

**ACCIDENT**

<b>Aircraft Type and Registration:</b>	Agusta A109A II, N2NR	
<b>No &amp; Type of Engines:</b>	2 Allison 250-C20 SER turboshaft engines	
<b>Year of Manufacture:</b>	1986	
<b>Date &amp; Time (UTC):</b>	23 October 2010 at 1448 hrs	
<b>Location:</b>	Shanlieve, Mourne Mountains, Northern Ireland	
<b>Type of Flight:</b>	Private	
<b>Persons on Board:</b>	Crew - 1	Passengers - 2
<b>Injuries:</b>	Crew - 1 (Fatal)	Passengers - 2 (Fatal)
<b>Nature of Damage:</b>	Aircraft destroyed	
<b>Commander's Licence:</b>	Airline Transport Pilot's Licence	
<b>Commander's Age:</b>	63 years	
<b>Commander's Flying Experience:</b>	12,733 hours (of which 1,634 were on type) Last 90 days - 50 hours Last 28 days - 21 hours	
<b>Information Source:</b>	AAIB Field Investigation	

**Synopsis**

The helicopter was on a VFR flight from a private site near Londonderry, Northern Ireland, to Caernarfon Airport in Wales. Radar data showed that the aircraft was established on a direct track for Caernarfon, flying at an altitude of about 1,600 ft. As the helicopter approached Newry it turned onto an easterly heading and climbed to about 2,000 ft. Some 6.5 nm later the helicopter turned onto a south-easterly track towards Caernarfon Airport, followed by small track changes to the left and right. The groundspeed throughout the flight was about 150 kt. Hill walkers close to the accident site heard the helicopter impact the west face of Shanlieve. All three people onboard were fatally injured in the impact.

**History of the flight**

A co-owner of the helicopter, and a friend, were to attend a shoot on a private estate near Newtownstewart, County Tyrone. They departed in N2NR on 22 October 2010 from a private site near Bagshot, Surrey, routing through Ronaldsway Airport, Isle of Man, where the helicopter was refuelled before continuing on to St Angelo Airport (EGAB), Enniskillen, arriving at 1650 hrs. There was a delay with the refuelling at Ronaldsway and this delayed their arrival at St Angelo. For this reason it was decided to refuel at Caernarfon Airport (EGCK) instead of Ronaldsway on the return flight.

On the morning of the accident, the pilot arrived at St Angelo airport at about 0830 hrs. He went to the ATC

tower and faxed the General Aviation Report required for flights from Northern Ireland and also filed a VFR flight plan for the return flight to Bagshot via Caernarfon Airport. He also ensured that ground staff refuelled the helicopter's fuel tanks to full. This was recorded in the refuelling log as being complete at 1110 hrs. The pilot then carried out a daily inspection of the helicopter and was later seen in the café and flight planning areas, mainly reading a book. It was not possible to establish what meteorological information the pilot had obtained prior to the flight.

At about 1350 hrs the pilot was seen speaking on his mobile telephone and, shortly afterwards, informed the ground staff that he was departing. He contacted ATC and was passed the aerodrome QNH of 1005 mb and the QFE of 1000 mb. He started the helicopter, ground taxied to Runway 33 and departed to the northeast. He informed ATC that he was changing frequency but it could not be ascertained which frequency he changed to. A review of ATC tapes from other Air Traffic Service Units (ATSUs) did not identify any other unit being contacted. The helicopter arrived at the estate to pick up the two passengers, who seated themselves in the rear forward-facing seats. A guest, who went to the helicopter to see the passengers before they departed, took a photograph and noted "lots of paperwork" on the unoccupied left front seat. The pilot started the helicopter and witnesses estimated that it departed at about 1420 hrs.

The helicopter was first recorded on radar at 1425 hrs and was seen transiting to the south-east. The pilot was flying in Class G airspace and was not required to contact any of the available ATSUs, such as Belfast International or City airports. It is possible that he monitored the Belfast International approach frequency of 128.500 MHz. A replay of that frequency, covering the duration of the flight, revealed that on three occasions the Belfast

controller passed the aerodrome QNH of 1006 mb to departing or arriving air traffic. There were, however, no transmissions specifying the Belfast Altimeter Setting Region (ASR) QNH of 1001 mb.

Radar data showed the helicopter maintaining a constant altitude of about 1,600 ft and a track of 130°, with a groundspeed of approximately 150 kt. With about 8 nm to run to Newry, the helicopter turned left onto a heading of 090° and climbed to 2,000 ft with a coincident reduction in airspeed to 130 kt, before it levelled off and accelerated back to 150 kt. It maintained this for a further 6.5 nm. This revised track would have taken the helicopter 2 nm north of the northern edge of the Mourne Mountains and the coastal town of Newcastle, County Down. However, after 6.5 nm the helicopter turned right to resume a track 130°. It maintained this for a further 3.5 nm before carrying out a series of minor heading changes to the left and right.

Three hill walkers on Castle Bog, approximately 0.75 nm from the accident site, were in fog and heard a helicopter pass overhead. One of them saw what he thought was the silhouette of the helicopter in, or possibly above, the cloud. A lone hill walker, also in cloud 0.8 nm north-north-west of the accident site and north of the helicopter track, also heard the helicopter but could not see it due to poor visibility. He and the other hill walkers heard an impact and, after reporting a possible accident to the police on mobile phones, commenced a search. Despite difficult terrain and 100 m visibility they located the still burning wreckage of the helicopter near the summit of Shanlieve. All those onboard had been fatally injured.

At about 1500 hrs a police helicopter was tasked to search for the missing helicopter. It departed Belfast International Airport at 1505 hrs and arrived in the area of Leitrim Lodge at 1521 hrs. Its pilot described the weather

during the flight as mainly broken cloud at about 2,000 ft with good visibility below the cloud with occasional light rain in showers. He flew at 1,500 ft, on the QNH of 1007 mb, down the road towards Rosstrevor and attempted to fly up the valleys towards the higher slopes of the mountains. However, he was prevented from doing so by cloud “tumbling down the valleys” and was only able to reach the northern end of Castle Bog, and climb to a height of about 1,400 ft, approximately 1,500 metres from, and some 500 ft below, the accident site.

### **Witness evidence of observed weather**

As noted above, there were four people walking in the general area of the accident site, a group of three and one individual.

The lone individual planned to walk from Leitrim Lodge to Rocky Mountain, Hen Mountain, Cock Mountain, Slievemoughanmore, Eagle Mountain, Shanlieve, Pierces Castle returning to Leitrim Lodge. When he departed Leitrim Lodge at 0945 hrs the weather was “fine, dry and sunny”. These conditions continued as he climbed the

summits of Rocky Mountain and Hen Mountain. On his arrival on the summit of Cock Mountain, the cloud had moved in quite quickly. He took a series of photographs at 1138 hrs, two of which are shown at Figures 1 and 2.

