



Australian Government

Australian Transport Safety Bureau

Helicopter winching accident involving an Agusta Westland AW139 helicopter, VH-SYZ

16 km WSW of Wollongong Airport, New South Wales | 24 December 2011



Investigation

ATSB Transport Safety Report

Aviation Occurrence Investigation

AO-2011-166

Final – 16 May 2013



Australian Government
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ATSB TRANSPORT SAFETY REPORT
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16 km WSW of Wollongong Airport,
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on 24 December 2011**

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SAFETY SUMMARY

What happened

On 24 December 2011 an Agusta Westland AW139 helicopter departed Bankstown Airport in response to an emergency personal locator beacon in the Budderoo National Park, about 16 km west-south-west of Wollongong Airport, New South Wales. On board the helicopter were a pilot, an air crewman, two paramedics and a doctor.

On locating the emergency beacon, the crew identified a seriously injured person on a rock ledge near the bottom of a waterfall. They assessed that it would not be possible to winch emergency personnel directly to the patient. In response, the crew landed at a nearby clear area and devised a plan to access and retrieve the patient. During the retrieval, the patient and one of the paramedics hit rocks at the base of the waterfall. The paramedic died from the impact. The patient was subsequently transported to hospital for treatment.

What the ATSB found

The Australian Transport Safety Bureau (ATSB) identified that, due to reduced light, the paramedic and patient were accidentally pulled from the rock ledge as the helicopter was manoeuvred in preparation to lift them out using its winch.

The ATSB also identified several safety issues relating to training and use of the helicopter's lighting and radios. A number of organisational issues that could adversely influence the way crews act in similar circumstances were also identified.

What has been done as a result

In response to this accident, the Ambulance Service of New South Wales and the helicopter operator took safety action in respect of the operating scope applied to retrieval operations and procedures used by helicopter emergency crews. In addition, paramedics, in their role as ambulance rescue crewmen, are now required to conduct annual night winching currency training. Finally, proactive safety action was taken by these parties in the areas of general crew training and operational risk assessment.

Safety message

This accident highlights the dangers associated with modifying established procedures in order to complete a difficult, and potentially not previously experienced, rescue task. Specifically, the use of procedures that are neither documented nor trained for by crews makes it difficult to identify hazards and manage the related risks.

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Prepared By

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THE AUSTRALIAN TRANSPORT SAFETY BUREAU

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 appropriate, or to raise general awareness of important safety information in the industry. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

TERMINOLOGY USED IN THIS REPORT

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.

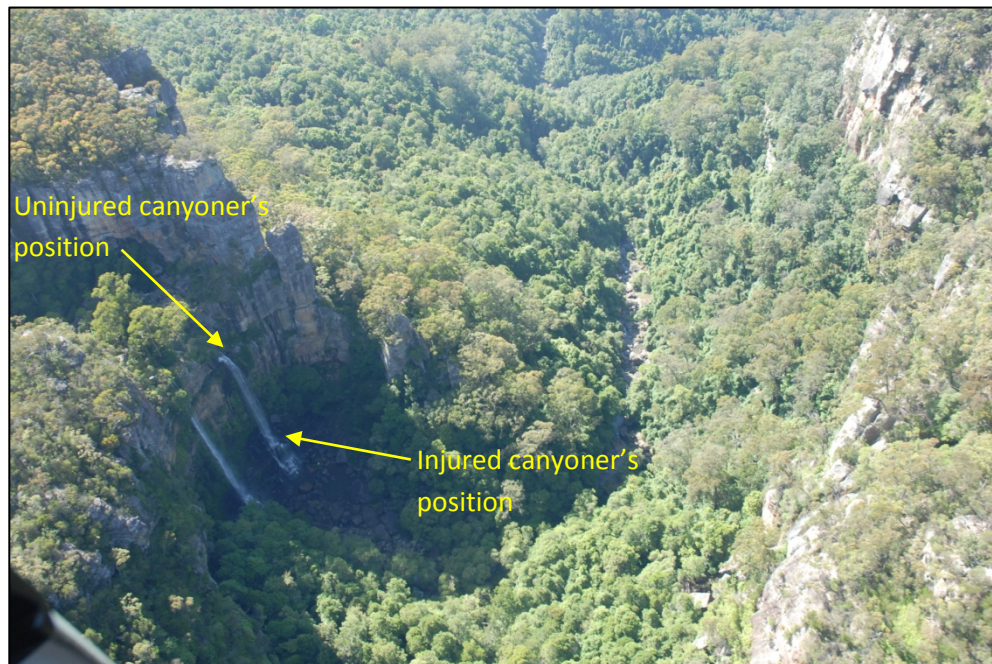
Safety action: the steps taken or proposed to be taken by a person, organisation or agency in response to a safety issue.

FACTUAL INFORMATION

History of the flight

On 24 December 2011, two people were canyoning¹ in the Budderoo National Park, about 16 km west-south-west of Wollongong Airport, New South Wales (NSW). At about 1615 Eastern Daylight-saving time², one of the canyoners was abseiling adjacent to a waterfall known as Bridal Veil Falls when his rope failed and he fell onto a rock ledge that was situated about 15 m above the bottom of the falls (Figure 1). The canyoner was seriously injured. In response, the uninjured canyoner activated a 406 MHz emergency personal locator beacon that resulted in the Rescue Coordination Centre Australia (RCC) declaring a distress phase at 1636. A short time later the RCC contacted the Ambulance Service of New South Wales (ASNSW) Rapid Launch Trauma Coordinator and requested the assignment of a rescue helicopter to track to the beacon.

Figure 1: Bridal Veil Falls³



Source: New South Wales Police Force

At 1717, an Agusta Westland AW139 helicopter, registered VH-SYZ and operating as 'Rescue 24', departed from its base at Bankstown Airport, NSW for the advised beacon location.⁴ On board the helicopter were the pilot, who was seated in the

¹ The sport of travelling down a river situated in a canyon by a variety of means including scrambling, floating, swimming and abseiling.

² Eastern Daylight-saving Time was Coordinated Universal Time (UTC) + 11 hours.

³ Both waterfalls are collectively known as Bridal Veil Falls.

⁴ Although closer, a Wollongong-based rescue helicopter had already been assigned to another mission at the time the RCC request was made to the ASNSW.

front right seat; an air crewman (ACM), who was seated in the front left seat;⁵ and a Special Casualty Access Team (SCAT) (see the section titled *Ambulance Service of New South Wales*) duty paramedic and doctor, who were seated in the rear cabin. Based on the advised location of the beacon and the potential for difficult patient access, an additional SCAT support paramedic was also on board, and seated in the rear cabin. Due to the additional weight of the support paramedic, the helicopter was operated on the ground for 13 minutes in order to reduce the fuel load and ensure the helicopter was below its maximum allowable weight prior to departure.

The helicopter arrived at the advised beacon location at about 1735 and, shortly after, the crew identified a person at the top of the waterfall and a second, apparently injured person on a rock ledge near the bottom of the waterfall. The crew conducted an aerial reconnaissance of the area and assessed that, due to the terrain and vegetation, it would not be possible to winch personnel directly to the injured canyoner's position and that a vertical winch retrieval would similarly not be possible. The pilot elected to land and shut down the helicopter in a nearby staging area (Figure 2) while a plan was devised to access the patient.

Figure 2: Operating area



Source: Google Earth

The plan for the recovery of the injured canyoner

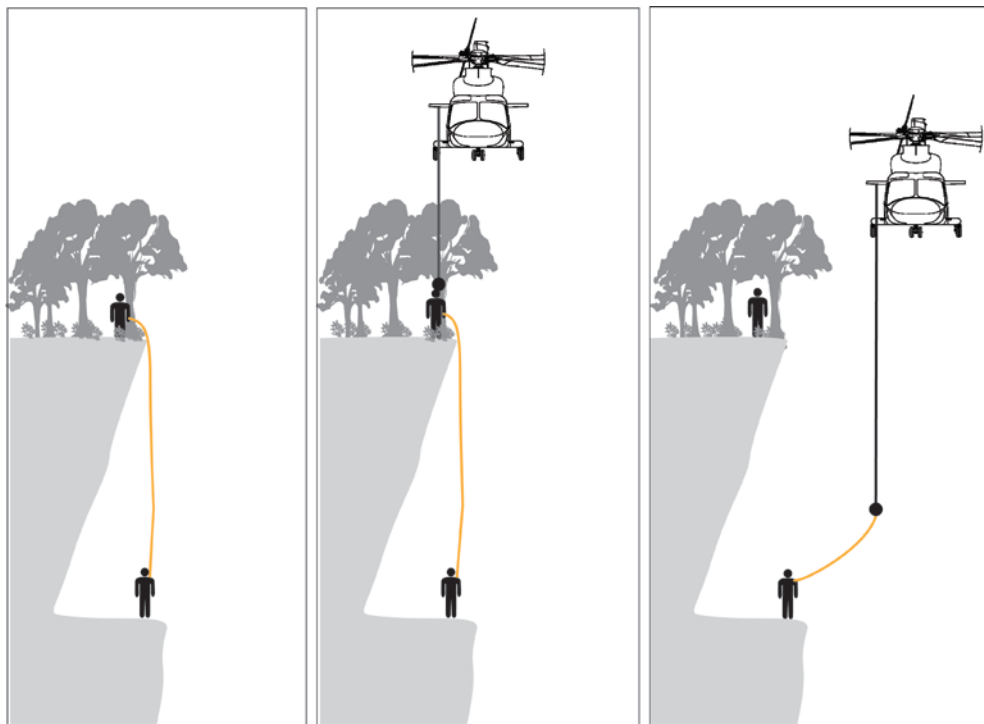
A plan was developed to winch the paramedics to the top of the waterfall, near the position of the uninjured canyoner. The intention was that the duty paramedic would then abseil down to assess the patient while the support paramedic remained at the top of the waterfall. In addition to the rope used to abseil down to the patient, the plan involved the duty paramedic taking one end of a second, yellow rope (tag line) (see the section titled *Role equipment*) down with him, while the other end of the tag line remained with the support paramedic. The purpose of the tag line was

⁵ The ACM generally occupied the front left seat and relocated into the rear cabin when required to operate the rescue winch.

to facilitate delivery of the winch hook to the rock ledge. If the paramedic assessed that the canyoner's injuries permitted him to be winched, the patient and paramedic would be winched together from the ledge.⁶

The delivery of the winch hook to the patient's location was to be achieved by the pilot hovering the helicopter overhead the top of the waterfall and the ACM lowering the hook to the support paramedic, who would attach one end of the tag line to the hook (Figure 3). The pilot would then manoeuvre the helicopter to a position adjacent to the waterfall, and the duty paramedic would pull the winch hook to his location using the tag line, while the ACM let out the winch cable.

Figure 3: Winch hook delivery using the tag line⁷



Source: ATSB

The crew identified that, given the overhanging cliff and surrounding vegetation (Figure 3), a vertical lift from the patient's position was not possible. A winch from a position laterally displaced from overhead the patient meant that, as the paramedic and patient were winched from the ledge, there would be a tendency for them to swing like a pendulum towards a position under the helicopter. In order to manage that pendulous tendency, it was planned that the duty paramedic would establish a stabilising rope system to minimise any swing, until he and the patient were directly underneath the helicopter (Figure 4).

The stabilising rope was never intended to support a significant component of the combined weight of the patient and paramedic, as it was anticipated that the angle of the winch cable from vertical would be minimal when they were winched from the ledge. The intent was for the weight of the personnel and equipment to be almost entirely supported by the winch cable, and that they would be winched from the ledge prior to the paramedic feeding out the stabilising rope to position the

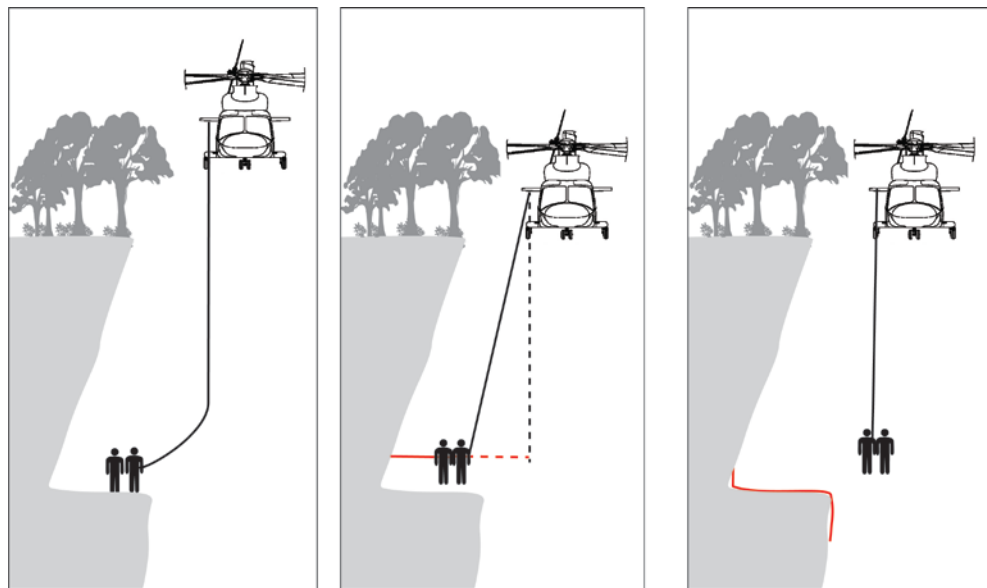
⁶ Commonly termed a 'double lift', where two persons are winched simultaneously.

