Grumman AA-5B, G-BDLR, 18 September 1999

AAIB Bulletin No: 4/2000 Ref: EW/C99/9/3 Category: 1.3

Aircraft Type and Registration:	Grumman AA-5B, G-BDLR
No & Type of Engines:	1 Lycoming O-360-A4K piston engine
Year of Manufacture:	1975
Date & Time (UTC):	18 September 1999 at 0904 hrs
Location:	Luton Airport, Bedfordshire
Type of Flight:	Private
Persons on Board:	Crew - 2 - Passengers - 1
Injuries:	Crew - 2 (Fatal) - Passengers - 1 (Fatal)
Nature of Damage:	Aircraft Destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	43 years
Commander's Flying Experience:	142 hours (of which 140 were on type)
	Last 90 days - 1 hour
	Last 28 days - Less than one hour
Information Source:	AAIB Field Investigation

This aircraft was equipped with four occupant seats and dual flying controls, with a full flight instrument panel for the front left seat occupant. The aircraft was equipped with a four place interphone system integrated with the aircraft's avionics audio system. Three damaged headsets were recovered from the aircraft after the accident. All three occupants on board at the time of the accident held Private Pilot's Licences. For reference during this report, the front left seat occupant will be referred to as FLSO, the front right seat occupant as FRSO, and the rear right seat occupant as RRSO. All three occupants had been wearing lap and diagonal harnesses at the time of the accident.

The FLSO's initial training course for the Private Pilot's Licence was conducted between June 1989 and January 1991. A total of almost 50 hours flying was undertaken during this period. A further 92 hours were then accrued during the intervening years, 58 hours of this being entered in the FLSO's personal flying log book as Pilot-in-Command.

On the day of the accident, the purpose of the flight was for the FLSO to gain some additional flight time towards the required minimum of five hours flying within a thirteen a month period, in

order that his Certificate of Experience for the Private Pilot's Licence could be revalidated. The FLSO desired to complete this process prior to 1 January 2000, which was the CAA target date for the implementation of revised and extended JAR Flight Crew Licensing experience requirements.

Since his most recent Certificate of Experience was signed, on 1 October 1998, the FLSO had flown three flights in this aircraft as Pilot-in-Command, totalling 1.7 hours duration. He had also flown twice in this aircraft with the FRSO for a total of 1.2 hours. The FLSO's most recent flight, prior to the day of the accident was on 13 July 1999. No other flying was recorded in his personal flying log book.

The FLSO had operated G-BDLR on many occasions over several years in the company of the FRSO. The FRSO had a total of about 191 hours as Pilot-in-Command. His personal flying log book indicated that he also had a further 156 hours flying experience. Since his latest Certificate of Experience was signed on 4 October 1998, he had flown a total of 8.3 hours as Pilot-in-Command (all in G-BDLR), plus a further 3.1 hours in G-BDLR which was entered as 'Dual or P2' in his log book. He had completed three flights as Pilot-in-Command of this aircraft, totalling 1.7 hours duration, during the three month period prior to the accident flight. His most recent flight had taken place on 30 July 1999, which was a shakedown flight after a maintenance check. The FRSO did not hold any Flying Instructor Rating. The FRSO was a Licensed Aircraft Engineer and was responsible for carrying out and certifying the maintenance of G-BDLR, on behalf of the owner of the aircraft.

The aircraft was available for use by a small group/club of licensed pilots approved by the aircraft's owner. The FLSO had been the Director of the group/club. The FRSO was effectively the flying group/club manager, being responsible for the issuing of approvals for licensed pilots to fly the aircraft. These approvals were only issued after a nominated Qualified Flying Instructor had carried out a competency check and confirmed the validity of a Certificate of Test or Experience for each licensed pilot who wished to fly the aircraft.

A current copy of the flying group/club's Flying Order Book could not be located, although reference to the existence of such a document was contained in a Notice to Members dated April 1991. Also, located in the back of the Technical Log was a blank copy of a 'Dual Check' form, dated February 1989, which indicated that a dual check (with a 'club authorised check pilot') was valid for a period of 6 months in the case of pilots with over 100 hours flying experience. There was also provision on the form to detail the applicable flying recency requirement and an individual's operating crosswind limit. No such completed forms for any pilots were located during this investigation.

