Air Accident Investigation Unit Ireland

SYNOPTIC REPORT

SERIOUS INCIDENT
Sikorsky S-92A, EI-ICG
Hook Head, Co. Wexford

6 December 2015

An Roinn Iompair
Turasóireachta agus Spóirt
Department of Transport,
Tourism and Sport

Foreword

This safety investigation is exclusively of a technical nature and the Final Report reflects the determination of the AAIU regarding the circumstances of this occurrence and its probable causes.

In accordance with the provisions of Annex 13[1] to the Convention on International Civil Aviation, Regulation (EU) No 996/2010[2] and Statutory Instrument No. 460 of 2009[3], safety investigations are in no case concerned with apportioning blame or liability. They are independent of, separate from and without prejudice to any judicial or administrative proceedings to apportion blame or liability. The sole objective of this safety investigation and Final Report is the prevention of accidents and incidents.

Accordingly, it is inappropriate that AAIU Reports should be used to assign fault or blame or determine liability, since neither the safety investigation nor the reporting process has been undertaken for that purpose.

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[1] **Annex 13**: International Civil Aviation Organization (ICAO), Annex 13, Aircraft Accident and Incident Investigation.
[2] **Regulation (EU) No 996/2010** of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation.
[3] **Statutory Instrument (SI) No. 460 of 2009**: Air Navigation (Notification and Investigation of Accidents, Serious Incidents and Incidents) Regulations 2009.

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In accordance with Annex 13 to the Convention on International Civil Aviation, Regulation (EU) No 996/2010 and the provisions of SI 460 of 2009, the Chief Inspector of Air Accidents on 8 December 2015, appointed Mr Kevin O'Ceallaigh as the Investigator-in-Charge to carry out an Investigation into this Serious Incident and prepare a Report.

Aircraft Type and Registration:	Sikorsky S-92A, EI-ICG	
No. and Type of Engines:	2 x General Electric CT 7-8A turbo shaft engines	
Aircraft Serial Number:	920150	
Year of Manufacture:	2011	
Date and Time (UTC)[4]:	6 December 2015 @ 14.15 hrs	
Location:	In the vicinity of Hook Head	
Type of Operation:	Non-Scheduled/SAR[5] (Civil)	
Persons on Board:	Crew - 4	Passengers - 2
Injuries:	Crew - 0	Passengers - 0
Nature of Damage:	Nil	
Commander's Licence:	Airline Transport Pilot Licence (Helicopters) issued by the Irish Aviation Authority (IAA)	
Commander's Details:	Male, aged 42 years	
Commander's Flying Experience:	2,718 hours, of which 601 were on type	
Notification Source:	The Operator	
Information Source:	AAIU Field Investigation & AAIU Report Form submitted by the Commander	

[4] **UTC**: Co-ordinated Universal Time. All timings in this report are quoted in UTC (equivalent to local time).
[5] **SAR:** Search and Rescue.

SYNOPSIS

During a Search and Rescue (SAR) mission in the vicinity of Hook Head, Co. Wexford on the afternoon of 6 December 2015, a Sikorsky S-92A helicopter crew located and winched two casualties from the water. During the winching operation one of the casualties, a 14 year old girl, slipped from the rescue strop and fell into the water from a height of approximately 45 ft. The casualty was recovered immediately from the water and winched up to the helicopter again. Both casualties were transferred to a nearby hospital in Waterford for medical treatment. The Investigation was subsequently informed by An Garda Síochána that one of the casualties, a 14 year old girl, had died on 10 December 2015.

NOTIFICATION

The occurrence was reported through the Operator's Safety Management System immediately and the IAA was made aware of the occurrence by the Operator. The AAIU was subsequently notified by the Operator of the Waterford SAR Service on 7 December 2015. Two Inspectors of Air Accidents travelled to the SAR Base at Waterford Airport (EIWF) on the same day to collect the Multi-Purpose Flight Recorder (MPFR)[6], the winching strops and documentation associated with the mission. Following an initial review of this data, the Chief Inspector of Air Accidents directed that an investigation of the occurrence be conducted. This Technical Safety Investigation focused on the participation of the Sikorsky S-92A helicopter and crew in the SAR mission at Hook Head on 6 December 2015.

1. FACTUAL INFORMATION

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1.1 History of the Flight

The Irish Coast Guard (IRCG) Marine Rescue Coordination Centre (MRCC)[7] in Dublin received a telephone call at 14.04 hrs on 6 December 2015, on the 999/112 emergency service line from a member of the public, alerting them to a number of "*kids in the water*" at Hook Head, Co. Wexford. Initially the caller indicated that there were two casualties in the water. However, during the call the number of casualties mentioned varied between two and four people. The MRCC operator asked the caller whether a lifebuoy could be provided to the casualties and if communication with the casualties was possible. The caller replied that the casualties were "*too far out*" and estimated that they were between 13 and 14 years old.

At 14.05 hrs the MRCC notified the Commander of the SAR Crew at the IRCG Base at EIWF about the emergency call and tasked him with an immediate SAR mission. The Commander activated the 'scramble' bell and when the Crew assembled he conducted a short briefing about the tasking[8]. Following the briefing, the Co-Pilot accompanied the Commander to the helicopter to commence the pre-flight checks. The Winchman and Winch Operator proceeded to the helicopter via the storeroom where they donned the necessary protective clothing and equipment specific to the mission. At 14.06 hrs the Co-Pilot contacted Waterford Air Traffic Control (ATC) by radio from the helicopter "*for an immediate departure to Hook Head; four children in the water*" and received permission to start engines.

[6] **MPFR:** Combines Cockpit Voice Recorder (CVR) and Flight Data Recorder (FDR) functions into a single unit.
[7] **MRCC:** The contact point responsible for SAR operations and routine operational matters in the area between Carlingford Lough in Co. Louth and Ballycotton in Co. Cork.
[8] The Crew had completed an initial briefing on taking over duty from the off-going crew at 13.00 hrs.

The Flight Crew started the engines and completed the after-start checklist items. When the Winch Crew had boarded the helicopter the Co-Pilot requested taxi clearance from ATC. The helicopter departed EIWF at 14.10 hrs using the call sign of '*R117*'[9] and routed directly to Hook Head, which is located 7 NM[10] to the south east of the airfield. During the transit to the search area the MRCC advised the Flight Crew that the most recent information received suggested that three teenagers had entered the water. The helicopter was the first IRCG asset to reach Hook Head. Upon arrival at the search location at 14.13 hrs the helicopter crew observed two people in the water and positioned the helicopter to commence winching operations.

The Winchman was deployed at 14.14 hrs via the winch with two Rescue Strops; one a Helicopter Rescue Strop and the other a Hypothermic Rescue Strop. He entered the water less than one minute later. This event was captured on the CVR by the sound of the Winchman's SARBE[11] beacon, which activated on immersion. The Winchman told the Investigation that when he reached the male and female casualties who were both teenagers, the female casualty was pale and unresponsive and was being supported by the male casualty who was anxious to keep her head above the water. Despite the risk to himself and the lack of survival equipment, the male casualty had remained with the female casualty out of concern for her well-being and kept her afloat until the arrival of the Winchman. The Winchman told the Investigation that the female casualty began to drift under the water. He said that he was aware from previous SAR experience that casualties in the water had been known to relax and stop trying to swim once the winchman had arrived to assist[12], and he was concerned that such a situation was about to occur. The Winchman was also concerned that if he winched one casualty to the helicopter, that the other would not be able to remain afloat until he returned. He said that there were no other vessels in the area that would be able to assist in the rescue at that time.

During separate interviews with the Investigation, the Winchman and the male casualty stated that the female casualty appeared to be unconscious for some time prior to, and during the rescue operation. The Winchman considered that his only option was to winch both casualties simultaneously. He placed the male casualty in the Helicopter Rescue Strop and the female in the Hypothermic Rescue Strop. The Winchman recalled that he placed her into the strop "*legs to the centre*, *head out, through the strop…with the toggle tightened*". He told the Investigation that the female was wearing blue jeans and a black fleece-type jacket with a grey hood. For additional security he attempted to place his legs around both casualties. He then signalled the Winch Operator to commence winching up. As the Winchman and the two casualties reached the door of the helicopter and were about to be recovered into the cabin, the female casualty slipped through the Hypothermic Rescue Strop and fell approximately 45 ft[13] into the water. The helicopter remained in position and the male casualty was taken into the cabin. The Winchman was then immediately winched back down to the female casualty in the water. The female casualty was winched to the helicopter and the crew began administering emergency medical treatment.

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[9] **R117:** Phonetically pronounced '*Rescue One One Seven'.*

[10] **NM:** Nautical Mile. 1 NM = 1.15 statute miles = 1.852 kms.

[11] **SARBE:** Search & Rescue Beacon Equipment is a water activated beacon that transmits a radio signal on the emergency frequency when immersed.

[12] Also referred to as Circum-Rescue Collapse (Golden et al, 1991).

[13] Information taken from the Flight Data Recorder; see **Section 1.8** and **1.9** of this Report.

The Cockpit Crew resumed a search pattern for a third casualty that they understood to be in the water. This search continued for a number of minutes during which time the male casualty in the helicopter informed the crew that there had been only two people in the water. Upon receipt of this information and having been updated by the Winch Operator on the female casualty's medical condition, the Commander decided to depart from the Hook Head area and route directly to a landing site adjacent to a nearby hospital. The Co-Pilot advised these intentions to the MRCC and the Dunmore East RNLI[14] Lifeboat that was en-route to the scene. The helicopter landed at a sports pitch near the hospital six minutes later at 14.27 hrs and both casualties were transferred by waiting ambulance to the hospital.

The Crew began preparing the helicopter for departure to Hook Head to resume search operations. However, the MRCC notified the helicopter Crew by radio that all search operations had been stood down and that the helicopter could return to base. The helicopter departed from the hospital landing site at 15.23 hrs and returned to EIWF. The MRCC log recorded that the Helicopter Crew notified them at 15.32 hrs that the helicopter was back at base.