⁷ The overhang above the ledge position is indicative only.

patient and himself directly underneath the winch. Once they were directly below the winch, it was intended that the duty paramedic would discard the stabilising rope and the ACM would then winch them up into the helicopter.

The specific construction of the stabilising rope system, including the manner in which it would be secured to the rock ledge, was not discussed by the crew during the planning stage. The support paramedic and ACM recalled that the duty paramedic advised that he intended to establish the stabilising rope system using a different rope to the tag line. Specifically, the support paramedic recalled intending to use a red safety line that was part of the roping equipment carried by SCAT personnel. In contrast, the pilot reported that he understood the duty paramedic intended to use the yellow tag line as a stabilising system.

Figure 4: Stabilising rope system (coloured red in this graphic, which is sequenced left to right)



Source: ATSB

The support paramedic reported that the duty paramedic described the use of the stabilising rope with reference to a similar technique used during a previous helicopter rescue that was well known to the SCAT paramedics. The support paramedic stated that he initially expressed concern with the use of that technique, specifically the potential difficulty of arresting the pendulous tendency associated with the laterally offset position of the helicopter. The support paramedic reported that, following additional explanation of the intended plan by the duty paramedic, he was satisfied that the risk associated with this hazard had been adequately mitigated.

During the planning stage, the ACM advised the crew that he was unfamiliar with the intended stabilising technique and enquired how the stabilising rope would be detached once the patient and paramedic were directly under the winch. The ACM reported that the duty paramedic advised that once he and the patient were in that position, he would disconnect from and discard the stabilising rope prior to the ACM winching them up and into the helicopter (Figure 4).

The ACM later reported that he had been assured by the other crew members that the rescue plan was not exceptional in emergency medical service (EMS) operations. This was consistent with the doctor's recollection that, in response to

the ACM's query of the intended winching technique, the pilot and paramedics advised the ACM that it was a technique that had been used before.

A number of other potential hazards were identified by the crew during the planning stage, including the amount of daylight remaining, the available fuel and power margin⁸ of the helicopter and the relative operational inexperience of the ACM (see the section titled *Personnel information*). In respect of the remaining daylight, the paramedics carried sufficient equipment to enable them to remain overnight at the waterfall in the event that the mission was unable to be completed due to fading daylight. The pilot was concerned that there may not be sufficient daylight left for him to establish the helicopter in the winching position by visual reference, rather than about conducting the winch retrieval at night once in the hover.

In order to improve the helicopter's hover performance, the doctor and all unnecessary equipment were offloaded at the staging area. The pilot advised that he had flown with the ACM during the crewman's recent transition to the AW139 and, although they had not conducted an operational winch together, he considered the ACM was competent to conduct the planned mission. At the conclusion of the planning and preparation of the necessary equipment, the entire crew agreed with the plan for accessing and retrieving the patient.

While on the ground in the staging area, the crew contacted the RCC and provided an update based on what they had observed during the initial survey of the waterfall. Due to the complexity of the proposed mission, the support paramedic contacted the SCAT coordinator and requested additional, ground-based SCAT resources to supplement the helicopter crew. The coordinator advised him that he would investigate the allocation of additional resources but that, given the role of SCAT paramedics was patient access rather than rescue (see the section titled *Ambulance Service of New South Wales*), consideration should be given to handing responsibility for the rescue to the local rescue agency if the injured canyoner was unable to be winched off the rock ledge.

Preparation for the recovery

After about 40 minutes on the ground planning and preparing equipment for the winch, the helicopter became airborne at 1838 to insert the two paramedics at the top of the waterfall. The support paramedic was winched into the location, followed by the duty paramedic with his pack containing roping, medical and overnight equipment. The helicopter returned to the staging area and was shut down at 1858.

The uninjured canyoner was not at the top of the waterfall when the paramedics arrived as, being unsure whether the helicopter would be able to access the location, he had abseiled down to the rock ledge to assist his injured companion at about 1815. The uninjured canyoner remained with his companion on the ledge for about an hour before deciding to use the remaining daylight to abseil to the bottom of the waterfall and walk out to seek assistance.

The doctor telephoned the duty paramedic at about 1920 to see if he and the patient were ready to be winched from the ledge. The duty paramedic advised that he was still preparing to abseil down to the patient and that he would need an additional 20 minutes. About 25 minutes later the crew tried unsuccessfully to contact the

⁸ The difference between the power available from the helicopter's engines and the power required to hover.

paramedics, so the pilot elected to fly overhead to attempt radio contact and ascertain if they were ready to be extracted. The pilot started the helicopter at 1951 and, shortly after, received a call on the helicopter's telephone from another SCAT paramedic. This paramedic advised that he had been assigned as a ground response and that he was en route to Bridal Veil Falls in the company of an ambulance supervisor.

Following that phone call, the pilot flew the helicopter overhead the waterfall and contacted the duty paramedic at 1957 via radio. The paramedic reported that he had just accessed the patient and that he would require another 15 to 20 minutes to prepare him to be winched out. In response, the pilot advised that he would fly to Wollongong Airport, refuel the helicopter and return to conduct the winch. The helicopter landed at Wollongong Airport at 2005 and was not refuelled⁹ before departing again at 2013.

The injured canyoner recalled that when the duty paramedic arrived on the ledge, the paramedic assessed his injuries, provided him with pain medication and advised him that the fading daylight meant they had limited time to prepare to be winched from the rock ledge. The paramedic then assisted the canyoner to move into the winching position before placing him in a rescue strop (Figure 5) and fitting protective equipment, including a pair of goggles that obscured his peripheral vision. The canyoner did not recall the paramedic describing how the winch was to be conducted and, due to his restricted vision, was unable to observe the paramedic's preparation.

Figure 5: Rescue strop



Source: ATSB

During the return flight to the waterfall, the flight crew received a satellite telephone call from the support paramedic requesting an update on the mission as he had been unable to communicate with the duty paramedic from the time that he had commenced abseiling down to the patient. In addition, from his position at the top of the waterfall, the support paramedic was unable to see the rock ledge below. The pilot provided an update to the support paramedic and advised that they were returning to conduct the winch.

Approaching the waterfall, the flight crew prepared the aircraft for winching and, in recognition that last light was approaching, the pilot activated and positioned the helicopter's SX-16 Nightsun searchlight (Nightsun) and a secondary searchlight for possible use during the hover and winch (see the section titled *Aircraft*

⁹ The refuelling of a helicopter with its engine or engines running. That activity is permitted in accordance with Civil Aviation Order (CAO) 20.10.

specifications). The pilot reported that when he turned on the searchlights it was not yet dark enough to see their beams and, as there was no cockpit indication of the position of the lights, he positioned the secondary searchlight to illuminate what he assessed was the right side of the helicopter (the pilot, winch and winching position were located on the right of the aircraft). The pilot reported that the secondary searchlight's position remained unaltered after initial positioning, as selecting the switches to reposition it would have resulted in the Nightsun extinguishing. The ACM reported attaching a chemical light stick to the winch hook for ease of identification and requested that the pilot activate the winch-mounted lights to illuminate the area below the helicopter winch.

The multi-purpose flight recorder (MPFR)¹⁰ showed that at 2020, the flight crew received a radio call from the duty paramedic advising that he and the patient were '...ready for an accompanied stre [sic].., ah, accompanied hypo strop lift with equipment...'. The pilot asked the ACM to respond to the paramedic, but the recorded audio showed that the intended outgoing message was only transmitted over the helicopter's internal communication system (ICS) (see the section titled *Radio communication system*).

The pilot then responded to the duty paramedic and advised that the helicopter had been refuelled and that they were about 1 minute from the waterfall. The paramedic reiterated that he was ready for an accompanied hypo strop lift and that '...the tag line will be set by me...' (see the section titled *Role equipment*). He also advised that he had been unable to securely stow the canyons' rope and that, as such, it may present a hazard to the tag line during the retrieval.

The attempted recovery

About 2 minutes, later the pilot commenced an approach to overhead the support paramedic's position in order for this paramedic to connect the tag line to the helicopter's winch hook. During the helicopter's approach, the support paramedic activated a strobe to assist the identification of his position. Approaching overhead the top of the waterfall, the pilot called 'losing sight'¹¹ at 2022 and the ACM commenced providing verbal guidance to allow the pilot to manoeuvre the helicopter towards the support paramedic's position. Once the pilot established the hover, the ACM lowered the winch hook to the support paramedic who attached his end of the tag line to the hook and then let go of the hook.

The support paramedic advised that, when he connected the tag line to the winch hook, he bypassed the installed weak link (see the section titled *Role equipment* and Figure 21) by connecting the hook directly to the tag line, rather than physically removing the weak link. He stated that the weak link was bypassed after considering the potential forces associated with the duty paramedic retrieving the winch hook or in the event that the tag line was used as a stabilising system. Although it was required by the operator's procedures, the support paramedic

¹⁰ The multi-purpose flight recorder, commonly known as a 'black box' flight recorder, recorded certain flight parameters and ambient noises within the cockpit, including radio transmissions and conversation between the crew.

¹¹ This statement indicated that the pilot had lost sight of the winching area is a signal to the ACM to commence providing verbal guidance to assist the pilot to position the helicopter overhead the winching area. Given the relative position of the pilot to the helicopter winch, this will always occur approaching overhead the winching area.

reported that he did not advise the flight crew of the intention to bypass the weak link during the satellite telephone call or while attaching the tag line to the hook. The latter was due to radio communication difficulties.

Following the connection of the tag line to the winch hook by the support paramedic, the ACM provided additional verbal guidance to assist the pilot to slowly manoeuvre the helicopter adjacent to the waterfall in preparation to deliver the winch hook to the duty paramedic. As the helicopter was descended towards the winching area, the effect of the fading daylight was exacerbated and the ACM used a handheld searchlight to confirm that the rear of the helicopter was clear of the surrounding obstacles.

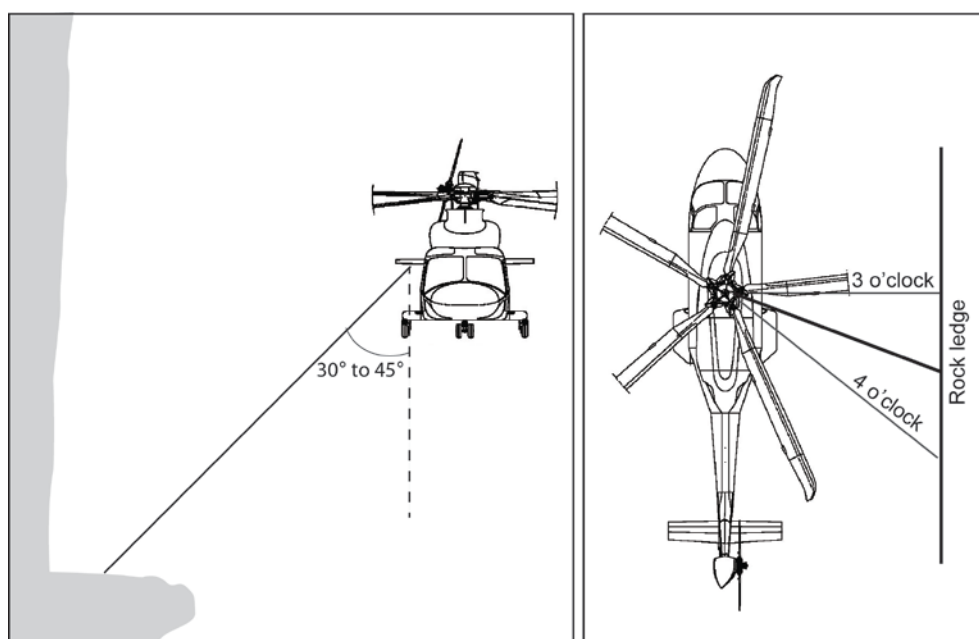
At one stage during the positioning, the pilot advised the ACM that he was experiencing difficulty with the available hover reference¹² due to the sheer cliff and the effects of the waterfall. In response, and after approval from the pilot, the ACM guided the pilot to descend and establish a hover position that was further down the waterfall and closer to trees that were in the pilot's field of view.

From his position at the top of the waterfall, the support paramedic assessed that the helicopter terminated to a hover such that the winch cable was running to the rock ledge at about the 4 o'clock position with reference to the front of the helicopter when viewed from above (Figure 6). He further assessed that the helicopter was about 1.5 to 2 main rotor diameters (21 to 28 m) horizontally from his position and about two thirds of the way down the waterfall.

