CIVIL AVIATION AUTHORITY
OF NEW ZEALAND

AIRCRAFT ACCIDENT REPORT

OCCURRENCE NUMBER 00/1198

ROTARY AIRFORCE 2000 GTX SE

ZK-RAG

NEAR MOKAU

6 MAY 2000

Glossary of abbreviations used in this report:

CAA	Civil Aviation Authority
CAR	Civil Aviation Rule(s)
E	east
ft	foot or feet
hp	horsepower
km	kilometre(s)
m	metre(s)
mm	millimetre(s)
NZST	New Zealand Standard Time
RAANZ	Recreational Aircraft Association of New Zealand
rpm	revolutions per minute
S	south
UTC	Coordinated Universal Time

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Aircraft type, serial number and registration:	Rotary Air Force 2000 GTX SE, H2-95-6-160, ZK-RAG
Number and type of engines:	One Subaru EJ22
Year of manufacture:	1995
Date and time:	6 May 2000, 0945 hours* (approx)
Location:	Near Mokau Latitude: S 38º 40.5' Longitude: E 174º 42.5'
Type of flight:	Private
Persons on board:	Crew: 1
Injuries:	Crew: 1 fatal
Nature of damage:	Aircraft destroyed
Pilot-in-command's licence	RAANZ Novice Pilot Certificate
Pilot-in-command's age	51 years
Pilot-in-command's total flying experience:	50.6 hours, all on type
Information sources:	Civil Aviation Authority field investigation
Investigator in Charge:	Mr O J Stewart

* Times are NZST (UTC + 12 hours)

Synopsis

The Civil Aviation Authority was notified of the accident at 1250 hours on Saturday 6 May 2000. The Transport Accident Investigation Commission was in turn notified shortly thereafter, but declined to investigate. A CAA site investigation was commenced the following day.

The pilot was attempting to take off from a sloping agricultural airstrip. The wreckage of the aircraft, together with the body of the pilot, was later found in the gully at the end of the strip. There were no witnesses to the accident.

1. Factual information

1.1 History of the flight

1.1.1 On 6 May 2000, the pilot left home at about 0930 hours, for a neighbour's airstrip where the gyrocopter was stored in a shed.

1.1.2 At 1130 hours, the pilot's wife went to the airstrip, as she had not heard him flying. She found the wreckage in the gully at the end of the strip and returned home to call emergency services. She returned to the strip with some friends who found the deceased pilot adjacent to the wreckage.

1.1.3 At approximately 0945 hours, a friend of the pilot who was duck shooting not far from the strip, heard a crash and a double thump noise from the direction of the airstrip. He did not associate the noise with the accident, at that time.

1.1.4 The accident occurred in daylight, at approximately 0945 hours NZST, 8 km east-north-east of Mokau, at an elevation of approximately 480 feet. Grid reference 260-R18-584788, latitude S 38° 40.5', longitude E 174° 42.5'.

1.2 Injuries to persons

Injuries	*Crew*	*Passengers*	*Other*
Fatal	1	0	0
Serious	0	0	0
Minor/None	0	0	

1.3 Damage to aircraft

1.3.1 The aircraft was destroyed.

1.4 Other damage

1.4.1 Nil.

1.5 Personnel information

1.5.1 The pilot held a RAANZ novice pilot certificate and a valid medical declaration expiring in March 2002. A "novice" certificate allowed the pilot to fly under dual instruction or solo under the direct supervision of an instructor. Each solo flight was required to be specifically authorised.

1.5.2 The pilot had flown 50.6 hours total time, all in ZK-RAG. Of this total, 42.1 hours were flown either with or under the direct supervision of an instructor, and all of this time was flown at Tauranga.

1.5.3 On 11 April 2000, the pilot, accompanied by his instructor, flew ZK-RAG from Tauranga via Hamilton to the airstrip near Mokau. According to his logbook, the pilot undertook a further 8.5 hours of solo flying from this strip. As far as can be determined, this was done without supervision or reference to an instructor.

1.6 Aircraft information

1.6.1 ZK-RAG was an enclosed-cockpit, two-seat, side-by-side gyrocopter. It was manufactured in November 1995 and was powered by a 130 hp Subaru EJ22 engine driving a Warp Drive 68-inch diameter 3-bladed propeller.

1.6.2 In early 1996 the engine was replaced after a bearing failure in the reduction gearbox, and in early 1999 the original propeller was replaced by a 4-bladed version.

1.6.3 The gyrocopter had been modified by the addition of a horizontal stabiliser. This was fitted to increase longitudinal stability, as the machine in its original state was prone to "porpoising". The required test flying and inspection had been undertaken, but no record of this work was entered in the aircraft logbook.