The Investigation was informed by An Garda Síochána that one of the casualties, a 14 year old girl, had died on 10 December 2015.

1.2 Personnel Information

The standard crew for a SAR mission is four personnel; a commander and co-pilot to fly and navigate the helicopter, a winchman who descends on a cable to the casualty to effect the rescue, and a winch operator to control the winch, advise the commander on the progress of the rescue and act as a link between the winchman and the commander.

1.2.1 The Commander

The Commander of the helicopter held a valid European Union Flight Crew Licence issued by the Irish Aviation Authority (IAA). He completed a Licence Proficiency Check (LPC) in May 2015 and held a Type and Instrument Rating for the S-92 helicopter that was valid until 31 May 2016. He completed an Operator's Proficiency Check (OPC) on 5 November 2015 and a Pilot Competency Check on 15 September 2015. He was certified as competent for command of the S-92 helicopter during All-Weather Search and Rescue (AWSAR) operations.

The Commander's Class One Medical Certificate was valid until 19 December 2015. He had 2,700 flight hours on helicopters of which 601 hours were on the S-92A. The Commander commenced duty at 13.00 hrs on the day of the occurrence and informed the Investigation that he had been free of all duties for 24 hours prior to commencing this duty. He was the Pilot Flying (PF) for the occurrence flight.

[14] **RNLI:** Royal National Lifeboat Institution.

1.2.2 The Co-Pilot

The Co-Pilot held a valid European Union Flight Crew Licence issued by the UK Civil Aviation Authority (CAA). He completed a LPC in August 2015 and held a Type and Instrument Rating for the S-92 helicopter that was valid until 31 August 2016. He completed an OPC in August 2015 which was valid until 29 February 2016. He completed a Pilot Competency Check in October 2015 and was certified as competent for command of the S-92 helicopter during AWSAR operations.

The Co-Pilot's Class One Medical Certificate was valid until 5 May 2016. He had 5,300 flight hours on helicopters of which 1,500 hours were on the S-92A. The Co-Pilot commenced duty at 13.00 hrs on the day of the occurrence and informed the Investigation that he had been free of all duties for 24 hours prior to commencing this duty. He was the Pilot Monitoring (PM) for the occurrence flight.

1.2.3 The Winch Operator

The Winch Operator advised the Investigation that he had been involved in SAR for approximately 19 years (15 years with his current employer and four years with a previous employer). He had been based at EIWF since the current SAR service began there in 2002. He held an EASA Class Two Medical Certificate that was valid until 3 December 2017 and had successfully completed his crew competency line check on 10 October 2015.

The Winch Operator's training file held by the Operator recorded that he had completed specific wet winching[15] training flights on eight occasions during 2015 and had last completed a wet winching training flight on 11 November 2015. He commenced duty at 13.00 hrs on the day of the occurrence and had been free of all duties for 24 hours prior to commencing this duty period.

1.2.4 The Winchman

The Winchman advised the Investigation that he had commenced employment with the Operator in December 2013 and qualified as a winchman in March 2014. He was in possession of a Class 2 Medical Certificate that was valid until 29 February 2020. He had successfully completed his crew competency line check on 29 March 2015.

The Winchman's training file held by the Operator recorded that the he had completed specific wet winching training flights on six occasions during 2015 and had last completed a wet winching training flight on 28 September 2015. He commenced duty at 13.00 hrs on the day of the occurrence and informed the Investigation that he had been free of all duties for 24 hours prior to commencing this duty period.

[15] **Wet winching:** Winching from a wet location such as a river, lake or the sea.

1.3 Aircraft Information

The Sikorsky S-92A is a twin-engine, medium weight helicopter. It is powered by two General Electric CT7-8A turbo shaft engines that drive a four-bladed, fully articulated main rotor and a four-bladed tail rotor. The helicopter has a maximum cruising speed of 151 kts. The helicopter was registered as EI-ICG (**Photo No. 1**) and configured for SAR operations. This configuration included auxiliary fuel tanks that increase the maximum range to 801[16] NM, thermal imaging cameras, a searchlight, a radio-altimeter[17] and an Automatic Identification System (AIS) which is described in **Section 1.8.2**. The helicopter did not sustain any damage as a result of the serious incident.

Photo No. 1: Sikorsky S-92A EI-ICG

1.4 Rescue Strops

1.4.1 General

Rescue Strops are fabricated straps designed to loop around a casualty and attach them to a winch or hoist hook during rescue operations. They are available in varying dimensions depending on customer requirements. However, the Helicopter Rescue Strop and Hypothermic Rescue Strop must be matched so that they operate correctly as a pair for double strop (hydrostatic) lifts.

The Investigation examined the two Rescue Strops used during the mission and found no evidence of wear and tear, damage or failure of either strop. The Investigation also contacted the Manufacturer of the Helicopter Rescue Strop and the Hypothermic Rescue Strop to provide information about the manufacture and operation of the strops.

[16] Range while retaining a 30 minute fuel reserve.
[17] **Radio-altimeter:** An aircraft instrument that measures vertical height above the surface by reference to the time taken for a radio signal to be transmitted to, and reflected from the surface to a receiver in the helicopter.

The Manufacturer confirmed that the strops in use for the rescue were correctly matched and that the maximum mass of a casualty for a single strop (including the Hypothermic Strop) is considered to be 136 kgs (300 lbs). This is based on a 97 percentile mass for military personnel of 105 kgs and also takes into account the estimated weight of a casualty's wet clothing. Information provided to the Investigation indicated that the mass of each casualty in this event was substantially less than this maximum figure. There is no minimum mass associated with the use of the strops. Details of the Helicopter Rescue Strop and Hypothermic Rescue Strop used during the rescue were as follows:

	Helicopter Rescue Strop	Hypothermic Rescue Strop
Part No.:	MRIGQ1857	MRIGQ1860
Drawing No.:	GQD21266 issue 8	GQD40021 issue 4
Ser. No.:	E1143502	E1187532
Date of Manufacture:	February 2013	February 2014

Table No. 1: Rescue Strop Details (*Manufacturer*)

1.4.2 Helicopter Rescue Strop

The function of the Helicopter Rescue Strop (**Photo No. 2**) during a SAR mission is to facilitate the lifting of a casualty via the hoist hook during winching into the helicopter from a vessel, the sea or the ground. The strop consists of a length of heavy polyester webbing, folded in four and stitched along each edge throughout its length. A D-ring is enclosed in the folds at each end and the centre portion is cushioned with a double thickness of expanded rubber, tapered at each end and covered with orange-coloured fabric. A strip of stippled material made from white webbing is sewn onto the inside face of the cushioned portion to aid grip.

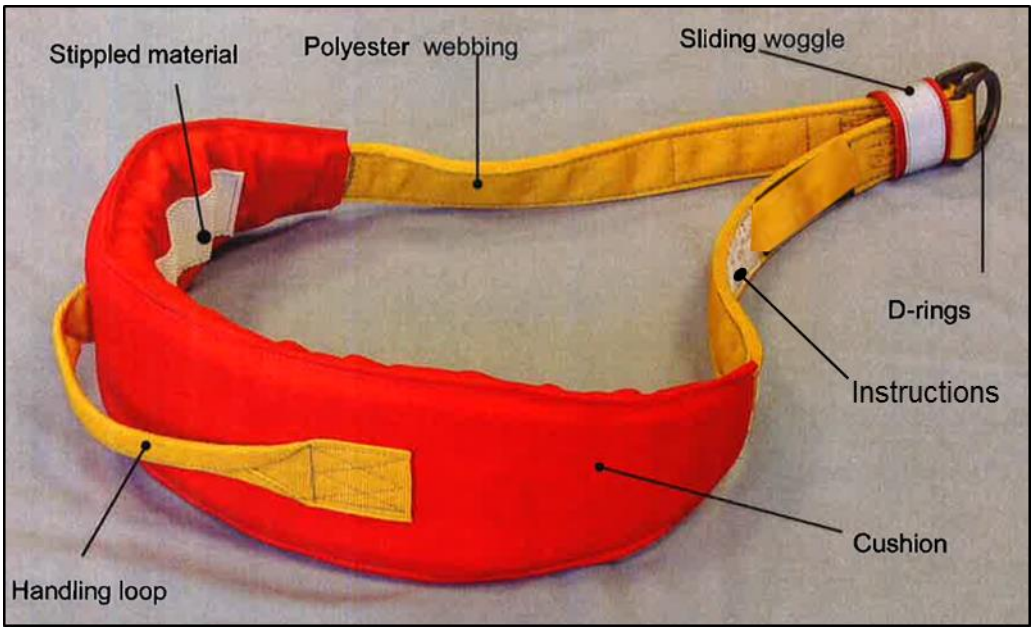

Photo No. 2: Helicopter Rescue Strop (*Manufacturer*).

The two ends of the strop pass through a sliding woggle which allows the strop to be drawn close to the torso of the wearer. Instructions for the correct use of the strop are attached to the webbing in the form of a pictorial guide (**Photo No. 3**). Prior to ascent, the strop is positioned around the casualty's torso and under the arms with the pad at the back and the sliding woggle at the front.

Step four of the instructions requires the casualty to keep their hands beside their body. A handling loop on the outside of the strop enables the winch operator to draw the casualty into the cabin after they are winched up to the helicopter door.

Photo No. 3: Instructions to operate the Helicopter Rescue Strop as sewn onto webbing.

When conducting a single strop lift using the Helicopter Rescue Strop, the winchman is positioned facing the casualty with one leg placed either side. This enables the winchman to control and assist the casualty and secure the strop while freeing the winchman's hands in order to signal the winch operator and assist in recovering the casualty into the helicopter.

1.4.3 Hypothermic Rescue Strop

In 1997, the UK Health and Safety Executive (UKHSE) undertook an extensive study[18] of reported and anecdotal instances of casualties being rescued from the water after extended periods of immersion, only to die in the 20-90 minutes after rescue. The study concluded that up to 20% of those who were responsive when taken from the water experienced significant post-immersion medical problems.