It appeared that this approval form had been superseded by a system of individual letters to pilots, issued by the FRSO at the commencement of flying of G-BDLR, which outlined in very basic terms the conditions under which they were approved to operate the aircraft, but which included reference to an initial dual check flight and to the pilot having a thorough knowledge of the content of the Aircraft Owner's Manual (the aircraft's Flight Manual which formed part of the aircraft's Certificate of Airworthiness).

The FRSO also issued occasional flying group notices to other members regarding the operation of the aircraft.

The RRSO had also flown G-BDLR several times (on at least 9 occasions as handling pilot) previously in the company of the FLSO and had the greatest amount of flying experience of the

three people on board. His most recent flight in G-BDLR had taken place in June 1996. Prior to the day of the accident he had arranged to come and fly the aircraft with the FLSO and had confirmed the arrangement by telephone on the morning of the accident.

Prior to the accident flight, Luton ATC was informed that the intention was for G-BDLR to carry out two short local flights. It was planned to do a 'running change' of handling pilot on the taxiway at Luton at the end of the first flight.

The FLSO had checked the meteorological forecast for the morning of the accident flight. Visibility and cloud ceiling were not a problem, but the surface wind was forecast to be from a south/south-easterly direction at 11 kt, with an increase forecast to occur between 0800 hrs and 1000 hrs to 20 kt, with gusts to 34 kt, representing a significant crosswind component when using Luton's active Runway 08. A checklist for G-BDLR, in the FLSO's flight equipment, indicated that the maximum allowable crosswind component for a solo student pilot was 10 kt, and the 'maximum demonstrated' crosswind component was 16 kt. Another reference to crosswind landing technique was contained in G-BDLR's Owner's Manual, which indicated that *'A power-off tail-low touchdown attitude is the best assurance of a porpoise-free landing, and excessive touchdown speed is not required with direct crosswinds up to 13 mph.'* A further reference to crosswind landing technique was contained in a generic AA-5B Pilot's Operating Handbook (later recovered from the FRSO's personal library) which indicated that *'When landing in a strong crosswind, use the minimum flap setting required for the field length. Although the crab or combination method of drift correction may be used, the crab method gives the best control. After touchdown, hold a straight course with the rudder and occasional braking.'*

AAIB calculations indicated that, with the estimated quantity of fuel on board, the aircraft with its three occupants was loaded within the allowable centre of gravity range and within the normal maximum allowable take-off weight limitation.

The FRSO operated the radio equipment and handled the communications with ATC throughout the flight. Taxi clearance was obtained at 0822 hrs, when the airport Automatic Terminal Information System (ATIS) broadcast indicated that the surface wind was from 160° at 10 kt. The aircraft then taxied out for Runway 08 and the pre-flight checks were apparently normal. Take-off clearance was given at 0831 hrs, when the surface wind was from 170° at 14 kt.

An unremarkable take off followed and the aircraft left the circuit area to the north. The aircraft was then transferred from Luton Tower control to Approach control in accordance with normal procedures. At 0842 hrs, the aircraft requested rejoin instructions. The Approach controller cleared the aircraft to join on a visual left base leg for Runway 08. Further instructions were then issued to transfer to the Tower frequency and for the aircraft to hold on left base, awaiting a suitable gap in the stream of inbound and outbound commercial jet traffic.

The aircraft held in a left base position, carrying out orbits, from 0848 hrs to 0901 hrs. From subsequent analysis of the recorded radar data, it was ascertained that the aircraft carried out a series of three orbits to the left, one to the right, a further three to the left, another to the right, then finally two further orbits to the left before positioning onto final approach for Runway 08. The series of orbits was carried out between 2,000 feet and 2,500 feet altitude. The average rates of turn ranged from 4.2 °/sec to 7.2°/sec. The calculated average bank angles during the turns were therefore in the range from about 20° to 35°.

At 0850 hrs, the pilot of a landing Boeing 737 reported that they had experienced a 'fair bit of chopping and airspeed change below 500 feet' during final approach. The comment was not specifically aimed at, nor repeated to, G-BDLR, but the aircraft was maintaining a listening watch on the same Tower frequency at the time of this pilot report.

