Air Accident Investigation Unit Ireland

SYNOPTIC REPORT

Accident
Robinson R44 Clipper II, G-DORM
Near Carlingford, Co. Louth, Ireland

12 March 2017

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 No. 460 of 2009, the Chief Inspector of Air Accidents, on 12 March 2017, appointed John Owens as the Investigator-in-Charge to carry out an Investigation into this Accident and prepare a Report.

Aircraft Type and Registration:	Robinson R44 Clipper II, G-DORM
Number and Type of Engines:	1 x Lycoming IO-540-AE1A5
Aircraft Serial Number:	12330
Year of Manufacture:	2008
Date / Time (UTC):[4]	12 March 2017 @ approximately 17.14 hrs
Location:	Approximately 1 nautical mile (NM) south of Carlingford, Co. Louth, Ireland
Type of Operation:	General Aviation
Persons on Board:	Pilot - 1 Passengers - 1
Injuries:	Pilot - 1 (serious) Passengers - 1 (serious)
Nature of Damage:	Helicopter destroyed
Commander's Licence:	Private Pilot Certificate (Rotorcraft-Helicopter) issued by the Federal Aviation Administration (FAA) of the United States of America (USA)
Commander's Age:	71 years
Commander's Flying Experience:	220 hours, of which 54 were on type
Notification Source:	Telephone call from the Emergency Aeromedical Service (EAS)
Information Source:	AAIU Field Investigation AAIU Report Form submitted by Pilot

[4] **UTC**: Co-ordinated Universal Time. All times in this Report are UTC, which was the same as local time on the date of the accident.

SYNOPSIS

While approaching to land at a site on the Pilot's property beside his house near Carlingford, Co. Louth, control of the helicopter was lost. This resulted in the helicopter's main rotor making contact with the surface of a public road before the helicopter impacted with dense trees/shrubs in the garden of a neighbour's house. The helicopter was destroyed. There was no fire. The Pilot and the one Passenger on board sustained serious injuries and were subsequently freed from the helicopter wreckage by the emergency services, before they were taken to hospital.

NOTIFICATION

The AAIU was informed of the accident by the EAS, who had been notified by the National Ambulance Service (NAS). Three AAIU Inspectors travelled to the scene and arrived there at approximately 20.00 hrs to commence an Investigation. The wreckage of the helicopter was recovered the following day to the AAIU's examination facility in Gormanston, Co Meath.

1. FACTUAL INFORMATION

1.1 History of the Flight

The helicopter left Derryogue airfield, which is approximately 1.2 NM south-west of Kilkeel, Co. Down, Northern Ireland, in the United Kingdom (UK) at approximately 17.05 hrs on a private flight with the Pilot and one Passenger on board. The Pilot reported that it was his intention to fly along the northern shore of Carlingford Lough towards Ballyedmund Castle (near Rostrevor), before routing north-east to Slieve Croob airfield, both of which are located in Co. Down (**Figure No. 1**). The Pilot reported that as he crossed over Cranfield, which is located close to the northern entrance of Carlingford Lough, "*the weather became very windy and extremely uncomfortable*". He stated that he decided instead to fly to his house near Carlingford, on the southern side of the Lough (and located within Ireland), which was "*only 3 to 4 minutes"* away.

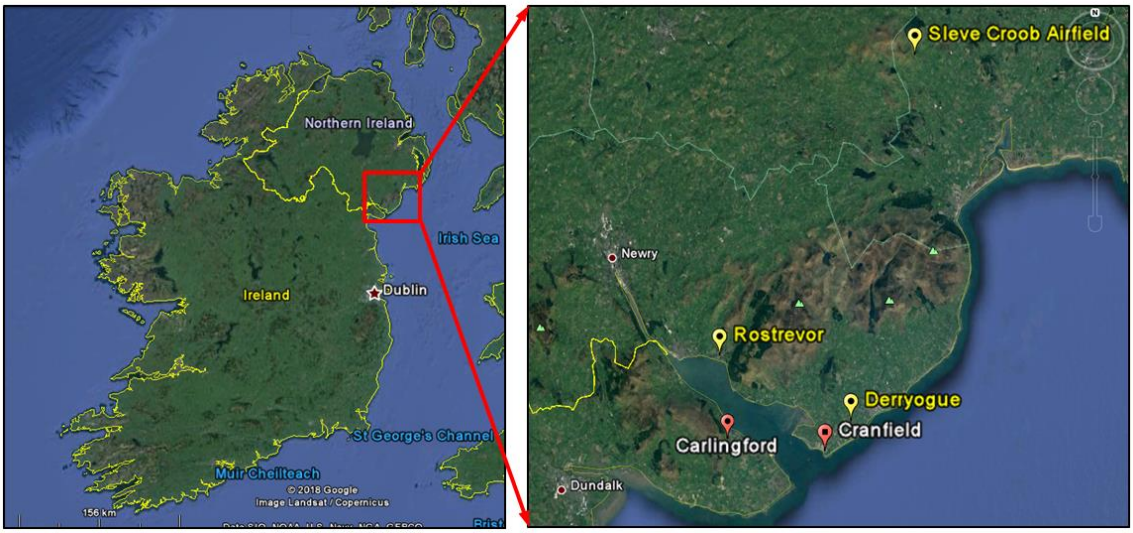

Figure No. 1: Derryogue, Cranfield, Rostrevor, Slive Croob and Carlingford (*Google Earth*)