When an individual is immersed in water, blood in the circulatory system outside the chest area is surrounded by a medium of approximately equal density and becomes effectively weightless. Hydrostatic compression[19] reduces the volume of blood in the veins. The result is a significant redistribution of blood in the body, combined with a reduction in the blood pressure required to supply the constricted blood vessels. Colder water is likely to cause a greater shift of blood to the upper body due to cold-induced vasoconstriction.[20] This would be in addition to the immediate effects on the casualty of cold shock and hypothermia.

[18] **OTH519:** *Review of Rescue and Immediate Post Immersion Problems – A Medical / Ergonomic Viewpoint.*
[19] **Hydrostatic compression:** The weight of the surrounding water pressing on the body.
[20] **Vasoconstriction:** Narrowing of the blood vessels to reduce blood flow from the core of the body.

Following the winching of a casualty who has been in the water for an extended period[21], the removal of hydrostatic compression on the body combined with gravity and the reduced blood pressure from the heart, results in blood pooling in the lower extremities of the body. This can cause myocardial ischaemia[22] or cerebral ischaemia[23] during the post rescue period. The casualty may also be subject to a form of circum-rescue collapse, which is caused by reduced levels of performance-enhancing adrenaline that can result in a relaxation associated with the casualty's belief that they are safe. This collapse can be perceived by the rescuer as the casualty giving up just as they are about to be rescued, or as a loss of consciousness of a casualty.

The Hypothermic Rescue Strop (**Photo No. 4**) was designed to mitigate these long term immersion effects when used in conjunction with the Helicopter Rescue Strop by enabling a more horizontal body position for the casualty being winched (Hypothermic Lift Technique). When winching persons in distress, a horizontal body position improves the chances of survival by avoiding the effects of vasoconstriction and the redistribution of blood during lifting. It can also reduce the effect of the removal of hydrostatic compression from the lower extremities of the body. Rescue crews carry a Hypothermic Rescue Strop on SAR missions as a standard equipment fit.

The Hypothermic Rescue Strop is slightly larger than the Helicopter Rescue Strop and is positioned under a casualty's thigh area to mitigate the effect of gravity and cold shock on the body. The Hypothermic Rescue Strop does not have any stippled material on the inside of the cushioned area. This is to allow the winchman to more easily slide the strop under the casualty's legs.

Photo No. 4: Hypothermic Rescue Strop (Manufacturer)

[21] **Extended period:** Defined in the study as a period of immersion greater than 30 minutes.
[22] **Myocardial ischaemia:** A lack of blood supply to the heart.
[23] **Cerebral ischaemia:** A lack of blood supply to the brain.

1.4.4 Strop Manufacturer's Observations

The Investigation requested the Manufacturer to comment on the use of the Hypothermic Rescue Strop for lifting a casualty from the water. The Manufacturer stated that *"It can also be used as a Rescue Strop on its own"* as it is sufficiently strong, with a similar basic construction to the primary Helicopter Rescue Strop.

While reviewing the usage of the strop, the Manufacturer identified a number of factors that should be considered, including whether the efficacy of a rescue strop is compromised by the fact that the casualty may be unconscious / semi-conscious. Following consideration of these factors the Manufacturer stated;

> *Security within the harness requires the casualty to have their arms by their side during the lifting element of a rescue. This is shown on the user instruction label on the Helicopter Rescue Harness* [[24]]. *In practice, if the person being rescued is conscious, to ensure that they do not slip from the strop, they are directed to keep their arms down and not reach for the cable or strop whilst they are being hoisted.*

The Manufacturer confirmed that it did not provide guidance on the use of their rescue strops with injured, or in particular, unconscious casualties and that *"This is left to the customers' specific SOPs[25]."* The Manufacturer was also asked to comment on the effectiveness of the Rescue Strop if a reverse method of lifting were to be employed, i.e. where the strop is positioned around the casualty's torso with the pad at the front and the sliding woggle at the back. The Manufacturer considered that, whilst this lifting method is possible and has been used by other organisations, it should be considered only in the most extreme of situations. Furthermore, the Manufacturer stated;

- *There is a quantifiable greater risk using the reverse method of lifting with the toggle at rear of the person being rescued.*
- *The person is not as secure because the arms are forced forwards and upwards during the lift. This is because of a person's physiology; the arms can articulate forwards and upwards from around the shoulders … Therefore, with an unconscious casualty, there is a higher probability of falling from the strop compared to the conventional lifting technique. A conscious casualty would more readily survive such a lift method, but their arms have to be positively held down and the toggle slid tightly down behind their back.*
- *Recovery into the aircraft would be more challenging.*
- *Breathing is indeed more difficult.*
- *It is more uncomfortable for the person being lifted,*
- *The person being lifted would require additional support by the legs of the winchman.*

[24] See **Photo No. 2 & 3**.
[25] **SOPs:** Standard Operating Procedures.

1.5 Meteorological Information

The Investigation requested an aftercast from Met Éireann Aviation Services Division. The weather provided to the Investigation for the time of the rescue was as follows;

Meteorological Situation:	The area was on the south-eastern side of a ridge of high pressure which extended to the northwest.	
Wind:	**Surface:**	Variable but generally north easterly 5-7 kts
	2000 ft:	090° 12 kts
Visibility:	10+km, Risk isolated 3000m	
Weather:	Nil	
Cloud[26]**:**	FEW 1,800 ft, SCT 2,000 ft Occasional SCT 500 ft	
Surface Temp/Dew Pt:	Temp 08°C, Dew Point 05°C	
MSL Pressure:	1,015 Hectopascals	
Freezing Level:	6,000 – 7,000 ft	

Table No. 2: Meteorological Conditions at Hook Head on 6 December 2016

The Investigation also requested information about the sea conditions at the time of the rescue. **Figure No. 1** shows the *Wave Height (Swell) Chart* in metres for 15.00 hrs on the day of the occurrence. This chart depicts the result of meteorological activity on sea conditions.

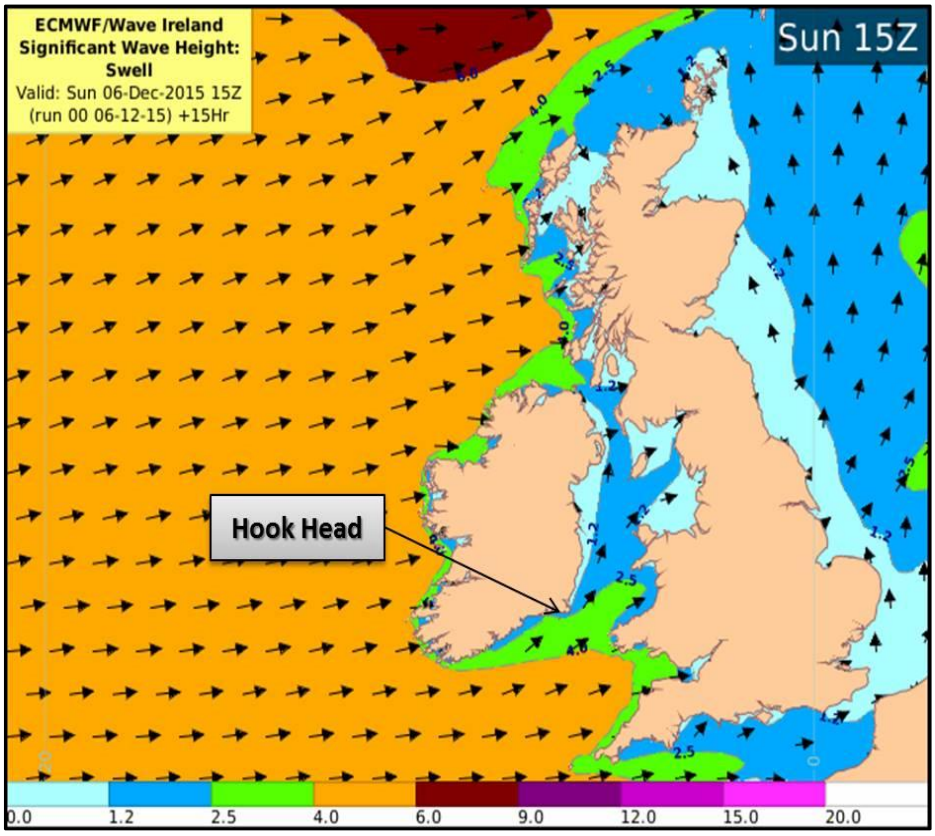

Figure No. 1: Forecast Swell 6 December 2015 at 15.00 hrs

[26] Cloud Cover is measured in oktas (1 okta= ⅛ of total cloud cover); FEW = 1-2 oktas; SCT = 3-4 oktas .

Figure No. 2 shows the *Wave Height (Sea) Chart* in metres for 15.00 hrs on the same day. This chart also includes the effect of additional factors, including the topography of the seabed, direction of the swell relative to the coastline and local wind effects.

