration of safe operation and potentially prevented the helicopter colliding with terrain.



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## SAFETY ACTION

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The safety issues identified during this investigation are listed in the Findings and Safety Actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

All of the responsible organisations for the safety issues identified during this investigation were given a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

### **Erroneous crew alerting system messages**

#### ***Significant safety issue***

The design and relative positioning of the external air vent and avionics modules permitted the ingress of moisture and particulates that led to corrosion and contamination of electronic avionics components, and the generation of multiple erroneous crew alerting system messages due to electrical shorting.

#### ***Safety action taken by the helicopter manufacturer***

Following a number of reports of AW139 helicopters experiencing erroneous crew alerting system messages, the helicopter and avionics system manufacturers established that the design and relative positioning of the external air vent was the source of the problem. Once identified, the helicopter manufacturer issued mandatory service bulletin (SB) 139-166 that was applicable to 'short nose configuration' helicopters.<sup>16</sup> The bulletin provided instructions to identify the presence of corrosion on the Modular Avionics Unit (MAU) modules and also detailed modification of the MAU2 ventilation duct to ensure that the modules were not subject to the direct flow of air from the duct outlet.

In addition, following notification of instances of moisture ingress following exposure to heavy rain, the helicopter manufacturer has developed a number of modifications to improve the overall water proofing of AW139 helicopters.

Service bulletin 139-105 is currently being prepared to provide the required detail to operators.

#### ***ATSB assessment of action***

The ATSB is satisfied that the action taken by the helicopter manufacturer adequately addresses the safety issue.

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<sup>16</sup> Current production 'long nose configuration' AW139 helicopters have the MAUs located in the nose section of the aircraft and do not utilise outside air for cooling.

### ***Safety action taken by the helicopter operator***

Following the occurrence, and prior to the issue of the manufacturer's SB, the operator developed a modification, in accordance with an engineering order, to prevent contamination of the modular avionics system. That modification was fitted to the operator's AW139 aircraft until the release of SB 139-166.

### ***ATSB assessment of action***

The ATSB is satisfied that the action taken by the helicopter operator adequately addresses the safety issue.

### ***Safety action taken by the Civil Aviation Safety Authority***

The Civil Aviation Safety Authority (CASA) identified that, under the current system of maintenance applicable to AW139 helicopters on the Australian register, compliance with a manufacturer's SB is not mandatory in all circumstances. Compliance is only mandatory for aircraft on the Australian register if an Airworthiness Directive (AD), issued by the National Airworthiness Authority (NAA) responsible for the type design of the aircraft, calls for compliance with a manufacturer's SB. At the time of writing, no such AD had been issued regarding compliance with SB 139-166.

Following this occurrence, CASA contacted the relevant NAA and ascertained that the NAA intends issuing an AD that will mandate compliance with SB 139-166. CASA is presently monitoring the development of this directive and, in the event that the relevant NAA does not issue the AD, CASA will consider if the issue of an Australian AD is warranted.

### ***ATSB assessment of action***

The ATSB is satisfied that the action taken by CASA adequately addresses the safety issue.

## **Use of crew resources**

### ***Minor safety issue***

The lack of formalised procedures in place requiring the air crew officer to monitor key instrument indications increased the likelihood of the undetected altitude loss.

### ***Safety action taken by the helicopter operator***

Shortly after this occurrence, the operator issued a safety bulletin to all flight crews emphasising the importance of effective crew resource management (CRM) during all phases of normal and emergency flight. This was followed by the development of crew standard operating procedures that were implemented at all of the operator's bases via a standards directive on 3 July 2009. Those procedures formalised the duties and responsibilities of the air crew officer while occupying the front left seat, including the monitoring of flight tolerances and provision of alerts to the pilot. The directive also detailed the introduction of sterile cockpit procedures

and altitude management procedures relating to setting and monitoring the helicopter's barometric and radio altimeters.

The operator also indicated that they intended to utilise this event in future CRM training.

#### ***ATSB assessment of action***

The ATSB is satisfied that the action taken by the helicopter operator adequately addresses the safety issue.

## **Failure of the multi-purpose flight recorder**

#### ***Minor safety issue***

Interruption of electrical power to the multi-purpose flight recorder due to moisture ingress removed an important source of information used by the flight crew to identify safety issues.

#### ***Safety action taken by the helicopter manufacturer***

The helicopter manufacturer has developed modifications to improve the overall water proofing of AW139 helicopters and is currently developing service bulletin 139-105 to provide the required detail to operators.

#### ***ATSB assessment of action***

The ATSB is satisfied that the action by the helicopter manufacturer will, once in place, adequately address the safety issue.