The ACM recalled that, once the helicopter was established in a hover, the winch cable was running to the ledge at between the 3 and 4 o'clock position and at an angle away from vertical of between 30 and 45 degrees (Figure 6). Although the ACM could not recall the amount of winch cable deployed as displayed on the winch control pendant, based on the relative position between the helicopter and the rock ledge, he estimated that about 150 ft (46 m) of cable was deployed once the helicopter was established in the hover. The injured canyoner recalled that, from his vantage point on the rock ledge, the cable ran up to the helicopter at about 45 degrees.

¹² The fixed references (e.g. trees) that the pilot uses to visually assess whether the helicopter is drifting from the intended hover position.

Figure 6: Position of the helicopter relative to the ledge¹³



Source: ATSB

As the helicopter was manoeuvred into the intended winching position, the ACM limited the amount of cable lowered to prevent the duty paramedic from accessing and connecting to the winch hook until the helicopter was established in a hover. Once established, the ACM lowered the winch cable and the paramedic retrieved the winch hook and connected the patient, the equipment pack and himself to the hook. The ACM then advised the pilot that he was winching in the excess cable, but that it was difficult to identify the amount of slack in the cable.

The ACM recalled that the winch cable did not stand out well against the background, although he could see the angle at which it left the helicopter and that it approached the ledge. The ACM also reported that, with the aid of his handheld searchlight, he could clearly identify the duty paramedic's high-visibility jacket. He advised the pilot that the paramedic appeared to be sorting out ropes on the ledge but it was difficult to specifically identify what he was doing. The ACM reported that the winch-mounted lights illuminated the area directly below the helicopter, but did not provide enough lateral light to illuminate the duty paramedic's position.

A comment from the ACM was recorded on the MPFR that showed he was trying to ascertain what the duty paramedic was doing on the rock ledge. In response, the pilot suggested that the ACM attempt to contact the duty paramedic via VHF radio. The MPFR recorded the ACM attempting to contact the duty paramedic to determine his readiness for the winch, but without success. The recorded data showed that the intended outgoing message was only transmitted over the ICS.

The pilot then attempted to contact the duty paramedic via the VHF radio. Although also unsuccessful in this endeavour, the distinct sound of the pilot's transmission was recorded on the MPFR, indicating that the pilot's radio transmission left the aircraft. As there was no apparent response from the duty paramedic, the pilot

¹³ The images are not intended to indicate the distance between the helicopter and the rock ledge, only the angles between the helicopter and the ledge immediately before the duty paramedic and patient departed from the ledge.

advised the ACM to communicate using hand signals. There was no indication on the MPFR that the winch-mounted lights were extinguished at that point, which would have indicated to the duty paramedic that hand signals were to be used (see the section titled *Helicopter operator*).

At 20:37:55, the pilot asked the ACM what the duty paramedic was doing with the ropes. Two seconds later, the ACM replied that he couldn't see as the paramedic was '...in a dark hole...'. The pilot acknowledged and at 20:38:05, the ACM advised the pilot that he had received a hand signal from the duty paramedic indicating that he and the patient were ready to be winched.

At 20:38:07 the ACM advised the pilot that he intended to winch in the slack in the cable and direct the helicopter closer to the intended winching position prior to actually lifting the patient and paramedic. The MPFR recorded the ACM stating at 20:38:15 that he was 'winching in the slack [in the winch cable]' and, at 20:38:23, the ACM again announcing that he was 'winching in the slack'. The ACM also instructed the pilot to 'Go up 20' at that time. The operations manual stated that, with regard to distance directions to a pilot by an ACM:

Once established in the hover all lateral, height and obstacle clearance information is to be given in 'feet'.

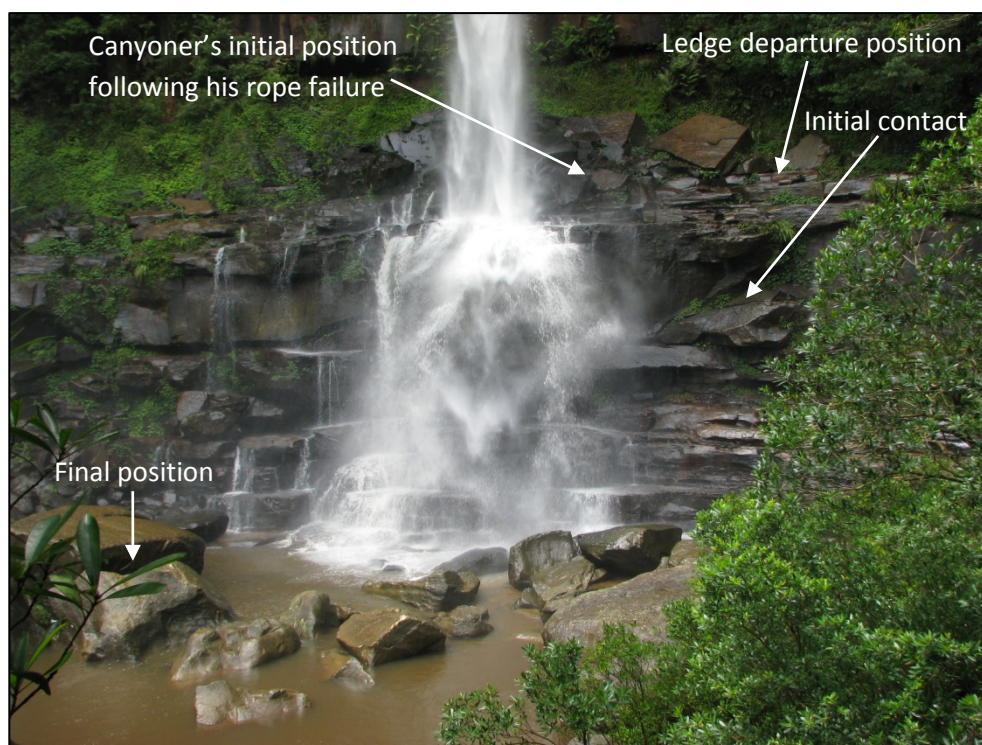
In that context, the instruction to the pilot was intended to climb the helicopter 20 ft, or about 6 m.

The ACM reported that a short time later the duty paramedic and patient appeared to move out from the ledge in a controlled manner however, after about 2 m of horizontal movement the ACM assessed that what he perceived as the red stabilising rope appeared to fail. The patient and paramedic fell several metres onto a lower ledge before swinging towards a position under the helicopter. In response, the ACM winched in the cable at full speed and directed the pilot to move the helicopter left. The ACM recalled that he was concerned that the patient and duty paramedic might swing back and contact the rock ledge. However, during the initial swing from the ledge towards the helicopter, they impacted a second rock at the base of the waterfall that was displaced about 26 m laterally and 15 m vertically down from the rock ledge and came to rest (Figure 7).

The MPFR recorded the ACM advising the pilot that the paramedic and patient were coming off the ledge at 20:38:31. Three seconds later, the ACM announced that he was winching in and that the duty paramedic and patient had fallen from the ledge, and instructed the pilot to 'move [the helicopter] left 5 [ft]'. None of the operator's standard voice commands associated with the commencement of the winch or the actual lift itself (see the section titled *Helicopter operator*) were recorded on the MPFR prior to the fall.

In the time between when the ACM instructed the pilot to climb the helicopter and when he announced that the patient and paramedic were coming off the ledge, the helicopter climbed about 2 m to a height of about 43 m above the base of the waterfall.

Figure 7: Rock ledge



Source: ATSB

The injured canyoner recalled that when the winch hook arrived on the ledge, the duty paramedic connected it to both of them. He was able to see the helicopter hovering and recalled that it climbed out of his vision before, a short time later, he and the paramedic were dragged from the rock ledge and fell in the manner described by the ACM.

The ACM recalled that after the fall the paramedic and patient were obscured by a large rock. The pilot attempted to contact the duty paramedic via VHF radio and, although a number of reply transmissions were received, the quality of these transmissions was low and the flight crew could not understand them.

The ACM guided the pilot to reposition the helicopter in an attempt to visually assess the patient and paramedic and facilitate the use of hand signals. However, the movement of the helicopter was limited by the generation of water spray from the main rotor downwash that obscured the pilot's hover reference. Due to the water spray and concern that winching the duty paramedic and patient from their obscured position may result in further injury, the pilot instructed the ACM to sever the winch cable using the manual cable cutters (Figure 11) so that the helicopter could depart.

After the winch cable was cut, the ACM assisted the pilot to reposition the helicopter clear of the waterfall and they again attempted, unsuccessfully, to contact the duty paramedic via radio. The pilot then landed the helicopter at the staging area and commenced organising assistance for the duty paramedic and patient.

From his position at the top of the waterfall, the support paramedic observed the ACM sever the winch cable and the helicopter move away from the waterfall. He attempted, without success, to contact the flight crew using VHF radio and by mobile telephone.

The pilot contacted the ASNSW Medical Retrieval Unit at 2055 and advised that there had been a fall during the winch operation. The pilot was subsequently connected to ASNSW Southern Operations to provide detail of the accident. He reiterated that there had been a fall while helicopter winching, but that the degree of injury was unknown as he had been unable to communicate with the duty paramedic. The pilot also advised that they had manually severed the winch cable while the patient and paramedic were on the ground and that he believed that a ground emergency response would be required. This was on the basis that the pilot felt that accessing the area at night to conduct a helicopter winch retrieval would be unacceptably hazardous. An emergency response, consisting of ambulance, police and state emergency service rescue personnel, was subsequently initiated with personnel sent to the staging area via road and a second, Wollongong-based, AW139 rescue helicopter operating as 'Rescue 23'.

The injured canyoner recalled that, following the fall, both he and the duty paramedic came to rest on a rock, partially immersed in water and tangled in a yellow rope that was 5–6 mm in diameter. He recalled that the paramedic had a bag strapped to his leg and believed that the rope may have originated from that bag. With the assistance of the paramedic, he managed to remove the lifting strop and then proceeded to untangle the yellow rope and remove the equipment pack from the winch hook. The canyoner could not recall whether the rope ran in any direction. However, the ground rescue party SCAT personnel reported retrieving the tag line from the vicinity of where the patient and duty paramedic came to rest.

The injured canyoner reported that he assisted the duty paramedic to remove his harness and equipment and repositioned himself out of the water before noticing a light. The canyoner believed that this indicated someone was descending down the waterfall and advised the paramedic that assistance had arrived. He then exited the water as he was shivering uncontrollably. A short time later the support paramedic arrived, and the canyoner advised him that the other paramedic was injured. The support paramedic then went over to assist the duty paramedic who, a short time later, succumbed to his injuries. The support paramedic then rendered assistance to the injured canyoner.

Due to uncertainty about the most effective way to retrieve the duty paramedic and injured canyoner, it was decided to send ground rescue parties to the top and bottom of the waterfall. Following this planning and the preparation of personnel and equipment, the ground parties commenced walking in to the waterfall shortly after midnight.

At about the same time, 'Rescue 23' departed the staging area to illuminate the general area and attempt to communicate with the paramedics at the accident site. The crew of 'Rescue 23' were able to establish radio contact with the support paramedic who advised that the duty paramedic had received fatal injuries. The support paramedic recalled that the crew of 'Rescue 23' advised him that it was too hazardous for them to conduct a night winch. 'Rescue 23' then departed the area for its Wollongong base followed shortly after by 'Rescue 24'.

Personnel from both ground parties subsequently arrived at the base of the waterfall and provided assistance to the injured canyoner and the support paramedic. They determined that the canyoner, although injured, was in a sufficiently stable condition for him to await the daylight arrival of a rescue helicopter, rather than their conducting a manpower-intensive ground recovery at night over difficult terrain.

The injured canyoner was subsequently winched from the base of the waterfall by helicopter and transferred to hospital on the morning of 25 December 2011. The support paramedic and the ground rescue personnel were then winched out using a second helicopter and transferred to the staging area.

The duty paramedic's body was retrieved via helicopter winch.

Personnel information

Pilot

The pilot held an Air Transport (Helicopter) Licence that was issued in 2005. He was endorsed on the AW139 and held a Command (Multi-engine Helicopter) Instrument Rating. The pilot also held a Class 1 Aviation Medical Certificate without restriction.

The pilot's logbook indicated that, prior to the accident flight, he had accrued a total of 4,269 hours helicopter flight time, of which 303 hours were in AW139 helicopters. The pilot's most recent flight review was conducted on 12 November 2011 in the form of a company check flight. A Command Instrument Rating flight test was also undertaken that day, also satisfying the requirements of a biennial flight review.

The pilot had been employed as an EMS pilot with the operator for about 15 months. He also had 12 months of previous EMS experience with another operator.

The operator's operations manual required pilots to conduct two operational winch procedures every 6 months. The pilot met that currency requirement at the time of the accident. His logbook indicated that his most recent day winch procedure was conducted on 6 December 2011, during the ACM's endorsement training. The pilot's most recent recorded night winch procedure had occurred on 5 October 2011.

Air crewman

The ACM had been employed by the helicopter operator for over 4 years in the rescue crewman and air crewman roles. The majority of that time was spent in the search and rescue (SAR) role as part of a two-pilot crew operating the Sikorsky S-76 helicopter. He had about 3 years of experience in the ACM role, having completed his winching operations training course on 26 February 2009.