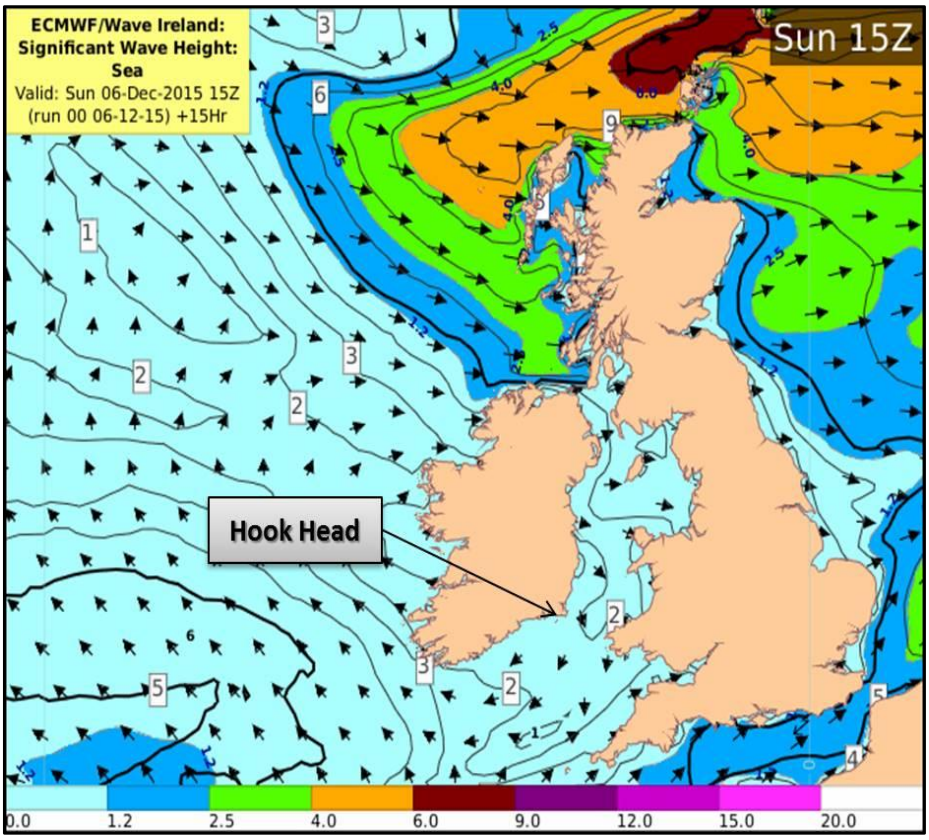

Figure No. 2: Forecast Sea 6 December 2015 at 15.00 hrs

These charts indicate that the forecasted height of the waves in the vicinity of Hook Head were not greater than 2.5 metres at 15.00 hrs. The forecasted sea conditions at 12.00 hrs were of similar magnitude. A photograph taken at 14.00 hrs approximately (**Photo No. 5**) depicts relatively benign offshore sea conditions. Historic tidal data from the Irish Marine Institute for Dunmore East (approx. 5 km NW of Hook Head) for 6 December 2015 indicated that High Tide was at 13.42 hrs and that the sea temperature at the time was 11°C.

Photo No. 5: Photograph of Hook Head taken on 6 December 2015 at 14.00 hrs approx.

Although **Photo No. 5** showed that the sea around Hook Head did not appear to be significantly rough or turbulent in the light northerly winds, **Photo No. 6** and **Photo No. 7** provided to the Investigation show images of the same area of rocks at Hook Head taken five minutes apart and 15-20 minutes prior to the occurrence. These photographs illustrate the volatile nature of the coastal sea conditions at the time.

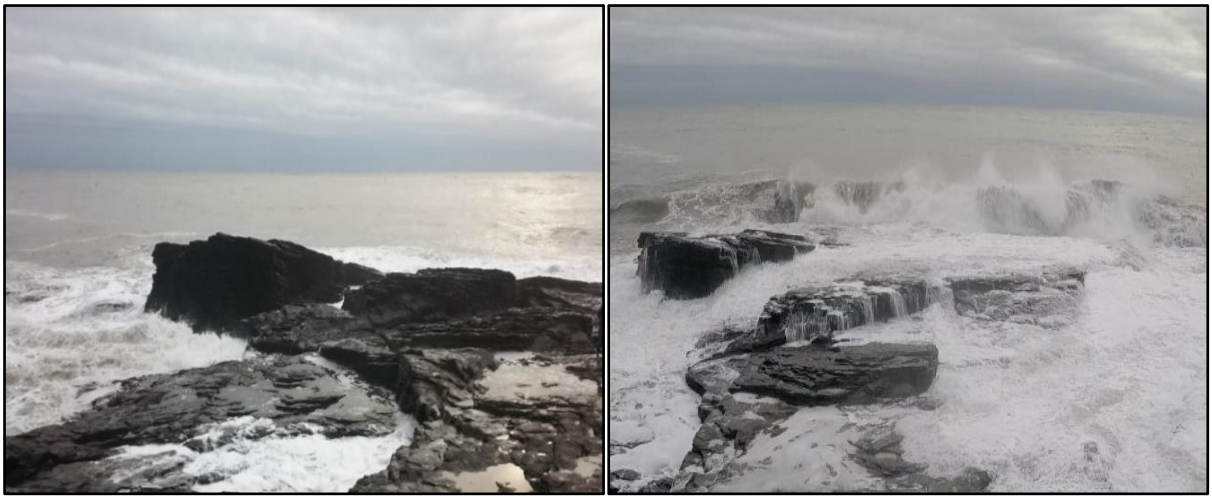

Photo No. 6 and 7: Photographs taken on 6 December 2015 showing the changeable conditions.

1.6 Organisational and Management Information

The Irish Coast Guard (IRCG) is a division of the Department of Transport, Tourism and Sport (DTTAS) and is responsible for Ireland's national system of marine emergency management within Ireland's EEZ[27] and inland waterways and is designated as the *SAR Authority*[28] in accordance with the provisions of the *Irish National Maritime Search and Rescue (SAR) Framework* published by the DTTAS. This authority is exercised through a number of regional centres. The coastal region from Carlingford Lough, Co. Louth to Ballycotton, Co. Cork is within the area of responsibility of the MRCC in Dublin.

The helicopter service was provided to the IRCG by a private company,[29] operating helicopter bases at Dublin, Shannon, Waterford and Sligo. The agreed performance criteria were for the helicopter to achieve a launch time within 15 minutes of urgent calls between the hours of 07.30 hrs and 21.00 hrs and within 45 minutes outside of these times[30].

[27] **EEZ:** Exclusive Economic Zone.

[28] **SAR Authority:** The authority within a National Administration with overall responsibility for establishing and providing SAR services and ensuring that planning for those services is properly coordinated.

[29] Referred to in this report as '*the Operator*'.

[30] As defined in the *Operations Manual Part F; Search and Rescue, Section 2 SAR Readiness*.

1.7 Documentation

1.7.1 General

Procedures for the conduct of SAR operations were prescribed in a number of the Operator's Manuals which were approved by the Irish Aviation Authority (IAA), including but not limited to:

- *Operations Manual Part A (OMA); General / Basic Procedures* (Updated: 1 Oct 2014)
- *Operations Manual Part D (OMD) Vol. 1; Training / Policy* (Updated: 1 Oct 2014)
- *Operations Manual Part F (OMF); Search and Rescue* (Updated: 15 Aug 2015)
- *Safety Management & Compliance Monitoring Manual* (SMS) (Updated: 1 Jun 2015)

1.7.2 Winching Methods

The *OMF* describes the methods that can be used to conduct a winch rescue (emphasis has been added by the Investigation for clarity):

> ***3.13.1 Types of lifts***
>
> *There are several lifting procedures used to meet various circumstances. Although these procedures may have to be modified to suit individual situations, the basic techniques are as follows:*
>
> 15
> *a. Single lift*
> *b. Double lift*
> *c. Multiple lift*
> *d. Hydrostatic (double strop lift)*[31]
> *e. Extended cable lift*
> *f. Stretcher lift*
>
> ***3.13.2 Single lift***
>
> *The single lift is principally used as a training exercise to give winching experience to other flight crew, or members of other rescue agencies.*
>
> *Prior to the flight, the person to be winched is to be given a thorough briefing on the operation of the strop. In addition, the dangers of static electricity and of being struck by the winch hook will be explained to the person to be winched.*
>
> *Except when training with experienced flight crew, a winchman will always be in attendance during single lifts. He will ensure that the casualty is properly secured in the rescue strop and make the appropriate hand signals to the winch operator.*

[31] The terms "*Hydrostatic*" and "*Hypothermic*" are used interchangeably.

3.13.3 Double lift

The standard method used by dedicated SAR helicopters to affect a rescue is the double lift. Provided that the casualty is not seriously injured or likely to be hypothermic, it is suitable for water, life-raft, deck and land rescues. The procedure for the double-lift is as follows:

a. … On the final stages of the approach the winchman and his equipment are winched out and placed alongside the casualty.
b. Once alongside the casualty, the winchman secures him using the rescue strop. The winchman then indicates to the winch operator with a 'thumbs up' that he is ready for the lift.
c. When the winch operator is satisfied that the winchman and casualty are secure and the aircraft is correctly positioned, he initiates the lift. The winch operator will ensure that the winchman and casualty are kept at a safe height during the lift. The winchman is to position the casualty between his legs and protect him from contact with the underside of the aircraft.

3.13.4 Multiple lift

The multiple lift technique may be used operationally when a large number of casualties are to be lifted from one point. In such cases the winchman will be lowered with two strops on the winch hook. Once ***on deck or in the life-raft****, the winchman will detach completely from the winch hook taking the strop(s) with him. To expedite the lift he will then place a casualty in each strop and, when ready, re-hook both casualty strops in preparation for the lift, which will be completed as for a single lift…The final lift would normally be a double lift…*

3.13.5 Hydrostatic (double strop) lift

This is a method of lifting a casualty as near to the horizontal as possible where a stretcher cannot be used. It should generally be used when lifting a casualty from the water, no matter how long they are reported to have been in the water. Exceptions to this rule may be required in excessively rough seas, or if the SAR crew actually see the person enter the water and can thus be sure that no risk of hypothermia exists…

3.13.7 Stretcher lift

When a casualty is injured or unconscious and conditions permit, a stretcher lift should be considered. No stretcher should ever be winched from an S92 without the use of a Hi-line[32]*.*

[32] **Hi-Line:** A Heaving-in Line; a line that is lowered to a vessel to facilitate a winchman's arrival on deck during winching in heavy seas or where vertical winching is not possible.

The Investigation interviewed the Helicopter Crew and a number of other senior SAR-qualified personnel employed by the Operator. There was a shared view that the procedures for winching using a strop(s) that were detailed in the *OMF* were equally applicable to conscious and unconscious casualties.

