ACCIDENT

Aircraft Type and Registration:	Eurocopter EC135 T2, G-IWRC
No & Type of Engines:	Two Turbomeca Arrius 2B2 turboshaft engines
Year of Manufacture:	2002
Date & Time (UTC):	16 September 2007 at 1316 hrs
Location:	East of North Weald Airfield, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Extensive damage to fuselage, tailboom and rotors
Commander's Licence:	Private Pilot's Licence
Commander's Age:	55 years
Commander's Flying Experience:	2,500 hours (of which 450 were on type) Last 90 days - 48 hours Last 28 days - 15 hours
Information Source:	AAIB Field Investigation

Synopsis

The pilot and his passenger were returning to the UK from Europe. Whilst passing through the Stansted control zone, the helicopter's autotrim in the Automatic Flight System disengaged and the helicopter pitched nose-down. The pilot, believing he had a double engine failure, entered autorotation. During the landing flare, the tail of the helicopter struck the ground first, severing the fenestron drive. The helicopter subsequently rolled on to its side and was extensively damaged. The occupants escaped without injuries.

History of the flight

The pilot and his wife were returning from Kotrijk, Belgium, to a private landing site near Oxford the day after a friend had died in a helicopter accident. The weather conditions were fine with a moderate north-westerly wind. At 1309 hrs the helicopter was at 1,000 ft in the Billericay area, when the pilot contacted Essex Radar for a clearance to cross the Stansted control zone. After obtaining the clearance, the pilot requested, and was cleared, to climb to 1,500 ft in order to remain clear of the airfield at North Weald. The pilot used the autopilot in the ALT ACQUIRE mode to climb to 1,500 ft. As he neared North Weald, he consulted his flight guide to obtain the radio frequency for the airfield and passed them his flight information via his second radio. With the autopilot engaged in NAV GPS and ALT modes, and whilst flying hands off, the pilot returned the guide to its stowage in the right door. At this time he heard, and felt, a dull thud from above and behind him, similar to a bird strike. He also felt the helicopter change attitude. He stated that as he looked forward he noticed that the helicopter was pitching nose-down. His wife, who was occupying the front left seat and had been reading a magazine, expressed her alarm and later mentioned that the helicopter felt 'wobbly'. The pilot placed his hands on the controls and entered an autorotation.

The pilot checked his instruments and he recalls that one of the needles on the triple tachometer gauge, which shows engine and rotor speeds, pointed up, one was in the normal position, and the third needle pointed down. He also stated that he was not aware of any visual or aural warnings. His immediate assessment was that he had lost all engine power and therefore decided to try and make an autorotative landing at North Weald Airfield, which he could see ahead of him. He made an emergency call to Essex Radar, who gave him a bearing and distance to North Weald. The pilot realised that he would not make the airfield and therefore selected an alternative landing site and informed Essex Radar that he would be landing in a field.

The helicopter handled normally during the approach and as it passed over the edge of the field the pilot commenced the flare. He was aware of the tail boom touching the ground before the helicopter landed on its skids and ran along the ground for a short period before rolling onto its right side. The pilot and passenger, who were uninjured, vacated the helicopter through the front left door. The pilot could hear at least one engine running at what he described as 'low power' and, therefore, he returned to the helicopter to shut down the engines.

Accident site

From police photographs it was established that the helicopter crashed in a field approximately 1 nm to the east of Runway 02/20 at North Weald. The field had been recently cultivated leaving a loose top surface of soil and straw. From ground marks it was established that the helicopter touched down tail first on a track of approximately 345º. The tail then dragged across the ground for approximately 3.5 m before both skids touched down at about the same time. The helicopter then ran across the field for a further 10 m before it rolled onto its right side.

The photographs show that the tail boom had broken just forward of the horizontal stabiliser and all four main rotor blades had failed close to the blade roots. Broken fragments of the blades were scattered around the helicopter.

Helicopter description

The EC135 T2 is a light twin-engine helicopter equipped with a 'Fenestron' torque control system and conventional helicopter controls. G-IWRC was equipped with a Central Panel Display System (CPDS), Pilot's Displays (PD), Navigation Displays (ND), an Auto Flight System (AFS) and a high skid assembly which increases the ground clearance.

Central Panel Display System

The CPDS incorporates the Vehicle and Engine Monitoring Display (VEMD) and the Caution and Advisory Display (CAD).