The ACM advised that he had 827 hours total flight time, of which 502 hours were accrued in the ACM role in the S-76 and 27 hours as ACM experience in the AW139. The ACM reported that he had conducted an average of one basic training winch (see the section titled *Helicopter operator*) per week while employed in the SAR role. He recalled having conducted one operational winch over that same time period.

The ACM commenced AW139 endorsement training on 5 December 2011 in preparation for his appointment as an EMS air crewman at the Bankstown base. The ACM reported that the endorsement included 1 week of ground school that covered the various aircraft systems, including the flight management, radio communication

and lighting systems. The ACM's training record indicated that the endorsement also included 3 flights that encompassed confined area and land winching operations. This included stretcher winching by day and night and familiarisation on the use of the helicopter's flight management system, and with assisting the pilot as required.

The ACM's appointment to the EMS role at the Bankstown base was his first experience of single-pilot operation as an air crewman. In support of this role, the operator required its ACMs to undergo a course of training to enable them to assist pilots with operational aspects such as the management of checklist procedures and the use of the Nightsun. The operator advised that the ACM completed that training as part of his AW139 endorsement and, as such, it was not recorded separately. The ACM reported that his previous use of radios was limited, as radio communication on the S-76 helicopter was largely carried out by the pilots.

The operator had different ACM winch currency requirements for the EMS role compared to those affecting SAR operations (see the section titled *Helicopter operator*). A review of the ACM's recency record identified that, at the time of the accident, he was qualified and current to perform night land winching.

Duty paramedic

The duty paramedic completed his initial SCAT training on 27 October 2006 and his most recent recertification in 2011¹⁴. The paramedic's initial ambulance rescue crewman (ARC) training on the AW139 was completed with the operator on 5 November 2008. His most recent ARC flight review was conducted in the AW139 on 3 July 2011 and consisted of rescue strop and stretcher winching by day. The paramedic's flight training record indicated that his last night winching review was on 30 November 2009 as part of an initial ARC qualification on the Eurocopter EC145 helicopter.

The operator had a requirement, detailed in the operations manual, for rescue crewman currency in a number of winch-related activities, such as the requirement to complete a land winch by day and night every 90 days. A note in the operations manual allowed for variation in the operator's night currency requirements in accordance with individual contracts. There was no night winching recency requirement in the ASNSW contract with the operator¹⁵ (see the section titled *Organisational and management information – Helicopter operator*).

A review of the paramedic's operational winching experience indicated that he had last conducted a night winch on 4 June 2011 and that, since February 2010, he had conducted 14 missions that involved winching operations. Of these, two involved night winching and possibly three others occurred around last light.

Support paramedic

The support paramedic completed his initial SCAT training in 1994 and his most recent recertification in 2011. The paramedic's initial ARC training on the AW139 was carried out with the operator on 28 October 2008. His most recent

¹⁴ SCAT recertification was required every 3 years.

¹⁵ ASNSW contract for the supply of *Rotary Wing Transport Services in the Greater Sydney Area for the Ambulance Service of NSW*.

ARC flight review was conducted in the AW139 on 16 December 2011. The paramedic's flight training record indicated that his last night winching review was carried out on 12 December 2009 as part of an initial ARC qualification on the Eurocopter EC145 helicopter.

A review of the support paramedic's operational winching showed that he had last conducted a night winch on 13 July 2011 and that, since October 2009, he had conducted 18 missions that involved winching operations. Of these, two involved night winching and possibly one other occurred around last light.

Aircraft information

Aircraft specifications

The AW139 is a medium-sized, single main and tail rotor helicopter that is powered by two turbine engines and equipped with retractable landing gear. VH-SYZ was equipped with an electrically-powered rescue winch that was fitted on the right of the helicopter, adjacent to the rear cabin (Figures 8, 12 and 13).

Figure 8: VH-SYZ



Source: New South Wales Police Force

The winch and 85 m long usable cable had a maximum allowable lifting weight of 272 kg and a cable winching and lowering speed that varied between 45 metres per minute (m/min) and 74.4 m/min depending on the weight on the cable. The Australian Transport Safety Bureau (ATSB) determined that the weight on the cable at the time of the accident was below the maximum allowable.

The winch manufacturer advised that the ultimate load that could be applied to the winch cable was about 1,429 kg. In order to limit the load on the cable, the winch incorporated an overload clutch assembly. This assembly was designed to 'slip' and reel out cable if a weight of over about 544 kg was applied to the winch cable.

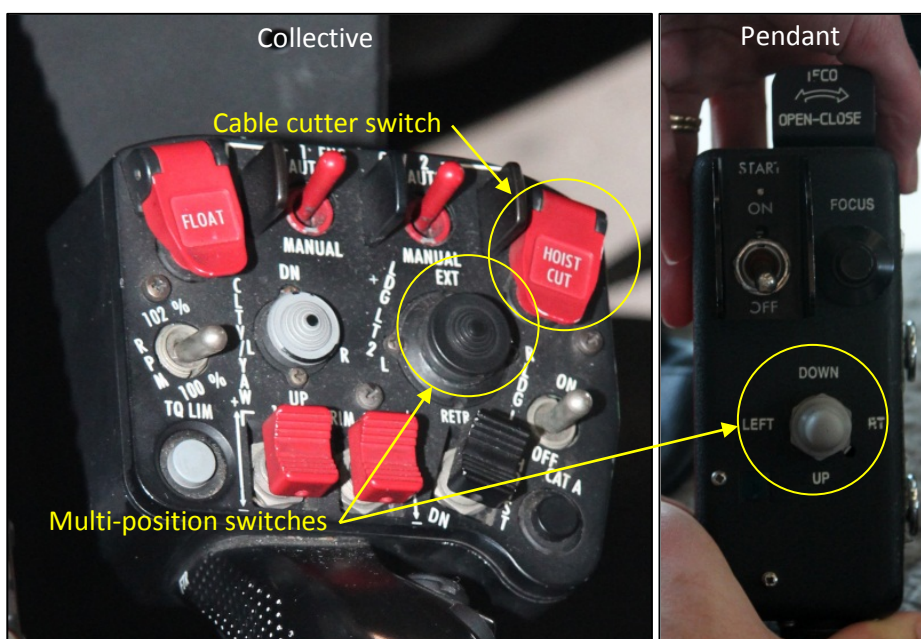
The winch manufacturer advised that the maximum permitted cable angle from the helicopter's vertical axis was 30°. However an angle in excess of 47° was required before the cable contacted a sacrificial guide at the winch inlet to the cable drum. The winch manufacturer stated that the primary concern should the 30° winching angle limit be exceeded was a reduction in cable life due to increased bending stresses due to contact with the cable drum.

As part of its consideration of the rescue winch installation, including the forces on the AW139 airframe during winching, the helicopter manufacturer imposed a

15° cable angle limit. This limit was published in the relevant winch supplement to the AW139 Rotorcraft Flight Manual (RFM).

The winch was equipped with an electrical cable cutter system that was able to be activated by the pilot via a guarded, collective-mounted switch (Figure 9), or by the ACM via a second guarded switch on the winch control panel in the rear cabin (Figure 10). Additionally, manual cable cutters in the rear cabin provided the ACM with a second means to sever the winch cable (Figure 11).

Figure 9: Searchlight controls



Source: ATSB

Figure 10: Winch operator control panel



Source: ATSB

Figure 11: Manual winch cable cutters



Source: ATSB

The helicopter was also equipped with an emergency Quick Splice Plate (QSP) assembly that was designed to restore winching capability in the event that the normal hook was cut away or damaged. The maximum allowable weight using the QSP remained at 272 kg.

Lighting system

The helicopter had a number of fixed and movable external lights, including a movable SX-16 Nightsun searchlight located on the left side of the fuselage and a second movable searchlight underneath the cockpit (Figure 12). The helicopter was also equipped with winch-mounted lighting (Figure 13), and a handheld searchlight for use by the ACM (Figure 14).

Figure 12: AW139 external lighting¹⁶



Source: Helicopter operator

¹⁶ A fixed landing light was mounted in each of the sponsons. The left landing light is obscured in this image by the Nightsun mount.

Figure 13: Winch-mounted lighting (looking out from the rear cabin)



Source: ATSB

Figure 14: Handheld searchlight



Source: ATSB

Movement of the Nightsun was achieved through the use of multi-position switches mounted on the collectives for use by the front seat occupants, or via a multi-position switch located on a pendant control box that could be used by the winch operator in the rear cabin (Figure 9). Movement of the secondary searchlight

could only be achieved via the collective-mounted switches. As there was only one switch on each collective, the controlling pilot was unable to move both searchlights simultaneously. The assignment of either searchlight to the multi-position switch on the collective was achieved using a controller mounted on a panel between the two front seats. The requirement to use a separate lighting switch to move between lights, rather than controlling both from the collective, was not unique to the AW139 and the ATSB is aware of other helicopter types with similar lighting control configurations.

Due to the Nightsun/secondary searchlight switch arrangement, it was possible to inadvertently extinguish the Nightsun when assigning control of the secondary searchlight to the multi-position switch on the collectives.

In order to prevent the accidental extinguishing of the Nightsun, the master switches on the pendant and panel-mounted controllers were required to be in the same position prior to selecting control of the secondary searchlight. This requirement was included as a note in the Nightsun searchlight supplement to the AW139 RFM. An operator flying staff instruction also explained the correct use of the Nightsun master switches.

The pilot stated that on the night, he was aware that the controller switches were not aligned and as a result there was a risk of the Nightsun being inadvertently extinguished. He further advised that he did not want to risk moving his (left) hand from the collective to activate the pedestal-mounted controller while hovering in close proximity to obstacles associated with the waterfall.

The operator advised that the Nightsun and secondary searchlight provided redundant sources of illumination for pilots to ensure adequate hover reference during night winching. They were not intended to illuminate the winching area.

Radio communication system

The helicopter was equipped with four radios (designated COM 1 to 4) and an onboard telephone. COM 1 and COM 2 were very high frequency (VHF) radios used by the pilot for communication with air traffic. COM 3 was a marine band VHF radio and was the primary means of radio communication between the flight crew and the paramedics on the ground. COM 4 was an ultra high frequency (UHF) radio that was available as an alternative means of radio communication between the flight crew and personnel on the ground.

The duty paramedic had portable radios that enabled him to communicate via COM 3 (marine band VHF) and COM 4 (UHF), and an ASNSW-issued mobile telephone. The support paramedic had a radio that enabled him to communicate via COM 3, a satellite telephone and a mobile telephone. The support paramedic reported that the satellite telephone ceased functioning during the mission due to its being accidentally immersed in water.

The paramedics were also able to connect a portable radio to their flight helmet; however, during operations on the ground, they used a different helmet that had no provision to connect to this radio. The resulting need to hold the radio near the operator's exposed ear meant that any ambient noise, including from the helicopter, would hamper communication between the paramedics and helicopter.

The air crewman (ACM) could talk on the helicopter's internal communication system (ICS) or transmit externally via the installed radios. ICS and radio

communications were controlled by the ACM via the winch operator's control panel (Figure 10) and an ICS control panel (Figure 15).

Figure 15: Winch operator ICS control panel



Source: ATSB

With the switch located on the winch operator control panel set to ICS, the ACM was able to use either a voice activated (VOX) microphone or a switch on the winch control pendant to communicate via the ICS. With the winch operator control panel set to RADIO, the ACM could use the switch on the winch control pendant to communicate externally via the radio that was selected on the ICS control panel.

Maintenance history

A review of the helicopter's maintenance documentation identified that, at the time of the accident, all of the required maintenance on the helicopter and its rescue winch had been completed. In addition, all of the necessary servicing on the winch after the accident, and in support of the 995 winch cycles carried out between the time of the accident and 26 March 2013 were carried out with no faults found.

During the course of the investigation, an Emergency Airworthiness Directive (AD) was issued by the European Aviation Safety Agency (EASA) in response to the failure of a winch overload clutch assembly during a 'maximum load cycle' that was being carried out as part of a maintenance test flight. An unintended winch cable run out resulted.

The winch that sustained a clutch failure and contributed to the development of the EASA Emergency AD was of the same type as that fitted to VH-SYZ.¹⁷

EASA determined that, if not detected and corrected, this condition could lead to further cases of in-flight loss of the hoist load, possibly resulting in injury to persons on the ground or that were being winched at the time. A one-time load check test was stipulated, with varying compliance times depending on the nature of the intended winch and the date of the respective versions of the AD.

On 26 March 2013, the operator complied with the winch load check test requirements of the EASA AD on the winch that was installed in VH-SYZ on the day of the accident. No fault was found with the winch overload clutch assembly.

¹⁷ See <http://ad.easa.europa.eu/ad/2013-0077R1>

The ACM recalled that the winch on VH-SYZ had operated normally throughout the operations on 24 December 2011. He advised being aware of the winch characteristics should the overload clutch activate, and did not believe that the clutch activated during the attempted winch retrieval of the duty paramedic and injured canyoner.

