No: 1/92 **Ref: EW/C91/7/3** **Category: 2c**

Aircraft Type and Registration:	Bell 206A, G-ROGR
No & Type of Engines:	1 Allison 250-C18 turboshaft engine
Year of Manufacture:	1969
Date & Time (UTC):	27 July 1991 at 1303 hrs
Location:	Sherdley Park, St. Helens, Merseyside
Type of Flight:	Public Transport
Persons on Board:	Crew - 1 Passengers - 4
Injuries:	Crew - Minor Passengers - 1 serious, 3 minor
Nature of Damage:	Aircraft damaged beyond economic repair
Commander's Licence:	Airline Transport Pilot's Licence (Helicopters)
Commander's Age:	47 years
Commander's Flying Experience:	4,000 hours (1,943 Rotary, 525 on type)
Information Source:	AAIB Field Investigation

History of the Flight

The aircraft was engaged on pleasure flying duties for the weekend at the St. Helens show, having positioned to the site during the previous day. The operation was manned by the pilot supported by four ground crew members. Emergency equipment, ground equipment, and the fuel supply (AVTUR) was contained in a support vehicle at the site. Fuel was contained in several 53 gall US (45 gall imp) drums in the vehicle. On the day before the accident, after initial appraisal of the site, and erection of landing site boundary markers, the pleasure flying operation commenced. A total of 31 pleasure flights was conducted, in five sessions, during the afternoon prior to the accident. Refuelling from the drums was carried out using a portable electric pump between flight sessions. Four refuelling operations were carried out using only two of the drums available at the site. During the course of the day, the pilot noted that operation of the forward fuel boost pump was noisy. He therefore elected to operate further flights with the circuit breaker for this pump pulled, in accordance with the company operations manual list of acceptable deferred defects.

After the last pleasure flight of the day, the final refuelling was carried out. The aircraft then departed from the showground to Barton Aerodrome for a night stop. The technical log indicated the total fuel contents at the time of departure as 70 gall US. The total fuel capacity of the aircraft was 76 gall US.

On the morning of the accident, whilst still at Barton, the door hinge of the aircraft was slightly damaged by rotor wash from an adjacent helicopter. This was duly repaired by local engineering staff, and the aircraft departed back to the St. Helens showground, with an indicated fuel quantity of 65 gall US. On arrival at St. Helens, the pleasure flying commenced without delay, the technical log showing a departure fuel quantity at the start of the session as 61 gall US.

A sequence of 15 pleasure flights was then carried out. Each pleasure flight was of approximately three minutes airborne duration, during which the helicopter travelled over a nominally standard route, within two miles of the landing site boundary, climbing each time to an altitude of approximately 500 feet AGL. This session ended at 1130 hrs UTC, the technical log entry showed the fuel contents to be 40 gall US, derived from the aircraft fuel gauge. Without refuelling, a further series of flights commenced at 1210 hrs UTC. The first ten flights were carried out without incident.

After a rotor running passenger change, which was the standard practice for this operation, the aircraft took off again at approximately 1301 hrs UTC, with four passengers on board. The take-off and departure were normal, and the helicopter proceeded along its standard route. The pilot reported that the turn back towards the landing site was made with approximately 50° bank angle, and may have been slightly out of balance. As the helicopter was about to be rolled out of the turn, the pilot became aware that the engine was running down. He therefore elected to land straight ahead on a clear area of a road construction site. However, it became apparent to the pilot that this course of action would take the helicopter onto a busy road during the landing run. He therefore elected to pull up slightly to overfly the road and the park boundary fencing. During the course of this manoeuvre, the rotor RPM decayed and the helicopter landed heavily just inside the park boundary. The touchdown was in a fairly nose-up attitude on sloping ground, causing the aircraft to bounce, pitch down and roll right. It came to rest on its right side. There was no fire, and rapid evacuation of the passengers was aided by witnesses from the nearby road.

An aftercast for the St. Helens area indicated a surface wind from 220° at 8 kt, a visibility of 20 km, no significant low cloud, and a surface temperature of 21°C, at the time of the accident.