The VEMD consists of upper and lower screens, which are used to display engine and dynamic system parameters. In addition to displaying the engine parameters (N1[1] , TOT[2] and torque) the upper screen also displays limitation exceedence information and warning messages following a failure of the Full Authority Digital Engine Controls (FADEC) or engines. A flight report is generated in the VEMD which contains details of the flight duration, engine cycles and any mast moment exceedences.

The CAD displays cautions, advisory messages and fuel system indications. A Master Caution light, located adjacent to the Warning Unit illuminates when cautions are generated on the CAD. Cautions are listed in the order of their appearance and can be cancelled by the pilot pressing the CDS/AUDIO RES switch on the cyclic stick grip.

Auto Flight System

The Auto Flight System is hierarchical in concept and on G-IWRC comprised a three axis Stability Augmentation System (SAS) and an autopilot. The SAS consisted of a Pitch and Roll SAS (P&R SAS) and Yaw SAS. The helicopter was also equipped with a pitch damper. These systems are used for stabilising the attitude of the helicopter about the longitudinal, lateral and yaw axes by applying limited authority inputs to the main controls. The SAS system is designed for 'hands-on' operation, which means that the pilot must provide control inputs through the cyclic control and yaw pedals in order to control the attitude of the helicopter. The SAS is automatically activated during the start procedures and can be disengaged by pressing either of the SAS DCPL switches located on top of each cyclic stick grip. Re-engagement of the SAS is through a four-way switch on the cyclic grip, labelled P&R/P – P/Y RST.

The three-axis autopilot is designed for hands-off operation. It is controlled by the Auto Pilot Mode Selector (APMS) mounted on the instrument panel, and comprises all the necessary controls to engage the autopilot and select one of its 12 modes. When the AP button on the APMS is selected the autotrim (A TRIM) automatically engages. The higher modes such as the altitude and navigation modes can then be selected via push buttons on the APMS. In normal operation the helicopter is flown with the basic autopilot, in attitude mode, permanently selected ON.

If the SAS DCPL switch is operated in flight, then the autopilot, pitch damper and the SAS will disengage. As the electro-hydraulic and electro-mechanical actuators in the flying control system will no longer receive any computed commands, they will return to their null positions, which can result in uncommanded small control inputs. The helicopter manufacturer stated that the uncommanded movement of the actuators may cause the helicopter to pitch up or down, and roll to the left or right. The following warnings are generated following the operation of the SAS DCPL switch:

Warning Unit - AP A TRIM lamp illuminates and gong repeats every three seconds. Warnings self-cancel after 10 seconds.

CAD - AUTOPILOT, P/R SAS, Y SAS, P DAMPER.

Master Caution - Illuminates until all the cautions on the CAD have been cancelled by the pilot.

PD - Red Y, R, P flash for 10 seconds then are replaced by an amber OFF.

Footnote

1 Engine gas generator speed.
2 Turbine Outlet Temperature.

Warning Unit

The Warning Unit is mounted near the top of the instrument panel and generates the visual and audio warnings for a number of systems. A memory within the unit stores, in chronological order, the last 31 warnings generated when the helicopter is in the flight condition. Whilst there is no timebase to determine when each warning was generated, there is a flag within each message code which toggles at the end of each flight. Consequently it is possible to determine the warnings which were generated during the last flight.

Emergency situations requiring immediate action will be indicated by a gong and the illumination of the relevant red warning light on the warning panel. The gong can be reset by pushing the CDS/AUDI RES button on the cyclic stick grip. The warnings that could be generated on G-IWRC include AP A TRIM, which is generated if the autopilot or autotrim is intentionally deselected, or if there is a failure in the AFS that does not allow the helicopter to maintain its attitude. The AP A TRIM warning and its associated gong self-cancel after 10 seconds.

Examination of the helicopter

The helicopter was examined after it had been moved by a maintenance organisation. The left side of the helicopter was mostly undamaged and the damage to the right side was consistent with it rolling onto this side. With the exception of a failed weld on the forward right shoe, the skid assembly was undamaged. Whilst the pilot's and one of the cabin transparencies had broken, the cockpit area remained intact.