Witnesses described seeing the helicopter approaching to land at the Pilot's house, before control was lost. The helicopter eventually came to rest on a heading of approximately 260 degrees magnetic, in dense trees/shrubs in the garden of a neighbour's house, to the east of a public road which separated the two houses (**Photo No. 1**). The house was unoccupied at the time. One witness to the accident, who was first to arrive at the scene, cut a restraint harness in the cockpit to make one of the occupants more comfortable until the emergency services arrived.

The two occupants were subsequently freed from the helicopter by emergency service personnel who arrived a short time later. The Pilot was airlifted by Irish Coast Guard helicopter to a Dublin hospital. The Passenger was taken by road ambulance to a local hospital.

Photo No. 1: Final resting position of G-DORM (main rotor blades annotated)

1.2 Radar Data

Radar data was obtained from Dublin Air Traffic Control (ATC) which showed the accident flight. The helicopter, which was fitted with a transponder[5], was first visible on radar at 17.05:24 hrs, approximately 0.5 NM south-west of Derryogue Airfield and at an altitude of approximately 300 feet (ft). The radar data shows the helicopter climbing while proceeding in a south-westerly direction across Carlingford Lough. At approximately 1,000 ft, having crossed the Lough, the helicopter turned and continued in a north-westerly direction. At approximately 1,300 ft, a descent was commenced while the helicopter was over the Carlingford peninsula.

Positional information extracted from the radar data indicates that the helicopter continued in a north-westerly direction and flew to the east of the landing site beside the Pilot's house, before turning towards the north-east (towards Carlingford Lough).

[5] **Transponder:** A receiver/transmitter that will generate a reply signal upon proper interrogation; the interrogation and reply being on different frequencies.

The data indicates that the helicopter then flew in a southerly direction before turning back towards the north-west in the direction of the landing site. The data also indicates that this section of the flight was to the west of the earlier track. Radar data ceased at 17.13:57 hrs when the helicopter was at an altitude of approximately 700 ft and approximately 0.25 NM to the south-east of the accident site.

1.3 Injuries to Persons

The Pilot and Passenger suffered serious injuries as a result of the accident.

1.4 Damage to Aircraft

The helicopter was destroyed. There was severe disruption to the cockpit area (**Photo No. 2**) and extensive damage to the main rotor blades, with one blade sustaining more damage than the other. The rotor blade that sustained most damage was bent downwards from approximately 1.3 m from the blade root. The outermost section of the blade, approximately 0.8 m in length, was bent upwards and rearwards (with reference to the direction of rotation). The lower surface of this section bore multiple scrape marks. Similar marks were also present on the lower surface, inboard of the bending point, for approximately another 0.8 m. The outermost section of the other main rotor blade, approximately 0.4 m in length, was bent rearwards (with reference to the direction of rotation). The blade tip cap was missing. The lower surface of this section also contained multiple scrape marks.

The aluminium fairing surrounding the main rotor mast sustained compressive damage to its entire leading edge. Small pieces of tree/shrub material were found trapped in the folded aluminium. The aluminium skin on the right hand side of the tail boom (close to the forward section of the helicopter) was torn, resulting in the partial separation of the boom. The aft section of the boom was bent downwards and the tail rotor drive shaft was fractured into two pieces. There was no evidence of flailing damage adjacent to the fractured drive shaft. The tail rotor blades did not sustain any damage.

Photo No. 2: Damage to helicopter (photograph taken during wreckage recovery)

1.5 Other Damage

The surface of the road close to the helicopter's final resting position exhibited a gouge approximately 0.8 m in length and a scuff mark extending from this gouge towards where the helicopter lay. An oval-shaped scuff mark was also visible approximately 0.7 m from the gouge. In addition, substantial damage was caused to the trees/shrubs at the helicopter's final resting position. There was no apparent damage to the stone walls which bounded the road (**Photo No. 3** and **Photo No. 4**).

Photo No. 3: Damage to road surface in foreground (circled), with helicopter in dense trees/shrubs behind wall in background (main rotor blade annotated)

Photo No. 4: Aerial image showing damage to road surface (circled), with helicopter in dense trees/shrubs (main rotor blades annotated)

1.6 Personnel Information

The Pilot reported to the Investigation that his flying experience was as follows:

Total all Types:	220 hours
Total on Type:	54 hours
Last 28 Days:	10 hours
Last 24 Hours:	1 hour

The FAA issued the Pilot with a Temporary Airman Certificate on 7 January 2017, following the successful completion of a flight test. According to the FAA, this document is valid for a period of 120 days while the actual Private Pilot Certificate is being processed. The FAA informed the Investigation that the Pilot's Private Pilot Certificate, which contains the same issue date as that of the Temporary Airman Certificate, was processed on 21 February 2017.