Examination of Wreckage

The helicopter had come to rest on sloping, uneven ground forming part of an infilled waste site. It lay on its right side with most of the tailboom detached and the skids missing. The main rotor had remained attached to the mast with the blades remarkably intact and free from major distortion but with the pitch control rods broken and the mast bent. The tail rotor and tail boom assembly had separated into several pieces and were found spread over a roughly triangular shaped area extending to some 38 metres to the north-west of the fuselage. The pieces of the boom bore clear signs of it having been struck by the main rotor blades at least twice.

The initial point of ground contact was somewhat indistinct but may have indicated a light touch with the tail skid before a heavy impact on the main skids caused them to collapse and swivelled the cross-tubes upwards. It was then evident that the machine bounced and yawed, hitting the ground 8.5 metres further on and turning onto its right side. The ground marks indicated that the aircraft had been travelling on a heading of 005° M. All the seat-belts and attachments were undamaged. The passenger compartment and cockpit were both intact despite the fact that the fuselage structure had clearly received considerable loading during the impact.

The on-site inspection did not yield any indications of major engine or transmission defects, although heavy in-flight staining of the fuselage showed that the main rotor gearbox had been leaking oil at a significant rate. The operator advised that this had been known but the leakage rate had been within acceptable limits.

Although several witnesses attending the scene immediately after the accident reported a strong smell of fuel, at the time of the AAIB inspection, some six hours later, there was no noticeable smell of fuel and neither were there any signs of liquid fuel dripping from the fuel tank. When the helicopter was pulled upright during the recovery process, visual examination of the fuel tank contents showed that it was effectively empty with only small pools remaining around the low points of the tank. The ground underneath exhibited a small area of fuel wetness directly under the point where the fuel filler cap had been. It was not possible to determine how much fuel had leaked and caused this wetness, but it did not, subjectively, appear to be a large amount.

Subsequent Examination and Testing

Upon recovery of the helicopter to AAIB Farnborough, a further examination of the engine was conducted but this did not reveal any defects which could explain the reported loss of power. Limited external power was introduced onto the aircraft for the purpose of checking the fuel systems. The tank was filled to capacity and de-fuelled in stages to calibrate the indication system. During these checks it was also confirmed that the forward booster pump did not run when selected. The rear pump was, however, serviceable.

The fuel tank was then replenished with 20 gallons of water and the helicopter rolled onto its side in approximately the attitude it had adopted at the accident site. The purpose of this was to establish whether that amount of fuel could have leaked away during the period between the accident and the time of the AAIB inspection. It was found that there was considerable leakage from both the filler cap and the external vent system.

In view of the inconclusive evidence of possible fuel starvation, it was deemed necessary to remove the engine and test-run it at the premises of an overhaul agency. Their report shows that, whilst the

engine started and ran normally, it was some 12% low on take-off power, 11% low on cruise power and 10% high on specific fuel consumption compared with the Allison specification for the engine. This was probably related to the high time achieved on the compressor (it was running on a 10% overhaul life extension).

Analysis of Fuel Consumption

Calibration of the gauge revealed it to be over-reading the actual fuel contents by approximately 4 gall US around the 20 gall contents indication, and up to 7 gall US around the 40 gall indication. Analysis of the flight time, number of flights, and recorded quantity indications revealed that each pleasure flight consumed approximately 1.5 to 2 gall US of fuel.

Examination of the technical log entries for the two days of operation revealed that a total of 106 gall US of fuel had been loaded into the helicopter during the period. All entries in the log were based on fuel gauge reading. The quantities loaded were not cross-checked with any other metering system.

The final drum used for fuelling the helicopter was removed to Farnborough for sampling. A quantity of fuel was found to be remaining in the drum. This quantity was measured and found to be approximately 5 gall US. As only two (53.5 gall US) drums had been used, and the other was empty, the total quantity available to be loaded was 102 gall US.

The aircraft flight manual for this type states that with one or both fuel pumps inoperative, the unusable fuel is 10 gall US. The pilot subsequently reported that the fuel gauge had indicated a quantity of 22 gall US just prior to the final take-off. The company minimum for operation was 12 gall US. At certain low fuel states, the fuel system is capable of being affected by angles of roll while in unbalanced flight. Without specific data on actual lateral or fore-and-aft accelerations experienced, it is not possible to quantify this effect.