The Investigation noted that *OMF Section 3.13.7 Stretcher lift* referred to lifting an unconscious casualty by use of a stretcher. The Helicopter Crew and a number of other senior SAR-qualified personnel considered a stretcher to be unsuitable for use during this mission as it would have taken a longer time to reach the casualties and the stretcher can only lift one casualty at a time. Furthermore, they considered that the mandatory use of the '*Hi-Line*' associated with a stretcher lift was not possible in this scenario as neither casualty had the capability, or was in a condition, to control the line. During interviews, the Crew of the helicopter and a number of other senior SAR-qualified personnel employed by the Operator stated that a stretcher would not be used when lifting a casualty from the water. The Operator informed the Investigation that a stretcher lift would not have been considered appropriate in this occurrence, as there were two casualties in the water and the winchman considered that either casualty would have been in imminent danger if left behind.

An unconscious casualty was referenced in the *OMF Section 14; Special Tasks*, which contains procedures for rescuing military aircrew. However, there were no specific changes to the winching procedures in this situation. There were additional procedures which related to extracting the casualty from a single seat life-raft prior to donning the strop.

17 **1.7.3 Winching Procedures**

The *OMF Section 3.11: Normal Procedures; Wet Winching* describes the procedure to be adopted when winching a casualty from the water (emphasis added by the Investigation for clarity);

> ***3.11.2 Casualty in the water***
>
> *The appropriate circuit is to be flown maintaining visual contact with the casualty. Briefing as appropriate to the urgency of the situation shall be carried out. The winchman is to be deployed at a safe height and the aircraft climbed if necessary. The aircraft is then to be guided forward towards the casualty and then maintained overhead using standard patter[33]. When he reaches the casualty* ***the winchman will carry out the appropriate double strop (hydrostatic) lift****. The winch operator will ensure that he maintains control of the amount of cable deployed throughout the lift. He will not allow excess cable/bights to remain in the water adjacent to the winchman and casualty. On receipt of the 'thumbs up' signal from the winchman, the winch operator will ensure that the cable is clear of both winchman and casualty and will then winch winchman and casualty clear of the water.*

[33] **Standard patter:** A standardised means of communication between crew members to ensure that ambiguity does not arise.

1.7.4 Training Requirements

The training requirements for SAR crews to maintain competence in winching were prescribed in the *OMF* which stated:

> ***5.2.4 Hover Reference Winching***
>
> *Hover reference winching training prepares the crew for live operations where limited visual cues are available to the pilot, such as rescue of:*
>
> *a. Casualty in water*
> *b. Casualty in ILB[34] / semi-rigid vessels / half-deckers*
> *c. Casualty(s) in single-seat or multi-seat life-raft*
>
> *Hover reference winching recency can be achieved by completing any of the following accepted disciplines:*
>
> *a. Drum winching[35], either using an actual training drum or making use of a simulated drum such as a marine marker buoy. Drum winching exercises can be conducted by day or night.*
> *b. Wet winching (single or double strop technique)*
> *c. ILB transfers with ILB stationary in the water*
> *d. Single-seat life-raft*
> *e. Multi-seat life-raft*
>
> *The minimum requirement is to complete at least one hover-referenced winching exercise by day by completing either drum winching or wet winching, within the three month period. During the winter season, from 01 October to 31 March, the requirement is to complete one night drum within any three-month period. This can be completed by either using an actual training drum or making use of a simulated drum such as a marine marker buoy. Although it is not mandatory, crews should endeavour to achieve recency in all hover-referenced winching disciplines within the three-month period. This is subject to the availability of ILB vessels and life-raft training equipment.*

Documentation provided to the Investigation by the Operator showed that the crew met the training requirements to undertake the mission as per the approved Operations Manuals.

1.8 Recording Devices

1.8.1 Multi-Purpose Flight Recorder (MPFR)

The helicopter was equipped with a Penny & Giles D-51615-102 MPFR, which served the dual purpose of CVR and FDR. Both the FDR data and CVR audio were recorded on a crash-protected solid-state memory unit. The MPFR records 25 hours of flight data and up to 2 hours of audio data. It then overwrites itself. Following the handover of the casualties to ambulance personnel, the helicopter returned to base at EIWF and landed at 15.32 hrs. On 7 December 2015 two Inspectors of Air Accidents travelled to Waterford and collected the MPFR.

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[34] **ILB:** Inshore Lifeboat.

[35] **Drum Winching:** A training discipline where a floating object of suitable construction is winched by use of a grapnel hook attached to the winch hook.

1.8.1.1 Cockpit Voice Recording Information

The CVR recorded a total of six audio files from four separate audio channels:

- Three separate audio channels (the Commander, Co-Pilot and Winch Operator) from the aircraft intercommunication system for the previous 30 minutes.
- A combined single audio track of the three intercommunication system channels for the previous 120 minutes.
- Cockpit Area Microphone for the previous 30 minutes with a bandwidth of 150 Hz to 6 kHz.
- Cockpit Area Microphone for the previous 120 minutes with a reduced bandwidth of 150 Hz to 3.5 kHz.

As the aircraft had flown for more than 30 minutes since the event, the three separate audio channels were over-written. However, a good quality combined single audio track of the three intercommunication system channels was available which included the entire occurrence flight.

1.8.1.2 Flight Data Recorder Information

The FDR component of the MPFR on the helicopter recorded a total of 952 parameters over a period of 25 hours. The data was downloaded with the assistance of the UK AAIB[36]. The data frame layout required to decode the FDR data was provided by the Transport Safety Board (TSB) Canada. The Manufacturer, Penny & Giles Aerospace Ltd., subsequently provided technical assistance to the Investigation during the analysis of the data.

1.8.2 Automatic Identification System (AIS)

AIS is a ship-borne transponder system that operates in a similar manner to an aircraft transponder system, transmitting a range of data to a compatible receiver unit. AIS utilises the VHF[37] frequency band to transmit information that can include ship position, name or registration, course, speed, destination and activity. This information can assist in quickly locating vessels without the need for airborne primary radar. The SAR helicopter used during the mission was equipped with an AIS transceiver.

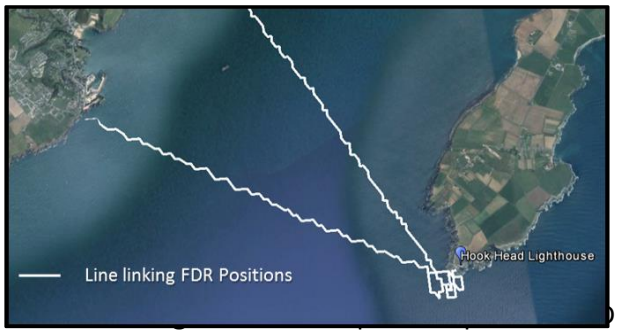
The IRCG provided the Investigation with the AIS recorded data from the area around Hook Head for the time of the occurrence. The data provided positional information for the helicopter and information about other AIS-equipped vessels in the area at the time.

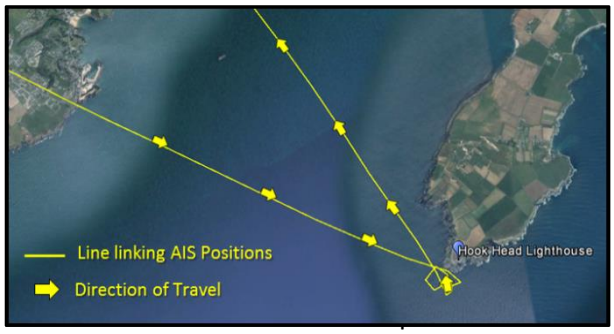
[36] **AAIB:** Air Accidents Investigation Branch.
[37] **VHF:** Very High Frequency.

1.9 Recovered Flight Data

1.9.1 General

The Investigation correlated the data received from the FDR and AIS systems for the period of the SAR mission. **Figure No. 3** shows the position data for the mission. The white line shows the positional information recovered from the FDR and the yellow line shows the equivalent data from the AIS. There was a high degree of correlation between the positional information from these two independent sources.





1.9.2 Significant timings

The FDR and CVR timings were matched by synchronising transmissions to Waterford ATC on both devices. This provided the Investigation with a timeline of events as follows:

Call received on 112/999 from member of public	14.04 (From MRCC Log)
MRCC Dublin task R117 with SAR mission	14.05 (From MRCC Log)
Co-Pilot reaches helicopter, requests start from ATC	14.06:22
Taxi request	14.09:07
Take off	14.10:22
Arrival on scene / search begins	14.13:28
Casualties sighted / positioning	14.14:04
Winch-out begins	14.14:16
Winchman reaches casualties (SARBE activates)	14.15:02
Winch up begins	14.16:29
Winch op advises casualty has fallen	14.16:56
Winch out	14.17:05
Winchman reaches casualty	14.17:27
Winching up begins	14.17:51
Casualty in helicopter / Search resumes for '*3rd casualty*'	14.18:11
Helicopter off scene for hospital	14.21:35
Helicopter arrives at Hospital landing site	14.27:17

The response time from receipt of the call from MRCC to the helicopter being airborne was approximately six minutes. This was less than the required response time of 15 minutes to be airborne as prescribed in *OMF Section 2 SAR Readiness*. The casualties were winched at 14.16:29 hrs which means that they were in the water for at least 12 minutes.

1.9.3 Location of the Casualties

The Investigation overlaid the positional information from the AIS on to a maritime navigation chart to reconstruct the flight path of the helicopter (**Figure No. 4**). The maritime navigation chart legend stated that *"Depths are shown in metres (m) and are reduced to Chart datum which is approximately the level of Lowest Astronomical Tide"*. The SAR was conducted within one hour of High Tide, which at Dunmore East (approx. 5 km NW of Hook Head) was at 13.42 hrs on 6 December 2015.

The data indicated that the helicopter transited from Waterford Airport to Hook Head at a height of approximately 500 ft above the ground. Upon reaching the Hook Head area and commencing search operations, the helicopter descended to approximately 50 ft above the surface. During the winching operation, the helicopter remained at approximately 45 ft above the water. Since these heights were measured by radio-altimeter from the surface, the measurement would include height variations of up to 2.5 metres due to the sea swell (as noted in **Section 1.5 Meteorological Information**).