The Pilot's '*Medical Certificate Second Class*' was issued by an FAA-approved Aeromedical Examiner on 2 November 2015 which, according to the United States' 14 CFR[6] 61.23, in the case of the Pilot, was valid for 24 months "*after the month of the date of examination shown on the Medical Certificate*".

1.7 Aircraft Information

1.7.1 General

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The four-seat helicopter, a Robinson R44 (Clipper II), was manufactured in 2008. It was fitted with a Lycoming IO-540-AE1A5 six-cylinder reciprocating engine. This powered a counterclockwise-rotating (viewed from above) two-bladed main rotor, with a diameter of 10.06 metres (m) and a two-bladed tail rotor, with a diameter of 1.47 m (mounted on the left hand side of the tail). The Manufacturer's Pilot's Operating Handbook (POH) describes the main and tail rotor blades as "*all-metal*".

This helicopter type is fitted with two inter-connected collective control levers[7], with one located to the left of each front seat. A cyclic control stick[8] is located between the front seats and is designed to be operated from the right hand seat. An extension piece/adapter can be secured to the cyclic control stick by means of a quick release pin, to permit operation from the left hand seat. An '*RPM[9] governor*' is also installed, which according to the POH, is designed to assist in controlling engine RPM "*under normal conditions*". The governor is active when the toggle switch on the end of the right hand collective lever is switched ON and the engine RPM is above 80%.

[6] **CFR:** Code of Federal Regulations.
[7] **Collective control lever:** This lever changes the pitch angle of both main rotor blades simultaneously, and on this helicopter type, adjusts the engine throttle, thereby increasing or decreasing lift/thrust.
[8] **Cyclic control stick:** This stick changes the pitch of the main rotor blades during each cycle of rotation, resulting in the rotor disc tilting in a particular direction and causing the helicopter to move in that direction.
[9] **RPM:** Revolutions Per Minute.

A twist-grip throttle control is located on each collective lever. However, in normal flight, a throttle correlator opens the throttle as the collective lever is raised. According to the helicopter Manufacturer, the pilot may not have to manipulate the twist grip at all during normal flight, except for increasing the engine RPM at the beginning of a flight and decreasing it at the end. The Manufacturer also stated that a normal approach to land would not require any throttle control by the pilot, but that some situations such as an aggressive flight manoeuvre may require a twist grip input.

The POH outlines that each seat is equipped with a combined seat belt and inertia-reel shoulder strap and that "*four or five point harnesses are optional for the front seats*". In the case of G-DORM, each front seat was equipped with a four-point harness.

Pop-out floats, which according to the POH, are "*intended for safety during over water flights*", were fitted to the helicopter's landing skids. The floats can be inflated with helium from an on-board high pressure cylinder by activating a lever located on the right hand collective control lever. A safety pin can be fitted to the release valve on the cylinder to prevent inadvertent pressure release during maintenance and to facilitate cylinder transport.

The helicopter was fitted with a portable satellite navigation system. Assistance was requested from the UK Air Accidents Investigation Branch (AAIB) in an attempt to download the GPS data from the unit. The unit is capable of storing flight logs on internal (volatile) memory that is dependent on an internal battery to maintain its contents. However, the AAIB found that the battery was depleted on the unit removed from G-DORM, and although it was still capable of navigation, the recording of flight logs was not possible.

1.7.2 Airworthiness and Maintenance Certification

The helicopter's Certificate of Airworthiness was issued by the UK CAA on 22 September 2008. An Airworthiness Review Certificate was issued by an approved Continuing Airworthiness Management Organisation (CAMO) on 2 March 2017 and was valid until 1 March 2018. Maintenance records indicate that a 50-hour scheduled maintenance inspection was performed on 17 February 2017.

The helicopter Manufacturer issued Service Bulletin SB-78B on 28 September 2012, which required R44 helicopters with all-aluminium fuel tanks to be retrofitted with bladder-type tanks "*to improve the R44 fuel system's resistance to a post-accident fuel leak*". The SB states that it should be complied with "*as soon as practical, but no later than 30 April 2013*". The European Aviation Safety Agency (EASA) subsequently issued an Airworthiness Directive (AD No. 2014-0070) on 19 March 2014 (effective 2 April 2014), which mandated the incorporation of the SB within 24 months of the effective date of the AD. Maintenance records indicate that the SB was incorporated on G-DORM on 21 October 2016.

The Pilot informed the Investigation that he acquired the helicopter in late October/early November 2016. Extracts from the helicopter's logbook indicate that the helicopter did not fly from 1 April 2016 until 21 October 2016.