The fenestron and rear section of the tail cone had broken away from the helicopter, and the aft drive shaft for the fenestron fan had failed just behind the forward flexible coupling. The fenestron fan had made contact with the inside of the duct and two of the blades had broken away at the blade roots. The remainder of the blades were bent slightly forwards. The damage to the inside of the duct was greatest between the 3 and 6 o'clock positions, when looking from the right side of the helicopter. The tail bumper and right side of the fenestron duct were also damaged. All the damage to the fenestron was consistent with a heavy tail strike and it is assessed that the fenestron drive shaft probably failed when the tail first struck the ground.

Apart from the right engine exhaust, which was slightly dented, the engines were undamaged and the turbines rotated freely. The air intake guards on both engines were covered in matted vegetation, which was considerably denser around the right engine intake. An internal inspection was carried out using a borescope and no damage was evident that would cause either engine to stop in flight. It was noted that the turbine blades on the right engine were covered by a black coating that was later identified by the engine manufacturer as burnt vegetation. The engine and main gearbox magnetic chip detectors were examined and found to be clean.

The main rotor head had been extensively damaged and the main rotor blades had been destroyed. All the damage was consistent with the rotor blades striking the ground whilst engine power was still being delivered to the main rotor transmission. As far as could be established there was no pre- impact damage to the hydraulic system or control actuators. All the drive shafts and clutch assemblies between the engine, main transmission and fenestron operated correctly.

The warning unit was tested and found to be satisfactory. The main rotor transmitter and the cabling between the engine and main rotor transmitter, as well as the triple tachometer gauge were examined and found to be undamaged. The triple tachometer gauge was tested using its in-built test facility and found to be satisfactory. Signals representing the main rotor and engine speeds were injected into the triple tachometer gauge cabling at the main rotor transmission and engine bulkhead plugs, and the readings on the gauge were satisfactory.

Due to the damage to the helicopter it was not possible to conduct a full dynamic test of the AFS. Nevertheless the condition of the AFS was checked as far as possible by using the AFS Development Test Set. In addition, with the assistance of the helicopter manufacture, the investigation identified the conditions that would generate the AP A TRIM warning light and, as far as possible, established the serviceability of the components in this part of the system.

Recorded information

Secondary radar returns from G-IRWC were recorded by Stansted and Debden radars and indicated that prior to the accident the helicopter was maintaining a ground speed of approximately 120 kt at an altitude of approximately 1,000 ft and a track of 295º. Approximately four minutes prior to the accident the helicopter climbed to 1,600 ft at 969 ft/min and approximately three minutes later started to descend at 2,300 ft/min before the radar return was lost at approximately 500 ft. The radar returns did not show any other aircraft in the vicinity of G-IWRC in the period prior to the final descent.

Testing and examination

FADECs

Both FADECs were returned to the engine manufacturer where they were tested and the internal memory downloaded. The tests established that both FADECs were serviceable and that during the flight the Training and Manual modes were switched off as is normal.

The data from the download revealed that at 4,039 and 4,040 seconds (approximately 1 hour 7 minutes) after the power to the left and right FADECs was turned on, both engines went into One Engine Inoperative (OEI) mode for a period of 0.36 seconds. During this event the left and right engines N1 were, respectively, 93.71% and 91.26%, N2 were 105.23% and 98.13%, and the torques were 63.6 dNm and 65.74 dNm. The OEI event was recorded because the torque from each engine went above the normal limit of 59.52 dNm. The difference in the recorded values for each engine is believed to be due to the sampling frequency of the FADECs.

Engines

Both engines were tested by the engine manufacturer with the FADECs that were fitted to the helicopter during the accident flight. Both engines ran normally and their performance was considered to be within normal in-service limits.

Fuel

Following the accident there was a total of 284 kg of fuel on board the helicopter with 42 kg in each of the supply tanks. Fuel samples from all the helicopter's fuel tanks were analysed by QinetiQ and found to be of a satisfactory standard.

Warning unit

The warning unit was returned to the equipment manufacturer and the data contained in its internal memory was downloaded. There were 31 warnings recorded in the memory; all occurred during the last flight. The oldest warning was generated by the autopilot when the main rotor rpm went above 112%. This warning would have illuminated the AP A TRIM red warning light and caused the ROTOR RPM red warning light to flash. A permanent audio tone, which could not be cancelled and which would remain on while the rotor speed was high, would also have been generated. Successive warnings indicated that the main rotor rpm fluctuated between about 106% and 112%. During this period the AP A TRIM remained illuminated and the ROTOR RPM caption would have flashed whenever the rpm exceeded 106%. In this speed range the permanent tone would have changed to a gong which, unless cancelled, would sound every three seconds. The AP A TRIM warning light then extinguished and the ROTOR RPM flashing warning and gong would have been generated each time the rotor rpm exceeded 106%.

