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Investigation of R44 Accident Focuses on Weight and Balance

There was no record that weight-and-balance calculations were performed after the passengers changed their seating assignments for the second leg of the charter flight in Australia. The helicopter was overweight and had a forward center of gravity when it struck terrain.

FSF Editorial Staff

A Robinson R44 Astro was overweight and its center of gravity (CG) was beyond the forward limit when the helicopter struck a ridge in northwestern Australia as the pilot was flying the helicopter back to its home base after a chartered fishing trip, the Australian Transport Safety Bureau (ATSB) said in its final report on the accident.[1] The helicopter was destroyed in the Nov. 8, 2003, accident, and the pilot and all three passengers were killed.

The report said that the helicopter was about 27 kilograms (60 pounds) heavier than the maximum takeoff weight (MTOW) of 1,090 kilograms (2,403 pounds) and that its CG had a forward arm of 2,334 millimeters (91 inches), which the report characterized as being "outside the published forward limit" of "not less than 2,362.2 millimeters [92.1 inches]."

The accident occurred about 1044 local time, 17 minutes after the pilot of the accident helicopter and the pilot of another company helicopter — a Bell 206 — conducted takeoffs from the Cape Dommett area of northern Western Australia for the flight to Kununurra. The seven passengers on the two helicopters had changed their seating assignments for the return flight.

Both flights proceeded at 500 feet above ground level until the pilot of the Bell 206 received a radio transmission from the pilot of the R44, who said, "I am going in hard."

The Bell 206 pilot immediately conducted a right turn and "observed a mushroom cloud of smoke rising from a nearby ridge," the report said. He declared mayday, a distress condition, and flew his helicopter above the accident site to look for indications that there were survivors.

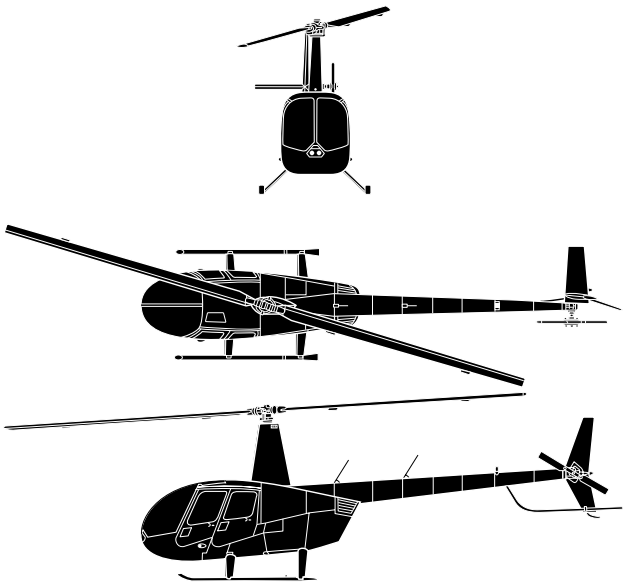
"With no signs of life visible, and unable to identify a safe place to land, the pilot of the [Bell] 206 made an operational decision to continue to Kununurra," the report said. "The first rescue team to arrive at the site confirmed that all four occupants had received fatal injuries."

The accident pilot received a student pilot license April 22, 2003; an endorsement to fly Robinson R22 helicopters May 7, 2003; an R44 endorsement June 16, 2003; and a commercial pilot license (helicopter) July 4, 2003. He had 190 flight hours, including 15.6 flight hours in R44 helicopters (of the 15.6 flight hours, 8.5 were as pilot-in-command), and a Class 1 medical certificate.

The investigation found "no evidence … that the pilot suffered any sudden illness or incapacity that may have affected his ability to control the helicopter" and no indication of physiological or psychological factors that might have interfered with his conduct of the flight, the report said.

The accident helicopter was manufactured in the United States in 1995 and was certified as a normal category helicopter. At the time of the accident, the helicopter had 3,029 flight hours. The helicopter was maintained as a day visual flight rules (VFR), Class B[2] helicopter, in accordance with manufacturer documents and Australian Civil Aviation Safety Authority (CASA) continuing airworthiness requirements.

Maintenance records indicated that the last scheduled maintenance on the helicopter was a 100-hour inspection that was completed Oct. 23, 2003; at the time, the helicopter had 3,019 flight hours. The last unscheduled maintenance occurred Nov. 6, 2003, after a report of a high engine-oil operating temperature; a component of the engine-oil-cooling system was changed, and a test flight found that engine temperatures were normal.



Robinson R44 Astro

The Robinson R44 Astro is a four-seat light helicopter first flown in 1990. The design incorporates some elements of the two-seat R22, including the tri-hinge underslung rotor head designed to limit blade-flexing and rotor vibration.