1.7.3 On-Site Examination

When the Investigation examined the helicopter at the accident site, the helicopter's two fuel tanks each contained a large quantity of fuel. The extension piece for the cyclic control stick to permit operation from the left seat was not fitted. The associated quick-release pin was present in the control stick. The engine RPM governor toggle switch, located on the end of the right hand collective lever, was found to be in the ON position.

The Investigation observed that the left hand shoulder strap at the left hand front seat had been cut. The safety pin was found fitted to the pressure cylinder for the landing skid floats. Due to the extent of the damage to the helicopter, it was not possible to verify control continuity; however, there were no discontinuities in the linkages examined.

1.8 Interviews

1.8.1 Witnesses

Several witnesses to the accident were interviewed by the Investigation. The following are synopses of three of their accounts:

1.8.1.1 Witness No. 1

Witness No. 1 was walking with two other persons on the road close to the Pilot's house. The witness saw the helicopter flying towards the landing site and said that it then "*turned around and went back out towards the lough*". The witness said that when the helicopter came back in to land the tail started to "*sway*" (swing from side to side) and that the helicopter *"came back up and swung around*" and "*started to spin out of control*". The witness said that the helicopter "*spun forwards and backwards and around* […] *you couldn't actually tell which way it was going to land or fall*". The witness was asked about the direction of spin and recalled that "*looking up at the sky*", the helicopter was spinning "*anticlockwise*" (counterclockwise). The witness described running with the two other persons to avoid the impact and therefore did not actually see the impact occurring.

1.8.1.2 Witness No. 2

Witness No. 2, who was situated approximately 300 m to the south-east, heard the helicopter shortly after five o'clock. The witness reported that the helicopter came in from the south but recalled seeing it approach from the east on previous occasions and also seeing it land and take-off the day before.

The witness remembered noticing that the windsock at the landing site was "*out at horizontal"* and that *"there was a good northerly breeze*". The witness said that the helicopter "*was going into the wind*". The witness recalled that the helicopter went over the Pilot's house *"as usual towards his landing spot and started to go straight down"*. The witness said that "*he wasn't fully down, because when he's fully down, I can't actually see him land, so I can't see his rotors, but I still saw his rotors, so he didn't touch down*".

The witness commented that "*he came back up then quite rapidly, about 20 or 30 feet* […] *and he was still in a horizontal position at that stage and he started to rotate anticlockwise and he did about three rotations anticlockwise but on a level and I thought maybe he was just jockeying for position* […] *but then the rotation escalated and the noise went up*". The witness said that there were "*no signs of anything breaking. I didn't see anything come off it, no smoke, nothing like that. Everything seemed normal, but then the noise increased and he started to go up and came straight across in an arc, rotating the whole time* […]". The witness then heard a "*thud*", requested a family member to ring the emergency service, drove towards the accident site, and was first to arrive at the scene. The witness "*cut the straps*" to make the Pilot more comfortable until the emergency services arrived and said that "*I saw the switches and I thought about fuel and I turned a couple of the switches off*".

The witness was "*surprised to see* [the helicopter] *on the level, because the angle that it came in at, I thought it was going to be upside down, or mounted into the ground at an angle".* The witness again recalled that when the helicopter approached initially it appeared to be "*quite controlled*". The witness didn't see the tail swinging from side to side (as observed by Witness No. 1), but commented on the speed that the helicopter came back up with: "*He came back up very rapidly* […] *he didn't disappear, so he hadn't actually touched down* […] *he must have been within 10-15 feet over the ground* […] *and then it was a very rapid ascent of 20 or 30 feet and then the rotations started*".

1.8.1.3 Witness No. 3

Witness No. 3, who was approximately 800 m away, saw the helicopter "*coming into land*" The witness said "*everything was looking perfect*, *with the helicopter and he was landing into the wind*". The witness noted that the helicopter "*was descending and the engine sounded to me normal as I would know it*". The witness recalled that "*as* [the helicopter] *descended, I couldn't tell you how high he was from the ground at that point, but he was hovering and the next thing the helicopter seemed to start to become unstable*". The witness said that the Pilot "*then appeared to try to lift off again and the helicopter spun round and at that point he was in obviously a lot of difficulty* […] *he was now coming with the wind and the helicopter* […] *went on its side. I could see the bottom of the helicopter sideways-on and it was descending really rapidly then and then I heard a thud. From where I was I couldn't* […] *see it hit the ground*".

1.8.2 Interview with Pilot

Due to the extent of his injuries, the Pilot was unable to be interviewed by the Investigation until three months after the accident. When interviewed, he said that earlier on the day of the accident he had flown from his house near Carlingford to Derryogue, where he remained for a "*couple of hours*". He stated that he left Derryogue sometime after five o'clock with the intention of flying to Slieve Croob, but because the flying conditions became "*very, very bumpy*", he decided to return home. The Pilot reported that he approached the site from the south-east. He said that the wind was "*north, slight north-westerly and just when I got here* [near the accident site]*, something seemed to hit me like a squall and pushed me down*". He said that he had experienced "*rogue winds*" at the site before which caused him to "*go-around*" (abort the landing). The Pilot acknowledged that he could see the wind sock at the site and that it was "*fairly full*", indicating that the wind speed was "*somewhere between 15* [and] *20* [kts]".