During the last nine warnings the AP A TRIM red warning light illuminated then extinguished before the LOW FUEL warning illuminated. The ROTOR RPM red warning light then illuminated as the rotor rpm went below 95%, which would have also generated a pulsed tone. The final warning was the AP A TRIM, which occurred when the rotor rpm was below 95%.

The signal for the AP A TRIM warning is generated by the autopilot and supplied to the Warning Unit through switch 50CA. A test was carried out by removing switch 50CA from its mounting rail and tapping it with a screw driver. The test revealed that vibration, or a heavy shock, will cause the contacts in the switch to briefly move and generate the AP A TRIM warning. However, because the signal is not generated by the autopilot, the light goes out as soon as the contacts move back to their original position.

VEMD

Interrogation of the VEMD revealed that the accident flight lasted for 1 hour 6 minutes during which the mast moment limitation was exceeded. It was assessed that the mast moment limitation occurred when the helicopter rolled over and the rotor blades struck the ground.

Attitude and Heading Reference System (AHRS)

As a result of this accident the manufacturer undertook a ground test to establish if a disturbance to the airframe, sufficient to cause the thud reported by the pilot, could have caused the autotrim to disengage. The hydraulic system on the helicopter was pressurised, air speed set to 80 kt and the HDG and ALT modes engaged in the autopilot. The AHRS units were tapped, with the result that the autotrim disengaged and the GYRO warning was briefly displayed on the CAD. This test indicated that a sudden disturbance could cause the autotrim to disengage.

EC135 simulator assessment

An assessment of possible malfunctions that could have caused the initial upset was conducted, with the pilot who had been in command during the accident flight, in an EC135 full motion simulator. Reducing the power from one of the engines to ground idle at 120 kt produced engine indications and a yawing motion that where similar to the symptoms that the pilot recalled experiencing at the start of the incident. A similar yawing and 'wobbly' motion was also reproduced by disconnecting the SAS. This was achieved by pressing the SAS DCPL switch on the second pilot's cyclic stick grip. Disconnecting the SAS in this manner caused the AP A TRIM red warning light to illuminate and an aural warning 'gong' to sound. A red flashing 'P' 'Y' and 'R' was also displayed on the PFD. All the warnings self-cancelled after ten seconds when the 'P', 'Y' and 'R' on the PD changed to amber OFF. In addition the Master Caution illuminated and the following warnings were displayed on the CAD: AUTOPILOT, DECOUPLE, P/R SAS, YAW SAS and P DAMPER.

Engine off landings

In order to perform a normal engine off landing in a helicopter, the pilot must first flare the helicopter at a specific height above the ground. The exact height, which must be carefully judged, depends on the helicopter's weight and the wind conditions on the day. If the pilot flares too high he looses the benefit of the flare effect and he will land heavily. If he flares too low, then the pilot risks either striking the tail, or landing hard and fast. This manoeuvre is not normally practised by pilots of twin engined helicopters. When it is practised, it is with the SAS engaged; the manoeuvre would be more difficult to fly with the SAS disengaged.

Previous event

In November 2007 an experienced helicopter pilot with over 14,000 hours on helicopters and over 2,000 hours on type, submitted a Mandatory Occurrence Report[3] following the uncommanded disengagement of the autopilot on another EC135. The pilot was flying 'hands-off' at about 125 kt, with the autopilot engaged, when he heard, and felt, a dull thud from above and behind him. At the same time the AP A TRIM warning light illuminated, the gong sounded and the CAD displayed 'GYRO' for approx five seconds. On checking the APMS he noted that the autopilot was OFF. The pilot said that he initially thought that the thump was the result of hitting a large bird, but also stated that it felt as if a hydraulic ram had moved very quickly. The SAS remained engaged and the pilot stated that following the initial disturbance the helicopter gently pitched up and started to climb. The autopilot was re-engaged in flight and has since operated satisfactorily. The company maintenance engineers were unable to establish why the autopilot suddenly disengaged.

