Bell 206L Longranger, G-IANG

AAIB Bulletin No: 3/2004	Ref: EW/C2003/04/05	Category: 2.3
Aircraft Type and Registration:	Bell 206L Longranger, G-IANG	
No & Type of Engines:	1 Allison 250-C20B turboshaft engine	
Year of Manufacture:	1977	
Date & Time (UTC):	30 April 2003 at 1432 hrs	
Location:	Longfaugh Farm near Pathhead, Midlothian	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 2
Injuries:	Crew -1 (Minor)	Passengers - 1 (Minor)
Nature of Damage:	Damaged beyond economic repair	
Commander's Licence:	UK Airline Transport Pilot's Licence	
Commander's Age:	48 years	
Commander's Flying Experience:	4,469 hours (of which 2,269 were on type)	
	Last 90 days - 32 hours	
	Last 28 days - 9 hours	
Information Source:	AAIB Field Investigation	

Synopsis

Towards the end of a flight, the pilot had transited through Edinburgh Airport Zone in preparation for a landing at his home site of Oxenfoord Castle, north of Pathhead. When to the east of Edinburgh, he deviated to the south to avoid some low cloud but, as he started heading east towards his intended landing area, the pilot encountered further low cloud at the beginning of a valley. He descended to remain in sight of the ground and almost immediately saw pylon cables directly ahead of the helicopter. He initiated a climb but the rear of the helicopter struck a cable and the tail rotor/fin assembly detached. G-IANG force landed heavily on the upslope of a grass field. The helicopter was extensively damaged but the three occupants escaped with minor injuries. The pilot's shoulder harness failed during the forced landing.

History of flight

The pilot had organised a commercial undertaking for 30 April 2003, to transport passengers around various locations in Scotland. Accordingly, with his brother in the left cockpit seat, who was not qualified as a pilot but who was an experienced ground crewmember, he left his normal base at Oxenfoord Castle at 0727 hrs to fly to a site near Edinburgh. There, he picked up two passengers and subsequently flew five flights ending at a landing site at Perth; during this sequence of flights, he made a landing back at his home base to uplift some fuel. At Perth, an additional passenger was boarded and a flight was then made to a site near Aberdeen. At that point, the original two passengers left the helicopter and the pilot prepared for his return to his home base; he agreed to give the third passenger a lift back to Oxenfoord Castle and considered this a private flight. Prior to this final flight, the pilot flew to Aberdeen Airport with his brother and the one passenger to uplift some additional fuel. At 1422 hrs he tookoff from Aberdeen, with his brother beside him and the passenger in the rear right seat of the cabin, for the flight to Oxenfoord Castle.

On the initial part of this flight, the pilot was flying at heights of between about 800 feet and 1,500 feet agl because of variable weather. With ATC clearance, his route was along the coast and then through the RAF Leuchars MATZ, after which he contacted Edinburgh ATC on frequency 121.2 MHz and agreed a FIS. He entered the Edinburgh Zone and positioned G-IANG near the threshold of

Runway 06 at 1,500 feet amsl. Once cleared, he set course, remaining south of the city, for Dalkeith VRP, which was his usual route to his home base. However, as he flew east, he could see low scattered cloud over a housing area ahead and decided to avoid this weather by flying to the south, where he knew he would not overfly any built-up area. By now, he was clear of Edinburgh Zone and advised ATC that he would call them once he was on the ground at Oxenfoord Castle. As he flew south, he descended to 500 feet agl over open land and, maintaining 70 kt, began following a disused railway line to the south of Gorebridge. Then, knowing that he was clear of any congested area, he started heading in an easterly direction towards his home base. He now saw some cloud ahead and so descended to maintain visual contact with the ground.