During interview, the Pilot did not recall descending to land and then ascending as noted in witness accounts (**Section 1.8.1**) and said there was "*no go-around*" on this occasion. He suggested that perhaps the decent and ascent that the witnesses noted were part of the accident sequence. He said he didn't recollect seeing anybody on the road, but that there may have been due to it being a Sunday evening. The Pilot said that he had no recollection of being that close to his landing site, stating that "*if I was over there, I'd have had her down*". In subsequent correspondence with the Investigation, the Pilot reiterated that he did not reach the intended landing zone, and stated that he did not *"make an abrupt ascent there*".

1.8.3 Interview with Passenger

The Investigation also interviewed the Passenger. He was asked if he could recall any details regarding the final moments of the flight. The Passenger explained that as they approached the Pilot's house, the landing area was to the right of the house. He said that "*we were landing ok*" and that he could see the top of the Pilot's house, but that a "*draught or wind pulled us down*", before the helicopter went into a "*spin*".

1.9 Meteorological Conditions

Met Éireann, the Irish meteorological service, was asked to provide details of the weather conditions prevailing in the Carlingford area at the time of the occurrence. The report received by the Investigation stated that the meteorological situation was as follows:

> *"Carlingford was under the influence of a weak ridge of high pressure with just very shallow convective potential at the lowest levels allowing for some very isolated localised showers to form…".*

The details provided are contained in the table below.

Surface Wind:	290° at 10-12 knots (kts)
Wind at 2,000 feet:	290° at 20 kts
Surface Temperature:	9° Celsius (C)
Mean Sea Level (MSL) Pressure:	1019 hectopascals (hPa)
Visibility:	Circa 20-25 kilometres (km)

1.10 Pilot Licensing Requirements

1.10.1 European Requirements

Regulation (EU) 1178/2011, laying down technical requirements and administrative procedures related to civil aviation aircrew, came into force in Ireland on 8 April 2013. The IAA availed of an allowable exemption to the Regulation's requirement that pilots flying aircraft registered in an EU Member State are required to have an EU Part FCL licence. This exemption was extended until 8 April 2018 and was in place at the time of the accident. Therefore, national requirements applied.

1.10.2 Requirements within Ireland

The Investigation sought clarification from the IAA regarding the use of an FAA Private Pilot Certificate to operate a UK-registered helicopter within Ireland. The IAA advised the Investigation that:

> *"*[…] *the combined effect of Article 5 , paragraph (2)(b) and Article 5 , paragraph (10) of the Irish Aviation Authority (Personnel Licensing) Order, 2000 (S.I. No. 333 of 2000)* [see **Appendix A**] *would permit the operation of a UK-registered helicopter in Irish airspace under the privileges of a USA FAA-issued Airman Certificate endorsed with rating 'Rotorcraft- Helicopter', when such helicopter was being operated as a 'private aircraft' (within the meaning of the said Order) and all of the validity/currency/medical requirements of* [a] *pilot's FAA licence were met*".

1.10.3 UK Requirements

The CAA advised the Investigation that at the time of the accident a derogation regarding the requirements of Regulation (EU) 1178/2011 applied and that "*the holder of a valid FAA PPL (H) had privileges to fly a G-registered aircraft in UK airspace, without holding a separate licence validation issued by the UK CAA* […]".

1.11 Flight Planning Requirements

A flight between Carlingford, Co. Louth and Derryogue, Co. Down crosses an international border and also the Scottish/Shannon Flight Information Region (FIR) boundary which divides UK and Irish airspace.

Irish Flight planning requirements are contained in '*ENR (en route) 1.10-1*' in the IAA's Aeronautical Information Publication (AIP). It states that a flight plan is required prior to operating "*any flight across international borders*". The IAA advised the Investigation that it had no record of a flight plan being submitted for the earlier flight on the day of the accident from Carlingford to Derryogue.

Flight planning requirements for the UK are contained in CAP (CAA Publication) 694. It states that a flight plan is required for "*all flights to or from the United Kingdom which will cross the United Kingdom FIR Boundary*". The UK CAA informed the Investigation that no flight plan had been filed for the accident helicopter from 1 March 2017 to 12 March 2017.

1.12 Loss of Tail Rotor Effectiveness (LTE)

To be effective in countering the reaction of a helicopter due to the rotation of its main rotors, appropriate tail rotor pedal[10] application by the pilot is required. The FAA's '*Helicopter Flying Handbook*' (FAA-H-8083-21A, dated 2012), states that effective tail rotor operation also "*requires a stable and relatively undisturbed airflow in order to provide a steady and constant anti-torque reaction*".