From the photographs, the cloudbase at that time was later estimated at 1,600 ft to 1,700 ft. As he continued, the cloudbase descended, with visibility in the cloud reduced to approximately 150 metres. He descended from Slievemoughanmore into the saddle of Windy Gap (elevation 1,377 ft) and could not recall being clear of the cloud at that height. He arrived at the summit of Shanlieve with the visibility still about 150 metres and at about 1415 hrs he descended towards Pierces Castle. He was approximately 300 metres north of Pierces Castle when he heard a helicopter pass overhead, followed by the sound of an impact. He did not see the helicopter but notified the police using his mobile telephone and commenced a search. He met up with the three other walkers, who had been on Castle Bog and had also heard the helicopter pass overhead. They eventually located the accident site in the cloud.



**Figure 1**

View from Cock Mountain, looking southeast towards the coast at 1138 hrs



**Figure 2**

View from Cock Mountain at 1138 hrs, looking west towards the direction from which N2NR approached at about 1445 hrs

## Meteorology

An Aftercast provided by the Met Office following the accident was produced from surface charts, satellite imagery, and TAF and METAR information for Belfast International and Belfast City airports.

The Aftercast showed an area of low pressure located over the North Sea, with an associated occluded front lying from the Humber through Manchester to Donegal at 1200 hrs, moving south with an unstable north-easterly flow to the rear of the front. By 1800 hrs this front had moved south and was along a line from Norwich to Luton to Cardigan Bay.

As a result, the showery occluded front had passed over the Mourne Mountains from north to south at about 1300 hrs, introducing a cloudy moderately unstable north-easterly flow at the time of the accident at 1450 hrs. Also a trough of low pressure was very close to the Mourne Mountains and some light to moderate rain showers were evident on the radar imagery.

Broken or overcast amounts of cloud were in evidence over the area with a base of 1,200 ft to 2,500 ft amsl and likely tops of between 5,000 and 8,000 ft. Light to moderate showers of rain were in the locality. The freezing level was estimated at between 3,000 and 4,000 ft with icing a hazard within the cloud layers and there was a risk of hill fog.

The surface wind would have been between 010°/5 to 10 kt, with the 2,000 ft wind estimated at 030°/15 kt. A representative temperature at the surface would have been +7°C, with a dewpoint of +6°C.

The weather at Belfast International Airport at 1450 hrs was surface wind 040°/09 kt, visibility 10 km, cloud FEW at 1,300 ft and BKN at 4,400 ft, temperature +7°C,

dewpoint +5°C and the QNH 1006 mb. The elevation of the airport is 268 ft amsl.

The weather at Belfast City Airport at 1450 hrs was 010°/10 kt, visibility 10 km with showers in the vicinity, cloud FEW at 1,200 ft, SCT 1,900 ft and BKN at 2,500 ft, temperature +8°C, dewpoint +5°C and QNH 1006 mb. The airport elevation is 15 ft amsl.

The Belfast Regional Pressure Setting at the time of the accident was 1001 mb.

## Recorded data

Two sources of recorded data giving positional information for the helicopter during the accident flight were available for the investigation.

### *Radar data*

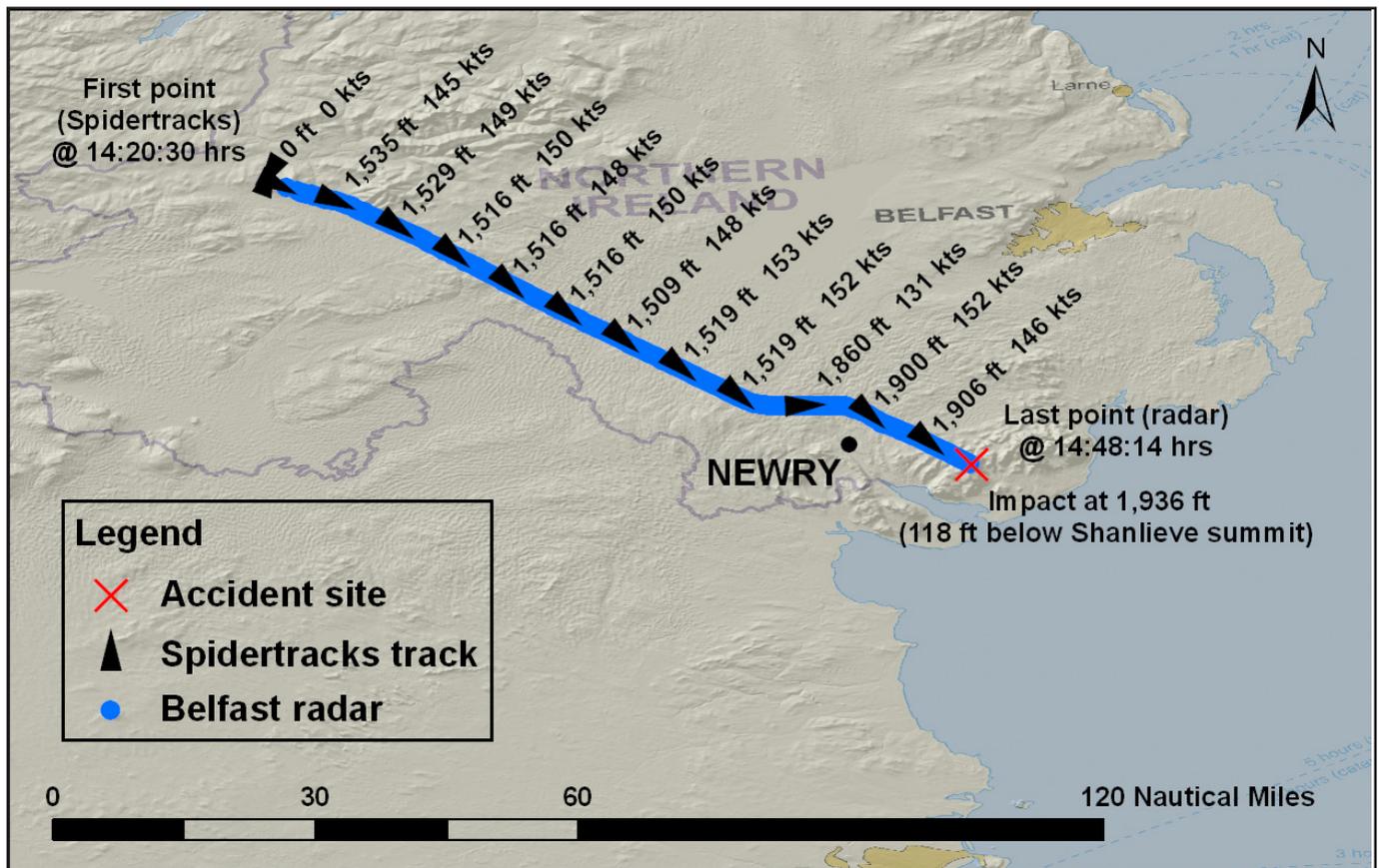
Radar data, recorded every five seconds from Belfast's secondary surveillance radar (SSR), recorded the helicopter's position and time, and Mode C pressure altitude (with ±50ft resolution).

