Air Accident Investigation Unit Ireland

FACTUAL REPORT

ACCIDENT

Sud Aviation SE 313B, Alouette II, N577AG
Newcastle Airfield, Co. Wicklow

16 July 2022

An Roinn Iompair
Department of Transport

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.

Extracts from this Report may be published providing that the source is acknowledged, the material is accurately reproduced and that it is not used in a derogatory or misleading context.

[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.

AAIU Report No: 2023-011

State File No: IRL00922030

Report Format: Factual Report

Published: 11 October 2023

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 16 July 2022, appointed Ray Jordan as the Investigator-in-Charge to carry out an Investigation into this Accident and prepare a Report.

Aircraft Type and Registration:	**Sud Aviation SE 313B, Alouette II, N577AG**
No. and Type of Engines:	**1 x Turbomeca Artouste II C6**
Aircraft Serial Number:	**1666**
Year of Manufacture:	**1961**
Date and Time (UTC)[4]:	**16 July @ 12:03 hrs**
Location:	**Newcastle Airfield (EINC), Co. Wicklow, Ireland**
Type of Operation:	**General Aviation**
Persons on Board:	**Crew – 1 Passengers – Nil**
Injuries:	**Crew – 1**
Nature of Damage:	**Substantial**
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:	**55 years**
Commander's Flying Experience:	**6,000 hours, of which approximately 3 hours were on type**
Notification Source:	**Pilot in Command**
Information Source:	**AAIU Report Form submitted by the Pilot AAIU Field Investigation**

[4] **UTC**: Co-ordinated Universal Time. All times in this report are quoted in UTC unless otherwise stated; local time was UTC + 1 hour on the date of the accident.

SYNOPSIS

The helicopter, an Alouette II, was parked near a helipad at Newcastle Airfield. The Pilot, who was the sole occupant, started the engine and performed a lift-off. The helicopter hover-taxied at a low height along a grass taxiway before it commenced an uncommanded yaw to the left from which the Pilot was unable to recover. The helicopter impacted with terrain and sustained substantial damage. The Pilot, who was occupying the right-hand seat, was seriously injured in the accident. The accident caused a small grass fire which was quickly extinguished by individuals who came to the assistance of the Pilot.

NOTIFICATION AND RESPONSE

The AAIU Inspector-On-Call was notified by the Pilot immediately following the occurrence and an Investigation was commenced.

1. FACTUAL INFORMATION

1.1 History of the Flight

The helicopter, an Alouette II, was parked near a helipad at Newcastle Airfield, Co. Wicklow. The Pilot decided to move the helicopter to another location on the Airfield and performed a pre-flight inspection, during which, according to the Pilot *'everything seemed normal'.* The helicopter was started with the aid of a 24-volt DC power pack[5] and no anomalies were noted by the Pilot during the start sequence. CCTV footage obtained by the Investigation shows the helicopter prior to lift off (**Figure No. 1**).

Figure. No 1: CCTV image of helicopter on tarmac surface prior to lift-off
(blue helicopter in foreground, image looking east)

[5] **Power Pack**: A self-contained and typically transportable unit which stores and supplies electrical power.

The CCTV recording shows the helicopter lifting off in a controlled manner and commencing a slow right turn to establish on an easterly heading at a height of approximately 20 feet. Approximately 33 seconds after lift-off, the helicopter yawed to the left and descended (**Figure No. 2**). The rate of yaw increased, and the helicopter commenced a rolling motion to the right from which the Pilot was unable to recover.

Figure. No 2: Helicopter yawing to the left and descending

The helicopter's main rotor blades impacted with the ground while the helicopter was banked to the right and on a southerly heading. The main body of the helicopter then impacted with the ground and the tail boom separated. With the engine still driving the main rotors, the helicopter rotated around its vertical axis by approximately 450 degrees before coming to rest on an easterly heading. The Pilot, who was wearing a four-point harness, was seriously injured in the accident but was able to evacuate the helicopter unaided once the main rotors had stopped turning. The Pilot said he then leaned back into the cockpit to shut the engine down. A small grass fire ignited in the vicinity of the accident site, which was quickly extinguished by individuals present at the airfield who had come to the assistance of the Pilot.