[10] **Tail rotor pedals:** Depressing a pedal in a given direction changes the pitch of the tail rotor blades, thereby increasing or decreasing tail rotor thrust and making the nose yaw in the direction of the applied pedal, or maintaining heading when power is adjusted.

According to the FAA's Advisory Circular (AC) No 90-95 ('*Unanticipated Right Yaw in Helicopters*'), "*LTE is a critical, low speed aerodynamic flight characteristic which does not subside of its own accord and, if not corrected can result in loss of aircraft control*".

The AC also states that it "*may occur in varying degrees in all single main rotor helicopters at airspeeds less than 30 knots*". The AC describes flight and wind tunnel tests which identified different "*relative wind azimuth*[11] *regions*" and resultant aircraft characteristics that can, either singularly or in combination, create an LTE-conducive environment "*capable of adversely affecting aircraft controllability*".

The relative wind regions and the associated aircraft characteristics, as highlighted in the AC (for helicopters with counterclockwise-rotating main rotors), are described below:

> "*Main rotor disc vortex interference (285^o to 315^o): Winds at velocities of about 10 to 30 knots from the left front will cause the main rotor vortex to be blown into the tail rotor by the relative wind. The effect of this main rotor disc vortex is to cause the tail rotor to operate in an extremely turbulent environment* [...].
>
> *Weathercock stability (120^o to 240^o): Tailwinds from 120^o to 240^o, like left crosswinds will cause a high pilot workload. The most significant characteristic of tailwinds is that they are a yaw rate accelerator. Winds within this region will attempt to weathervane the nose of the aircraft into the relative wind* […]*. If the pilot allows a right yaw rate to develop and the tail of the helicopter moves into this region, the yaw rate can accelerate rapidly* […].
>
> *Tail rotor vortex ring state (210^o to 330^o): Winds within this region will result in the development of the vortex ring state of the tail rotor* [...]*, which causes a non-uniform, unsteady flow into the tail rotor. The vortex ring state causes tail rotor thrust variations which result in yaw deviations. The net effect of the unsteady flow is an oscillation of tail rotor thrust* [...]. *If a yaw rate is allowed to build, the helicopter can rotate into the wind azimuth region where weathercock stability will then accelerate the right turn rate* […].
>
> *Loss of translational lift*[12] *(all azimuths): The loss of translational lift results in increased power demand and additional anti-torque requirements* [pedal inputs] […] *Insufficient pilot attention to wind direction and velocity can lead to an unexpected loss of translational lift* […]".

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1.13 Landing Site at Pilot's House

1.13.1 Location

The prepared area used as a helicopter landing site is located approximately 140 m (460 ft) above sea level on an elevated site on the side of a hill, on the Pilot's land beside his house. The surface consists of compacted soil/hard core.

[11] **Relative wind azimuth:** A horizontal angle measured clockwise from a reference line, in this case, the longitudinal axis of the helicopter.

[12] **Translational lift:** The additional lift (or rotor thrust) obtained from horizontal airflow across the main rotor, due to helicopter movement or the effect of wind.

At the time of the accident, a wind sock was present at the site. The surrounding hillside slopes upwards to the north and west of the site and downwards to the east and south. There are three other houses nearby. One is located approximately 100 m to the south-east of the helipad and adjacent to a public road separating the two houses. The final resting position of the helicopter was in the garden of this house, which was unoccupied at the time. Another house is located approximately 100 m to the north-east and another is located approximately 170 m to the south-east.

1.13.2 Legislative requirements for Landing Sites

The IAA's (Irish Aviation Authority) '*Aerodromes and Visual Ground Aids Order*' (SI 355 of 2008), states the following in paragraph (1) of Section 5 ('*Place of take-off etc. of aircraft*'):

> *"An aircraft shall not take-off from or land at any place in the State save at: […] (d) in the case of a rotorcraft or balloon, not being used for public transport, any place where the aircraft may take-off or land without undue hazard to persons or property and in respect of which the owner or occupier of that place shall have given permission for such use, except that, in the case of a rotorcraft, where that place is of an elevated construction, located on the roof of a building or a structure, it shall also be licensed by the Authority under this Order for such use by that rotorcraft"*.

1.13.3 Local Authority Planning Requirements

The Investigation sought guidance from the local authority responsible for the area where the accident occurred regarding planning requirements for sites used as helicopter landing pads. The relevant local authority advised the Investigation that because the site used was not developed in a manner that constitutes "*development*" in accordance with Section 3 of the Planning and Development Act, 2000 (as amended), planning permission was not required.

1.13.4 Location of Previous Helicopter Accident

On 19 July 2015, another helicopter accident occurred close to the location of the subject event. On that occasion, the helicopter had just taken off from the prepared site that the subject helicopter was approaching to land, when control was lost. This resulted in an attempted forced landing in a nearby field, causing substantial damage to the helicopter. There were no reported injuries. AAIU Report No. 2016-011 refers.