This cloud was at the start of a valley and the pilot was confident that he was over fields and well clear of any obstructions. Almost immediately, however, he saw power cables ahead of the helicopter and used both the cyclic and collective controls to try and avoid a collision. Shortly after, he heard a loud 'clunk' and G-IANG started to rotate to the right. As the rate of rotation increased, he was aware of the helicopter being 'nose high'. The application of forward cyclic control levelled the helicopter and the pilot tried to initiate a descent to achieve more forward speed. However, he quickly realised that this had no effect on the rate of rotation and he decided to enter autorotation. He lowered the collective lever and reduced airspeed to close to zero but did not close the throttle. The nature of the ground and the continuing rotation meant that he could not consider a run-on landing and so, as he saw the ground approaching, he applied full collective control to try and arrest the rate of descent. The pilot was aware of a violent 'jolt' and could remember nothing further until he felt his brother undoing his seat belt and urging him to get out.

Following the impact, the passenger and the pilot's brother undid their own seat belts, opened their respective doors and ran from the helicopter. Once clear, they were both aware that the pilot was still in the helicopter and ran back to assist him. They helped him away from G-IANG and the passenger used his mobile telephone to alert the emergency services. While the passenger went to alert some onlookers, the pilot used his mobile telephone to call Edinburgh ATC and advise them of the accident and that they were safe. The passenger was subsequently taken to hospital by an air ambulance. The pilot and his brother were taken to hospital by road vehicle.

Operational information

The aeronautical chart found in G-IANG displayed the location of the power cables struck by the helicopter. Subsequent inquiries revealed that the one cable struck by the helicopter was approximately 120 feet agl. The accident site was some 2.5 nm from the home base of the helicopter and less than 1 nm from the location previously used by the pilot as a base.

The Meteorological Office at Bracknell provided a weather aftercast for the flight. The synoptic situation at 1200 hrs showed a moist, unstable, south-westerly flow covering southern Scotland. There were rain showers over the area. Visibility was generally 25 km but reducing to 3,000 metres in showers. Cloud was as follows: Scattered (SCT) Stratus base 800 to 1,200 feet amsl; FEW/ SCT Cumulus base 2,000 to 2,500 feet amsl; Broken (BKN), locally SCT, Strato-cumulus base 4,000 to 5,000 feet amsl; high risk of localised Cumulo-nimbus base 1,500 to 2,000 feet amsl. The surface wind was 070°T/ 05 kt; at 1,000 feet amsl, the wind was 090°T/ 10 kt; at 2,000 feet amsl, the wind was 100°T/ 10 to 15 kt.

The Edinburgh TAF issued at 1205 hrs, and valid from 1300 to 2200 hrs, was as follows: Surface wind variable at 05 kt; visibility greater than 10 km; cloud SCT at 1,800 feet amsl, BKN at 3,000 feet amsl; temporarily throughout the period, 7,000 metres visibility with rain showers and cloud BKN at 1,500 feet amsl.

The Edinburgh METAR at 1420 hrs was as follows: Surface wind 100°T/ 05 kt; visibility 3,000 metres; rain showers; cloud FEW at 1,200 feet amsl, SCT at 1,800 feet amsl, BKN 3,000 feet amsl; temperature 10°C, dew point 8°C; QNH 1009 hPa; recent rain.

Engineering information

The helicopter had struck the top (earth) cable of a set of 132 kV cables suspended across the valley at a height of about 120 feet above the valley floor, approximately mid way between two pylons. The impact had frayed the outer sheath of the cable but the central core remained intact. Contact with this cable was made by both tail rotor blades, and this removed some 15 cm from their tips. An additional impact on the bottom of the vertical fin had caused the extreme aft section of the tailboom to tear-off, complete with the tail rotor gearbox and fin. This was found on the ground some 60 metres away from the point of contact with the cable; the main wreckage lay on a slope in a grass field, some 245 metres from the damaged cable.