1.2 Recording Devices

CCTV footage of the accident was provided to the Investigation by the Airfield Operator. The footage recorded the Pilot's pre-flight inspection, engine start and the accident sequence. Based on CCTV time stamps, the duration of the flight from lift-off to initial impact was 37 seconds. While reviewing the footage, the Investigation noted that the helicopter also flew on 7 July 2022 to another location on the airfield and took a similar initial route to that taken on the accident flight. On 12 July 2022, four days before the accident, the helicopter flew again from this location back to the position near the helipad.

1.3 Interview with the Pilot

The Pilot stated that he acquired the subject helicopter in either October or November 2021 from the previous owner and transported it by road to EINC. The Pilot said that prior to purchasing the helicopter, he performed an engine run to satisfy himself that the engine was operational, as he was aware that the helicopter had been in an accident some years before and had no current airworthiness certification. Prior to transporting the helicopter by road, the main rotor blades were removed and were reattached following the helicopters arrival at EINC.

The Pilot informed the Investigation that he had researched the helicopter type and it was his intention to return the helicopter to an airworthy condition. An engineer had been due to come from the UK to inspect the helicopter and the Pilot stated that he intended to retain the helicopter for his personal use once all the necessary work had been completed. The Pilot re-registered the helicopter in the United States and informed the Investigation that a number of options were being considered to operate the helicopter including certification in the FAA experimental category (**Section 1.8**).

The Pilot stated that the helicopter was normally stored in a hangar but that he occasionally took it outside to perform ground runs of the engine, a function he carried out himself on the helipad. The Pilot said that he flew the aircraft on a previous occasion as there was a '*special day of flying'* at the airfield on 9 July 2022 and he wanted to move the helicopter out of the way. This flight occurred on 7 July 2022. The Pilot flew the helicopter again on 12 July 2022 back to the helipad. The Pilot noted that on those two flights he had '*no issues at all'* with the helicopter and there were '*no delays in the pedals…no delay in power, no delay in pitch'.*

On the day of the accident, the Pilot decided to reposition the helicopter again as it was blocking access to the helipad. The Pilot stated that as part of his pre-flight inspection he checked the pulleys located on the tail boom and the associated control cables for freedom of movement and that they were in good condition. He said he started the engine, and no anomalies were noted during the engine start sequence. The Pilot said that following lift off and when established on an easterly heading he heard a loud bang which he believed was caused by '*something breaking, snapping'.* The Pilot's immediate reaction was to get the helicopter '*on the ground'* as it had developed a nose down attitude, and he stated that he had no tail rotor authority.

To recover from this nose-down attitude the Pilot said he held the cyclic control stick[6] in the fully back position to raise the nose prior to impacting with the ground. Following the impact and after the main rotors had stopped turning, the Pilot, released his four-point harness and was able to evacuate the helicopter unaided. The Pilot said that the accident '*happened in a split second*'. He estimated that the fuel on board was approximately 160 litres of Jet A1.

[6] **Cyclic Control Stick:** This control 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.

1.4 Witnesses

The Investigation interviewed two individuals who witnessed the accident. The first witness, a qualified fixed-wing Pilot, was in the vicinity of the hangar and observed the helicopter getting airborne. He stated that when the helicopter was at a low height, he heard what he believed to be a change in main rotor rpm and reported seeing the tail rotor '*slowing down and coming to a complete stop'*. The witness also described the helicopter as '*spinning around its own axis'.*

The second witness, who was also a qualified fixed-wing pilot, was landing his aircraft on Runway (RWY) 18 at the time of the accident. During the landing roll, he observed what he thought was a '*hedge cutting machine'* but as he vacated the runway onto the grass taxiway, he realised that it was a helicopter in '*bad shape'* and that the tail boom had '*snapped'* off. He parked his aircraft and proceeded to the accident site where he observed the Pilot, who had by this time evacuated the helicopter. This witness, a medical professional, was able to offer some assistance and arrange for an ambulance to transport the Pilot to hospital. The witness said that the Pilot told him at this time that the tail rotor had failed.

