Agusta Bell 206B, G-FLYR

AAIB Bulletin No: 1/98 Ref: EW/C97/7/2Category: 2.3

Aircraft Type and Registration:	Agusta Bell 206B, G-FLYR
No & Type of Engines:	1 Allison 250-C20 turboshaft engine
Year of Manufacture:	1973
Date & Time (UTC):	13 July 1997 at 1050 hrs
Location:	Glamis Castle, Forfar, Scotland
Type of Flight:	Private
Persons on Board:	Crew - 1 - Passengers - 5
Injuries:	Crew - None - Passengers - 1 Fatal
Nature of Damage:	Aircraft damaged beyond economic repair
Commander's Licence:	Airline Transport Pilot's Licence for Fixed Wing Aircraft and a Commercial Pilot's Licence for Helicopters
Commander's Age:	55 years
Commander's Flying Experience:	Fixed Wing: 13,484 hours
	Helicopters: 1,830 hours (of which 1,770 were on type)
	Last 90 days - 64 hours
	Last 28 days - 30 hours
Information Source:	AAIB Field Investigation

Background to the accident

The 24th Scottish Traffic Extravaganza was held at Glamis Castleon the 13 July 1997. One of the major events planned for theday was to be a series of helicopter flights for children withspecial needs. This element was organised by a registered charity,whose objective is to offer children, between 6 and 16 years ofage and with a variety of special needs, the opportunity to experiencea flight in a helicopter. This charity arranged for the provisionof the three helicopters and organised the administration andreception of the children and their families but contracted theorganisation of the operational aspects of the helicopter flyingto a helicopter operator based at Edinburgh Airport. This operatorhad agreed to arrange the site facilities including the necessarysafety equipment, provide aircraft handlers and overall site managementand provide, at commercial rates, one of the

three helicopters,an Enstrom 480. Since this operator did not have an Air Operator'sCertificate (AOC) it had previously arranged, with the agreementof the Civil Aviation Authority (CAA), that this helicopter wouldbe operated under the auspices of another company's AOC. An AOCis required for the operation of a Public Transport flight. Thesecond helicopter, an AS350 Squirrel, was contracted from a separatehelicopter operator, based at Inverness Airport and was operatedunder that company's own AOC. The third helicopter, an AgustaBell 206B, was provided by a commercial organisation. Since theservices of this helicopter and its pilot were donated completelyfree of any charge the helicopter was operating in a Private capacityand was therefore not required to operate under an AOC. Thiscommercial organisation had donated the services of the same helicopterand pilot to support the charity at similar events on two previousoccasions.

History of the flight

At 0715 hrs on the morning of 13 July 1997 the pilot of the Bell206B took off from a private helicopter strip located to the southof Edinburgh with the intention of flying to Glamis Castle. Initiallythe weather was fine but just to the north of Glenrothes the pilotencountered low cloud and poor visibility; he decided to landat Glenrothes to await an improvement in the weather. After abouttwo hours the weather conditions had improved and the pilot tookoff again by which time he was in radio contact with the pilotflying the Enstrom 480. This helicopter was about seven minutesahead of the Bell 206B and its pilot relayed details of the weatherconditions en route. When they arrived at Glamis the Enstrom480 landed first followed by the Bell 206B; the AS350 landed fiveminutes later, at about 1005 hrs, having flown from Inverness. The weather conditions on arrival were estimated by the pilotof the AS350 to include a visibility of approximately 5,000 metresin light rain with complete cloud cover at about 600 feet aboveground level (agl).

When the three helicopters had landed and shut down the pilotsconducted their briefing. They agreed upon the departure andarrival paths and the route to be flown, however, during thisbriefing doubts were expressed about the viability of the weatherby the pilots of the Bell 206B and the AS350. Whilst the conditionswere safe for flight they were concerned with flying a high intensityoperation, involving three helicopters, in such conditions. Itwas agreed that the pilot of the Enstrom 480 would conduct aninitial flight with the purpose of confirming the suitabilityof the weather for the planned operation.

Meanwhile the teams of aircraft handlers received instructionon the use of the seatbelts and doors of their allocated helicoptersand were then required to demonstrate their ability to operatethese items. Each team consisted of four people and their functionwas to control the passengers allocated to their helicopter. They were required to monitor them closely when in the proximityof the helicopter and to ensure that each passenger was correctlystrapped into their seat and the doors of the helicopter securelyclosed before flight. The teams consisted mainly of experiencedhandlers from Edinburgh Airport, helicopter pilots and airportfiremen, all of whom were familiar with helicopter operations. The team allocated to the Bell 206B did include one inexperiencedhandler and she had been comprehensively briefed on her dutiesand during the familiarisation had been shown how to operate thedoors and the seatbelts.