The R44 has one 194-kilowatt (260-horsepower) Textron Lycoming O-540 six-cylinder reciprocating engine, derated to 168 kilowatts (225 horsepower) for takeoff and to 153 kilowatts (205 horsepower) for continuous operation.

The R44 has a height of 3.28 meters (10.76 feet) and a main-rotor diameter of 10 meters (33 feet). Cruising speed at maximum takeoff weight and 75 percent power is 113 knots, and maximum rate of climb at sea level is 1,000 feet per minute. Service ceiling is 14,000 feet; hovering ceiling in ground effect is 6,100 feet, and hovering ceiling out of ground effect is 4,500 feet. Maximum range, with no fuel reserve, is about 643 kilometers (347 nautical miles).

The R44 Astro was replaced in 2000 by the R44 Raven, which has hydraulic flight controls, adjustable anti-torque pedals and elastomeric tail-rotor bearings.♦

Source: *Jane's All the World's Aircraft*

The helicopter's empty weight was 651.5 kilograms (1,436.3 pounds). Before the charter flight began, all heavy baggage was loaded into the Bell 206; the Bell 206 pilot said that passengers in the accident helicopter carried only small items, such as cameras and fishing reels, which were estimated to have weighed about two kilograms (four pounds) per person.

At the time of the accident, the helicopter's fuel tanks contained about 62 liters (16 U.S. gallons; or 44 kilograms [96 pounds]) of fuel in the left (main) tank and about 28 liters (seven U.S. gallons; or 19 kilograms [42 pounds]) of fuel in the right (auxiliary) tank. The helicopter also contained an equipment pack weighing 10.9 kilograms (24.0 pounds).

The weight of the helicopter at the time of the accident, including fuel, equipment and the four occupants (according to descriptions obtained from medical records and family members), was estimated at 1,117 kilograms (2,463 pounds).

The company's operations manual said that for all passenger flights (except "standard tourist flights"), a manifest and flight note were to be completed and left with a company representative or other responsible person at the departure airport. Load calculations for helicopters with fewer than seven seats were to be completed using actual weights of all occupants and baggage. The operations manual also said that if a passenger "embarks or disembarks at an intermediate stopping place, a new list must be completed and a copy [must be] left at that place, except where that particular change had been notated on the list left at the initial aerodrome of departure."

The flight note prepared before the accident flight and left at the Kununurra base contained details of the flight for both the accident helicopter and the Bell 206 but did not include passenger names or weights and "did not contain a change of passenger details covering the passenger exchange prior to takeoff for the return flight," the report said. "Those actions were not in accordance with the published requirements of the operator's operations manual."

Weather conditions at the time of the accident were hot and humid, with a warm low-pressure system. (The report did not provide further details about air temperature and humidity.) Scattered convective cumulus clouds began to develop after 1100, but there was no rain or thunderstorm activity. Passengers in the Bell 206 said that their helicopter had encountered turbulence, but their pilot reported no weather conditions that could have contributed to the accident.

The accident helicopter was not equipped with a cockpit voice recorder or a flight data recorder; neither was required. A global positioning system (GPS) navigation unit recorded flight track data that showed that the takeoff occurred at 1027 and that, after four minutes of maneuvering, the pilot

established a heading of 153 degrees. Groundspeed varied between 86 knots and 102 knots. The heading changed slowly to 170 degrees by 1042, when the groundspeed was about 97 knots.[3]

"That heading and groundspeed [were] maintained until between 1044:20 (last track point with the helicopter on a heading of 170 degrees) and 1044:28 (next GPS-recorded track point), at which time the helicopter's heading started to change and the speed started to decay," the report said. "The heading continued to change until 14 seconds later at 1044:42 (last GPS track point), when the helicopter had a groundspeed of 48 knots on a heading of 266 degrees. … This track point aligned closely with the initial ground impact point."

All major helicopter components were accounted for, but because of damage caused by the impact and the subsequent fire, investigators could not examine some components, could not verify the integrity of flight-control systems and could not determine how much power was being produced by the engine before the impact. Nevertheless, the report said that steel components associated with the collective and the cyclic flight controls were "in their expected locations" and that flight-control pushrods for the cyclic and collective at the swash plate were connected and locked. An inspection of the power plant revealed no problem that could have contributed to the accident.

The operator of the accident helicopter had a large fleet of piston helicopters and turbine helicopters, and held a CASA air operator's certificate for charter flights and other aerial work, including mustering flights and tourist flights. The R44 was identified in company documents as acceptable for charter flights.

The company's operations manual described the following minimum flight crew requirements for pilots involved in VFR charter operations in single-engine helicopters with an MTOW of 2,750 kilograms (6,063 pounds) or less: commercial pilot license (helicopter), type endorsement or class endorsement and a minimum of five flight hours as pilot-in-command or "acting as pilot-in-command under supervision" in the helicopter type.