1.5 Injuries to Persons

The Pilot sustained serious injuries.

1.6 Helicopter Information

The SE 313B Alouette II is a lightweight utility helicopter originally designed for military use. The airframe is of a tubular steel frame construction through which all the major engine and transmission components can be viewed. Located below the main gearbox is a large capacity fuel tank. The cabin is fully enclosed, with most panels constructed of clear plexiglas[7] to maximise all-round visibility. The cockpit is accessed by two large doors located on either side of the cabin.

The helicopter is equipped with dual controls. The anti-torque-pedals are connected to the tail rotor pitch change mechanism through a control rod, control quadrant, and control cable arrangement. These cables are routed through a series of pulleys which run along the bottom of the tail boom. The three-bladed main rotor is driven by a Turbomeca Artouste II C6 turboshaft engine via an input shaft connected to the main gearbox. The tail rotor and its associated gear box is driven through a series of drive shafts connected to the main gear box (**Figure. No 3**). The subject helicopter was fitted with a skid type landing gear.

[7] **Plexiglas:** A solid transparent plastic made of polymethyl methacrylate. The term is used in this report to refer to the generic clear plastic material and not to any patented commercial product of the same name.

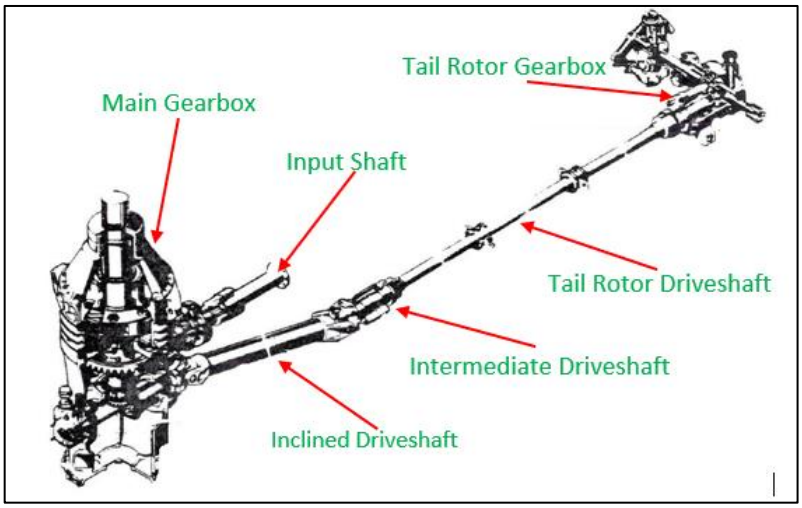

Figure. No 3: Gearbox and Driveshaft arrangement

1.6.1 Helicopter Torque Reaction

The main rotors on the Alouette II, when viewed from above, rotate in a clockwise direction, therefore, there is a tendency for the fuselage to turn in the opposite direction (i.e., yaw to the left). This is known as torque reaction (**Figure No 4**). To counteract this tendency to yaw left, opposite right pedal (anti-torque pedal) is applied which alters the pitch of the tail rotor blades and increases the thrust produced by the tail rotor.

A failure of the anti-torque system can be the result of, *inter alia*, tail rotor driveshaft failures, tail rotor pitch control system failures, tail rotor gear box failures or a complete loss of the tail rotor itself. If a failure occurs at a low airspeed and a high power setting on a helicopter with clockwise-rotating main rotors, then a yaw or spinning motion to the left will occur, with the rate of yaw increasing rapidly.