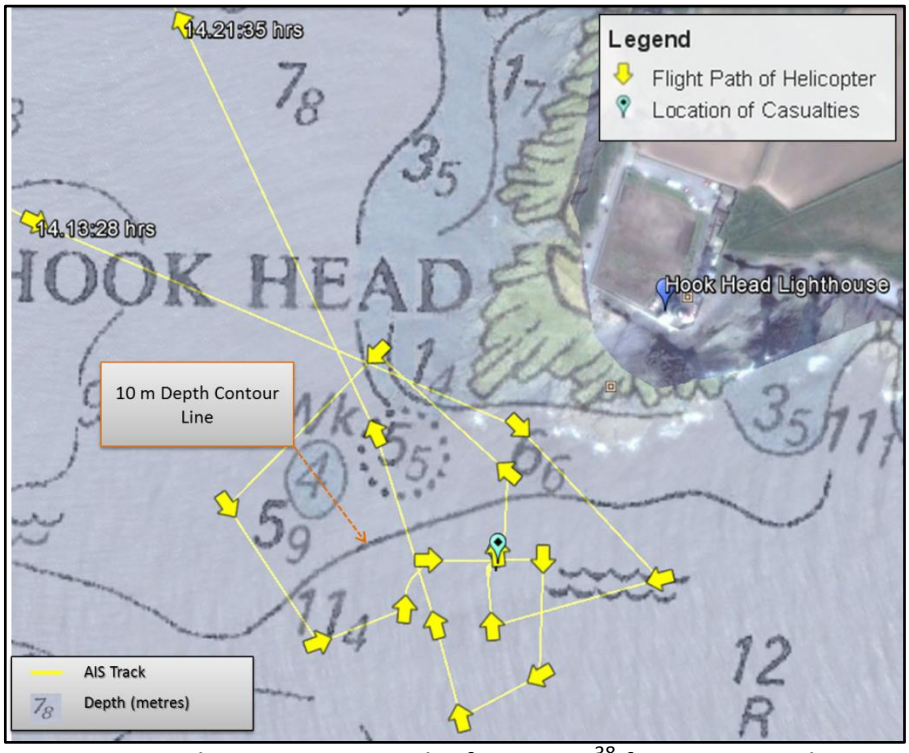


Figure No. 4: Helicopter Positional Information[38] from 6 December 2015

Timings taken from the CVR and video recorded from the shoreline indicated that the casualty fell from the strop into the water at 14.16:56 hrs. The Winchman exited the helicopter nine seconds later and reached the casualty at 14.17:27 hrs. The Winchman told the Investigation during interview that upon reaching the casualty he immediately lifted her head out of the water before placing the strop over her head. The casualty was in the water for a period of approximately 31 seconds from the fall until the Winchman reached her the second time. The casualty was subsequently winched back to the helicopter 24 seconds after being reached by the Winchman.

[38] The displayed data is a sequence of positions (latitude and longitude) plotted on the map. The lines joining each position are straight lines rather than the helicopter's specific path over the surface as the purpose of the plot is solely to establish the location of the rescue.

The location of the winching operation (**Figure No. 4**) was approximately 110 m from the coastline at Hook Head and approximately 30 m south of the 10 m depth contour line. This line joins areas with a common depth of 10 m below the sea surface as measured at low tide.

The AIS data also provided the location of all other suitably equipped vessels in the area at the time of the search and rescue mission. The nearest operational vessel in area was a fishing vessel, which was 5.6 NM south west of the casualties and the time of winching[39]. The AIS transmission from the boat concerned showed that it was engaged in fishing activity and therefore was only capable of 2-3 kts[40]. The nearest rescue vessel was an RNLI lifeboat that at the time of the winching incident was in the process of being launched from Dunmore East to assist. The Investigation examined photographs and video taken at the time and found no evidence of any non-AIS equipped vessels in the vicinity of Hook Head during the rescue. The CVR recording indicated that the helicopter crew were aware, prior to commencement of winching, that there were no vessels or IRCG vehicles available to assist at the time that the winching occurred.

1.10 Other Recorded Data

Members of the public provided the Investigation with photographic and video data that showed the sequence of events during the rescue. There were no photographs or videos available to the Investigation of the casualties entering the water prior to the 999/112 telephone call.

The photographs showed both casualties during a visit to the Lighthouse earlier in the day. The female casualty appeared to be wearing blue denim jeans, heavy boots and a black fleece-type jacket with a grey hood. It could not be determined if the jacket had buttons or a zip fastener, but the jacket was seen to be open at the front in photographs and video taken prior to the casualties entering the water. The video and photographic evidence indicated that as the female casualty fell from the hypothermic rescue strop, the open jacket was pulled up over her head and off her. The jacket fell into the water after the casualty and was not recovered from the water. The Investigation was unable to determine from the available photographic and/or video data, the orientation of the Rescue Strops on the two casualties during the winching.

1.11 Medical and Pathological Information

The male casualty was interviewed and was of the opinion that the girl was unconscious from soon after the time that they entered the water. He stated that he attempted to conduct CPR[41] on her in the water but that she was unresponsive. During interview, the Winchman stated that the female casualty was unconscious when he reached her in the water. Upon arrival at the hospital the female casualty was admitted to the Intensive Care Unit. On 8 December 2015 she was transferred to a children's hospital in Dublin; records indicate that she died at 11.30 hrs on Thursday, 10 December 2015.

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[39] Other fishing vessels were closer at the time, but were in either in port or at anchor.
[40] **Kts:** Knots, or Nautical miles per hour.
[41] **CPR:** Cardio-Pulmonary Resuscitation.

A post mortem was conducted on 11 December 2015 to establish the cause of death. It noted that the evidence was consistent with "*a period of somatic*[42] *survival following resuscitation following a near-drowning episode*". The post mortem report further noted that there was *"no evidence of any primary brain injury"* and *"no evidence of any traumatic brain injury"*.

1.12 Tests and Research - Other Operators

The Investigation examined a number of extant manuals from other organisations that engage in search and rescue activities. In particular the Investigation examined the guidance provided to crews regarding unconscious casualties being winched by use of a single strop.

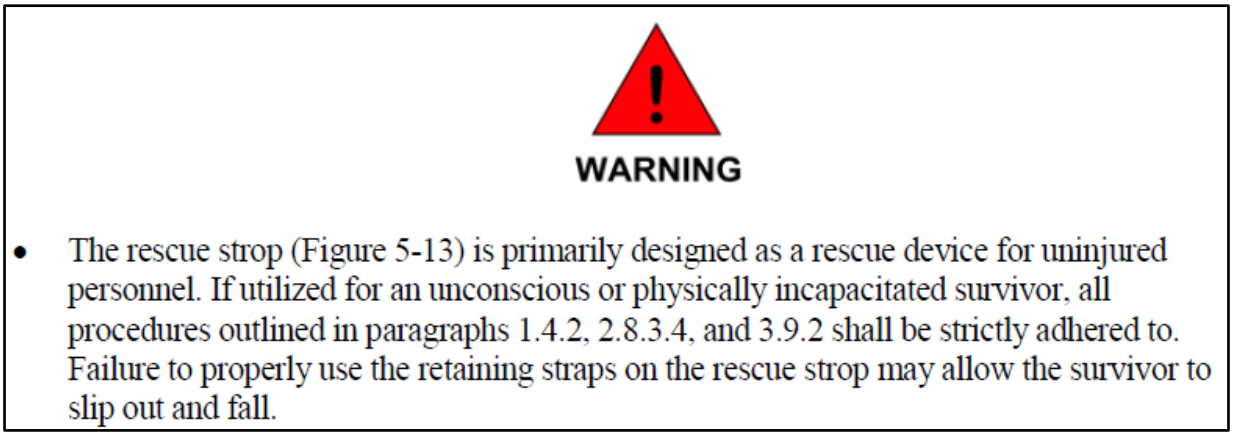
1.12.1 The *United States Coast Guard (USCG) Commandant Instruction (COMDTINST) M3710.4C Helicopter Rescue Swimmer Manual* dated 22 April 2011 provides the following warning (in RED text) in *Section 9. Vertical Surface Recovery Procedures* (i.e. winching);

WARNING

WHENEVER HOISTING USING THE QUICK STROP…FAILURE TO CONNECT THE CROTCH STRAP[43] ON AN UNCONSCIOUS OR INCAPACITATED SURVIVOR MAY RESULT IN SURVIVOR SLIPPING OUT OF THE QUICK STROP. TO MAINTAIN PROPER POSITIONING OF THE QUICK STROP, THE CROTCH STRAP SHOULD NOT BE TIGHTENED UNTIL A LOAD IS TAKEN ON THE HOIST CABLE.

23

1.12.2 The *United States Navy Search and Rescue (SAR) Manual* NTTP[44] 3-50.1 dated April 2009 includes a warning to crews engaged in recovering an unconscious casualty using a single rescue strop (**Figure No. 3)**. The warning is associated with the possibility of gravity affecting the unconscious casualty, causing their arms to lift over their head and subsequently slip through the rescue strop.



WARNING

- The rescue strop (Figure 5-13) is primarily designed as a rescue device for uninjured personnel. If utilized for an unconscious or physically incapacitated survivor, all procedures outlined in paragraphs 1.4.2, 2.8.3.4, and 3.9.2 shall be strictly adhered to. Failure to properly use the retaining straps on the rescue strop may allow the survivor to slip out and fall.

Figure No. 3: Extract from United States Navy SAR Manual NTTP 3-50.1

[42] **Somatic:** Of, affecting, or relating to the body especially, as distinct from the mind or the psyche.
[43] **Crotch Strap:** An additional strap that is integral to the Rescue Strop used by the USCG. The strop used by the Operator does not incorporate such a strap.
[44] **NTTP:** Navy Tactics, Techniques and Procedures.