The allocated passengers were loaded into the Enstrom 480 whichdeparted on its first flight during which it completed a weathercheck, the pilot radioed back to the other two helicopter pilotsthat the cloud base was estimated to be 600 feet agl with an inflight visibility of 5,000 metres although the intensity of therain had increased. Both pilots on the ground regarded theseweather conditions as acceptable to at least commence the plannedflying programme and began loading their passengers. On the Bell206B the inexperienced aircraft handler strapped in the passengerseated in the rear left

seat and the seat belt was then checkedby one of the more experienced handlers. As soon as the doorsof this helicopter were closed the windows and windscreens beganto mist up: the passengers were wet and the relative humiditywas high. An aftercast issued by the Meteorological Office indicatedthat the relative humidity was 92% at the nearby airfield of Strathallenand 98% at the RAF station at Leuchars, 17 miles to the south-east.

Meanwhile the pilot of the Bell 206B had started the engine ofhis helicopter, he opened the air vents and selected the DefogBlower to ON in an attempt to clear the condensation from thewindscreens. He also asked the site manager to retrieve a lintcloth from the rear baggage compartment which he then used towipe the windscreens in a further attempt to clear them. Thepilot stated that prior to take-off the screens were clearingbut the aircraft handlers, standing approximately 30 yards infront of the helicopter, described the transparencies as "hazy"or "misted" and they could barely see the passengersinside. A video recording of the helicopter as it lifts off showsthat the view through the forward transparencies to the interioris obscured as a result of the condensation. The AS350 also mistedup as soon as the doors were closed but after approximately tenminutes with the engine set to Flight Idle Power (a high powersetting for ground operations), the demister selected to ON andthe heating set to Maximum the misting cleared: the Enstrom 480apparently suffered no misting problems.

Once airborne the pilot of the Bell 206B intended to follow thepre-arranged route but within about 30 seconds he was awarethat the misting on the forward windscreen was increasing. Afterapproximately one minute he decided that the misting had becomeso significant that he would have to land and he made a radiocall on the frequency in use to say that he was returning to thelanding site. The pilot of the AS350, who at this stage was stillon the ground, heard this call as "I can't see anything,I am returning" so he asked the pilot of the Bell 206B ifhe meant that the external visibility had reduced because of rainbut the reply was, "I can't see out of the windscreen". As the intensity of the misting increased the Bell 206B pilotdecided to avoid returning to the landing site because of hisrestricted vision and instead looked elsewhere for somewhere suitableto land the helicopter. Initially he selected a field to thesouth of the landing site but at a late stage he decided thatit was not suitable and instead made for an adjacent open fieldfurther to the west. When established over that field, at a heightof about 4 feet, he was aware of some nearby cattle and decidedto hover taxi away from the cattle maintaining a height of 3 to4 feet and at a speed equivalent to a fast walking pace. Whilstattempting to do so the helicopter ran into a wire strand fence,tipped over onto its nose and eventually came to rest on its leftside. The pilot had not seen the fence. The pilot undid hisown seat belt and then assisted the passengers to release theirseat belts and get out of the helicopter. The young child whohad been seated in the left rear seat was trapped through thedoor aperture with his upper body underneath the fuselage anddespite attempts by the pilot and a local farmer they were unableto lift the helicopter to release him. The farmer, who had arrangedfor the emergency services to be called when on his way to thecrash site, then went for a tractor and loader which could beused to raise the helicopter. At this stage the first policeunits arrived and when the helicopter was eventually raised apoliceman cut through the seat belt in order to free the youngchild: previous attempts to release the seat belt had been unsuccessful. Attempts were made to resuscitate the child but to no avail.

Post crash activities

The pilot of the Enstrom 480 was aware that the Bell 206B hadmisted up and that its pilot was intending to land nearby; whilsthe was on his second flight he saw that helicopter hovering closeto the ground in a field due south of the landing site. Afterclarifying the situation with the Enstrom pilot the pilot of theAS350 took off for his flight. However, he encountered deterioratingweather

conditions with heavy rain and reduced visibility andimmediately decided to return to the landing site, he made a radiocall to this effect and returned to land. The Enstrom 480 pilothad also decided to curtail his flight and returned to land. Both helicopters shut down and the pilots agreed to suspend theflying until the weather improved. The pilot of the AS350 wasvery concerned for the safety of the Bell 206B and after landingmade frequent attempts to make contact on the radio but withoutsuccess, he also expressed his concerns repeatedly to the pilotof the Enstrom 480 and the site manager. The pilot of the Enstrom480, who had seen the Bell 206B in a stable, low hover in a fieldto the south and with no immediate obstructions nearby saw noreason to be concerned. The site manager had seen the Bell 206Bdescending to the south in a controlled manner and also felt noreason to be concerned for the safety of that helicopter, particularlywhen he heard the description provided by the pilot of the Enstrom480.