#### ***Safety action taken by the helicopter operator***

Following the occurrence, the operator developed a modification, in accordance with an engineering order, to prevent moisture ingress affecting the multi-purpose flight recorder power supply. Details of the modification were supplied to the helicopter manufacturer.

#### ***ATSB assessment of action***

The ATSB is satisfied that the action taken by the helicopter operator adequately addresses the safety issue.

## **Lack of an altitude deviation alert in the Australian Defence Air Traffic System**

#### ***Minor safety issue***

The absence of an altitude deviation alert within the Australian Defence Air Traffic System increased the risk of undetected altitude variation and contributed to the significant loss of altitude.

### ***Action by the Australian Government***

In May 2010, the Australian Government announced that the replacement Air Traffic Services (ATS) system for the Australian Defence Air Traffic System and the Australian Advanced Air Traffic System (TAAATS) would be via a joint acquisition project that would result in a common ATS system throughout Australia. It could be expected that the system would include common alert functions, such as the existing cleared level adherence monitoring (CLAM) alert in TAAATS.

### ***ATSB assessment of action***

The ATSB is satisfied that, on the basis that the replacement common ATS services system will retain some form of CLAM-like alert, the action taken by the Australian Government will, once in place, adequately address this safety issue.

## **Other safety action**

### **Inadvertent altitude hold disengagement**

Although no safety issue was identified concerning the fleet-wide sensitivity of the helicopter's Air Data System to turbulence and minor airflow differences, the following safety action was taken by the helicopter operator, helicopter manufacturer and the ATSB.

#### ***Safety action taken by the helicopter operator***

Following troubleshooting advice from the helicopter manufacturer, the operator changed a number of Air Data System components and conducted a series of test flights without disengagement of the ALT function. Following the return of the helicopter to service however, the ALT mode disengaged. The operator is continuing its investigation to determine the source of the fault.

The operator also issued a safety bulletin to all flight crews highlighting the possibility of the inadvertent disengagement of the ALT mode.

#### ***Safety action taken by the helicopter manufacturer***

The helicopter manufacturer identified that, in addition to the ALT mode disengagement identified in this occurrence, selection of the alternate static pressure source may also result in the disengagement of the ALT mode. The manufacturer is currently considering a modification to the emergency section of the AW139 flight manual to highlight this possibility to flight crews.

#### ***Safety action taken by the ATSB***

With the assistance of the Civil Aviation Safety Authority, the ATSB contacted Australian operators of the AW139 helicopter and advised them of the possibility of the inadvertent disengagement of the ALT mode. The ATSB also supplied a copy of this report to Australian AW139 operators.

## **AW139 refresher training**

### ***Safety action taken by the helicopter operator***

Although no safety issue was identified concerning the training of flight crews to operate the AW139, the operator advised that following this occurrence the involved crew participated in AW139 refresher training.

Additionally, a requirement was introduced into the company operations manual that all flight crew must conduct a minimum of a familiarisation flight with an appropriate Training and Checking person if they have not crewed/flown a specific aircraft type for more than 60 days.



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# APPENDIX A: SOURCES AND SUBMISSIONS

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## Sources of Information

The sources of information during the investigation included the:

- flight crew of VH-ESH (ESH)
- helicopter operator
- helicopter manufacturer
- helicopter avionics system manufacturer
- flight crew of a second AW139 who were involved in a similar occurrence
- Bureau of Meteorology (BoM)
- Civil Aviation Safety Authority (CASA)
- Royal Australian Air Force (RAAF)
- Directorate of Defence Aviation and Air Force Safety (DDAAFS)
- United Kingdom Air Accidents Investigation Branch (UK AAIB)
- Ente Nazionale per l'Aviazione Civile (ENAC)
- Agenzia Nazionale Per La Sicurezza Del Volo (ANSV)
- National Transportation Safety Board (NTSB)

## References

Singer, G. and Dekker, S.W.A. *Pilot Performance During Multiple Failures: An Empirical Study of Different Warning Systems*, Transportation Human Factors Vol 2(1) pp. 63-76.

## Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), the Australian Transport Safety Bureau (ATSB) may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the flight crew of ESH, the involved air traffic controllers, the helicopter operator, the helicopter and avionics system manufacturers, the NTSB, the ANSV, CASA, the UK AAIB and DDAAFS. Submissions were received from the helicopter operator, the helicopter and avionics system manufacturers, the ANSV, CASA and the UK AAIB. In addition, after the release of the final report to the public, a submission was received from DDAAFS.

The initial submissions from the respective parties were reviewed and, where considered appropriate, the text of the final report was amended accordingly. Consideration of the submission from the DDAAFS meant that, subsequent to the release of the final report, a number of additional changes were made to that report.

Operational event, 89 km south-east of Townsville Aerodrome,  
Queensland, 2 February 2009, VH ESH, Agusta Westland AW139.