Meteorological information

The Bureau of Meteorology conducted an analysis of the likely weather conditions in the vicinity of the Bridal Veil Falls at the time of the accident. That analysis concluded:

Upon examining all the meteorological observation and analyses, it is considered that the weather conditions at the location at the time of the incident were of light winds, with no precipitation, significant low cloud or other visibility reducing phenomena present. The temperature was between 20.5 and 22.5 degrees Celsius and the QNH [atmospheric pressure] was between 1012 and 1013 hPa. From the upper wind and temperature observations it is also evident that there was no significant turbulence or icing present.

The ACM reported that there was localised low cloud in the vicinity of the waterfall when the crew were on the ground at the staging area planning the recovery of the injured canyoner. He recalled that it was still present when they returned to the waterfall after refuelling; however, as the evening progressed the cloud dissipated to a fine evening. The ACM's observations were consistent with those of a local National Parks and Wildlife Service (NPWS) field officer who assisted with the ground recovery.

Last light on the day of the accident was at 2040.¹⁸ With regard to the determination of last light, paragraph 1.2 of GEN 2.7 *SUNRISE/SUNSET TABLES* of the Aeronautical Information Publication stated:

...parameters used in compiling the Daylight and Darkness Graphs do not include the nature of the terrain surrounding a location, or the presence of other than a cloudless sky and unlimited visibility at that location. Consequently, the presence of cloud cover, poor visibility or high terrain to the west of an aerodrome will cause daylight to end at a time earlier than that extracted from the appropriate graph.

Site and equipment examination

On-site examination

The access sequence to the waterfall area in support of the ATSB's investigation is detailed in Table 1. The ATSB is aware of a number of other visits by various parties to the top of the waterfall that were undertaken for purposes other than assisting its investigation. However, the ATSB is satisfied that none of these parties interfered with or touched the equipment used by the canyoners or the duty paramedic.

¹⁸ Last light was computed using the National Aeronautical Information Processing System.

The ATSB did not examine the accident site immediately following the accident as, based on the description of the area, it was assessed that accessing the rock ledge would be unacceptably hazardous. Following additional advice from NSW Police Force officers and ASNSW personnel regarding site access, ATSB investigators examined the lower part of the waterfall, including the rock ledge on 20 February 2012. This examination was carried out in company with police and ambulance officers.

Table 1: Sequence of accident site access

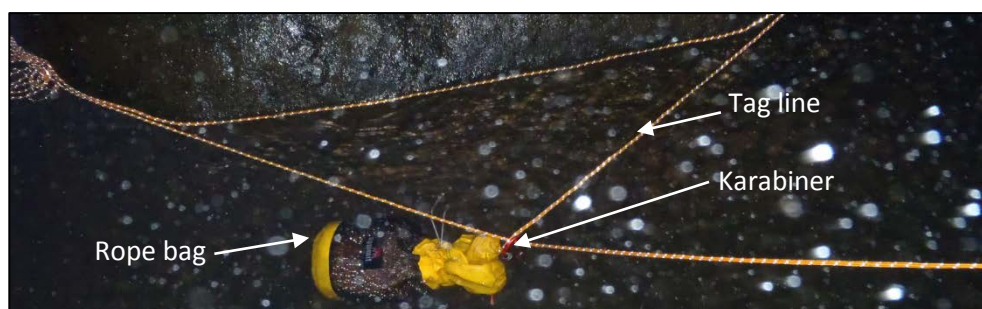
Date	Attending personnel	Comment
25 December 2011	NSW Police Force officers ASNSW officers	Initial accident site assessment and retrieval of the tag line and other equipment used by the duty paramedic. The rock ledge was not accessed during this visit.
31 December 2011	NSW NPWS officers	In preparation to guide police and ambulance personnel into the accident site, two NPWS officers accessed the top and bottom of the waterfall area, including the rock ledge. This allowed the NPWS officers to familiarise themselves with the access routes to the waterfall.
4 January 2012	NSW Police Force officers ASNSW officers NSW NPWS officers	Second site assessment and retrieval of equipment from the top and bottom of the waterfall, including the rock ledge.
20 February 2012	NSW Police Force officers ASNSW officers ATSB investigators	Site assessment of the lower waterfall area, including the rock ledge.

Access on 25 December 2011

The rescue personnel who accessed the site on 25 December 2011 observed the tag line and its associated bag in the vicinity of where the duty paramedic and patient came to rest after the fall (Figure 16). They recalled there being a loop knot and a free-running karabiner¹⁹ on the tag line, and that the weak link (see the section titled *Role equipment*) remained connected and intact.

¹⁹ A metal clip with a spring for quickly and reversibly connecting components.

Figure 16: Tag line



Source: Ambulance Service of New South Wales

Access on 31 December 2011

The two NPWS field officers who accessed the rock ledge on 31 December 2011 stated that they observed an abseiling rope, subsequently identified to be the one used by the duty paramedic, running up to the top of the waterfall with the lower end tied to a rock immediately adjacent to the waterfall (Figure 17). Advice from other SCAT paramedics indicated that the rope was probably tied to the rock to prevent it being a hazard to the helicopter during the retrieval.

The NPWS officers also observed a red rope, coiled up on a green rope bag that contained the remainder of the duty paramedic's abseiling rope. They advised that, although they observed and photographed a number of ropes on the ledge, they did not touch any of the equipment that had been used by the canyonsers or the duty paramedic.

One of the field officers advised that while at the site, he coiled up a yellow climbing rope that had been used by a member of the ground rescue party who abseiled from the top of the waterfall after the accident.

Access on 4 January 2012

Police and ambulance personnel who attended the site on 4 January 2012 observed the same arrangement of ropes as described by the NPWS personnel. They reported finding no evidence that a stabilising rope system had been established on the rock ledge. They also observed that, due to the presence of the waterfall, the wet rock ledge surface was extremely slippery and that the environment was noisy.

Access on 20 February 2012

The same characteristics as described by police and ambulance personnel on 4 January 2012 were observed by ATSB investigators who attended the site on 20 February 2012. During its visit to the site, the ATSB observed that, from the rock ledge, the terrain may have permitted a helicopter to attain a near-vertical position overhead. That view was supported by SCAT paramedics who accessed the ledge. Of note, these observations were made in daylight.

A senior SCAT paramedic who walked in to the bottom of the waterfall assessed that, due to the difficult terrain, ground recovery of the injured canyonsers would have required about 50 personnel and about 12 hours to perform.

Figure 17: Duty paramedic's ropes



Source: New South Wales National Parks and Wildlife Service

Helicopter and role equipment examination

The helicopter was examined by the ATSB at the operator's Wollongong base on 26 December 2011. The condition of the end of the exposed winch cable was consistent with its being severed with manual cutters (Figure 18).

The severed winch cable and hook were visually examined and, having identified that the winch hook was not defective or damaged, the ATSB returned it to the helicopter operator (Figure 19). The winch cable was retained for further examination.

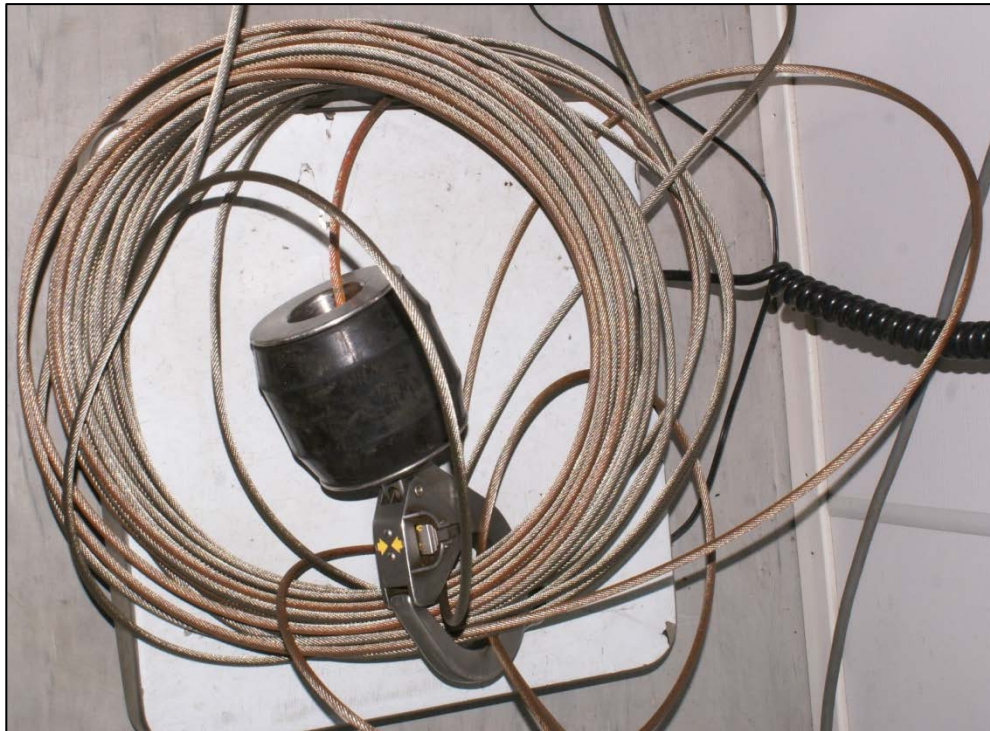
The helicopter's multi-purpose flight recorder (MPFR) was also retained for further examination.

Figure 18: Severed end of winch cable



Source: ATSB

Figure 19: Severed winch cable and hook



Source: ATSB

The duty paramedic's equipment that was retrieved from the accident site by the rescue party was also examined by the ATSB. The tag line that had been used to deliver the winch hook, together with a number of other roping-related components used by the duty paramedic, was also retained for further examination.

Examination of recovered components

All of the retained helicopter and roping-related components were examined at the ATSB's technical facility in Canberra. The results of those examinations are outlined in the following paragraphs.

Multi-purpose flight recorder

The recorded audio and flight data from the accident flight were successfully downloaded from the helicopter's MPFR. Elements of those recordings were particularly important in understanding the conduct of the flight and the interaction between the flight crew and paramedical officers.

Relevant extracts of the audio recordings and recorded flight data are referenced throughout this report.

Rescue winch cable

The surfaces of both ends of the severed winch cable were compared to the surface from a sample of cable that was severed by the ATSB using the helicopter's manual cable cutters. Magnified visual comparison of the cut surfaces confirmed that the winch cable was severed on the day of the accident using manual cutters.

The section of severed cable that had been attached to the winch hook was 25.1 m long. That length of cable was probably not representative of the amount of cable deployed at the time of the fall as the MPFR recorded the ACM verbalising that he was winching the cable in and then out after the fall, but prior to cutting the cable.

A number of kinks were observed in a section of the severed cable that was attached to the winch hook. The circumstances surrounding the kinking of the cable could not be identified.

Tag line

Examination of the tag line (see the section titled *Role equipment*) identified that it was cut into two lengths of 49 m and 64 m respectively. The support paramedic advised that he cut the tag line while removing equipment that had entangled the duty paramedic.

Magnified visual inspection of the tag line identified evidence of abrasion consistent with previous use; however, with the exception of the reported deliberate cut of the line by the support paramedic, there was no evidence that the tag line had failed. The weak link in the tag line was intact and attached to one end of the longer of the cut lengths.

Two knots were also identified in the longest section of the tag line. The first knot, located about 30 m from the weak link, was a figure eight knot. A second, loop knot was identified about 62 m from the weak link.

Spring-loaded camming devices

Six spring-loaded camming devices (see the section titled *Role equipment*) that were carried by the duty paramedic were examined for defects and/or damage. Although all of the devices showed signs of normal wear, there was no evidence of their being forcibly removed from a rock fissure, or that any of the devices had failed.

Medical and pathological information

The examining pathologist identified that the fatal injuries sustained by the duty paramedic were the consequence of blunt trauma injury. In addition to the autopsy report, the ATSB sought the expertise of a trauma surgeon to provide an assessment of a number of survivability-related aspects relating to the death of the duty paramedic. The surgeon's assessment was based on the review by the surgeon of the autopsy report and a number of associated x-ray and photographic images. Additional details of the accident were provided to the surgeon by the ATSB.

The surgeon concluded that the cause of death was hypovolaemic shock (blood loss) secondary to internal bleeding due to fractures of the pelvis and that the injuries were consistent with a fall from height. Based on these injuries, the surgeon concluded that:

...the only prospects of survival for the deceased would have been instituting definitive medical care at a major trauma centre within approximately 60 minutes from the time of injury. It should be noted that even if the patient was able to be evacuated to a major trauma centre within this time-frame, there would still be a moderate to high risk of death from injuries of this severity.

A supplementary assessment of the injuries sustained by the duty paramedic was undertaken by the surgeon using the Injury Severity Score (ISS)²⁰. This assessment identified a high to very high risk of death, even with definitive medical treatment available. The surgeon advised that use of the available medical equipment and expertise at the site may have extended the timeframe before having to commence definitive medical care at a trauma centre by no more than about 4 hours.