The telephone call to the emergency services was logged at 1052hours and all three emergency services responded. The fire serviceand police units arrived at the crash site at 1055 hours and theambulance arrived at 1104 hours. The focus of the initial activityat the crash site was in attempting to assist the child who hadbeen trapped under the helicopter but at 1126 hours the survivorsof the accident, two adults and three children, who were physicallyuninjured but suffering from shock were despatched to the DundeeRoyal Infirmary.

Arrangements for seating in the helicopter

When organising such an event the charity did not select the specificchildren that were to fly, believing that this was best left tothe relevant school or special needs unit who had the detailedknowledge of the children under their care. The charity taskedthese organisations to arrange the children into groups of threeplus one adult/carer who would accompany the children on the flight,thus, there would then be five people on each flight includingthe helicopter pilot. From this information the charity preparedpassenger manifests for each helicopter. This process was followedfor Helicopter 1, the Enstrom 480, but the charity produced passengermanifests which allocated four children plus an adult/carer toHelicopter 2, the AS350, and Helicopter 3, the Bell 206B. Thesehelicopters were thus tasked to carry a pilot plus five passengersand whereas the AS350 was configured to carry this number theBell 206B only had seating for the pilot plus four passengers. The passengers were directed to their allocated helicopter byreference to the relevant passenger manifest which was annotatedHelicopter 1, 2 or 3 together with the associated aircraft registration.

The site plan that was constructed by the site manager in chargeof the helicopter operations placed the Enstrom 480 (Helicopter1) at Gate 1, the Bell 206B (Helicopter 3) at Gate 2 and the AS350(Helicopter 2) at Gate 3. Therefore the Enstrom 480 receivedthe passengers that were allocated to it but the Bell 206B receivedthe passengers originally allocated to the AS350 and the AS350received the passengers allocated to the Bell 206B. However,despite this confusion the Bell 206B would still have receivedfive passengers even if it had been parked at Gate 3. The charitystated that it had sent copies of the passenger manifests to thesite manager in advance, however, he is adamant that he had notreceived these manifests when the first flight took place despiterepeated requests for them.

When passenger loading of the Bell 206B commenced the young childinitially placed in the front left seat, next to the pilot, wasjudged by the pilot to be unsuitable for that seat because hissmall stature prevented him being adequately restrained by theseatbelt; the pilot was also concerned that the child's constantarm movements might interfere with some of the controls. Thepilot therefore instructed the handlers that this child shouldbe placed in the rear seating, he was then placed on his

father'slap in the centre rear seat and a single lap strap was fastenedaround them both. One of the other children was placed in thefront left seat and the other two were secured in the rear leftand rear right seats.

The Flight Manual issued with this helicopter incorporates additionallimitations required by the CAA. Included in these is the requirementthat '*The number of persons carried shall not exceed 5 norexceed the number for which seating accommodation approved foruse during take-off and landing is provided. Children under theage of three years who are carried in the arms of passengers maybe left out of the account for these purposes*.'

On-site examination of the wreckage

The helicopter was in a field belonging to a farm which was self-evidentlyconcerned with the breeding of cattle. The fuselage lay on itsleft side pointing roughly opposite to the direction in whichit had been travelling. The tailboom was missing from the mainfuselage but could readily be seen to be present around the sitein the form of many small fragments. This had been caused bymultiple strikes from the main rotor blades - the main rotor itselfhad detached and was lying close to the main wreckage. It boresigns of severe damage caused by both the tailboom strikes andimpact with the ground. There were at least two heavy slashesin the ground and it was concluded that the main rotor had beenrotating at normal speed under considerable engine power at thestart of the impact sequence. A strand from a wire fence waswrapped around the fuselage.

Looking back along the aircraft's track, there were two marksassociated with the landing gear skids. These commenced about2 metres before a fence which had been largely destroyed but hadcomprised six strands of wire supported by wooden posts togetherwith electric fence conductors. It had been a little over 1 metrehigh and the helicopter's heading upon contacting the fence was235° M. Contacting the wire strands at roughly right-anglesto the line of the fence, it was evident that the machine hadbeen pitched heavily onto its nose, breaking the lower perspexwindow panels and one of the skids. It had then continued foranother 18 metres with the skids on the ground, dragging and breakingsome of the wire fence strands behind it.