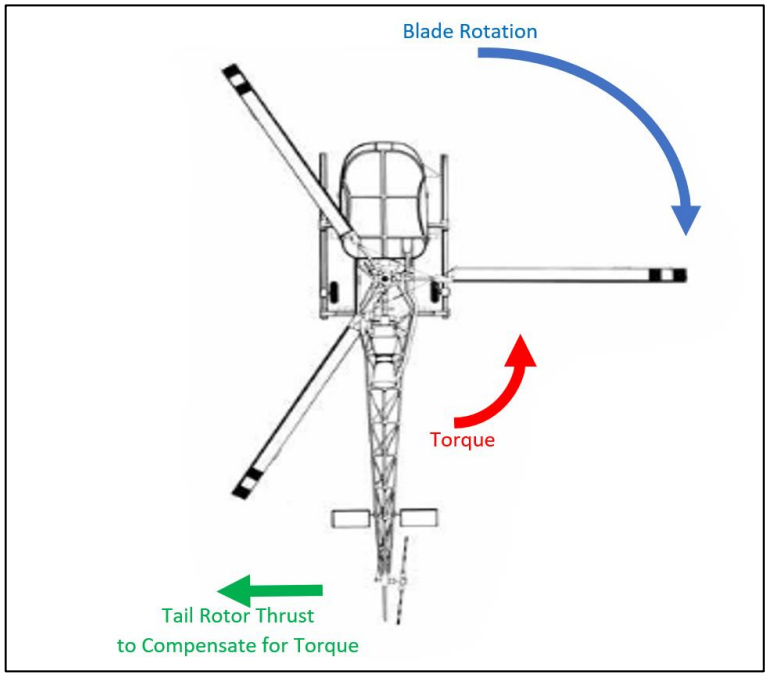

Figure No. 4: Torque Reaction

1.6.2 Previous History

The subject helicopter was manufactured in 1961 by Sud Aviation under type designation SE 3130 and was completely re-built in January 1999. The helicopter was subsequently re-designated as an SE 313B and was purchased by the previous owner in 2004. The helicopter was registered as N577AG and transported to Ireland, where a replacement engine, a Turbomeca Artouste II C6 was fitted.

The helicopter was involved in an accident on 24 October 2007 and sustained substantial damage. Following an Investigation by the AAIU (Report No 2008-015), the helicopter wreckage was returned to the previous owner who placed it in storage. The previous owner informed the Investigation that the helicopter was restored over a period of many years and that he sold it to the current owner in October 2021. Following the accident on 16 July 2022, the Investigation was provided with the helicopter's logbook. The last certified maintenance entry was dated 7 October 2007.

1.7 Damage to Helicopter

Following the accident, the helicopter was recovered to a remote location on the airfield (**Photo. No 1**) and subsequently to the AAIU's wreckage examination facility at Gormanston, Co. Meath, for a more detailed examination by the AAIU and an advisor from the current Type Certificate Holder[8].

The helicopter had come to rest in a nose up attitude. There was buckling of the right-hand skid consistent with impact. The cockpit was mostly intact, with some of the plexiglas panels having shattered during the accident sequence. No significant damage was observed to the control cables connecting the control quadrant to the tail rotor pitch change mechanism; however, some of the pulleys on which these cables ran were not rotating freely and exhibited some damage. All three main rotor blades sustained substantial damage consistent with ground strikes during the accident sequence.

Photo. No 1: Damage to helicopter (photo taken following recovery at airfield)

[8] **Type Certificate Holder:** In this instance, a helicopter manufacturer from the state of design, as the original manufacturer no longer exists.

The tail rotor blades exhibited chordwise creasing at the roots (**Photo. No 2)**, however, the tips and leading edges of both blades did not show any damage. The tail boom had separated from the main body of the helicopter and the tail rotor drive shaft was bent and had separated from the intermediate driveshaft. The centrifugal clutch, which transfers power from the engine to the main gear box, exhibited heat damage and there was molten metal visible on its surface. The Investigation noted that a number of fasteners on the airframe and main gearbox were not secured by split pins and were loose.