### *GPS-based 'Spidertracks' tracking system*

The second source of data was from the GPS-based Spidertracks aircraft locator system carried on the helicopter. This transmitted position, altitude and groundspeed information to a ground station every 60 seconds. The combined 'Spidertracks' and radar tracks of the helicopter are shown at Figure 3.

The altitude, groundspeed and track data are shown in Figure 4.

The Spidertracks data started at 1420:30 hrs with the helicopter hovering shortly before takeoff and ended at 1446:30 hrs just as the helicopter reached the Mourne Mountains. The radar data started at 1425 hrs as the



**Figure 3**

Accident track of N2NR from radar and GPS sources  
(showing height amsl & groundspeed, at two-minute intervals)

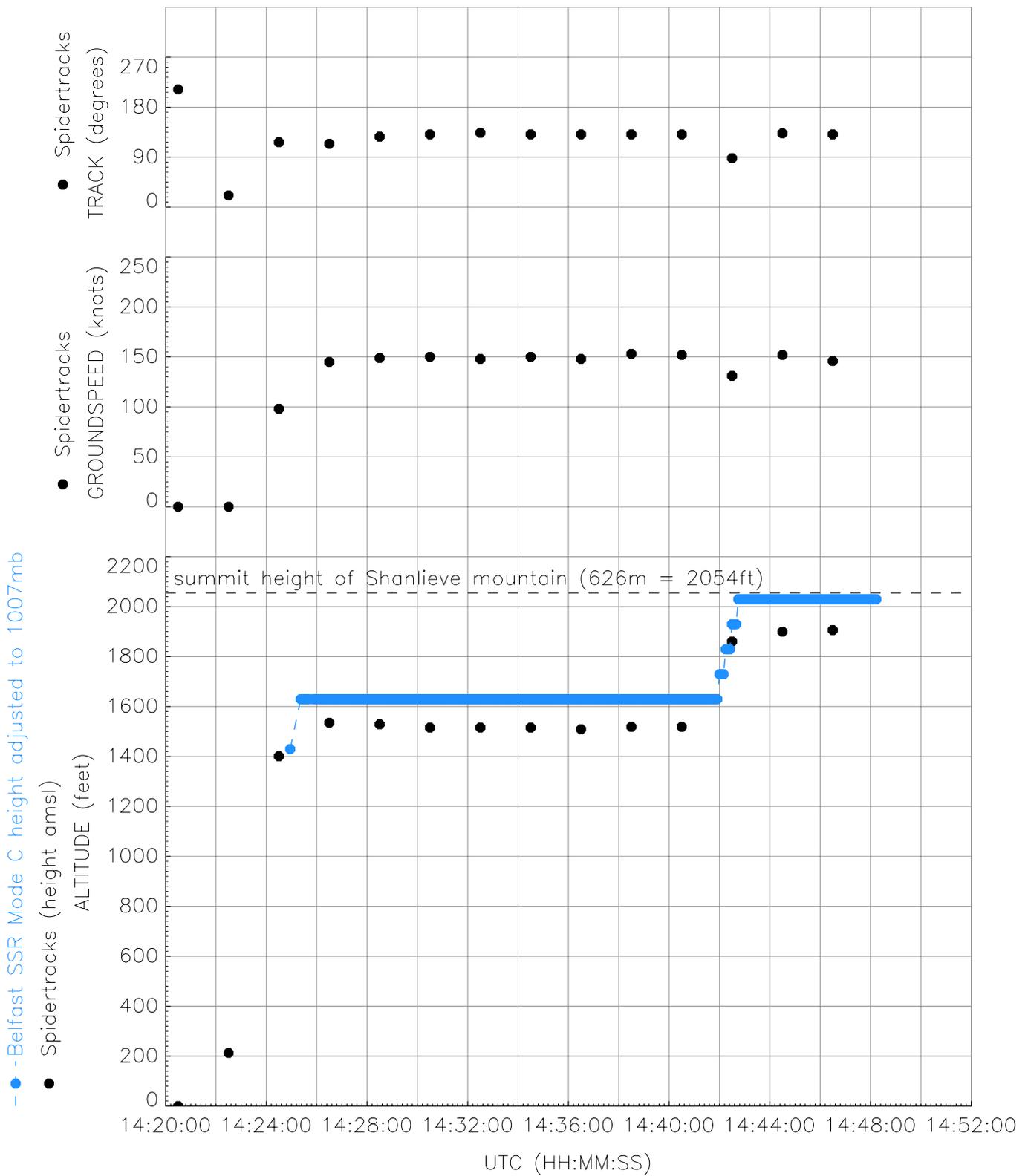
helicopter climbed through 1,400ft (based on 1007mb) and ended at 1448:14 hrs, just before the impact into Shanlieve.

The initial track, towards Newry, was flown at 1,630 ft<sup>1</sup> (based on 1007 mb) with a groundspeed of about 150 kt. At 1440:45 hrs, approximately 8 nm from Newry, the helicopter started a turn left through 40° onto an easterly track. The helicopter also climbed to 2,030 ft (based on 1007 mb) during which the groundspeed reduced to 130 kt before returning to

150 kt after the level off. The helicopter maintained this track for about 6.5 nm before turning right back onto a track of 130° (ie parallel to the initial track). Apart from small deviations to the left and right, the helicopter remained on this track, at 2,030 ft (based on 1007 mb) and 150 kt groundspeed until impact, just below the summit of Shanlieve. The final portion of the track is illustrated in Figure 5, superimposed onto a Google representation of the local terrain.

#### Footnote

<sup>1</sup> The GPS altitude (amsl), as recorded by the Spidertracks system, was about 110 ft less than the pressure altitude corrected to 1007 mb throughout the flight.