The helicopter then appears to have become airborne again, asthe marks disappeared and a further, single-strand electric fencewas not broken, however a heavy main rotor slash and fuselageimpact marks were found a little beyond this. The effect of themain rotor hitting the ground would be to rotate the fuselageviolently clockwise (viewed from above) and the main rotor probablysimultaneously made a series of strikes on the tailboom. Therear of the fuselage then struck the ground and structural distortioncaused the baggage compartment on the left side to burst open,releasing its contents which comprised lifejackets, spare headsetsand tie-down equipment etc. In addition this impact probablyallowed the passenger door on the left side to open.

As the machine came to rest on its left side, a final main rotorblade ground-strike caused detachment of the complete main rotorassembly. The left-hand passenger door was open and, as the fuselagestopped moving, it broke from its hinges and was found under thefuselage in the correct orientation for a wide-open door but detached.

Subsequent examination of wreckage

Upon completion of the site examination, the wreckage was transportedto the AAIB facility at Farnborough. By this time evidence fromwitnesses and observations on-site strongly suggested that therewas no reason to suspect other than that the engine was deliveringpower and the helicopter

was under control up to the point atwhich it had contacted the fence. Effort was therefore concentratedon the performance of the demisting system and the question ofsurvivability.

G-FLYR had been an Agusta-Bell 206A which had been converted toa 'B' model after original manufacture in 1973. The cabin heatingsystem had also been modified to be supplied with engine bleedair rather than the original combustion heater but, because ofengine performance limitations, use was prohibited during take-off,landing or hover. The heater selector was found in the OFF positionand it should be noted that the heater output was fed solely intothe floor-level vents in the cabin. There was no separate feedof heated air supplied for windscreen demisting.

The pilot had two controls associated with windscreen demisting. The first was a switch in the overhead panel labelled DEFOG BLOWER. Selecting this to ON supplied power to two electric fans in thefront of the cockpit which blew recirculated cabin air onto theleft and right windscreens. This switch was found in the OFFposition but the pilot is certain that it had been selected toON prior to flight. Since it is adjacent to the Battery and Generatorswitches which the pilot switched-off before exiting the helicopterit is probable that this switch was also selected to OFF at thisstage. There were also two VENT knobs to the left and right ofthe instrument panel which, when pulled, allowed fresh air fromoutside to be directed onto the windscreens. These were onlyeffective when the helicopter was moving forwards, since the electricfans could not boost the flow of fresh air. The VENT knob wasfound to be pulled on the pilot's side. In this configuration,assuming the DEFOG BLOWER switch was ON, with the aircraft stationarythe fan would have been blowing cabin air over the pilot's windscreenbut, as the aircraft gathered forward speed this would changeto a mixture of outside and cabin air.

Consideration of the design of the heating/demisting system showsthat, given the weather conditions of the day and the fact thatthe passengers' clothing was also probably very damp, there wasno combination of selections available to the pilot which wouldhave been efficient in keeping the windscreen from misting. Itwould require relatively dry, warm, unsaturated air to be blownacross the screen and no such source was available. After theaccident the DEFOG BLOWER motor on the pilot's side was serviceablebut the motor on the passenger's side did not function and hadconsiderable white deposits, resembling corrosion products, whichprevented the fan from turning freely. Chemical analysis of thesedeposits showed that they were associated with the constituentsof fire-fighting foam that had entered the interior of the motoritself, causing a commutator brush to seize out of contact. Thiswas the reason that the motor did not work when first tested. The maintenance company stated that both motors were checkedand serviceable at the last 50 hour check on 7 July 1997.

Evidence from those first on the scene of the accident was unanimousthat the young victim of the crash in the rear left seat was properlystrapped-in. However the simple lap-strap supplied for rearseatpassengers was demonstrably incapable of preventing his upperbody from hanging outside the helicopter as it rolled onto itsleft side in the absence of the door. There is no requirementto fit upper body restraints for rear-seat passengers and, indeed,such provision is uncommon in civilian aircraft. By using ananthropomorphic (crash-test) dummy as close to the victim's heightand weight as possible it was demonstrated that, by placing itin the seat which the boy had occupied and properly adjustingand fastening the seat belt, it was still possible for his upperbody to fall outside the cabin and be trapped underneath as thehelicopter rolled onto its left side with the door fully open.

The aircraft's technical documentation was examined and foundit to be in order. It possessed a valid Certificate of Airworthinessin the Private Category.