The main wreckage comprised the cabin, in an upright position, complete with the engine and main rotor gearbox. The tailboom, which bore evidence of main rotor strikes, lay alongside the cabin. Unusually, the landing skids, which were of the extended high type had remained attached at the forward mounts but detached from the rear, such that the helicopter was sitting inside the skids which were back-to-front and upside-down relative to their normal position. This suggested that the machine had impacted the ground travelling backwards and, as the aft end of the skids dug into the ground, the rear mounts failed and the fuselage pivoted around the front mounts. Marks were found which showed that the rear of the skids and the rear fuselage had made heavy contact with the ground, thus confirming this scenario.

Numerous main rotor blade ground strikes were found and both blades had been badly fragmented, with blade debris scattered around the accident site. The main rotor mast had been bent and partially fractured but had not quite detached. Examination of the cockpit and cabin showed that the latter was undamaged whilst the former had been distorted with both windscreens destroyed. All the seats were intact but it was noted that the pilot's upper torso restraint stitching had failed at the point where it emerged from the inertia reel mechanism located behind his neck, Figure 1.

Figure 1

Photograph of intact left front seat upper torso restraint

Survivability

The accident was clearly survivable and the major impact forces were almost certainly in a predominantly aft direction, followed by lateral forces during the helicopter's gyrations on the ground. It was thus surprising that the pilot's upper torso restraint had failed. It was unclear whether his head injuries were directly caused by the failure of the restraint, or even which part of the aircraft structure contacted his head, but it was considered, subjectively, that the stitching had failed at a very low loading.

As shown in Figure 2, the upper torso restraint comprises an inertia reel unit behind each front seat occupant's neck. A single webbing strap is wound around the reel and emerges as a tongue from the unit. To achieve the inverted 'Y' shape strap, which divides either side of the occupant's neck, a second strap is folded at 45° and stitched to the tongue. The quality of this stitching was generally poor and irregular on both of the front seat restraints fitted to G-IANG.

Figure 2

Photograph of failed stitching on front right seat upper torso restraint

Restraint system history

Enquiries with the operator revealed that all the restraint harnesses in the aircraft had been replaced about two years before the accident. The helicopter had been completely retrimmed internally by a specialist company who used the services of a CAA licensed engineer to certify the work. The owner had asked this company to change the colour of the restraints, as they no longer matched the new interior colour scheme. Although the specialist company was not able to manufacture new belts, they chanced upon a small company of aircraft furnishers who said that they could do such work and so they were commissioned to make the replacement items. These were fitted and certified by the engineer. The specialist company stated that the belts had been supplied with documentation to the effect that they had been manufactured in compliance with applicable FAA standards, but they were no longer able to locate any related documents. The company that manufactured the belts is no longer trading.

Restraint system standards and testing

Information from the FAA showed that there are several applicable documents, which they regard as relevant to the design and testing of restraint systems. These are Technical Standard Orders (TSO) C22g and C114, and an associated Society of Automotive Engineers (SAE) Standard AS8043. The latter carries information about all aspects of restraint testing, and is aimed at providing guidelines to system designers and manufacturers. It does not relate specifically to upper torso restraints and the test procedure is clearly aimed at proving the strength of the whole system, including inertia reel and buckle performance. The procedure requires the use of a shaped block, roughly simulating a seat occupant, around which the restraints are fastened, while forces are applied at the anchor points. It contains no information about proof testing of individually manufactured items.

Examination of a similarly-designed torso restraint system from a Bell 206 helicopter, and made by an original equipment manufacturer (OEM), exhibited a label identifying the various conformance standards under which it had been manufactured, and a figure of 1,500 lbf which identified the rated strength of the safety belt system in accordance with TSO C22g. No such label was found on the restraints from G-IANG. It was therefore decided to organise a destructive test of the intact front passenger upper torso restraint assembly, using this loading figure as a guide. The equipment employed was of the type used to perform tensile tests on material samples, and the method of gripping the anchor points ensured that all the stitched joints would be loaded. At a load of about 900 lbf, the stitched joint at the bifurcation failed, i.e. at the same location as on the pilot's restraint.