At 0900 hrs, G-BDLR was cleared onto final approach and was passed a surface wind check from 170° at 14 kt. The Luton Tower controller also held a Private Pilot's Licence and realised that G-BDLR may be affected by the wind conditions and turbulence during the final approach phase. The aircraft was cleared to land on Runway 08 at 0902 hrs and a surface wind check of 170° at 17 kt was passed (the two minute mean wind velocity indicated by the Vaisala Anemometer system, sourced from the sensor adjacent to the Runway 08 landing threshold). Further instantaneous wind checks were then passed by the controller as 170° at 20 kt and, as the aircraft was observed to be crossing the landing threshold, 160° at 20 kt.

The Tower controller observed that the aircraft flew above the surface of the runway at a height of about ten feet with the right wing down (into wind). The wind was having an obvious effect on the aircraft's flight path and a little wing rocking was observed. About 650 metres into the runway, the aircraft had adopted a nose up attitude, then levelled again. At this time, there was a marked left wing drop, which then recovered to wings level. By this time, the aircraft had yawed to the left and was heading about 30 to 40° left of runway centreline track. The aircraft left the paved surface of the runway and was airborne over the grass. The controller observed that the aircraft touched down on the grass. He expected it to come to rest on the grass area, so he initiated an Aircraft Ground Incident initially and alerted the Airport Fire Service. As he did so, the aircraft appeared to accelerate and became airborne again momentarily, overflying the parallel taxiway. It appeared to fly into the front right side of a parked Shorts 330 aircraft, registration G-SSWU, which had been correctly parked and left unattended facing south on parking stand 22 on the south apron. The Tower controller immediately initiated Aircraft Accident status and the Airport Fire Service were rapidly in attendance at the scene.

Both the FRSO and the RRSO were killed instantly. The FLSO was still alive but unconscious and was cut free from the wreckage. He died later in hospital from his multiple severe injuries sustained during the impact. The post-mortem examination of the three individuals did not reveal any evidence of pre existing disease or any other factors which might have contributed to the cause of the accident.

An aftercast from the Meteorological Office indicated that, at the time of the accident, there was a complex frontal system lying across southwest England and Ireland, associated with a deep area of low pressure to the west of Ireland. Ahead of the fronts, a strong southerly flow covered the Luton area. The visibility was around 30 km, with scattered cumulus cloud base 1,500 feet and scattered stratocumulus cloud base 2,500 feet. The temperature was 16°C and the dew point 13°C. The surface wind was from 180° at 14 kt, with gusts to around 22 kt. At 500 feet, the wind was from 190° at 25 kt and at 1,000 feet it was from 200° at 32 kt. The mean sea level pressure was 1003 mb.

Luton Airport is equipped with a modern Vaisala automated anemometer system, with sensors to indicate the surface wind at each end of the active runway. The standard ATC procedure is to report the surface wind from the landing threshold (and start of take-off run) for the active runway and this was the case at the time of this accident. There is no anemograph recording equipment at Luton Airport and the automated anemometer system does not have any data archiving facility. Therefore, apart from the instantaneous wind reports issued by the Tower controller as G-BDLR was on short final approach, and the half hourly METAR reports (which record the automatically calculated

mean surface wind over the ten minute period prior to the observation time), no record of the actual threshold surface wind conditions or gusts was available for this investigation.

Engineering investigation

The two aircraft were initially examined in-situ at the accident site. G-BDLR ('LR') had come to rest at right angles to G-SSWU ('WU') with its fuselage against the right main landing gear and wing strut of 'WU' and its left wing under the right wing of 'WU'. The engine and propeller of 'LR' had folded upwards due to failure of the engine mounting structure and was at right-angles to its usual orientation. The cockpit canopy had been removed by the emergency services and there was severe crushing damage down the right side of the nose and cockpit. There was also extensive damage to the right fuselage side of 'WU' from roughly underneath the windscreen extending back to below the forward emergency exit. There were two large holes in the fuselage skin and two distinct propeller slash marks. A third slash mark, midway between these could just be discerned, having been overlaid by contact with the engine cowling of 'LR'. Despite this damage, 'WU' had remained on all three landing gears, but it had been pushed about 50 cm aft and the nose rotated to the left the same amount.