Fast disconnect of Auto Flight System and regulations

As helicopters have developed, the control response and control sensitivity has increased. With the stabilisation systems disconnected, modern helicopters are generally considered more difficult to fly than their predecessors. Meanwhile, advances in electronics and autopilots have made flight control systems more effective. Consequently, in comparison with older helicopter designs, the difference in handling between the stabilised and unstabilised flight modes is greater with modern machines.

The EC135 was originally certified under JAR 27, which was superseded by EASA CS-27. Paragraph 672 of CS-27 addresses stability augmentation systems, and paragraph 1329, autopilots.

> *'Paragraph 672 states 'the design of the stability augmentation system or any other automatic or power-operated system must allow initial counteraction of failures without requiring exceptional skill or pilot strength by overriding the failure by movement of the flight controls in the normal sense and deactivating the failed system In the guidance material relating to paragraph 672 it states Consideration should be given to the consequences of inadvertent de-selection of the automatic stabilization system, especially if the de-activation control is mounted on a primary control grip.*

Footnote

[3] MOR 200711114 dated 9 November 2007.

Paragraph 1329(a)(2) states that 'Each automatic pilot system must be designed so that the automatic pilot can:………be readily and positively disengaged by each pilot to prevent it interfering with control of the aircraft.'

A SAS DCPL switch is mounted on top of each cyclic grip and, whilst it is protected from inadvertent operation by an annular guard, the switch sits about 1 mm proud of the guard (see Figure 1). Tests were undertaken, on the ground, to establish if either of the front seat occupants could have inadvertently operated this switch. In the first test the corner of the magazine which the passenger had been reading was knocked against the switch. The test proved that it is possible for the corner of a heavy magazine to operate the switch. The second test simulated the pilot turning to place a book in the right door stowage. This test proved that it is possible for an elbow to operate the switch. On both tests the pressure to operate the switch also caused the cyclic stick to move forwards.

SAS DCPL SWITCH

Figure 1

Position of SAS DCPL Switch

Human factors

In an attempt to reconcile the pilot's report with the recorded data, a prominent human factors expert was consulted. In the view of the consultant, the pilot's report of a dull thud at the onset of the emergency was likely to be reliable, as this was the first stimulus to attract his attention and it preceded his appreciation of the subsequent changes in attitude, and other alarming stimuli. The pilot suspected he had a power failure, and his previous single engine experience may have predisposed him to enter an autorotation without delay.

The pilot would have been naturally concerned about rotor rpm, and did interrogate the triple tachometer gauge (see Figure 2). However, controlling the helicopter attitude and selecting a suitable landing site would have demanded most of his visual attention during the short time available and so it is likely that he only gave the gauge a brief glance.

The two N2 pointers are below the NR pointer in this photograph of the gauge at rest. Note the tail of the NR pointer.

Figure 2

The triple tachometer gauge

The triple tachometer gauge is a complex instrument and a brief examination might lead to errors in interpretation, such as confusing rotor rpm and engine N2, or mistaking the tail of the rotor rpm needle for an engine N2 pointer. The pilot appears to have gained a vivid impression of an unusual set of indications, but not a detailed and accurate interpretation sufficient to inform him that the engines were performing normally.

The sudden onset of what appeared to be a major emergency was likely to increase the pilot's arousal levels and affect his cognitive performance. In such situations narrowing of attention is probably the most commonly reported effect with the auditory channel the most commonly affected sense. This would account for the pilot's failure to notice any audio warnings.

It is possible that the pilot may also have been somewhat predisposed to land quickly following the death, the previous day of a friend in a helicopter accident. The presence of his wife as a passenger can only have accentuated any such predisposition.

Flight testing

A flight test was undertaken with the manufacturer to establish what happens when the SAS DCPL switch and autopilot are disconnected whilst the helicopter is flying at 130 kt with the AP height hold and NAV modes engaged. The test revealed no marked departure from the established flight path or noises, such as a dull thud. Moreover, at this cruise speed the cyclic stick is far enough forward to make it unlikely that the pilots elbow would have inadvertently operated the SAS DCPL switch.