1.12.3 The *Ambulance Service of New South Wales, Australia*, which was operated on behalf of the New South Wales Government by a private company, conducted SAR missions during 2012 using an Augusta Westland AW139 helicopter. The *AW139 Cabin Staff Syllabi and Training Notes*, Chapter 10: *Role Equipment*, Revision 3, dated June 2012, stated;

> ***11. RESCUE STROP / HYPOTHERMIA STROP COMBINATION***
>
> ***Introduction***
> *The Rescue Strop/Hypothermia Strop combination is used as a Rescue Strop for recovery of experienced or pre-briefed personnel who are in a fit state to keep them in the strop. They can be specifically briefed beforehand, or by a Rescue Crewman lowered to brief them prior to the winch.*

It was noted by the Investigation that in each of these manuals the use of a single strop to lift an unconscious casualty from the water was authorised on condition that the necessary risks were known to the crew and mitigated.

1.13 Tests and Research - Previous Occurrences

1.13.1 Previous Winching Occurrences - General

On 31 August 2013, the crew of a *Bell* 412EP helicopter was tasked to recover a patient who was reported to have sustained injuries during a fall in the hills near Mansfield, Victoria, Australia. The recovery was conducted with the patient in a rescue strop, accompanied by a paramedic. As the paramedic and patient reached the helicopter's skid-landing gear, the patient became increasingly unresponsive and began slipping from the rescue strop. Despite the efforts of the paramedic and winch operator, the patient slipped out of the rescue strop and fell to the ground, sustaining fatal injuries.

The Australian Transport Safety Bureau (ATSB) published a preliminary investigation report into the event on 15 October 2013. On the same day the Australian Civil Aviation Safety Authority (CASA) issued Airworthiness Bulletin (AWB) 25-025 (see **Appendix A**) to "*clarify the use and application of Rescue/Retrieval Strops"*. The ATSB Final Report (AO-2013-136) was published on 7 April 2015. While the circumstances surrounding this accident are somewhat different to the mission at Hook Head, both occurrences resulted in an unconscious casualty slipping through the rescue strop and falling. The CASA AWB made the following Recommendation:

> *As a Rescue Strop requires active participation by an occupant who is not formally trained in its use and may likely be in a highly stressful situation, the following points should be considered prior to use of the strop:*
>
> *1) Whether life is at imminent risk;*
> *2) The state of the person to be winched, particularly whether the rescuee will remain conscious and coherent during the winch process;*
> *3) The potential for the person to remain compliant with winching brief;*
> *4) Alternative methods and devices to recover the person; and*
> *5) Whether the risk of falling from the device would not result in further serious injury or death.*

The ATSB Final Report of the 31 August 2013 event also highlighted the medical issues which must be considered in relation to any use of a strop to lift casualties. It stated:

Haagensen and others (1998) compared the lung ventilatory capacity of 12 healthy male subjects who were suspended in a rescue strop, a rescue strop with hypothermic strap or in a stretcher. Ventilatory capacity was found to be significantly reduced amongst the participants in all lifting techniques as compared to the standing position. The rescue strop was assessed by 10 of the 12 participants as having the most adverse effect on their breathing capacity.

The researchers concluded that the reduction in ventilatory capacity would be easily tolerated by healthy individuals, but should be considered when planning to winch patients with severe respiratory problems. They also noted that an unconscious patient can slip out of either a rescue strop or a rescue strop with hypothermic strap...

Murphy [*[45]*] *and others (2011) noted that current winch rescue methods have significant limitations, '*including the potential for cardiorespiratory compromise due to direct chest compression and/or posture'*. They compared the effects on 27 healthy adult subjects in Australia ranging in weight from 45 to 106 kg of being suspended in a rescue strop, rescue strop with hypothermic strap, a rescue stretcher and a rescue basket…. The researchers measured forced expiratory volume in 1 second (FEV1), forced vital capacity (FVC), FEV1/FVC ratio, inspiratory capacity (IC) and heart and respiratory rates. These measurements were compared to those when in a normal seated position.*

The rescue strop was associated with significant decreases in FEV1, FVC and IC and significant increases in heart and respiratory rates. The rescue strop with hypothermic strap and the stretcher resulted in decreases in FEV1 and FVC, but much less than those for the rescue strop and no significant variations of heart and respiratory rates were observed. The rescue basket had no influence on any of these parameters. The researchers concluded that further caution was required regarding the use of the rescue strop and that the use of the rescue strop with hypothermic strap was a more benign alternative.

1.13.2 Previous Winching Occurrences - Ireland

EU Regulation (EU) 376/2014 states that "*relevant civil aviation safety information should be reported, collected, stored, protected, exchanged, disseminated and analysed, and appropriate safety action should be taken on the basis of the information collected. This proactive and evidence-based approach should be implemented by the relevant aviation safety authorities of Member States, by organisations as part of their safety management system*". In Ireland, the Irish Aviation Authority (IAA) operates a *Safety Occurrence Tracking System* (SOTS) for this purpose. The Investigation reviewed the SOTS database and noted that there was no previous report of a casualty slipping through a rescue strop and falling into the water. The Operator similarly informed the Investigation that they had received no reports of such an occurrence through their internal safety reporting system.

[45] Murphy, D Garner, A Bishop, R 2011, 'Respiratory function in hoist rescue: comparing slings, stretcher, and rescue basket', *Aviation, Space, and Environmental Medicine*, vol. 82, pp. 123-127.

1.13.3 Casualty Responsiveness Data

In November 2016, the UK Marine Accident Investigation Branch (MAIB) published a Report into a fatal accident where a crew member of a fishing vessel fell overboard. The Report included data from other marine occurrences in the UK, reproduced here for the years 2015 and 2016 as **Table No. 3,** showing the time taken for a victim to become unresponsive after falling from a boat and entering cold water. The Report stated that *"In the majority of these cases the person in the water was initially responsive and able to help themselves before they rapidly succumbed to the incapacitating effects of cold water"*.

Vessel name	Date	Sea state	Water temperature	Victim unresponsive in water
King Challenger	23/06/2016	Slight	10.5°C	4 minutes
Our Sarah Jane	09/06/2016	Slight	12°C	8 minutes
Apollo, INS179	18/04/2016	Rough	9°C	7 minutes
Annie T	04/10/2015	Heavy swell	12°C	10 minutes
Aquarius	17/08/2015	Slight	14°C	10 minutes
Enterprise	09/07/2015	Rough	13°C	15 minutes

Table No. 3: Time for victim to become unresponsive based on MAIB data 2015-2016 (MAIB)

Data provided by the Irish Marine Institute indicated that the sea temperature at Dunmore East on 6 December 2015 between 13.30 hrs and 17.00 hrs was approximately 11°C.

2. ANALYSIS

2.1 General

Search and rescue missions are, by their nature, high risk relative to other aviation operations. Comprehensive procedures and processes are required to ensure the safety of the casualties and crews concerned. Robust and extensive training and checking programmes are crucial to ensure that crews achieve and maintain the necessary standards of proficiency. Notwithstanding this, the dynamic and unpredictable nature of SAR operations and the potential for imminent risk to life means that there is always the possibility for a scenario to develop that has not previously been trained for. This may require the crew member to select a particular course of action based on previous individual experience, on the information available at that time, and on their best judgement while under significant time pressure.

2.2 The Crew

The Crew had been off duty for 24 hours prior to commencing the current duty period. The timing of the tasking from the MRCC meant that the crew had completed a full initial duty briefing and an equipment check as part of the handover from the off-going crew within the 60 minutes prior to launch. This contributed to the launch time for this mission being less than the minimum 15 minutes readiness prescribed in the *OMF Section 2; SAR Readiness*.

The Crew for the mission had significant experience of SAR operations, with both Pilots being qualified aircraft commanders on the S-92 helicopter for AWSAR missions. Each of the four Crew members fulfilled or exceeded the applicable training requirements listed in the *OMF Section 5.2.4. Hover Reference Winching.* During interviews with the Crew and other senior SAR crew personnel there was a shared view that the same winching procedures would be used irrespective of whether a casualty was conscious or not.

2.3 Survival Aspects

The location of the winching operations was approximately 110 m from where the casualties entered the water at Hook Head and approximately 30 m south of the 10 m depth contour line (See **Figure 4)**. This contour line joins sea areas with a common depth of 10 m below the surface as measured at low tide. The post mortem noted that there was *"no evidence of any primary brain injury"* and *"no evidence of any traumatic brain injury"*. Given the available information, the Investigation has concluded that the unconscious female casualty fell from the strop into open water of at least 10 m depth.

The Investigation analysed the mission times extracted from the FDR and AIS to estimate the casualties' immersion time in the water. As it is likely that the call to the MRCC occurred shortly after the casualties entered the water, the time of immersion was estimated to be approximately 12 minutes. This is less than the 30 minutes of immersion that would cause sufficient hydrostatic compression to necessitate a hydrostatic or double strop lift. However, it is within the time period indicated by the MAIB data (**Table No. 3**) when a casualty would be expected to become unresponsive after entering cold water.

2.4 Rescue Strops

The Investigation requested the Manufacturer to comment on the use of the Hypothermic Rescue Strop for lifting a casualty from the water. The Manufacturer informed the Investigation that *"It can also be used as a Rescue Strop on its own"* as it is sufficiently strong, with a similar basic construction to the primary Helicopter Rescue Strop. There was no evidence of wear and tear, damage or failure of either strop. The Investigation was unable to determine from the available photographic and video data, the orientation of the strops on the two casualties during the winching. The Winchman recalled that he placed the female casualty into the Hypothermic Rescue Strop "*legs to the centre*, *head out, through the strop*…*with the toggle tightened*". In any case, the Manufacturer advised that other lifting methods, such as the reverse lift, are possible and have been used by other organisations. However, they should be considered only in the most extreme of situations as "*there is a quantifiable greater risk*" in doing so. The Manufacturer confirmed that it did not provide guidance on the use of their rescue strops with injured, or in particular, unconscious casualties and that *"This is left to the customers' specific SOPs."*

2.5 Operator's Documentation

The Investigation reviewed the Operations Manuals and did not identify any differences in the procedures for winching with a strop(s) based on the casualty's condition, or additional guidance in the Operations Manuals regarding the state of consciousness of a casualty prior to winching.