**Figure 4**

Recorded data from the Spidertracks GPS during the accident flight, with Mode C pressure altitude, corrected to 1007mb



**Figure 5**

Final portion of the accident track, based on radar data, and crash site

### **Enhanced Ground Proximity Warning System (EGPWS)**

The helicopter was equipped with a Honeywell Mk XXI Enhanced Ground Proximity Warning System (EGPWS) that sustained sufficient damage during the crash impact to require assistance by the manufacturer to download the data stored in its internal memory<sup>2</sup>. The download was conducted on 8 November 2010 in the United States, during which it was found that the unit had not been powered-up since the unit had

#### **Footnote**

<sup>2</sup> This unit was capable of providing aural ‘terrain’ warnings to the crew and also provided data to a Bendix/King KAC-502 EGPWS module that could generate terrain images and visual warnings to the Bendix/King KMD-540 multifunction display (MFD) that was also installed on the helicopter.

been reconfigured with a new software release and terrain database. From the maintenance records for the helicopter, this reconfiguring probably occurred during October and November 2009, when this particular replacement Mk XXI unit was installed. The associated KMD-540 multifunction display was too damaged to determine whether it was switched on or off.

### **Pilot information**

The pilot started flying training in the Army in 1970 and graduated as a helicopter pilot in February 1971. During his Army service he was a squadron pilot and became a Qualified Helicopter Instructor (QHI). He transferred to the Royal Air Force (RAF) in September 1985 and became a squadron QHI on the Puma

helicopter. He served in Northern Ireland in both the Army and the RAF and was familiar with the area of the Mourne Mountains. He left the RAF in January 1999 and flew as a commercial pilot, before rejoining the RAF for two years, leaving in January 2006. His last flight in Northern Ireland had been in April 2004 and after leaving the RAF he flew commercially, both as an instructor and charter pilot.

#### *Licence privileges*

The pilot held a UK CAA ATPL(H) which permitted him to operate the US Federal Aviation Authority (FAA) registered helicopter within United Kingdom airspace. This is covered in Code of Federal Regulations, CFR 14, Part 61.3 (1) which states:

***'61.3 Requirement for certificates, ratings, and authorisations.***

*(a) Pilot certificate. No person may serve as a required pilot flight crew member of a civil aircraft of the United States, unless that person-*

*(1) Has a pilot certificate or special purpose pilot authorization issued under this part in that person's physical possession or readily accessible in the aircraft when exercising the privileges of that pilot certificate or authorisation. However, when the aircraft is operated within a foreign country, a pilot license issued by that country may be used.'*

The pilot's licence and log book were normally in his possession but were not recovered at the accident site, probably due to the intense post-impact fire. A review of the CAA records confirmed that the pilot's licence, instrument rating and medical certificate were in date. A

check of the technical logs of helicopters recently flown by the pilot, and a summary of his hours provided to a client, were used to establish the flying hours stated in this report.

#### **Medical and pathological information**

A post-mortem examination carried out on the pilot, and a review of his medical history, did not identify any pre-existing disease or condition which might have contributed to the accident. Toxicological examination showed no evidence of drugs or alcohol.

#### **Aids to navigation**

The helicopter was approved for flight under the Instrument Flight Rules (IFR) and was equipped with avionics capable of displaying VOR, DME and NDB information. In addition, there were two moving map displays: a Bendix/King Skymap IIIC and a Garmin GPS Map 695. The Garmin GNS 430 navigation/communication control heads were also capable of displaying GPS-derived navigation information.

A CAA Northern England and Northern Ireland, ICAO air navigation chart scale 1:500 000, Edition 33, was also onboard the helicopter and was recovered from the accident site; the relevant area of the pilot's chart is shown at Figure 6. On this chart, the Maximum Elevation Figure (MEF) is shown in quadrangles bounded by graticule lines for every half-degree of latitude and longitude. They give the elevation of the highest known obstacle within that graticule square and are calculated using the highest figure from either:

- The highest obstacle, rounded up to the next 100 ft, or
- The highest ground level plus 300 ft, rounded up to the next 100 ft.

MEF symbology shows elevation in thousands of feet, represented by a large figure and hundreds of feet represented by a smaller, superscript figure. The MEF for the western area of the Mourne Mountains was 2,700 ft, increasing to 3,100 ft to the east. In this case 1,000 ft is added to the MEF to obtain the Minimum Off-Route Altitude (MORA).

From discussions with people who knew and flew with the pilot, his normal method of navigation when operating in visual conditions was to use the chart as his primary means of navigation and the Skymap IIIC as an additional aid.

He generally used the Garmin GNS 430s primarily as NAV/COM control heads, but also for displaying navigation information. No evidence was identified to

indicate that the Jeppesen database installed into the Garmin GNS 430s had been updated since the systems were installed in 2003. The database supplier confirmed that the database at the time of installation included a region of South Armagh designated as a Prohibited Area, EG P436. Therefore, if the database had not been updated this Prohibited Area would have been included in the depicted airspace. At the time of installation the GNS 430 was not capable of displaying terrain information.

The Skymap was located on the instrument glare shield in front of the pilot, convenient for use as an additional aid during visual flight. The Garmin GPS Map 695 had been installed on a temporary mounting at the bottom left of the left windscreen for the co-owner to evaluate and was not accessible from the commander's seat, on the right side.



**Figure 6**

The pilot's 1:500 000 map showing terrain colouring and spot heights with Maximum Elevation Figures

The database operating in the Skymap IIIC was Version 1.22 software containing the Atlantic International Region with a database cycle dated July 2009. The South Armagh Prohibited Area (EG P436) was cancelled in 2007, was not included in the 2009 database and was therefore not displayed on the Skymap IIIC. It was also not depicted on the 1:500 000 map carried onboard the helicopter, although it was shown on a chart, of an earlier edition, displayed in the flight planning room at St Angelo. The pilot's chart, recovered from the wreckage, did not have any route or track lines drawn on it and its condition, when recovered from the accident site, prevented a positive determination of how the chart had been folded.

*Skymap IIIC display*

The manufacturer of the Skymap IIIC assisted the investigation by demonstrating the use and presentation

provided by the display. The display in N2NR was set up in the landscape mode and used a helicopter icon to represent the position of the helicopter. The map and icon were orientated in the 12 o'clock position which indicated the direction of flight. The projected track of the aircraft (example, Figure 7) is shown extending from the helicopter icon with terrain, towns and airspace depicted on the map using lines, icons and colour coding. The default scale was set at 8 nm and this could be adjusted in set stages reducing or increasing the scale of the map. There are various display modes but the one normally used for navigation was the map mode with the TOPO (topographical) data displayed; the colour coding is based on terrain elevation AMSL and is shown at Figure 8.