Discussion

There was neither any report nor indication of any technical malfunction with the helicopter during the accident flight up to the time of the cable strike. The weather forecast for the series of flights carried out by G-IANG indicated that they could be completed, but that there would be a possibility of showers with an associated reduction in visibility and cloud base. When the pilot became aware of adverse weather on his intended route near his home base, he diverted to the south and followed a disused railway line until he considered that he was well clear of congested areas. By now, he was in an area close to his home base and should have been aware of the local geography, together with any potential hazards. While the pylon cables, at a height of approximately 120 feet agl, were not a particular hazard for a transiting helicopter, they were a potential danger to any helicopter taking-off or approaching to land in the area. The proximity of the pilot's current and previous landing sites, together with the fact that the subject cables were marked on a topographical chart found in the helicopter wreckage, should have made him aware of the location of these cables. His sudden confrontation with the cables, however, indicated that he had lost awareness of his exact geographical position.

Once the pilot sighted the cables, his immediate reaction was to initiate a climb using cyclic and collective control to attempt to avoid them. However, the rear of G-IANG struck the uppermost cable, causing detachment of the tail rotor assembly and the fin. With the loss of anti-torque capability against the main rotor torque, the helicopter began rotating to the right. The pilot's initial attempt to use the vertical stabiliser to provide some directional stability, by increasing speed, was unsuccessful, as the fin had detached. However, any further increase in speed and associated loss of height would have placed it very close to the ground and, as the terrain was unsuitable for a 'run-on' landing, the pilot quickly entered a zero speed autorotation. G-IANG descended in a level attitude, but in a rotating turn to the right. The pilot applied full collective control as he saw the ground approaching but the rapidity of the developing situation was such that the pilot did not close the throttle. If the throttle had been closed, this would have reduced the tendency for the helicopter to rotate to the right. The ground contact was hard and caused considerable damage to the helicopter and failure of the pilot's upper torso restraint.

Rule 5 of the ANO requires that aircraft should remain at least 500 feet clear of persons, vehicles, vessels and structures except during the process of taking off or landing. Unless the pilot was intending to land, either as a precaution or at his destination, adherence to a safe height should have been his priority. During this investigation the pilot stated that it was, in fact, his intention to carry out a precautionary landing and that soon after becoming visual with the chosen landing site, he saw, but was unable to avoid, the cables. While he may have thought that he knew exactly where he was flying at between 60 kt and 70 kt, in the prevailing weather conditions it would have been sensible to have reduced airspeed to allow more time to avoid any potential hazards such as cables.

Conclusions from restraint examination and testing

The figure of 1,500 lbf on the label attached to the OEM's restraint of the other Bell 206 helicopter examined, indicated its rated strength; the replacement item fitted to G-IANG achieved only some 60% of this value, but at failure, which indicated that its ultimate strength, relative to an OEM restraint, would be lower than 60%. However, the belt tested from G-IANG was not new and, presumably, some reduction in strength in-service would be anticipated, even for an OEM-supplied item. The right seat (pilot's) restraint system would experience the most use and hence likely experience the greatest deterioration.

Safety recommendations

As restraint systems age and become worn, replacement becomes almost inevitable. Although such equipment is required by the CAA to be supplied from an approved source, and fitted by a licensed engineer, this accident has highlighted the possibility that sub-standard equipment could be installed in other aircraft. This is not likely to be of importance in the normal course of flying, where the restraint retains an occupant in a seat through turbulent conditions, but it could be critical in a survivable accident scenario. It is not known how many aircraft on the UK register have been fitted with replacement occupant restraints, but it is likely to be a significant proportion of the fleet.

It is therefore recommended that:

Safety Recommendation 2004-12

The CAA should re-emphasise to the aeronautical community in general, and licensed engineers in particular, the importance of ensuring that any occupant restraint systems already fitted, or to be replaced, on an aircraft or helicopter, comply with the relevant airworthiness requirements.