There was no guidance on unconscious or unresponsive casualties in *OMF Section 3.13.1 Types of Lift* relating to multiple casualties in the water, and *Section 3.13.4 Multiple Lift* referred to multiple casualties only when *"on deck or in the life-raft".* This Section also stated that "*the winchman will be lowered with two strops on the winch hook"* but did not specify which Strop(s) to use in this scenario.

OMF Section 3.13.7 Stretcher lift referred to lifting an unconscious casualty by use of a stretcher. The Helicopter Crew and a number of other senior SAR-qualified personnel considered a stretcher to be unsuitable for use during this mission as it would have taken a longer time to reach the casualties and the stretcher can only lift one casualty at a time. Furthermore, the mandatory use of the '*Hi-Line*' associated with a stretcher lift was not possible in this scenario as neither casualty had the capability, or was in a condition, to control the line. Finally, the Crew of the helicopter and a number of other senior SAR-qualified personnel employed by the Operator stated that a stretcher would not be used when lifting a casualty from the water.

The Investigation noted that *OMF Section 3.13.1* stated that "*procedures may have to be modified to suit individual situations",* thereby acknowledging that a winchman may need to use their judgement during a SAR mission in order to effect the successful winching of a casualty. While the Investigation accepts that SAR missions may require such initiative on the part of the crew, it is considered appropriate that guidance on the risks associated with winching an unconscious casualty using a Rescue Strop should be provided to the Operator's SAR personnel.

2.6 Conduct of the Rescue

When the Winchman entered the water he was faced with the task of recovering a male casualty and a female casualty who was unresponsive. The Winchman was of the opinion that if he winched the female casualty to the helicopter first, then the male casualty may have been unable to remain afloat until the Winchman returned. He considered the location of the casualties, their physical condition and the lack of available local assistance. He concluded that lifting both casualties simultaneously was the only viable course of action. The Investigation considers that the Winchman made a reasonable decision given his perception of the prevailing circumstances, the imminent risk to life and the consequent time pressure that he faced. The Investigation acknowledges the challenges faced by the Winchman in placing each casualty into a separate rescue strop and preparing them for winching in a rolling sea and trying to secure both casualties during the winching process. The Investigation also acknowledges the exceptional effort made by the male teenager in keeping the female casualty afloat until the arrival of the SAR Helicopter, despite the immediate and significant risk to his well-being.

The Investigation examined a number of operations and training manuals from other organisations engaged in SAR missions and noted that while the winching of an unconscious casualty by use of a rescue strop was permitted, guidance was issued to crews engaged in such missions identifying the risks associated with winching an unconscious casualty.

In 2013, following the publication of a preliminary investigation report by the ATSB, the Australian CASA issued an AWB (**Appendix A**) associated with a fatal accident where an unconscious casualty slipped from a rescue strop during a rescue mission. The five points listed in paragraph 4 of the AWB provide the basic framework for the creation of a risk assessment for winching casualties. Applying the content of the AWB to the mission undertaken on 6 December 2015, the Investigation is of the view that the lives of the two casualties were *'at immediate risk'*. In the case of the Hook Head event, the Winchman took the decision to lift both casualties simultaneously, one of whom was unresponsive. This decision was based on the Winchman's previous SAR experience as there was no guidance in the Operator's *OMF* for the winching of unconscious casualties from the water using strops. In the circumstances of this particular rescue, there is nothing to suggest that the Winchman's decision-making was anything other than sound. However, the Investigation considers that such a scenario where there are multiple conscious and/or unconscious casualties in the water requiring immediate rescue by use of a Rescue Strop(s) is an event for which the Operator should issue guidance to crews.

In light of the CASA AWB Recommendation, the documented guidance in the manuals of other SAR operators and the observations of the strop Manufacturer, the Investigation accordingly issues a Safety Recommendation to the Operator in this regard.

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Safety Recommendation No. 1

CHC Ireland should provide documented guidance to their SAR crews that can be used to assess and address the operational and medical risks associated with winching casualties, whether conscious or unconscious, by use of a helicopter rescue strop.

(IRLD2017004)

3. CONCLUSIONS

(a) Findings

1. The Commander of the Waterford-based helicopter Crew was tasked with an immediate SAR mission by the MRCC Dublin.

2. The SAR Crew were qualified to undertake the mission.

3. The SAR Crew had commenced duty at 13.00 hrs on the day of the occurrence and had been off duty for 24 hours prior to reporting for the duty.

4. The SAR Crew had completed an initial mission briefing on commencing duty thereby reducing the time taken by the crew to respond when tasked by the MRCC.

5. The response time from receipt of the call from the MRCC to the helicopter being airborne was approximately six minutes.

6. Information provided to the helicopter Crew about how many casualties were in the water changed a number of times during the mission.

7. The hydrostatic (double strop) lift was the Operator's standard method of winching casualties from the water.

8. The Winchman decided that given the prevailing circumstances at the time, the only viable course of action was to attempt to lift both casualties simultaneously.

9. There were no other vessels or vehicles available to support the Helicopter Crew during the winching operation.

10. The casualties had been in the water for at least 12 minutes prior to being winched.

11. As the Winchman and casualties reached the door of the helicopter, the unconscious female casualty slipped through the Hypothermic Rescue Strop and fell from a height of approximately 45 ft into open water of at least 10 m depth.

12. From the time that the Winch Operator advised the Commander that the female had fallen from the strop until he advised that the Winchman had reached her again was approximately 31 seconds.

13. There was no evidence of wear and tear, damage or failure of either the Helicopter Rescue Strop or the Hypothermic Rescue Strop used during the mission.

14. There was a shared view among the Operator's SAR personnel interviewed by the Investigation that SAR crews used the same winching procedures irrespective of whether a casualty was conscious or not.

15. A review of the Operator's manuals confirmed that the same guidance was provided to crews for winching casualties, whether conscious or unconscious, from the water.

16. The strop Manufacturer informed the Investigation that, apart from the instruction label on the Helicopter Rescue Strop, it does not provide guidance on the use of strops to lift unconscious casualties and leaves this to the Operator's SOP's.

17. The strop Manufacturer informed the Investigation that other lifting methods, such as the reverse lift, are possible and have been used by other organisations. However, they should be considered only in the most extreme of situations as there is a quantifiable greater risk in doing so.

18. There was a lack of documented guidance in the Operator's *OMF* specific to winching unconscious casualties from the water using strop(s).

19. The Operator's *OMF* did not provide guidance to SAR crews on the medical implications for all casualties when using a Rescue Strop(s).

(b) Probable Cause

A casualty slipped through the Hypothermic Rescue Strop and fell into the water during the simultaneous winching of two casualties.

(c) Contributory Cause(s)

1. An imminent risk to the lives of both casualties.

2. The female casualty was unresponsive prior to winching.

4. SAFETY RECOMMENDATIONS

No.	It is Recommended that:	Recommendation Ref.
1.	CHC Ireland should provide documented guidance to their SAR crews that can be used to assess and address the operational and medical risks associated with winching casualties, whether conscious or unconscious, by use of a helicopter rescue strop.	IRLD2017004
View Safety Recommendations for Report 2017-005		

Appendix A; ATSB AIRWORTHINESS BULLETIN (AWB) 25-025 – Rescue Strops

Australian Government
Civil Aviation Safety Authority

AIRWORTHINESS BULLETIN

Rescue Strops

AWB 25-025 **Issue :** 1
Date : 15 October 2013

1. **Effectivity**

   All ATSO-C1003 Rescue/Retrieval Strops

2. **Purpose**

   To clarify use and application of Rescue/Retrieval Strops.

3. **Background**

   Rescue Strops were originally designed for retrieval of persons from the water in rescue situations. They were designed as an alternative to using 3 or 5 point harnesses which are problematic to don in a water environment. A separate version was developed to lift persons who may be suffering hypothermia.

   ATSO-C1003 Rescue/Retrieval Strop refers to AS/NZS 1891.1:1995 Amdt 4 Retrieval Strap as the base standard. AS/NZS 1891.1:1995 defines a Retrieval Strap as "an upper torso harness designed for the attachment of a line in a rescue situation".

   A Rescue strop (excluding the Hypothermic version) requires the occupant to be conscious and compliant, and requires active participation from the occupant to ensure safe use. The occupant must follow directions correctly from a trained operator throughout the winch.

4. **Recommendations**

   As a Rescue Strop requires active participation by an occupant who is not formally trained in its use and may likely be in a highly stressful situation, the following points should be considered prior to use of the strop:

   1) whether life is at imminent risk;
   2) the state of the person to be winched, particularly whether the rescuee will remain conscious and coherent during the winch process;
   3) the potential for the person to remain compliant with winching brief;
   4) alternative methods and devices to recover the person; and
   5) whether the risk of falling from the device would not result in further serious injury or death.

5. **Enquiries**

   Enquiries with regard to the content of this Airworthiness Bulletin should be made via the direct link e-mail address:

   AirworthinessBulletin@casa.gov.au

   or in writing, to:

   Airworthiness and Engineering Standards Branch
   Standards Division
   Civil Aviation Safety Authority
   GPO Box 2005, Canberra, ACT, 2601

- END -

In accordance with Annex 13 to the Convention on International Civil Aviation, Regulation (EU) No. 996/2010, and Statutory Instrument No. 460 of 2009, Air Navigation (Notification and Investigation of Accidents, Serious Incidents and Incidents) Regulation, 2009, the sole purpose of this investigation is to prevent aviation accidents and serious incidents. It is not the purpose of any such investigation and the associated investigation report to apportion blame or liability.

A safety recommendation shall in no case create a presumption of blame or liability for an occurrence.

Produced by the Air Accident Investigation Unit

AAIU Reports are available on the Unit website at www.aaiu.ie

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