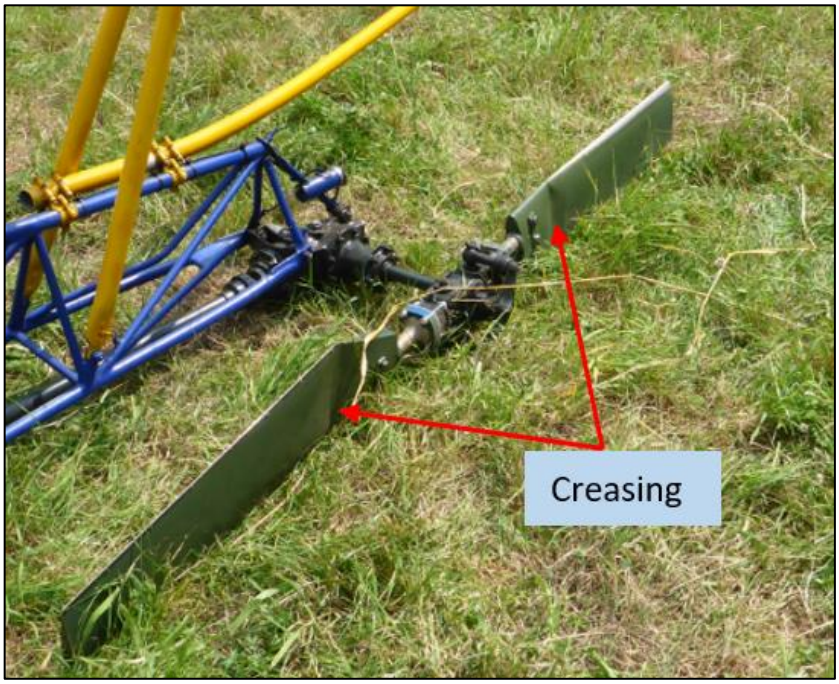

Photo No. 2: Chordwise creasing of tail rotor

1.7.1 Tail Rotor Inclined Drive Shaft

The tail rotor inclined drive shaft (**Figure No. 3**) is part of the tail rotor transmission system and is connected to the main gearbox output flange via a universal joint. This universal joint is secured to the flange by four bolts and associated nuts, washers, and split pins. The universal joint was found to have completely separated from the main gearbox output flange and all four bolts were missing. The universal joint exhibited impact marks consistent with it having separated from the main gear box output flange and coming into contact with the main rotor brake disc at high rpm (**Photo No. 3**). The mating surface of the universal joint was deeply scored. Rotational witness marks were observed on the inclined drive shaft where it made contact with the airframe following the separation.

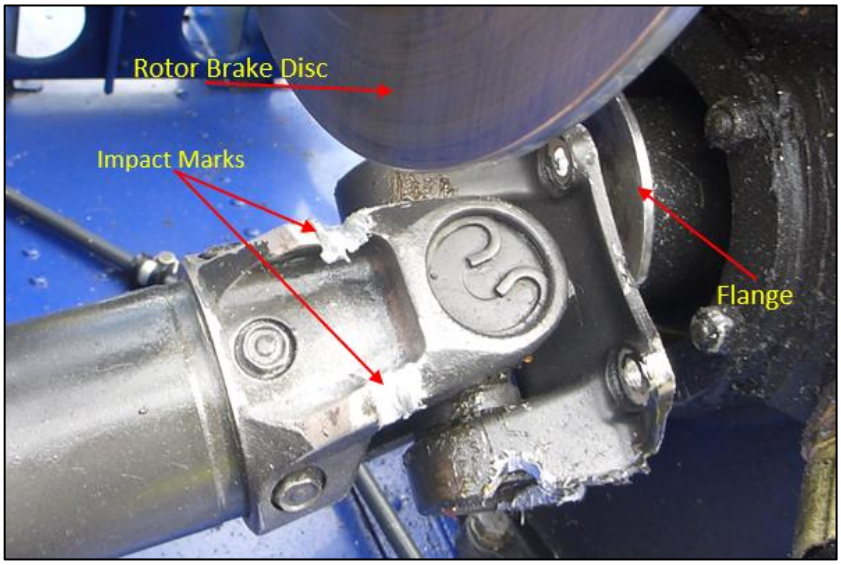

Photo. No 3: Damage to universal joint

1.8 Special Airworthiness Certificate

A Special Airworthiness Certificate in the Experimental Category is an FAA authorisation to operate an aircraft in United States airspace only, unless permission has been granted by the Competent Authority of the country in which the aircraft is to be operated.