The right wing of 'LR' had become detached near the root and was lying against the left main landing gear of 'WU'. Mainwheel tyre marks from 'LR' could be discerned at an angle of about 25° to the fuselage axis of 'WU', commencing about 18 metres before impact. The first impact occurred when the right side nose of 'WU' was struck by the propeller of 'LR'. The engine and cowling then gouged heavily into the fuselage of 'WU'. At about the same time, the right wing of 'LR', which had slid under the nose, hit the nose landing gear, causing its detachment. This yawed 'LR' sharply to the right, digging the nose even more firmly into 'WU's fuselage and wrenching the engine upwards; there was some evidence that the propeller, still rotating, had entered the cockpit of 'LR'. The impact sequence is depicted in the attached diagram at Figure 1.

During the course of the examination of 'LR', it was noted that there were scrapes on the underside of the left wing tip and elevator tip. No signs of matching scrapes could be seen on the parking apron or the taxiway and it was deduced that the marks had been caused by runway contact. An inspection of the runway showed a long smear of grey paint about one-third of the way down, arcing away to the left from the centreline. This mark then ceased, to be replaced by a left mainwheel tyre mark, still curving towards the left and then, as the aircraft was about to leave the paved surface, marks from both mainwheels could be discerned. The aircraft then appeared to become airborne for about 40 metres over the grass until mainwheel tracks were found, over the next 25 metres, still indicating a curved heading towards 'WU'. No more ground marks were found until those leading up to the impact described above.

The wreckage of 'LR' was recovered to the AAIB facility at Farnborough for further examination.

Further examination

Examination of the aircraft showed that there were no pre-impact disconnections of the flying controls. Inspection of the electric flap actuator showed that the flaps were in the UP position. It was, however, noted that the left aileron movement was restricted due to interference between its mass balance weight and the shaped slot in the glass-fibre wing tip through which it emerges at high 'up' deflections of the aileron (Figure 2). As-found, the left aileron was deflected downwards, in which condition the weight is inside the wing tip. When trying to move the aileron up, resistance was felt as the weight contacted the inside of its slot. This could be overcome using some

considerable force applied at the aileron as the weight deformed the slot, but the reverse now applied, inasmuch as the same force had to be used to get the aileron to move from the fully 'up' position. It was obvious that the tubular arm mounting the weight had been bent inwards, causing interference with the slot, it was also evident that the weight had made contact with the runway as it, too, had the same distinctive concrete scrape marks as the tip. This observation is discussed later.

Since the propeller slash evidence, the condition of the propeller itself and the eyewitness evidence pointed towards the presence of high power at impact, no detailed examination of the engine was performed. Carburettor heat was selected to COLD at impact. The brakes were examined and, although it was not possible to functionally test the entire system, no anomalies were found with the individual components.

Engineering discussion

No technical defects were found which could account for this accident prior to the moment the left wing made contact with the runway. There is little doubt that high power was being demanded of, and developed by, the engine. The spacing of the propeller slashes in the side of 'WU' pointed to a groundspeed of 60 kt with an engine speed greater than 2,000 RPM at first impact. This technique, of course, requires the assumption of one unknown in order to calculate the other, but this combination of groundspeed and RPM seems to best fit the circumstances. The orientation of the slashes also shows that 'LR' was in a very nose-high attitude, reinforced by the absence of any ground marks made by the nosewheel.

The possibility that, after the first touch of the left wing tip on the runway, the ailerons were jammed or restricted by the deformed mass balance weight remains unresolved. The restriction occurred over the range of left aileron fully 'up' to about 15 mm trailing edge 'up'. If forced 'down' beyond this, the weight cleared the slot and the ailerons were free to move in the opposite direction. The condition of the flying controls prevented testing to establish whether the restriction could be overcome through control wheel input. If the ailerons had been immovably jammed in the left-wing-low sense, it is difficult to see how further wing tip strikes and probably a ground-loop could have been prevented. However, it is still theoretically the case that a wing tip scrape on this type of aircraft could lead to restricted aileron movement or roll control input difficulty.

Operational analysis

At the time of departure, the surface wind was not a limiting factor, although the forecast for Luton indicated that the surface wind strength was due to increase during the morning to give a crosswind component which would have been beyond the 'maximum demonstrated' value of 16 kt quoted in the pilot's checklist for the aircraft. The FLSO had obtained the meteorological forecast and the latest airport ATIS.