In respect of the potential adverse effects of winching the injured paramedic in a harness, the surgeon stated that:

It is well known that internal bleeding as a result of severe and unstable pelvic fractures may be worsened by movement of the fracture site. In this way, it is possible that the deceased's injuries may have been aggravated by winching in a harness. The correct method of extrication of a patient sustaining unstable fractures of the pelvis such as that sustained by the deceased is with the patient lying supine (flat on their back) on a spinal board or within a rigid litter, and with the pelvis supported by a pelvic binder. This is in order to reduce movement of the fracture site that could accelerate any internal bleeding from the injury.

Toxicological analysis detected a 'clinically insignificant' level of alcohol in the paramedic's blood. The examining pathologist concluded this was most likely due to natural post-mortem generation of alcohol rather than the result of consumption.

The injured canyoner's most significant injury was a fractured lumbar vertebra.

Organisational and management information

Helicopter operator

The helicopter operator was contracted to provide emergency medical rotary wing transport services in the greater Sydney area for the ASNSW. Specifically the operator provided the helicopters, pilots, air crewman (ACM) and maintenance personnel as well as training for ASNSW paramedics in their role as ambulance rescue crewmen.

The contract required an AW139 helicopter and a Eurocopter EC145 helicopter to be based at Bankstown, with a second AW139 at Wollongong and a second EC145 at Orange. At the time of the accident the EC145 helicopter at Bankstown

²⁰ The Injury Severity Score (ISS) is an anatomical scoring system that provides an overall score for patients with multiple injuries.

was night vision goggle (NVG)-capable; however, the crew that was on duty to operate that helicopter that night was not qualified to conduct winching operations using NVGs. At the time of the accident, the operator's AW139 helicopters were not permitted to conduct NVG winching operations.

Winching procedure

Hi-line transfer

The operator's operations manual included procedures in support of vertical lift and Hi-line transfer winching techniques. The Hi-line transfer procedures stated that:

A Hi-line procedure is used when conducting either over water or over land rescue winch recoveries when normal winching would be hazardous.

- a. When the winching area is confined or obstructed in such a way that there is a risk of the winch cable snagging or the RCM [rescue crewman] / MA [medical attendant] striking obstructions...
- c. When normal winching techniques would be unable to effect transfer.

The Hi-line transfer technique involved the attachment of one end of a rope (Hi-line) to the rescue winch hook and the delivery of the other end to the winching area using the rescue winch. The technique generally employed a Hi-line attendant at the winching area who used the rope to manoeuvre the winch hook and occupants as the rescue winch was raised or lowered. The operations manual cautioned that excessive cable angle was to be avoided during Hi-line transfers in order to reduce the tendency for a swing to develop. The manual recognised that in certain circumstances, the rescue crewman may be the last to be recovered and that, in that situation, there would be no Hi-line attendant on the ground during the recovery. This increases the risk that a swing may develop during the last transfer.

The crew's plan to recover the injured canyoner relied on a technique that was similar to the Hi-line transfer, especially with regard to the role of the pilot and ACM. However, the operator advised that the use of a self-stabilising rope system anchored to a secure point was not a procedure that was either documented or for which its crews had trained. The ASNSW advised that the use of a self-stabilising rope system, where the helicopter was laterally offset from the pick-up point, had never been undertaken by its staff.

The operator advised that the past conduct of high profile winch rescues, where the helicopter was offset laterally was 'strong in folklore' among the ambulance and flight crews, but that the use of such techniques had been actively discouraged. In contrast, a number of paramedics who had been trained as ambulance rescue crewmen (ARC) by the operator reported that winching from an offset position had not, in their mind, been actively discouraged. As there was no documented evidence provided to confirm either understanding, the difference of opinion could not be reconciled.

Night winching

The operations manual detailed the necessary lighting to be available to the pilot and ACM in support of night winching as follows:

A crew shall not engage in winching operations at night unless the helicopter is equipped with the following items:

- i. Two white lights, controllable by the winch operator, shining downwards and of sufficient intensity to clearly illuminate the winch cable and the area directly below the helicopter...
- ii. Two white lights controlled by the pilot in azimuth and elevation without removing his hands from the flying controls.

The operator's lighting requirements for over land night winching reflected those in Civil Aviation Order (CAO) 29.11 *Air service operations—helicopter winching and rappelling operations*.

Communication

The importance of effective communication during winching operations was highlighted as follows:

Winching operations require a high degree of co-operation and mutual trust between all members involved

...To facilitate co-operation, an accurate and steady communication between all three crewmembers [pilot, ACM and ARC] on the operation must take place. The majority of this communication shall be between the [ACM] and the flying pilot.

Communication with the [ARC] when external to the aircraft is an important element of the overall winching operation. With this in mind, the [ARC] is to have two-way radio communication with the aircraft (where practical) during all winching operations both land and water.

In addition to the use of radio communication, a system of hand signals was available for use between the ACM and the ARC. In particular, the signal that indicated that the ARC was ready to be winched was one arm extended horizontally from the body with the thumb up (Figure 20). The operations manual modified the use of hand signals for night winching operations as follows:

For Night Operations and/or in low light, the activation of the [ARCs] Strobe Light or a verbal confirmation (by radio) will also mean; Ready to be winched up.

...Note: Night Hand Signals: In general Night Hand Signals are the same as those for day operations, however it should be noted that the [ARC] will have little to no vision when looking up at the aircraft.

During Rescue Winch operations the [ARC] should refrain from looking directly into the aircraft winch light; should the [ACM] need to communicate with the [ARC] via hand signals then the winch light is to be extinguished. Upon recognition of this fact the [ARC] is to make eye contact with the winch operator and follow any hand signals accordingly.

These requirements were included in the operations manual in September—October 2009.

ASNSW management and individual ARCs advised that they were not aware of the significance of the ACM extinguishing the winch lights, which indicated the need by the ACM to revert to the use of hand signals. Examination of the helicopter operator’s ambulance rescue crewman training notes, which supported the training provided to ASNSW personnel by the operator, identified that the notes did not contain the additional night hand signal guidance.

The operator advised that, unlike the operations manual, the training notes were not subject to amendment action and were intended to summarise and draw the trainees’ attention to the relevant contents in the operations manual. The operator advised that the training notes were developed prior to September 2009 and had not been revised since.

The MPFR-recorded communication between the pilot and ACM did not indicate that the winch lights were extinguished after the pilot instructed the ACM to use hand signals. This action was suggested by the pilot once radio contact could not be established with the duty paramedic (see the earlier section titled *History of the flight*).

Figure 20: ‘Ready to be winched’ hand signal



Source: Helicopter operator

The operations manual listed a number of specific commands that were to be used during winching (Table 2). Neither the ‘Up gently’ nor ‘Taking the weight’ commands were recorded on the MPFR prior to the fall.

Table 2: Winching commands

Command	Meaning
‘Clear to winch’	Request from the winch operator to commence winching IN/OUT.
‘Winching in the slack’	This call warns the pilot that the winch operator is winching in the slack cable.
‘Up gently’	Instruction to start a gentle climb or to lift the load clear of the ground, water or deck...
‘Taking the weight’	The winch operator is about to lift the survivor with the winch.

Risk assessment

The helicopter operator advised that the procedures in the operations manual were developed following an assessment of the risks involved in winching and the extent to which compliance with the operator's procedures would mitigate those risks. The operator advised that in that context, a specific risk assessment was not required prior to commencing winching operations.

The operator stated that there was an expectation that its crews would consider the potential environmental risks both prior to, and during the conduct of a mission. This included the weather conditions and available ambient light. In addition, the operator advised that, while the pilot in command had overall responsibility for the safety of the aircraft, all members of the crew were expected to participate in the consideration of the potential risks to a mission. The mission was only to proceed if all crew members were satisfied that it was safe to do so.

Checking and training

The operations manual specified winching-related recency requirements for pilots, air crewmen (ACM) and rescue crewmen (RCM) who were engaged in emergency medical service roles and the operator's pilots and ACM complied with those requirements. This included the conduct of one winch by day and night every 90 days.

The paramedics, in their role as ambulance rescue crewman (ARC), were required to comply with the operator's day and night winching recency requirements as specified for RCM. The operations manual allowed night recency to be varied as part of individual contracts. The ASNSW's contract with the operator included a personnel and stretcher winch at 6-monthly intervals. The requirement for a night winch within those minimum standards was not stipulated in the contract.

The lack of a night winching currency requirement in the contract was interpreted by the operator as a variation to the RCM currency requirements in the operations manual and that therefore there was no night winching currency requirement for ASNSW personnel. The ASNSW reported being unaware of the night winching currency requirements in the operations manual.

The operations manual detailed a number of requirements in relation to the winching area that could be used for the conduct of winch training. The areas were defined with reference to CAO 29.11 and differed for the conduct of basic and advanced winch training. Basic winch training was required to be conducted to an area that was largely free of obstacles, whereas advanced winch training could be conducted to more confined areas.

In addition to the requirements relating to the area used for winching, the operations manual contained a recommendation that, during personnel winching (live winching) for training purposes:

Persons carried on the winch shall be kept at a height above the surface where in the event of separation from the cable the likelihood of injury is reduced.
The recommended height above the surface for over land operations shall be no more than 15 ft [4.6 m].

The operations manual also permitted advanced live winch training, in accordance with CAO 29.11, to a maximum height of 50 ft (15.2 m). Prior to the conduct of

winch training at increased height the operations manual required that a comparison of the training benefit was to be made with the potential risk to the involved personnel. The conduct of winch training that did not involve live winching was not subject to height constraints. The ACM advised that the majority of his live winch training was basic winch training. However, his line training and check flights, as well as a number of his currency flights, were reported to have involved advanced winching at increased height.

Ambulance Service of New South Wales

Role of the Special Casualty Access Team

The Special Casualty Access Team (SCAT) was developed by the ASNSW about 30 years ago to enable paramedics to access patients in hazardous or remote locations. The SCAT training manual described the role of SCAT paramedics as follows:

The ultimate role of SCAT is to provide 'Clinical Access' – the '**Access, Triage, Treatment & Evacuation**' of patients in order to provide medical care. SCAT also provides medical oversight of the immediate environment and personnel for the duration of a mission.

...SCAT skills are unique – not recreational, not rescue, not mountaineering, but '*Clinical Access*'.

ASNSW management representatives advised that the improved capability of helicopters and rescue winches had greatly affected SCAT operations. This has resulted in the vast majority of patients in difficult to access areas now being retrieved by helicopter rescue winch, rather than via ground rescue teams.

SCAT personnel have been involved in a number of high profile, visually spectacular rescues that are well-known within the SCAT paramedic community. This includes the previous rescue that was referred to by the duty paramedic when planning to access the injured canyoner. That previous rescue was conducted by a different helicopter operator.

ASNSW management advised that SCAT officers were trained in access procedures and in the equipment used for those procedures. That training was adapted to the mission at hand on an as required basis. This was the case with the high profile mission that was referred to by the duty paramedic when planning to access the injured canyoner, and involved the application and adaptation of existing procedures and training. However, the ASNSW reported that the earlier rescue was extensively risk managed and included the use of a command and control system under the supervision of an accredited rescue agency.

A number of SCAT paramedics advised that several missions over the years had used innovative patient retrieval methods that involved the adaptation of skills learnt during training. In respect of the plan to retrieve the injured canyoner, ASNSW management considered that the use of a self-stabilising system and the method used to deliver the winch hook were both innovative as they were neither documented nor trained for, and had not been previously undertaken. While acknowledging that a level of innovation may be required to complete missions, the use of those techniques was considered by ASNSW management to be beyond the

expected level of innovation. No guidance was given to SCAT personnel regarding the acceptable level of innovation.

SCAT training

To qualify as a SCAT member, paramedics were required to undergo an 8-week training course. The objective of the course was to develop and assess prospective SCAT member's skills in three key areas:

- intensive care paramedic skills
- specialist access skills, including basic and advanced roping
- psychological resilience to ensure that missions are achieved in spite of obstacles.

The training course also included training in operational risk management, leadership and mission planning and preparation. It did not include helicopter operations in general²¹ or the conduct of rescue operations. For those SCAT personnel transitioning to rescue helicopter operations, an additional training course was carried out by the helicopter operator. This course qualified SCAT paramedics as ambulance rescue crewmen.

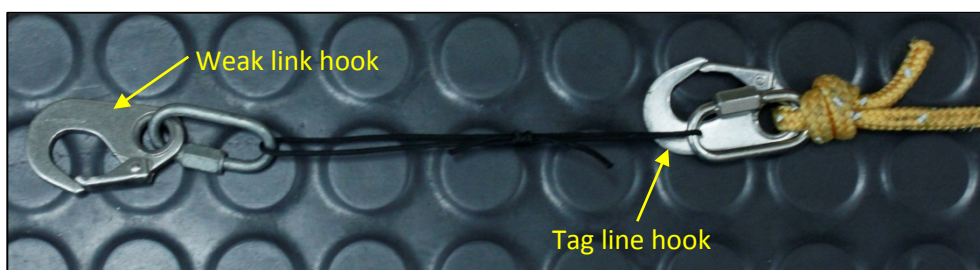
Additional information

Role equipment

Tag line

The tag line that was used to assist the delivery of the winch hook to the ledge was a 6 mm diameter rope that was about 120 m long and contained a hi-visibility reflective tape to aid night visibility (Figures 16 and 21). It also incorporated a weak link with a breaking strength of 140 kg (Figure 21). The tag line itself was capable of supporting 560 kg prior to failure.