Analysis

The technical investigation established that both engines functioned normally throughout the flight and the accident sequence most probably started when the autotrim disengaged whilst the pilot was flying hands-off with the autopilot engaged. It is suspected that the dull thud which appeared to emanate from the engine area, and the possible misreading of the N2 pointers on the triple tachometer gauge, led the pilot to believe that he had lost engine power. Based on this information the pilot entered an autorotation and successfully positioned the helicopter for what he believed was a power-off landing. However, he misjudged the flare and the tail struck the ground first resulting in the failure of the tail pylon and fenestron drive shaft. As the helicopter skidded across the field, the left skid dug into the soft soil, which caused the helicopter to roll onto its right side.

Possible reasons for the autotrim function to disengage in flight include the inadvertent operation of the SAS DCPL switch, power failure to the SAS computer or the autopilot detecting a sensor failure, transient fault or disagreement.

Whilst it was possible for the pilot's elbow to operate the SAS DCPL switch inadvertently on the ground, in flight the position of the cyclic control, when the helicopter is flown at 130 kt, means that it is unlikely that he could have done so whilst returning the flight guide to its stowage. The passenger was a frequent flyer on the helicopter and the pilot believes that it is also unlikely that she would have inadvertently knocked the SAS DCPL switch with her magazine.

The symptoms described by the pilot and the warnings recorded in the warning unit are very similar to those associated with the occurrence reported by an experienced commercial pilot in November 2007. On both occasions the pilot's described a dull thud from the engine area and on the first occasion the pilot reported that the autopilot disconnected and a GYRO warning displayed on the CAD. As part of this investigation the manufacturer undertook a ground test of the AHRS units which indicated that a disturbance could result in the auto trim disengaging and the GYRO warning illuminating briefly. The manufacturer has unsuccessfully attempted to reproduce the thud during test flights and has stated that they are unaware of any other cases where this has occurred.

The dull thud could have been caused by an external influence such as a bird strike, turbulence, wake vortex or the helicopter manoeuvring; but none of these factors applied to either of the reported occurrences. It is therefore most likely that the thud was a consequence of a slight change in the pitch of the rotor blades as a result of a disturbance in either the hydraulic system or the flying controls. Unfortunately, the extensive damage to the helicopter meant that it was not possible to test the hydraulic system, or to test the AFS dynamically.

The manufacturer has stated that they are unaware of any previous occurrences of the SAS disengaging in flight and, given the design of the hydraulic system, do not believe that it would have caused the thud. Whilst the actuators will move to their neutral positions following the disengagement of the SAS, in the given flight conditions this movement is likely to be small and have a negligible effect on the helicopter. It would, perhaps, only become significant if the SAS disconnected in turbulent conditions.

The autopilot is designed to monitor and disengage the autotrim function if it detects a discrepancy, failure or transient fault in the AFS. It would therefore seem that on this occasion it was probably the autopilot which disengaged the autotrim function. However, this should not have caused the helicopter to start to pitch nose down. Nevertheless, the investigation could not establish if the disengagement of the auto trim occurred before or after the dull thud, and it is possible that movement of the rotor control system, sufficient to cause the dull thud, might have moved the cyclic stick slightly forward such that the helicopter adopted the nose-down attitude reported by the pilot.

From the information in the warning unit it was established that in the early part of the accident sequence the AP A TRIM warning light illuminated and a gong sounded every three seconds for 10 seconds. The Master Caution light would also have illuminated and messages informing the pilot of the loss of the AFS systems would have be displayed on the CAD and PD. However, the pilot believed that he had an engine problem and therefore entered an autorotation, which would have required him to pitch the helicopter nose up initially to reduce speed. This would have caused the rotor rpm to increase, and the engine power to decrease. The engine N2 would have remained at 100%. From the warning unit it is know that the rotor rpm exceeded 112%, which would have caused the ROTOR RPM warning light to flash and a constant tone to be generated in the pilot's headset. It is possible that in glancing down at the triple tachometer gauge the pilot mistook the tail of the rotor NR pointer as being one of the engine N2 pointers, thereby reinforcing his belief that he had an engine problem (see Figure 3). However the engine and torque indications on the upper VEMD screen would have shown that both engines were still operating normally.