The company also operated a flight school; the school's chief flight instructor, who also was a CASA-approved training officer, conducted all flight training for the accident pilot.

The flight instructor described the accident pilot as "having a commonsense approach to his flying" and said that he flew R22 and R44 helicopters especially well, that he was a cautious student with a professional attitude and that he was "not a risk-taker."

As a student, the accident pilot successfully flew practice autorotational descents with power-on recovery, the flight instructor said.

"[The flight instructor] also stated that the occurrence pilot had been rigorously trained … to include the nature of his emergency, if he had identified it, in any radio transmission he made," the report said. "These would include 'engine failure,' 'drive-belt failure' or 'tail-rotor failure' for any of these serious emergencies. … The occurrence pilot did not make any such reference in his only radio transmission of the occurrence flight."

Investigators considered several possible reasons for the helicopter's departure from the planned flight path in the minutes preceding the accident.

"While prevailing weather conditions were unlikely to have contributed to the occurrence, the effect of an upset due to turbulence leading to large control inputs by the pilot and a possible low-g [low-gravity] maneuver could not be ruled out," the report said.

Nevertheless, examination of the main-rotor mast revealed no damage indicative of a low-g maneuver.

The report said that the pilot might have established the helicopter in an autorotation.

At the minimum rate of descent, an autorotational descent from the accident helicopter's cruise altitude would have taken about 22 seconds; in the best-glide-distance configuration, the helicopter would have traveled about 712 meters (2,336 feet), the report said.

Recorded GPS data showed that the flight ended about 22 seconds after the accident helicopter departed from the planned course, and the GPS recorded a position change of about 757 meters (2,484 feet). GPS data also showed that the helicopter's speed before the last recorded GPS track point was never less than 48 knots; the manufacturer's *Pilot Operating Handbook* (*POH*) said that airspeed should be about 55 knots during an autorotational descent at the minimum rate of descent.

"Given the similarity of distance covered and the flight time after the divergence from track when compared with published figures, it was also possible that the R44 was established in autorotational flight, and that the pilot initiated a right turn to a selected forced landing site," the report said.

"The metallurgical evidence indicated high energy in the rotor system. This could indicate that the pilot may have been terminating the flight in a forced landing autorotative maneuver, or may have been in the midst of a recovery maneuver, such as that required for a low-g event recovery.

"If the pilot had been executing an autorotation, the high gross weight of the helicopter would have assisted him in maintaining optimum rotor rpm [revolutions per minute], if the autorotation procedures recommended by the helicopter manufacturer had been followed. However, the pilot would have

had to use an amount of aft cyclic input to the flight controls to counteract the effects of the forward center of gravity. If he had been attempting an autorotative landing, the forward center of gravity may have compounded the already aft cyclic position and adversely affected his ability to flare the helicopter to the extent required to arrest the descent and reduce forward groundspeed. This may have resulted in a heavier-than-intended landing and a higher-than-intended groundspeed and may have been the reason for the pilot's broadcast that he was going in hard. It was unlikely that the pilot had previously conducted an autorotation at MTOW and/or with a forward center of gravity in the occurrence helicopter type."

The pilot probably was unaware of the helicopter's weight and CG, the report said, and "the absence of passenger information on the flight note indicated that an accurate calculation of MTOW was probably not conducted."

The report said that the pilot probably was in control of the helicopter until it struck trees on the ridge, damaging the main-rotor system. Because the pilot's radio transmission did not mention a specific problem, because there were no witnesses and because evidence was destroyed by the post-impact fire, the investigation did not determine reasons for the descent from cruise altitude and for the impact with the ground.

As a result of the accident, the operator emphasized to its pilots the requirements discussed in the operations manual, including the importance of calculating the aircraft CG before flight, the report said.♦

Notes

1. Australian Transport Safety Bureau. Investigation Report BO/200304546, *Robinson R44, VH-YKL, 43 Km NW Kununurra, WA, 8 November 2003*. July 11, 2005.

2. The Australian Civil Aviation Safety Authority (CASA) defines a Class A aircraft as an Australian aircraft (other than a balloon) that "satisfies either or both of the following … : The aircraft is certificated as a transport category aircraft; [and] the aircraft is being used, or is to be used, by the holder of an air operator's certificate which authorizes the use of that aircraft for the commercial purpose referred to in Civil Aviation Regulations (1988) 206 (1) (c)." CASA defines a Class B aircraft as "an Australian aircraft that is not a Class A aircraft."

3. Investigators also examined digital images from a camera operated early in the flight by the front-seat passenger. The images showed the helicopter's instruments, which appeared to be operating normally. The changes in heading and speed recorded by the global positioning system just before the accident occurred nearly four minutes after the last image was stored in the camera memory.

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