Figure 21: Tag line weak link



Source: ATSB

The tag line was normally used during stretcher winching to counter the tendency for the stretcher to spin in the helicopter downwash. In such cases, one end of the

²¹ SCAT training did contain a helicopter familiarisation module; however, it was only intended for those paramedics performing occasional duties on the rescue helicopter.

tag line was connected to the stretcher via the weak link²². The other end of the line was controlled by a tag line attendant (TLA) such that:

Optimum tag line control is achieved through a shallow tag line angle ie, the further the TLA is displaced from the stretcher the better.

The required displacement between the tag line and the stretcher was achieved either by the TLA moving away from the stretcher, or alternatively via the movement of the helicopter, and therefore the stretcher, away from the TLA. In the first instance the angle of the tag line was controlled by the TLA and in the second by the flight crew. The function of the TLA was performed by the SCAT paramedics in their ARC role and included providing advice to the flight crew on how the tag line would be controlled.

The operations manual contained a warning that neither the bag containing the tag line nor the tag line itself was to be secured to the TLA.

Spring-loaded camming devices

Spring-loaded camming devices use rock fissures to establish a series of anchor points. When combined, these points form an anchor system for an abseiling rope (Figures 22 and 23).

Figure 22: Camming devices



Source: ATSB

Figure 23: Rope anchor system



Source: New South Wales National Parks and Wildlife Service

²² The operations manual permitted the use of the tag line without the weak link. In such cases, the helicopter crew was to be advised that the weak link was not connected.

‘Pause point’ risk assessment

The insertion of a ‘pause point’ in normal operations provides a means to ensure that all operational personnel have the opportunity to review the current situation and proposed next actions, and to raise any appropriate concerns or considerations for discussion with the rest of the crew. As a result, crewmembers share an accurate understanding of the situation and proposed actions and can assure themselves that all necessary support actions have taken place.

Pause points have been used successfully in the healthcare industry to enhance the likelihood that checklists for safe surgery were followed. A pause point generally occurs before any major or critical event and ensures that all involved staff have the opportunity to provide input or query any aspect of the operation prior to that major event or critical point (for example, just prior to an incision).

ANALYSIS

Introduction

The ATSB identified that the crew were qualified for the flight and the helicopter and rescue winch were serviceable. In that context, this analysis will examine the operational and organisational factors and risks associated with the development of the accident.

Development of the accident

While on the ground at the staging area, the crew conducted deliberate planning for the mission that was based on their prior assessment of the waterfall area. At the conclusion of this planning, all crewmembers were satisfied that the identified hazards had been adequately managed, and that the planned technique to retrieve the injured canyoner from the rock ledge was understood and acceptable to all involved.

The time required for the duty paramedic to safely abseil down to the patient resulted in the winch retrieval commencing with the approach of last light. The terrain associated with the waterfall and the possible presence of cloud cover meant that the local time of last light probably occurred prior to the calculated time of 2039. Although it was recognised during the crew's planning that the approaching end of daylight might affect the mission, the pilot's primary concern was to position the helicopter at the injured canyoner's location in daylight, not with any requirement for the winch to be completed in daylight.

The radio call from the duty paramedic as the helicopter returned from refuelling identified that he and the patient were ready for an accompanied hypo strop lift. The duty paramedic's remark during this transmission that '...the tag line will be set by me...' was more appropriate to, and generally associated with winching stretchers, rather than the intended recovery via rescue strop in this case. The duty paramedic's remark may have been referring to the previously-agreed plan to control delivery of the winch hook to the supporting and then duty paramedic on the ledge below via the yellow tag line. Equally, it may have been an unintended remark by the duty paramedic that was made out of habit. This would have been consistent with the self-correction of his initial radio transmission that he was '...ready for an accompanied stre [sic – possibly stretcher].., ah, accompanied hypo strop lift with equipment...'. However, as the intended use by the duty paramedic of the tag line was not questioned by the flight crew, it was not possible to determine its meaning.

As the air crewman (ACM) assisted the pilot to position the helicopter in preparation for winching, the waterfall and sheer cliff adversely affected the pilot's hover reference. In response, the ACM guided the pilot to descend and reposition the helicopter such that sufficient hover reference was established in the fading light. However, the resulting offset position of the helicopter meant that additional winch cable had to be fed out to reach the rock ledge than if the helicopter had been able to hover directly overhead. In the event, the combination of the reported 150 ft (46 m) of deployed winch cable immediately before the fall, the reported angle of the winch cable away from the vertical at that time of about 30° to 45°, and the position of the helicopter meant that, if the injured canyoner and paramedic fell

from the rock ledge after connecting to the winch hook, contact with the uneven ground below was unavoidable.

The processes of climbing the helicopter and winching in the winch cable, either singularly or in combination, acted to tension the winch cable. In addition, this manoeuvre was carried out in low light conditions, preventing the ACM from being able to see all of the winch cable clearly. This adversely affected his ability to accurately assess the effect of commanding the upwards movement of the helicopter, while winching in the cable slack. The result was that the injured canyoner and duty paramedic were unintentionally pulled from the ledge. This was consistent with the absence in the recorded data of all but the 'winching in the slack' standard winching command by the ACM, and the injured canyoner's observation that the helicopter climbed out of his view shortly before he and the duty paramedic were pulled from the rock ledge.

Importantly, the flight crew considered that the winching operation was proceeding safely up until the fall occurred. In this context, the use of a 'pause point' risk assessment at an agreed time during the winch, such as prior to hook-up, would have provided an opportunity to identify and manage the risk associated with the ACM being unable to clearly see all of the winch cable.

Rope stabilising system

The Australian Transport Safety Bureau (ATSB) considered a number of reasons why there was no evidence of the planned stabilising system, including the associated anchors, on the rock ledge. The possibility that the site had been tampered with prior to examination was considered; however, given its relatively remote location and difficult access, that was considered unlikely.

The observation by National Parks and Wildlife field officers of the red safety rope coiled up on a bag adjacent to the abseiling rope indicated that it had not been used in the attempted retrieval. In addition, the as-found position of the red rope meant that the duty paramedic would have been unable to reach it from the hook-up position on the ledge. This suggested that the paramedic did not intend to use the red rope once connected to the winch hook. Based on these observations, it is probable that, in the low light conditions, the ACM's perception that the paramedic eased himself and the injured canyoner away from the rock ledge using a red rope was incorrect. His assessment that the first movement of the duty paramedic and injured canyoner appeared to be controlled was probably due to them being inadvertently drawn from their position at winch hook-up to the edge of the rock ledge by the increasing tension on the winch cable. The ACM's perception of a failure or loss of control of the stabilising rope by the duty paramedic corresponded to the fall from the ledge.

Excluding the possibility that the red rope was used, only the yellow tag line was available for use as a stabilising rope. Discussion with a number of Special Casualty Access Team (SCAT) personnel highlighted that the duty paramedic may have used an anchor system that permitted him to retrieve the stabilising rope after being lifted by the winch, leaving no evidence of either the anchor system or rope. However, given that the duty paramedic's plan was to discard the stabilising rope once the paramedic and injured canyoner were directly underneath the helicopter's winch, the establishment of a more complex self-retrieval system was considered unlikely.

It was also considered unlikely that the rope or anchors had failed during the winch, as examination of the duty paramedic's camming devices and the tag line, including its associated weak link, did not identify any evidence of their failure.

The only remaining possibilities were that either the paramedic elected not to establish the stabilising system, or that he was in the process of establishing it when he and the patient were inadvertently pulled from the rock ledge.

In respect of the possibility that the duty paramedic changed his mind and elected not to establish the stabilising system, ATSB investigators and SCAT paramedics who accessed the rock ledge following the accident, assessed that the terrain may have permitted a helicopter to attain a near-vertical position for the winch. If the duty paramedic had formed a similar view from the winch point on the ledge, and concluded that any pendulous tendency at winch pick-up would be minimal, he may have considered that a stabilising line was unnecessary. However, the lack of information about whether the duty paramedic changed the initial plan to use a stabilising system, precluded any further assessment of this possibility.

The injured canyoner's recollection that, contrary to normal practice, the tag line bag was secured to the duty paramedic's leg, the fact that the canyoner and duty paramedic were tangled in the tag line when they came to rest on the rocks below, and the presence of the knots and karabiner on the tag line could support the hypothesis that a stabilising line was being established when the accident occurred. In contrast, the establishment of a stabilising system using the tag line would have been difficult for the duty paramedic once connected to the canyoner and equipment via the winch hook, as his mobility would have been limited.

Given the low light conditions that existed at the time of the winch, it is possible that the ACM may have misinterpreted the duty paramedic's movement in preparing a stabilising rope as an indication that he was ready to be lifted.

Although there was no evidence that a stabilising system was established prior to the fall, the ATSB considered whether one would have affected the outcome. The purpose of the planned stabilising system was to control any pendulous tendency, rather than to support the full weight of the injured canyoner, paramedic and equipment once winched from the ledge. In this context, any device that was only intended to control pendulous movement, including its associated anchors, may not have been strong enough to arrest the fall. In addition, the weak link that was found attached to the tag line would have failed at a weight lower than the combined weight on the rescue hook, meaning that any rope system that used that weak link would probably have failed as the canyoner, equipment and paramedic fell. The ATSB concluded that the establishment of a stabilising system using the available equipment may not have affected the outcome.

Use of the helicopter's lighting

The ATSB considered the potential that the use of the available lighting influenced the development of the accident. The winch-mounted lights were primarily intended to illuminate the area vertically below the winch. Given the offset position of the helicopter, they would have been of limited use in illuminating the winch cable clearly, as required by the operator's operations manual.

The ACM did use the handheld searchlight during the winch. However, he also had to control the winch via a pendant controller and manually control the winch cable,

the combination of which required the use of both hands. As such, he would have been unable to continuously illuminate the winch cable with the handheld searchlight. In short, the effectiveness of the lights available to the ACM was adversely influenced by the winching procedure that was being used.

The external lighting switch selections on the night meant that assigning control of the secondary searchlight to the collective-mounted control increased the risk of extinguishing the Nightsun. The pilot was aware of this risk, which influenced his use of the lights during the winch. However, as it was possible to independently move both searchlights via the use of different switch selections without extinguishing either, the ATSB examined the potential benefits of using one of those lights to illuminate the winch cable and rock ledge.

The primary purpose of the movable searchlights was to provide pilots with redundant sources of light such that, in the event of a light failure, sufficient illumination, and therefore hover reference was assured. If, in contrast, one of the lights had been focussed on the rock ledge to facilitate the winch, leaving one searchlight to allow for sufficient hover reference for the pilot, the illumination of the rock ledge would have provided limited hover reference had the other searchlight failed. In these circumstances, the pilot would have been faced with likely insufficient hover reference, while in close proximity to obstacles and having to focus inside the cockpit to select control of the remaining light to his collective. The ATSB concluded that while the use of one of the searchlights to the right-rear of the helicopter may have assisted with the illumination of the winch cable, rock ledge and personnel, it would have placed the helicopter and flight crew in a potentially hazardous situation.

Survivability

Following the fall, the flight crew considered whether to retrieve the injured canyoner and duty paramedic using the winch. Due to their position among the rocks being obscured, and concern that further injury may result from a second winch, the flight crew elected not to attempt the winch and instead manually severed the cable to allow the helicopter to depart and initiate an emergency response. The specialist trauma surgeon's assessment of the effect of the injuries to the duty paramedic supported the flight crew's concern that additional injury to the paramedic may have resulted from a second winch.

As the winch cable was cut using the manual cutters, the option remained for restoring the helicopter's winching capability using the onboard emergency quick splice plate. However, the pilot assessed that re-entering the known difficult winching location in darkness would have been too hazardous, an assessment that was supported by the pilot of 'Rescue 23'. The operator's advice that the crew of the EC145 rescue helicopter were not qualified to conduct winching operations using night vision goggles (NVG) meant that the enhanced capability afforded by NVGs was not available.

Under those circumstances, the only available emergency response prior to daylight was via ground party. Given the trauma surgeon's assessment of the injuries to the duty paramedic, it was therefore not possible to have conveyed him to a major trauma hospital that night in sufficient time to provide the possibility of having saved his life.

Communication

During the course of the mission, there were several occasions where radio communication was unable to be established between relevant parties. However, all of the flight crew and personnel on the ground were able to successfully communicate via radio at some stage, including the pilot with the duty paramedic and the support paramedic with the crew of 'Rescue 23'. It was therefore considered unlikely that there were any technical issues with the respective radios. More probably, there appear to have been either environmental (for example, terrain shielding or ambient noise) or equipment operator-related issues that adversely influenced this capability.