After departure, the aircraft was airborne for only 11 minutes before a return to the airfield was requested, during which time the aircraft was operating between 2,000 feet and 2,500 feet amsl. Given the weather conditions prevailing at the time, it is quite probable that the aircraft was subjected to some degree of turbulence, which may have prompted the decision to shorten the planned flight and return to the airfield. In the event, because of the amount of commercial traffic flow at this time, G-BDLR was requested by ATC to hold close to the airfield on a left base leg. A series of ten orbits was carried out during the 13 minute holding period. In conditions of turbulence, this manoeuvring, coupled with a relative lack of recent experience in the air, could have had some

physiological effects, possibly affecting the handling pilot's performance during the subsequent approach to the landing runway three minutes later.

From the eyewitness reports, it seems clear that the aircraft flew at a low height above the runway surface for a longer than usual distance before the initial touchdown. This may have been due to the handling pilot using a higher approach speed with the given wind conditions. It is also unclear as to whether the flaps were deployed for this approach, or whether they were subsequently retracted during the attempted go-around.

There is evidence that the left wing tip touched the runway surface before the main wheels touched down, or at least coincident with the left main wheel touching down. This was most probably caused by a gust, or a combination of gust when the airspeed was close to the stall, or an excessive left rudder input. Even if the flaps had been fully deployed at this point, the geometry of the aircraft is such that they would not have contacted the ground. It is unlikely that the handling pilot applied left roll control prior to this event, as normal crosswind landing technique would require the handling pilot to try to keep the into-wind wing (right wing) down, necessitating use of right roll control and left rudder to keep the aircraft straight along the runway (in a right sideslipping condition). In the event of a gust causing the left wing to drop, the handling pilot would instinctively apply further right roll control, causing the left aileron to be deflected further downwards in an attempt to generate more lift on the left wing. In this condition, the aileron mass balance weight is further retracted into the wing tip fairing. It is therefore unlikely that the bending of the aileron mass balance weight would have occurred on initial left wing tip strike. Subsequent aileron movement could then have caused the mass balance weight to come into contact with the runway surface. In any event, had the handling pilot sensed that the flying controls were not responding properly to the inputs, then a go-around would probably not have been attempted.

It seems clear that a go-around was initiated after the aircraft left the paved runway surface to the left. At that time, the aircraft heading was about 30 to 40° to the left of the runway centreline track. Wheel marks were present for a short distance on the grass surface, indicating that the aircraft had been airborne over the grass for a short distance while off to the left side of the runway, before effectively bouncing/rolling briefly on the grass surface prior to it becoming airborne once more. Eyewitness reports indicated that the engine was still powered and the aircraft seemed to 'fly into the side' of the parked aircraft.

Examination of the wreckage indicated that the flaps were in the fully up position. The aircraft's Owner's Manual indicated that the stalling speed with flaps retracted (idle power) was around 64 kt. The manual also recommended initiation of the take-off rotation (flaps up, full power) at 60 mph (about 52 kt indicated airspeed). From the engineering assessment of the impact speed at about 60 kt, and given the tailwind component present at that time of up to 13 kt, it is unlikely that the aircraft had achieved sufficient flying speed to get airborne and climb prior to the impact with the parked aircraft.

Command and control

The aircraft's booking diary indicated that the aircraft had been booked from 0900 to 1800 hrs on 18 September 1999 in the name of the FRSO.

The aircraft's Technical Log was recovered from the wreckage, but no pre-flight entry relating to this flight had been made and no copies of any pages had been deposited prior to departure. There was thus no signature to indicate who was the commander of the aircraft. The flying group/club did

not operate a flight authorisation and record sheet system, so no details of the flight were recorded by this means.

The booking out procedure at Luton did not routinely record the name of the aircraft commander.

From examination of the FLSO's and FRSO's personal flying log books, it was apparent that on about 74 previous occasions when they had flown together, it was their usual practice to individually annotate their flight time as handling pilot as pilot-in-command 'P1' and their flight time as non-handling pilot as 'Dual or P2', although such 'P2' flight time was not eligible for accreditation towards the experience requirements for any rating or certificate of experience when conducted in this type of aircraft.

The radio communications during the flight and the final approach phase had been conducted by the FRSO.

There was no physical evidence available to indicate which of the two front seat occupants had been handling the aircraft during the final stage of the flight.