The AP A TRIM warning light and gong would self-cancel ten seconds after they had been activated and the flashing red messages on the PD would change to amber OFF messages. The descent took approximately 42 seconds, during which the pilot's workload would have been very high. In addition to flying the helicopter,

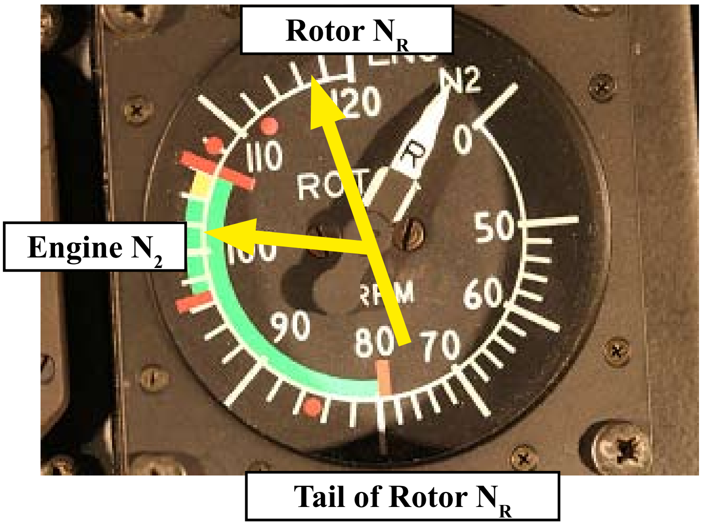

Figure 3

The Triple tachometer gauge with the positions of the pointers, as determined by the investigation, superimposed in yellow. The N2 pointers are not visible as, in this photo, they are hidden by the NR pointer

he made two radio calls and positioned the helicopter for a field landing. During this period the rotor rpm fluctuated between 95% and 112%. Each time the rpm exceeded 106% the ROTOR RPM warning light would have illuminated and a gong would have sounded every three seconds.

After the tail contacted the ground, it is likely that the helicopter would have pitched forward and landed heavily on the front of the skids, possibly causing the contacts in switch CA50 to briefly move and generate a further AP A TRIM warning. Since the autopilot did not generate this warning it would cancel as soon as the contacts opened again. At this stage the rotor rpm was still in the 95% to 106% band and the engines and FADECs were operating normally. With the fenestron drive shaft broken, any torque reaction would have caused the helicopter to yaw to the left. There were no ground marks to indicate this happened, so the collective lever was probably in a lowered position after the tail struck the ground. Ground marks indicated that the helicopter landed in a level (roll) attitude and as it slid across the field the left skid dug into the soft ground causing the helicopter to yaw to the left and roll onto its right side. As the main rotor blades struck the ground the torque from both engines briefly increased to 63.6 and 65.74 dNm in an attempt to maintain the rotor NR. As the main rotor blades disintegrated, the rotor NR would have started to increase and the FADECs would have reduced the engine power to prevent the turbines from over-speeding.

Whilst the pilot appears to have missed the warnings, his priority would have been to position the helicopter for the field landing. The disengagement of the autotrim would have generated 3 to 4 gongs during the first 10 seconds when his work load would have been very high. Subsequent gongs would only have been generated whilst the rotor rpm was above 106%, and it is not known how long the rotor rpm exceeded this threshold.

Safety Recommendation

Whilst it is unlikely that the inadvertent operation of the SAS DCPL switch caused this accident, it is felt that the guard provides insufficient protection and might not comply with the guidance given in EASA CS-27. The use of a guard that more effectively protects the switch might help to prevent inadvertent operation. Equally a change in philosophy, such that the initial operation of the AFS fast disconnect switch leaves a basic level of SAS still engaged, might help to prevent inadvertent operation.

Safety Recommendation 2008-038

It is recommended that Eurocopter review the design of the Stability Augmentation System (SAS) DCPL switch on the EC135 helicopter to reduce the likelihood of inadvertent de-activation of the SAS.

Conclusion

From the available evidence it would appear that the accident sequence started with the disengagement of the autotrim function when the pilot was flying 'hands-off' at a fast cruise speed. The pilot misread his triple tachometer gauge and, aware of the thud from the engine area, believed that he had suffered a total engine failure and therefore entered an autorotation. He successfully positioned the helicopter for a power-off landing in a suitable field, but misjudged the landing flare and the tail pylon broke off when it struck the ground first. As the helicopter travelled over the field, a skid dug into the soft earth causing the helicopter to roll onto its right side.

The investigation could not identify the reason why the autotrim disengaged or the cause of the dull thud which the pilot heard at the start of the accident sequence.