The information displayed on the Skymap IIIC system is prioritised to show aviation information, such as

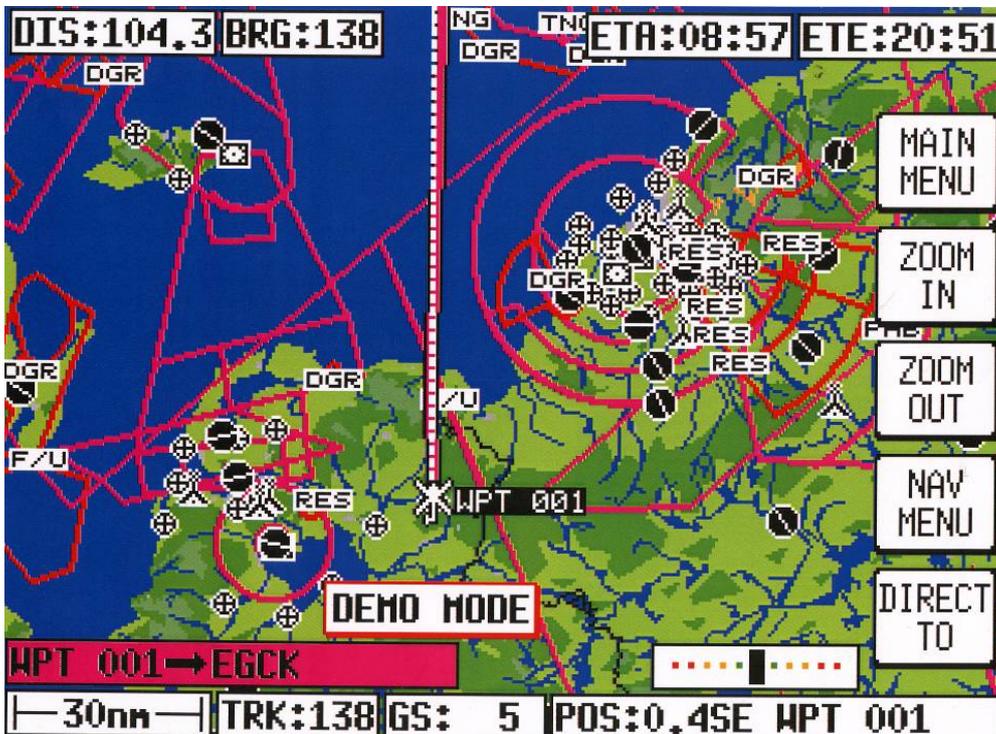


Figure 7

The screen print of the Skymap IIIC on 30 nm range, showing a projected track immediately prior to the left turn onto an easterly heading



Figure 8

The Skymap IIIC colour coding for the terrain elevations

airspace boundaries and airfields. The Skymap IIIC is a supplemental aid to navigation, and the data storage in the system is limited, so the terrain mapping is a representation of only the main features and, for capacity reasons, the terrain over 2,000 ft is not modelled in the database.

The two 'screen prints', Figures 7 and 9, are examples of the information provided. Figure 7 shows the helicopter at the point of the first left turn with a 30 nm scale set and a direct track to Caernarfon selected. Figure 9 shows the position of the helicopter immediately prior to impact with an 8 nm scale selected. It should be noted from both screen prints that the area of the Mourne Mountains is depicted using two shades of green. The shaded areas do not contain any spot heights, or the brown colour representing the terrain between 2,000 ft

and 3,000 ft, which is shown on the CAA Northern England and Northern Ireland chart. It is not known which page the pilot had selected.

It is not known which scale or scales the pilot was using during the flight but Figure 7 shows that, had the helicopter continued on the direct track towards Caernarfon, it would have transited Irish airspace. In order to remain clear of Irish airspace, the pilot would have had to route to Newcastle, County Down, from where a direct track to Caernarfon would have remained in UK airspace.

The Skymap IIIC cannot be coupled to the helicopter's autoflight system. Any track-following is achieved by changing the aircraft heading, either using the helicopter flying controls directly or the 'heading select' mode of

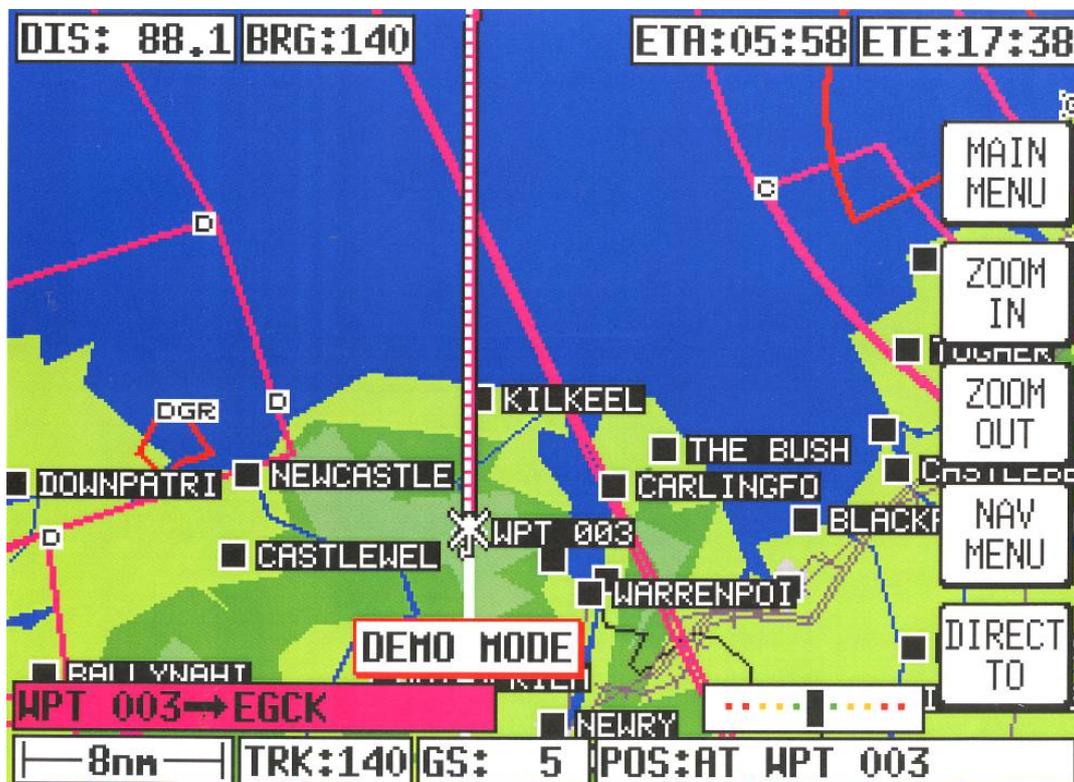


Figure 9

Skymap IIIC screen print on 8 nm range, showing no terrain above 2,000 ft, immediately prior to the impact with Shanlieve

the autopilot (AP). The pilot normally flew the helicopter in the cruise using the AP in the ‘heading’ and ‘altitude’ modes.