The ACM's unfamiliarity with the use of the helicopter's radios prevented his communication with the paramedics and resulted in the use of hand signals to communicate with the duty paramedic. The fact that the paramedic and the injured canyoner connected to the rescue hook indicated that they intended to continue the winch as planned. In that context, whether the ACM misinterpreted the duty paramedic's movement as a signal that he was ready to be winched, or if he actually did indicate 'ready', from this point the other factors that led to the fall would probably still have occurred.

Finally, although the support paramedic could not establish communication with the flight crew after the fall, based on the above survivability considerations, knowledge of what had occurred would likely not have enabled him to change the outcome for the duty paramedic. However, it would have permitted the support paramedic to access the duty paramedic earlier and provide pain relief and comfort.

Organisational influence

Access to the injured canyoner was achieved using established procedures with which the SCAT paramedics and flight crew were all familiar. The planned retrieval of the canyoner, although based on the Hi-line transfer procedure, involved adaptation to allow for the delivery of the winch hook and for a stabilising rope system. As such, the retrieval plan involved the use of techniques that were neither documented nor trained for by the operator or Ambulance Service of NSW (ASNSW) personnel. In addition, in the opinion of ASNSW management, the use of a self-stabilising rope system had not been previously undertaken and was not endorsed. The operator also reported that any variations to the procedures in its operations manual were not endorsed.

Despite the reported positions of ASNSW and the operator, the crew's willingness to adapt known techniques may have been due to their familiarity with the Hi-line transfer procedure, resulting in the crew viewing the plan for the retrieval as similar to an approved and known procedure. This willingness may also have been influenced by the pilot's and paramedic's reported awareness of previous similar jobs, as discussed during the planning for the recovery of the injured canyoner.

Both ASNSW management and a number of SCAT paramedics advised that SCAT officers are trained in a number of access procedures and the use of the associated equipment. That training is then applied or adapted to the mission at hand. For example, SCAT personnel have been involved in a number of visually spectacular helicopter rescues that were well known within the SCAT paramedic community, including the one referred to by the duty paramedic during the crew's planning to

access the injured canyoner. Although ASNSW management advised that that particular mission was extensively planned and risk managed, and included the use of a command and control system under the supervision of an accredited rescue agency, it created a high-profile precedent for SCAT personnel in the case of complex rescues that involved the adaptation of established skills and procedures. This was consistent with the reported description of the retrieval plan by the duty paramedic with reference to an adapted technique that had been employed on a previous high profile helicopter rescue. The ATSB concluded that the accepted use of adaptation and the past successful use of adapted techniques probably led to the specific technique that was developed to retrieve the injured canyoner.

ASNSW management acknowledged that a degree of adaptation was sometimes required in order to complete missions. However, no guidance was provided on how much variation from established procedures was acceptable. Although the definition of such a limit is inherently difficult, adaptation can result in the use of techniques with which crews have little specific familiarity. Such situations make an accurate assessment of the associated risk difficult.

Management representatives from ASNSW advised that the rescue capability available from the use of helicopters and rescue winches means that helicopter crews are often responding to rescue situations without the support of accredited ground rescue agencies. This can result in situations where patient retrieval can only be achieved using complex winch rescues. These recoveries can go beyond the current level of winch training and procedural support provided for the traditional SCAT clinical access role.

In this context, when SCAT personnel are performing the ambulance rescue crewman (ARC) role, for which they are trained, they are often conducting less complex rescues that are within their capability to perform. This formal training in the rescue role, when combined with the skills obtained from SCAT training, may increase the likelihood that complex rescues will be attempted.

The increased rescue capability, coupled with the support for innovation, training in the ARC role and the success of previous innovative rescues, increased the likelihood that complex rescues would be attempted without specialist ground support. This in turn increased the risk that crews would not have the skills or knowledge to identify the hazards associated with the proposed rescue.

Training

The majority of land day and night winch training that was routinely conducted by the operator involved vertical winches from low heights and within areas that were relatively free of obstacles. While these conditions did not replicate the offset winching technique used on the night, they were designed to reduce the overall risk to the involved personnel while also providing a level of familiarity and skill with winching procedures.

The conduct of recency training was designed to supplement operational experience and ensure that role-related skills, including winching, were maintained. Based on the winching experience of the duty and support paramedics in their role as ambulance rescue crewman (ARC), there appeared to be significantly more operational day winching conducted by ASNSW personnel compared to at night. In that context, not conducting night winching recency training, although interpreted by the operator as being permitted by the contract variation clause in the operations

manual, increased the risk that ARCs may be unfamiliar with night winching procedures and their associated hazards.

FINDINGS

From the evidence available, the following findings are made with respect to the winching accident that occurred 16 km west-south-west of Wollongong Airport, New South Wales on 24 December 2011 and involved Agusta Westland AW139 helicopter, registered VH-SYZ. They should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- The low light conditions prevented the air crewman from seeing the winch cable, affecting his assessment of the potential effect of the upwards movement of the helicopter while winching in the cable, and led to the patient and duty paramedic being unintentionally pulled from the ledge.
- The position of the helicopter at the time the patient and duty paramedic were pulled from the ledge, although necessary to ensure adequate hover reference in the low light conditions, made their contact with the ground unavoidable, and resulted in the fatal injuries sustained by the duty paramedic.
- The continued execution of the retrieval plan in dark conditions contributed to the air crewman's misperception of the amount of slack in the winch cable, and the extent that the helicopter was displaced from the rock ledge.
- The accepted use of procedural adaptation by special casualty access team paramedics, and the past success of rescues that involved adapted techniques, probably led to the retrieval procedure that was used on the night. *[Minor safety issue]*

Other safety factors

- The air crewman was unable to communicate with the paramedics via radio due to a lack of familiarity with the helicopter's radio system.
- The planned retrieval procedure, utilising a stabilising rope system, was neither documented nor trained for and the crew's resulting low level of familiarity made assessment of the associated risk difficult.
- Ambulance rescue crewmen did not conduct any night winching recency training, resulting in an increased risk of unfamiliarity with night winching procedures and their associated hazards. *[Minor safety issue]*
- The increased capability of helicopters and rescue winches enabled the conduct of complex winch rescues beyond the current level of winch training and procedural support associated with the traditional special casualty access team clinical access role, leading to an increased risk that hazards associated with complex rescues were not identified. *[Minor safety issue]*
- The helicopter's lighting set-up did not allow independent control of the searchlights by the pilot using the switches on the flight controls, as required by the operations manual and Civil Aviation Order 29.11, and increased the risk of the loss of hover reference and distraction in the case of a single light failure or switch mis-selection by a pilot. *[Minor safety issue]*

Other key findings

- There was no evidence that the planned stabilising rope system was established to reduce the pendulous tendency during the winch retrieval.

SAFETY ACTION

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 the 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

Special casualty access team operating procedures

Minor safety issue

The accepted use of procedural adaptation by special casualty access team paramedics, and the past success of rescues that involved adapted techniques, probably led to the retrieval procedure that was used on the night.

Action taken by the Ambulance Service of New South Wales

The Ambulance Service of New South Wales (ASNSW) advised of the following action in response to this accident:

- Flying staff instructions have been issued reinforcing that procedures must be in accordance with the operations manual, and equipment used for its intended purpose.
- Winching procedures have been reviewed and revised procedures, particularly relating to the position of the aircraft before attaching to the winch, have been issued.
- A mandatory winch review process has been introduced to ensure winching missions are conducted in accordance with procedures and to enable the detection of issues and potential scope creep.
- Cameras are being installed on helicopter rescue winches to facilitate training and mission review.
- A special casualty access team (SCAT) educator position has been created within the Special Operations Unit to focus on SCAT training development and certification.

Action taken by the operator

Immediately following the accident, the helicopter operator, with the agreement of ASNSW, verbally briefed all crews that 'combined roping techniques' were not to be carried out. That was followed by the issue of a flying staff instruction on 28 December 2011 that banned the use of such techniques. This ban remains in place and has been incorporated into the operator's operations manual.

Role of the special casualty access team

Minor safety issue

The increased capability of helicopters and rescue winches enabled the conduct of complex winch rescues beyond the current level of winch training and procedural support associated with the traditional special casualty access team clinical access role, leading to an increased risk that hazards associated with complex rescues were not identified.

Action taken by the Ambulance Service of New South Wales

In response to this accident ASNSW has:

- through its Statewide Services Division, introduced a mission governance procedure to ensure appropriate resources are supplied to support helicopter rescue missions
- through its Control Division, strengthened procedures to ensure supervisors and all appropriate agencies are notified, and dispatched, to missions involving a helicopter rescue or SCAT response
- undertaken an external review of its command and control procedures
- arranged to present the safety issue to the New South Wales State Rescue Board for consideration.

Night winching recency training

Minor safety issue

Ambulance rescue crewmen did not conduct any night winching recency training, resulting in an increased risk of unfamiliarity with night winching procedures and their associated hazards.

Action taken by the Ambulance Service of New South Wales

ASNSW advised that, in response to this accident, a requirement was implemented on 13 August 2012 that SCAT paramedics, in their role as ambulance rescue crewmen, comply with an annual night winching currency. In addition, ASNSW will liaise with the operator to consider the requirement for more frequent currency, or alternate methods of maintaining night operations awareness.

Action taken by the operator

The helicopter operator advised that training for the operator's crewmen and ASNSW paramedics had been amended to include night winching and a supervised task requirement for air crewmen. In addition, a requirement has been implemented that all new crew members undertake a familiarisation of possible difficult rescue areas in the mountains around Sydney prior to commencing operations.

External lighting in the operator's AW139 helicopters

Minor safety issue

The helicopter's lighting set-up did not allow independent control of the searchlights by the pilot using the switches on the flight controls, as required by the operations manual and Civil Aviation Order 29.11, and increased the risk of loss of hover reference and distraction in the case of a single light failure or switch mis-selection by a pilot.

Action taken by the operator

The helicopter operator advised that an engineering order will be developed to change the wiring and switch methodology in the operator's AW139 helicopters in order to simplify the operation of the searchlights. The changes will be incorporated during scheduled heavy maintenance of the operator's AW139 helicopters that is carried out in 2013.

Action taken by the ATSB

In response to this safety issue, the ATSB has commenced a safety issue investigation that will examine the control of helicopter external lighting in the context of the night winching requirements of Civil Aviation Order 29.11. The results of that investigation (AI-2013-080) will be published on the ATSB website www.atsb.gov.au

Other safety action

Although no safety issues were identified in respect of the general conduct of crew training and risk assessment in support of the attempted rescue, the following safety actions were reported by ASNSW and the helicopter operator.

Training

Action taken by the Ambulance Service of New South Wales

ASNSW advised that, together with the helicopter operator, the conduct of training and recertification of crews had been revised to involve more scenario-based training. In addition, crew resource management training was expanded to include paramedics, and the assessment of crew members will now consider the effectiveness of the team as well as the performance of individuals. Finally, a winch simulator is being constructed at the Bankstown base and will be used for scenario-based training from July 2013.

Action taken by the operator

The operator's crew resource management training that previously only involved the operator's flight crew has, as a result of this accident, been extended to include ASNSW paramedics. In addition, since the accident the operator has introduced a new operations and training manual that has been approved by the Civil Aviation Safety Authority.

Risk assessment

Action taken by the Ambulance Service of New South Wales

In respect of the application of risk management to ASNSW mission planning, ASNSW has advised that an external consultancy has been engaged to:

- develop operational risk profiles and associated control and mitigation factors for all common mission types. It is intended that these risk profiles will form the basis of a risk assessment tool that will be applied to each mission.
- strengthen aeromedical risk management including assurance processes. This will include consideration of the interface between ASNSW and its aviation contractors and all of the associated systems and processes.

Action taken by the operator

The operator has advised that, in response to this accident, a risk assessment program for flight crews has been implemented along the lines of the 'pause point' methodology.

APPENDIX A: SOURCES AND SUBMISSIONS

Sources of Information

The sources of information during the investigation included the:

- crew of VH-SYZ
- Ambulance Service of New South Wales (ASNSW)
- helicopter operator
- helicopter manufacturer
- helicopter multi-purpose flight recorder
- New South Wales National Parks and Wildlife Service
- New South Wales Police Force and Coroner
- Australian Maritime Safety Authority
- Bureau of Meteorology.

References

Gawande, A. (2010). *The checklist manifesto. How to get things right*. Profile books, London, UK.

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 crew of VH-SYZ, the injured canyoner, Special Casualty Access Team (SCAT) paramedics involved in the ground response following the accident, the helicopter operator and manufacturer, ASNSW and the Civil Aviation Safety Authority. Submissions were received from the crew of VH-SYZ, SCAT paramedics who were involved in the ground response following the accident, the helicopter operator and manufacturer and ASNSW. The submissions were reviewed and, where considered appropriate, the text of the report was amended accordingly.

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Investigation

ATSB Transport Safety Report

Aviation| Occurrence Investigation

Helicopter winching accident involving an Agusta Westland
AW139 helicopter, VH-SYZ, 16 km WSW of Wollongong
Airport, New South Wales, on 24 December 2011

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