The FAA advised the Investigation that it may have been possible for the subject helicopter to be certified in the Experimental Category; however, according to their records no authorisation was issued by the FAA in respect of N577AG.

1.9 European Union Aviation Safety Agency (EASA) Certification Information

According to EASA Certification Information No: 2010-03, dated 10 March 2010, the SE 3130 and SE 313B Alouette II models that were included in the DGAC[9] France Type Certificate No. 1 (dated 14 January 1958) had not been incorporated into the EASA Type Certificate as these models were deemed to fall under the scope of Annex II of Regulation (EC) No 216/2008 on the common rules in the field of civil aviation.

Annex I of Regulation (EU) 2018/1139, which supersedes Regulation (EC) No 216/2008, lists the categories of aircraft that are exempt from the Regulation and are therefore regulated by national aviation authorities. These categories include the subject helicopter type.

1.10 Pilot Information

The Pilot held a Private Pilot Certificate for '*Rotorcraft-Helicopter*' which was issued by the FAA on 20 June 2016. The Pilot held a Medical Certificate, Second Class issued by an FAA approved Aeromedical Examiner which was valid until 30 June 2023. The Pilot completed a Flight Review on 29 August 2020 which was valid for two years. The Pilot's stated flying experience, as provided to the Investigation, is outlined in **Table No. 1**.

[9] **DGAC:** Direction générale de l'aviation civile, the French Civil Aviation Authority.

Total all types:	6,000 hours
Total on type:	3 hours
Last 90 days:	10 Hours (all types)

Table No. 1: Pilot's Flying Experience

1.11 Legislative Requirements

1.11.1 Licensing Regulations

As stated in **Section 1.9**, the subject helicopter is categorised in Annex 1 of *'Regulation (EU)2018/1139'* as being exempt from the Basic Regulation and therefore subject to national legislation.

S.I. No. 333 of 2000 '*Irish Aviation Authority (Personnel Licensing) Order, 2000*', Article 5 ('*Flight Crew Members to be Licensed*') states:

> *'(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.'*

1.11.2 Irish Airworthiness Requirements

S.I. No. 324 of 1996 *'Irish Aviation Authority (Airworthiness of Aircraft) Order ,1996'* which applies to aircraft registered in the State and to all other aircraft when in or over the State specifies the following on when certificates of airworthiness are required:

> *'7. (1) Subject to paragraphs (2) and (3) of this Article, an operator shall not permit an aircraft to fly or attempt to fly —*
>
> *(a) unless there is in force in respect thereof a certificate of airworthiness issued or validated under the law of the state in which the aircraft is registered; or*
>
> *(b) if there is not in force in respect thereof such a certificate, unless a permit in writing (in this Order referred to as a "flight permit") has been granted by the Authority to fly the aircraft;*
>
> *and the terms and conditions on or subject to which such certificate was issued or validated or such flight permit was granted (as the case may be) are complied with.'*

Paragraphs (2) and (3) of Article 7 are deemed not to be applicable as they relate to, balloons, gliders, and the testing of aircraft amongst other things.

1.12 Meteorological Information

Met Éireann, the Irish meteorological service, provided an aftercast of the estimated weather conditions prevailing in the Newcastle area on the day of the accident. The wind information in the aftercast reported a surface wind from the south to south-east of 5-8 knots with 40 km visibility and a surface temperature of 21 degrees Celsius.

1.13 Airfield Information

Newcastle Airfield (EINC) is a Licensed Aerodrome[10] located approximately six nautical miles north of Wicklow town, Co. Wicklow in Ireland. It has one grass runway designated 18/36 which is 690 metres in length. It has a single 18-metre-wide taxiway (TWY) designated A (Alpha) which leads from the main apron to the runway.