The Pilot Guide and Operating Manual for the Skymap system includes a Warning:

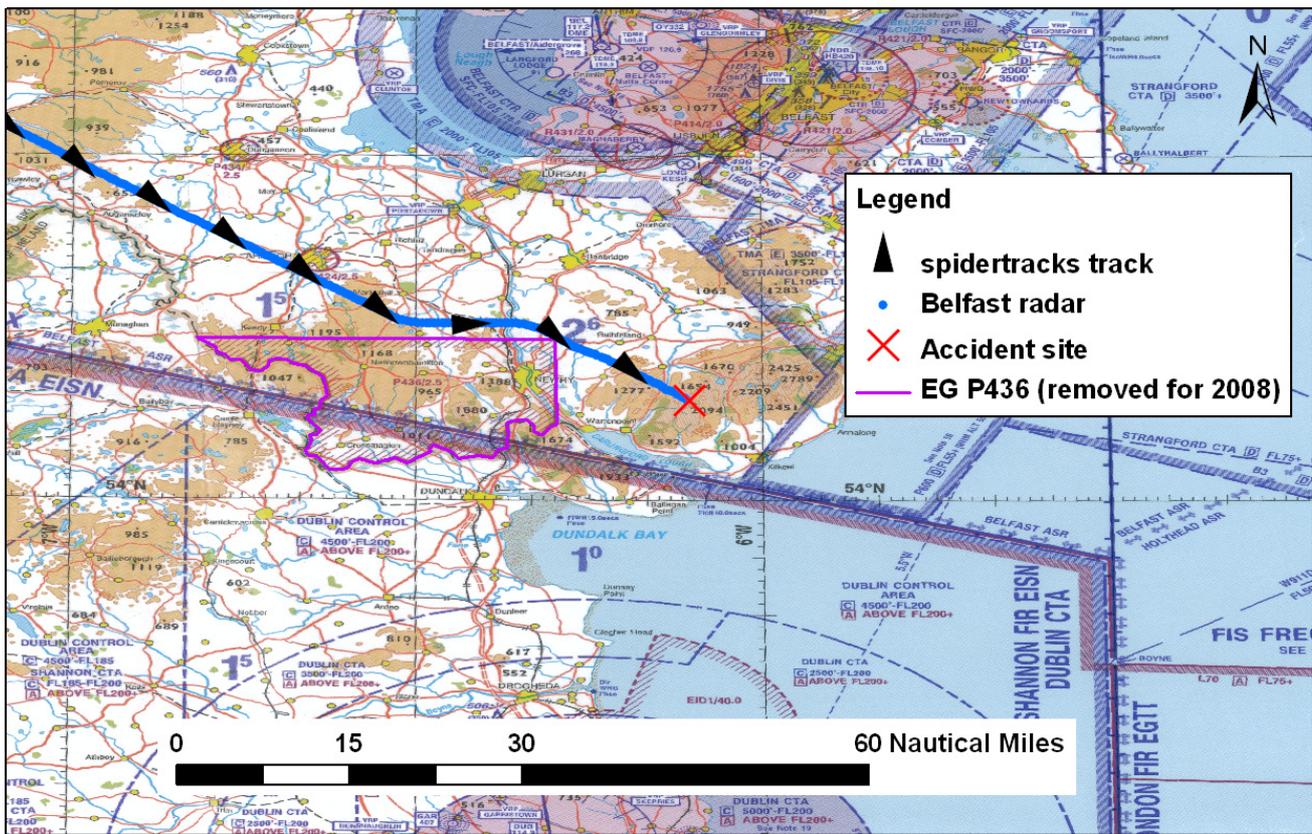
*‘Whenever you are using the unit for navigation in the air you should treat it as a **supplemental navigation system**. You should always carefully compare indications from your Bendix/King equipment with the information available from all other navigation sources including NDBs, VORs, DMEs, visual sightings, charts, etc. For safety, any discrepancies observed should be resolved immediately.’*

It also adds:

*‘This equipment is not a replacement for your chart. It is intended as an **aid to VFR navigation only.**’*

**Prohibited Area EG P436**

Prohibited Area EG P436 was removed for the 2008 air navigation chart and was not included in the Skymap IIC database, or on the pilot’s chart. It was, however, displayed in the flight planning area at St Angelo airport and, as noted above, was probably included in each of the Garmin GNS 430 navigation displays. Figure 10, below, plots the aircraft track in relation to EG P436 and the airspace boundaries.



**Figure 10**

The former Prohibited Area EG P436 and the Dublin CTA boundary

## Engineering investigation

### *The aircraft*

N2NR was an Agusta A109A II helicopter which had received a number of modifications since delivered new, mainly a general upgrade to the avionics, including three GPS-based navigation systems and the installation of an Enhanced Ground Proximity Warning System (EGPWS), fitted by a previous owner. It was equipped from new with an autopilot. Examination of the technical records indicated that the aircraft had been maintained to the appropriate schedule.

### *Crash site*

The site was first visited by the AAIB the day after the accident. The helicopter had almost completely disintegrated on impact with Shanlieve mountain at 590 metres (1,936 ft) amsl on a rocky incline of roughly 38° slope: debris had been thrown about 60 metres up and across the slope. The tailboom and tail rotor had detached in one piece and was found about 32 metres from the point of impact whilst the engines, main rotor gearbox and rotor head were located a further 20 metres up the slope. The engines and gearbox were badly affected by a localised fire and it was evident that there had been a fireball on impact through which many parts had passed, some continuing to burn after coming to rest.

The initial impact area contained the nose landing gear wheel and fork and the remains of some avionic boxes. A substantial rock jutted out from the slope just before the impact area and this rock bore no signs of contact; from this it was concluded that the helicopter must have been flying level, or possibly in a slight descent, for contact with the rock to be avoided. The degree of disruption of the cockpit and cabin indicated that the aircraft had been flying at high speed. No main

rotor blade slashes could be positively identified due to the rocky nature of the terrain and the fact that some of the rocks had been dislodged by impact, but the disintegration of all four blades indicated that the main rotor had been turning at speed.