2. ANALYSIS

2.1 Accident Sequence

Radar data and the account from Witness No. 1 indicate that the helicopter initially flew towards the area of the landing site, before flying away again. The radar data indicates that the helicopter performed what appears to be a right hand circuit of the area, before approaching the landing site to the west of the earlier track.

All witnesses described what appeared to be an initial attempt at a landing, which was followed by an ascent and a protracted period of loss of control prior to the final impact. Witness No. 1, who was closest to the helicopter, observed that before the helicopter "*came back up and swung around*", its tail started to "*sway*". Witness No. 2 said that the helicopter "*came back up very rapidly".* Similarly, Witness No. 3, who, it must be noted, was 800 m away, said that the helicopter "*seemed to start to become unstable"* before it "*appeared to try to lift off again".* During interview, the Pilot did not recollect these aspects and said that as he got close to where the accident occurred "*something seemed to hit me like a squall and pushed me down".* In subsequent correspondence with the Investigation, the Pilot reiterated that he did not reach the intended landing zone, and stated that he did not "*make an abrupt ascent there*".

The Pilot estimated that the wind was "*north, slight north-westerly*" with a speed of between 15 and 20 kts. This is consistent with Witness No. 2's observation that there "*was a good northerly breeze"* and was similar to the conditions outlined in the meteorological report provided by Met Éireann, which stated that the surface wind in the area was 290^{o} at 10-12 kts. The Pilot reported that he approached from the south-east; this would have been into wind. Witness No. 2 and Witness No. 3 also noted that the helicopter was travelling into wind as it approached the landing site.

The Pilot commented that the site was susceptible to "*rogue winds*". It is possible that as the helicopter approached to land, the prevailing wind direction, coupled with the effects of the local topography resulted in a downdraught which adversely affected the helicopter's lift. It is also possible that the local wind conditions necessitated continuous pedal movements to maintain directional control. The swaying observed by Witness No. 1 may have been indicative of these pedal movements. However, it could also have been associated with the onset of LTE due to the local wind conditions.

It is possible that the rapid ascent reported by Witness No. 2 was an attempted recovery manoeuvre. However, a large collective lever input, which would be required to produce a rapid ascent, would need precise pedal application to counter the increased torque reaction and maintain directional control of the helicopter. Furthermore, any change in the direction of the helicopter relative to the prevailing wind as a result of the observed rapid ascent, could increase the risk of LTE occurring. If directional control was lost either due to incorrect pedal application or as a result of LTE, the yaw rate would accelerate, without appropriate intervention. In such a scenario, a helicopter with a counterclockise-rotating main rotor (viewed from above) would tend to rotate ("*spin*") in a counterclockwise direction (viewed from below), which is what was reported by witnesses in this case. The Passenger also recollected that after being pushed down, the helicopter went into a "*spin*".

The damage evident on the road surface adjacent to the helicopter's final resting position and that observed on the main rotor blades, indicates that at least one main rotor blade made contact with the road during the impact sequence. The damage pattern on the road indicates that when the blade(s) made contact, the centre of the main rotor disc was to the east of the road (i.e. the same side as the final resting position). There was no apparent damage to the stone walls which bounded the road. For this to be the case, the helicopter was likely in an unusual attitude when a main rotor blade made contact with the road; this is supported by witness accounts. The damage to the cockpit area and the leading edge of the mast fairing, within which tree/shrub material was found trapped, indicates that the helicopter had some forward velocity when initial contact was made with the trees/shrubs.

Following main rotor contact with the road, the resulting reaction likely forced the helicopter towards its final resting position. It is also likely that the main rotor contact was such that it caused the engine to stop suddenly. This is evidenced by the lack of flailing damage adjacent to the broken tail rotor shaft and the lack of damage to the tail rotor blades.

2.2 Survivability

There was severe disruption to the cockpit area as result of the accident. However, although the two occupants were seriously injured, they both survived the accident. The two front seats were each equipped with a four-point harness. The use of these harnesses, in addition to the presence of dense trees/shrubs where the helicopter came to rest, likely contributed to the occupants' survival. Furthermore, maintenance records indicate that the helicopter Manufacturer's Service Bulletin SB-78B (which is mandated by EASA AD No. 2014-0070) had been incorporated on the helicopter in 2016. This SB was specifically designed to "*improve the R44 fuel system's resistance to a post-accident fuel leak*". When examined at the accident site, the helicopter's two fuel tanks each contained a large quantity of fuel. There was no post-crash fire and it is possible that the embodiment of the SB was a relevant factor in this.

It should be noted that the Investigation found the safety pin fitted to the pressure cylinder for the landing skid floats, which would have prevented their deployment if they were needed. This was an inappropriate configuration for a helicopter that was being operated over water.