The route flown by N577AG is depicted in **Figure No. 5.**

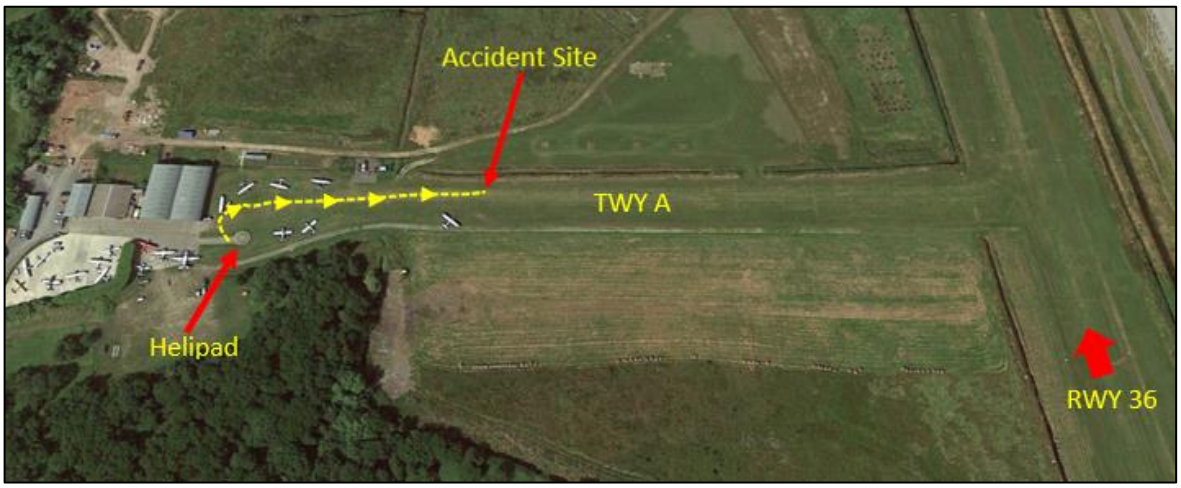

Figure No. 5: Route flown by N577AG (*Google Earth*)

2. AAIU COMMENT

The Investigation notes that the Pilot flew the helicopter on two previous occasions in July 2022. The Pilot reported no issues with the flight controls or other anomalies on these two flights. On the day of the accident, the Pilot decided to move the helicopter to another location on the airfield. Shortly after lift-off, the Pilot heard a loud bang followed by an uncommanded yawing motion to the left, which is consistent with a loss of drive to the tail rotor as observed by one of the witnesses to the accident. The Pilot was unable to recover from this yawing motion and the helicopter impacted with terrain on a grass taxiway in close proximity to other aircraft. The nuts and bolts that secure the universal joint to the main gearbox output flange were not found following the accident. The loss of drive was likely the result of these becoming loose and eventually failing or migrating.

[10] **Licensed Aerodrome:** An Aerodrome, Airfield or Airstrip that is subject to regulatory oversite.

The engine continued to run following impact and the main rotors continued to turn. This likely caused the centrifugal clutch to overheat, resulting in molten metal being ejected from the wreckage. A small grass fire occurred following the accident, which was likely caused by either hot exhaust gases or the molten metal. The small fire was extinguished by individuals who came to the assistance of the Pilot who was seriously injured in the accident. However, the use of a four-point harness likely reduced the severity of the injuries received.

Because the helicopter was categorised as Annex 1, national legislation applied. As such, the Pilot's FAA Private Pilot Certificate for *'Rotorcraft Helicopter'* was valid. However, in order to maintain a uniform level of safety, helicopters, like all aircraft are required to be maintained in accordance with specified criteria and for all maintenance to be correctly carried out and recorded. There was no record of any certified maintenance since 2007 and at the time of the accident the helicopter did not have any airworthiness certification or equivalent authorisation.

- 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.

Produced by the Air Accident Investigation Unit

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

An Roinn Iompair
Department of Transport

Air Accident Investigation Unit,
Department of Transport,
Leeson Lane,
Dublin 2,
D02TR60,
Ireland.
Telephone: +353 1 804 1538 (24x7)
Email: info@aaiu.ie
X (formerly Twitter): @AAIU_Ireland