### *Further examination*

Due to the weather and terrain, recovery of the wreckage was protracted but it was eventually despatched to the AAIB facility at Farnborough for further examination. All the debris was examined in conjunction with two representatives of the helicopter manufacturer and no anomalies were discovered, albeit the extreme disruption of the airframe and flying controls rendered a fully satisfactory inspection impossible. The following observations were, however, made during the course of the examination.

An initial subjective assessment of the disruption suggested that the helicopter had been travelling at a high groundspeed of approximately 150 kt. This speed was confirmed when the radar and Spidertrack information were processed.

The EGPWS AUD switch was found in the OFF position. Since it is necessary to pull the toggle before the switch can be moved from its detent, this is considered a reliable indication of pre-impact selection. The damage to the Skymap IIIC was such that it could not be positively determined that it was switched on at the time of the accident.

A barometric altimeter subscale mechanism was recovered (it is unclear which altimeter it was from). This suggested that the setting had been 1007 mb  $\pm$  1 mb.

The engines were given an initial appraisal by a representative of the engine manufacturer and then

despatched to an approved overhaul shop for strip examination in the presence of the AAIB and a further representative from the manufacturer. Evidence of rotation was found on both engines and no pre-impact mechanical failures were discovered. It was, however, noted that the first stage turbine nozzle guide vanes on both engines were in poor condition, possibly due to 'hot' starts at some time in their history (the engines were those which were delivered with the aircraft when new). This would not have caused a failure of either engine but would certainly have required replacement when the hot sections were dismantled for replacement of the gas generator turbine wheels, which was scheduled to take place in another 125 flying hours.

### **Flight trial**

During this investigation, the final track of the accident flight was flown using a Sikorsky S-76C helicopter. The flight was conducted with a visibility in excess of 10 km and cloud overcast at about 3,000 ft with patches of light rain. The peaks and ridges of the Mourne Mountains were all clearly visible. The purpose of the flight was to understand the likely view available to the pilot of N2NR.

When approaching the mountains from the northwest (Figures 11 and 12), the ground rises up in two stages. The first stage is from the Shankys river valley to the summits of Altataggart mountain (1,377 ft) and Tievedockaragh (1,551 ft). At the top is the relatively level area of Castle Bog (1,410 ft). The second stage is the steeply rising ground to the ridge formed by Eagle Mountain (2,093 ft) and Shanlieve (2,054 ft). At the northern end of the ridge, which was to the left in the direction of flight, the saddle of Windy Gap has its lowest point at 1,377 ft before rising up to the summit of Slievemoughanmore (1,833 ft). Figure 11 shows the terrain described taken from a distance of 3 nm and

an altitude of 2,000 ft amsl with the relevant stages of rising ground annotated.

At this range, and with the rising ground leading up to Castle Bog and the upper slopes and ridge of Shanlieve visible, the Northern England and Northern Ireland chart (Figure 6) can be related to the terrain ahead. This shows a spot height of 1,277 ft, rising initially to 2,094 ft and 2,209 ft on the projected track. With the upper heights of the terrain obscured by cloud, from and including Castle Bog, use of the chart becomes more difficult. As the distance to Shanlieve reduces, and the helicopter passes over the Altataggart mountain area as shown in Figure 11, the Shanlieve ridge becomes the dominant feature (Figure 12). From 2,000 ft, the area of Castle Bog is some 600 ft below and, providing the helicopter position is accurately known and the spot heights have been checked, the pilot would be aware that there is higher ground still ahead.

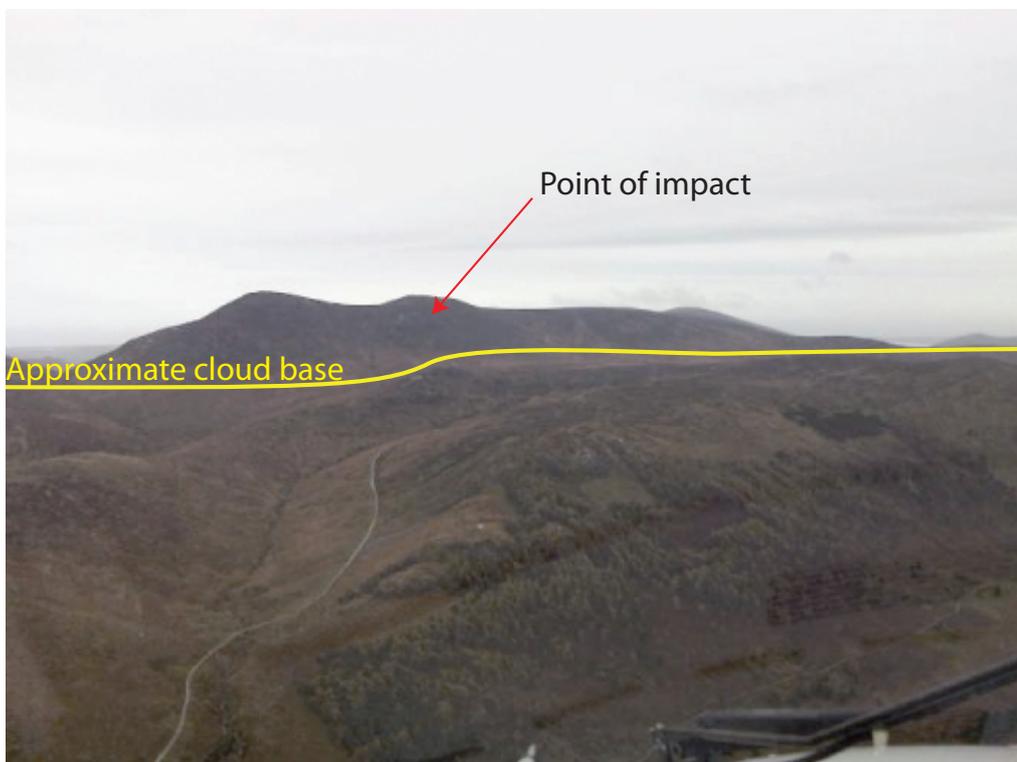
Spot heights were not displayed on the Skymap and the green colour coding would not have indicated that there was ground above 2,000 ft. If the spot heights on the projected track of the helicopter were not noted, and the Skymap were used for navigation, then with the upper slopes and Castle Bog obscured it could have been possible for the pilot to believe that he had overflown the high ground.

The hill walker witnesses were in cloud and it is not known how extensive the cloud cover was or whether any of the upper slopes or ridge were visible to the pilot; there may have been layers of cloud producing a false impression of the upper limits of the terrain. Whilst the terrain was clearly visible during the flight trial, if the upper slopes were obscured by cloud and the height of the terrain was known, it would have been apparent that it would not be possible to continue on the final



**Figure 11**

The first and second stages of rising ground, seen from a distance of 3 nm in the direction of flight



**Figure 12**

The Shanlieve ridge, showing the point of impact and the approximate cloudbase described by the witnesses

heading. An alternative route around the mountains would have been necessary.