2.3 Flight Planning Requirements

The Pilot informed the Investigation that his original intention was to operate from Derryogue to Slieve Croob. Such a flight would remain within the UK and according to CAP 694, a flight plan was not required for that particular flight. The Pilot stated that after the flight commenced, he decided to travel directly to his house near Carlingford due to the weather conditions. It is understandable that flight plan requirements may not readily come to mind when making such a decision. However, it may also have been possible to return to the departure airfield when conditions became unfavourable.

The Investigation notes that according to the Pilot, he flew from Carlingford to Derryogue earlier on the day of the accident. This was an international flight, which according to the IAA's ENR 1.10-1, required a flight plan. The IAA advised the Investigation that it had no record of a flight plan being submitted for this flight.

2.4 Landing Site at Pilot's House

A prepared helicopter landing site, with a compacted soil/hard core surface, is located on the Pilot's property beside his house. At the time of the accident, a windsock was present at the site. The location of the site in an area that, as highlighted by the Pilot, is subject to "*rogue winds*", may not be ideal. Such winds, which may have been a factor in the subject accident, could be due to the interaction of certain weather conditions with the local topography. The relevant local authority informed the Investigation that because the site used was not developed in a manner that constituted "*development*" in accordance with Section 3 of the Planning and Development Act, 2000 (as amended), planning permission was not required.

3. CONCLUSIONS

3.1 Findings

1. The airworthiness certification for the helicopter was valid.

2. The Pilot's licence and medical certification were valid.

3. The Pilot reported that the site of the attempted landing was susceptible to "*rogue winds*" and that a "*squall*" pushed the helicopter down.

4. Witness accounts describe what appeared to be a rapid ascent prior to loss of control. Witness No. 1, who was closest to the helicopter, observed the tail of the helicopter swaying before this ascent.

5. The swaying observed may have been due to pedal application or the onset of Loss of Tail rotor Effectiveness (LTE).

6. Witnesses described seeing the helicopter spinning prior to impact.

7. A large collective lever input, which would be required to produce a rapid ascent, if not correctly controlled, coupled with any change in the relative wind angle could result in an accelerating yaw rate.

8. Evidence indicates that a main rotor blade made contact with the road during the impact sequence, indicating that the helicopter was in an unusual attitude close to the ground, prior to the final impact.

9. One witness reported having to run with two accompanying persons to avoid the impact.

10. The use of four-point restraint harnesses likely contributed to the survival of the two occupants.

11. The embodiment of the helicopter Manufacturer's Service Bulletin SB-78B may have prevented a post-crash fire from occurring.

12. According to the Pilot, it was originally planned to remain within Northern Ireland (UK) after take-off on the accident flight. This would obviate the need for a flight plan to be filed with the UK CAA. However, a flight plan, submitted to the IAA, was required for the earlier flight from Carlingford to Derryogue. The IAA has no record of such a flight plan.

13. According to the relevant local authority, because the site of the intended landing was not developed in a manner that constituted "*development*" in accordance with Section 3 of the Planning and Development Act, 2000 (as amended), planning permission was not required.

14. A safety pin was found fitted to the pressure cylinder for the landing skid floats, which would have prevented their deployment if they were needed.

3.2 Probable Cause

Loss of control while approaching to land.

3.3 Contributory Cause(s)

The susceptibility of the site to adverse wind conditions.

4. SAFETY RECOMMENDATIONS

This Investigation does not sustain any safety recommendations.

Appendix A: Extract from IAA Licensing Requirements

Irish Aviation Authority (Personnel Licensing) Order, 2000 (SI No. 333 of 2000), Part II, General

5 ('*Flight crew members to be licensed'*)

(2) A person shall not, within the territorial limits of the State, act as a flight crew member of an aircraft registered in any other state unless –
[…]

(b) in the case of a private aircraft, that person is the holder of an appropriate licence, issued or validated by the competent licensing authority of the state in which the aircraft is registered or by the Authority, or a JAA licence.

(10) For the purposes of this Article, a valid and subsisting licence, other than a JAA licence, issued by any other state which is a member of the International Civil Aviation Organisation in conformity with Annex I (Personnel Licensing) to the Chicago Convention purporting to authorise the holder thereof to act as a flight crew member of an aircraft, not being a licence purporting to authorise that holder to act as a student pilot only, shall be deemed to be a licence validated by the Authority under the provisions of this Order entitling the holder thereof to fly as a member of the flight crew of a private aircraft[3] insofar as the holder is permitted to do so by the terms of the licence and by the law of the state by which it was issued:

Provided that—

(i) the holder of such a licence shall not, for the purposes of this Order, exercise any privilege relating to instruction in flying or flight under the instrument flight rules which may be attached to the licence unless otherwise so entitled under this Order.

(ii) if the Authority sees fit to do so, it may at any time prohibit the holder of such a licence from exercising the privileges conferred by this sub-paragraph and, in that event, such licence shall cease to be deemed to be a licence validated by the Authority under the provisions of this Order.

[3]: i.e. an aircraft used in the private category as permitted by the certificate of airworthiness issued by its state of registry.

- 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.

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