The Sikorsky S-76C used for the flight trial was equipped with an EGPWS similar to that in N2NR. During the trial the EGPWS provided accurate and compelling warnings during the approach to Shanlieve.

## **Analysis**

### *General*

The pilot was properly licensed and qualified to operate the helicopter under VFR and IFR providing he remained within UK airspace.

### *Evidence of flight path*

The helicopter was not fitted with a CVR or FDR and therefore no evidence of the activity in the helicopter, or onboard recorded flight data parameters, was available to the investigation. The flight path evidence was derived from the radar data and information available from the owner's onboard Spidertracks system. The evidence of weather conditions in the Mourne Mountains close to the accident site was based on the Met Office aftercast and the evidence provided by the four hill walkers in the area at the time of the accident. The photographs taken by one of them clearly showed the weather conditions some three hours prior to the accident, but these had changed significantly by the time of the accident, and the police helicopter pilot who attended the site provided a concise description of the weather some 30 minutes after the event. He had been able to transit along his route VFR, encountering some light rain but with good visibility and a cloud base at about 2,000 ft until he reached the mountains.

### *Pre-flight activity*

The pilot had submitted the required General Aviation Report and a VFR flight plan from St Angelo (EGAB)

to Caernarfon (EGCK) with the routing given as direct. It could not be established what flight planning the pilot had carried out, or what weather briefing he had received, but a computer terminal was available in the flight planning area with a link to the Met Office website. From the information provided in the Met Office aftercast, the weather was suitable for the planned flight under VFR, subject to routing.

### *The accident flight - track*

The initial track of the helicopter was direct from the private estate to Caernarfon. This routing would have taken the helicopter into Irish airspace which was not permitted under the FAA regulations. The initial left turn took the helicopter towards Newcastle, County Down, from where a direct track to Caernarfon was possible remaining clear of Irish airspace and it climbed from 1,600 ft to 2,000 ft. The helicopter then turned right to resume the direct track for Caernarfon but, again, this routing would have infringed Irish airspace. The investigation plotted the track and turns in relation to the cancelled Prohibited Area P436 (Figure 10) and the left turn took the helicopter along the northern boundary, with the right turn resuming the Caernarfon track as the eastern edge of P436 was cleared.

This Prohibited Area did not appear either on the Northern England and Northern Ireland CAA chart or the Skymap presentation but was marked on the chart in the flight planning area at St Angelo and was probably in the Garmin GNS 430s. The pilot was likely to have been aware of it from his earlier Service flying in Northern Ireland. If the Jeppesen database in the Garmin GNS 430 had not been updated Prohibited Area P436 would have been displayed, without terrain information, and the pilot may have manoeuvred the helicopter around it. It is also possible that the turns were to route around weather.

*The accident flight - altitude*

Whilst the pilot was experienced and qualified for IFR flight and the helicopter was equipped for IFR operation, the freezing level was given in the aftercast as between 3,000 ft and 4,000 ft *'with airframe icing a hazard in the cloud.'* The pilot's Minimum Off-Route Altitude (MORA) in the area of the Mourne Mountains was 3,700 ft, increasing to 4,100 ft on the track being flown, which would have placed the helicopter in icing conditions without an airframe icing clearance. Had he been using the chart, as opposed to the Skymap IIIC or Garmin GNS 430, the height of the ground ahead would have been clearly apparent, as marked, including the MEF on which to base the MORA. With cloud either fully or partially obscuring the high ground, the need to remain in visual contact with the surface at a cruising altitude of 2,000 ft would have been evident and paramount.

If the Skymap IIIC or Garmin GNS 430 was being used, there would have been no spot heights or sector heights indicated and, with the two shades of green displayed on the Skymap, the pilot could have been led to believe that the highest ground ahead was between 1,000 ft and 2,000 ft.

*The accident flight – visual conditions*

The groundspeed derived from the radar data indicated a steady cruising speed of about 150 kt, which only reduced to 130 kt during the climb. There was no reduction in speed up to the point of impact, which suggests that the pilot was content with the visibility ahead and that he was in VMC, or that he believed he had cleared the high ground. It is unlikely that a pilot of his experience would deliberately fly in IMC at 2,000 ft in an area of high ground, which might be up to 2,000 ft and with spot heights exceeding that.

If the helicopter was flying between layers of cloud, the pilot's visual picture may have been such that, having passed over the first stage of rising ground, he believed that he had already passed over the highest terrain and there was no high ground ahead. This possible scenario may have been combined with distracting activity within the helicopter such as refolding the chart or looking up information in a document, believing the way ahead was clear. He may also have been focussed on avoiding the Prohibited Area and unaware of the high ground ahead.

Although there was no evidence of any pre-existing disease or condition that may have contributed to the accident, subtle incapacitation of the pilot could not be entirely ruled out. The fact that shortly before impact the helicopter was making small track changes to the left and right suggests the pilot was not totally incapacitated.

The helicopter was equipped with an EGPWS but it had not been in use at least since the replacement unit was fitted in 2009. An EGPWS has significant safety benefits when operating under Instrument Meteorological Conditions (IMC), particularly overland. However, the EGPWS is not a requirement for helicopter operation and the alerts it provides in VMC can become considered as 'nuisance' alerts, as the system will frequently initiate "TERRAIN" alerts due to the proximity of ground which is already visible to the pilot. For this reason the EGPWS may be selected OFF and examination of the data by the manufacturer showed that the system in N2NR had not been powered up since the particular unit had been installed in late 2009. Had the system been in use on the accident flight, the presence of the high ground ahead of the helicopter should have initiated a "TERRAIN" alert activated by the Shanlieve feature.

*Conclusion*

The accident occurred when the helicopter flew at a near constant height, heading and groundspeed into the western slope of Shanlieve. No technical fault was identified in the examination of the wreckage, but given the extreme disruption of the airframe and flying controls, a full inspection was not possible and therefore a technical fault cannot be completely ruled out. The helicopter impacted the terrain some 100 ft below the summit height of 2,054 ft.

Without clearer evidence of the pilot's actions or intentions, no conclusive causal factors for the accident could be established. However, as possible contributory factors, it is likely that the upper slopes of the ridge were obscured by cloud and some combination of visual or distracting factors led the pilot to consider that he was clear of terrain. Whilst there was no evidence of any pre-existing condition or disease, subtle pilot incapacitation could not be ruled out.