1.6.4 A current RAANZ Microlight Flight Permit had been issued for the aircraft, and was valid to 14 April 2001.

1.6.5 The aircraft had completed approximately 656.4 hours total time in service.

1.7 Meteorological information

1.7.1 The weather at the time of the accident was described by the pilot's neighbours as "clear and absolutely still".

1.8 Aids to navigation

1.8.1 Not applicable.

1.9 Communications

1.9.1 Not applicable.

1.10 Aerodrome information

1.10.1 The agricultural airstrip was situated on a ridge, and sloped down to the south on a gradient of about 3°. The strip centreline was oriented 186° magnetic, and useable length was approximately 450 m. About 35 m from the southern end of the strip, the slope changed to 5-6° and then dropped steeply into a gully, some 15 to 20 m below the end of the strip. The strip elevation was about 630 feet at the top end.

1.10.2 The instructor who flew with the pilot from Tauranga to the airstrip, advised the pilot that the strip was unsuitable for novice pilots and should only be used by very experienced pilots.

1.11 Flight recorders

1.11.1 Not applicable.

1.12 Wreckage and impact information

1.12.1 Three wheel marks could be clearly observed in the grass at the northern end of the strip, suggesting that the pilot commenced his take off roll as close as possible to the northern end of the strip. A short distance down the strip, the marks became indistinguishable from those of vehicular traffic that had subsequently accessed the strip.

1.12.2 Approximately 25 m from the southern end of the strip there was a main rotor blade strike mark in the grass, approximately 250 mm long. The blade tip had penetrated the surface at an angle of approximately 10°.

1.12.3 Between the first strike mark and the end of the strip, there were a further three main rotor strike marks on the ground. Spacings between successive marks were 5.1 m, 5.8 m and 6.3 m. A sighting taken through the approximate centre line of the strike marks corresponded to an aircraft heading of 164°. A further main rotor strike mark was found in the rough terrain off the end of the strip, 13.5 m from the previous (fourth) strike mark.

1.12.4 Pieces of carbon fibre from the propeller were found within the vicinity of the main rotor strike marks on the ground. Inspection of the underside of the main rotor blades showed impact marks from the propeller approximately 600 mm from the root end of each blade.

1.12.5 The first fuselage impact mark was approximately 25 m from and 7 m below the end of the strip, on a small knoll. This indicated that the aircraft was in a nose-down, left wheel low attitude at the time of impact, which occurred on a heading of approximately 185°.

1.12.6 The section of the cockpit enclosure forward of the rear wall had been destroyed and lay scattered around the initial impact point. The substantial box section beam forward of the seats and supporting the nose gear, rudder pedal assembly, panel and forward fuselage had been broken in two.

1.12.7 The aircraft bounced from the first impact point, clearing a seven-wire batten fence, then slid and/or rolled down an almost vertical grassed bank to the floor of the gully.

1.12.8 The vertical fin and horizontal stabilisers were damaged during the ground impact sequence, with the rudder detaching from the rudder post and cables.

1.12.9 Neither the rudder nor the vertical fin was struck by the main rotor blades.

1.12.10 The main rotor blade flap stops on the main rotor head were impacted as the result of blade flapping beyond normal limits.

1.13 Medical and pathological information

1.13.1 Post-mortem examination of the pilot concluded that death was due to extensive injuries consistent with a high-energy impact.

1.13.2 There was no evidence of any pre-existing condition or incapacity that would have affected his ability to fly the aircraft.

1.13.3 Toxicological tests revealed only an insignificant urine alcohol level, consistent with the pilot's reportedly having consumed one or two cans of beer the previous evening.

1.14 Fire

1.14.1 There was no fire.

1.15 Survival aspects

1.15.1 The accident was not survivable owing to the high decelerative forces involved.

1.16 Tests and research

1.16.1 The engine and carburettor were removed and inspected by a Subaru agent. No mechanical defects were found in either component that would have contributed to the cause of the accident. Assessment by the agent indicated that the engine would have been about 40% down on power, influenced by a number of burnt exhaust valves and low compression in each cylinder

1.16.2 The computer chips were recovered from the main rotor tachometer and the manufacturer was contacted to see if there was any accessible memory obtainable. They reported that the chips were not designed to retain any memory.

1.17 Organisational and management information

1.17.1 Not applicable.

1.18 Additional information

1.18.1 Gyrocopters differ from helicopters in that the rotor is not powered, and relies on airflow generated by forward speed for rotation.

The thrust for forward flight is provided by an engine and propeller, which in the case of the RAF 2000, are arranged in a "pusher" configuration. The axis of the main rotor has a rearward tilt, so that in forward flight, there is an upward component of the airflow through the rotor. It is the upward airflow through the rotor that provides the driving force, in the same manner as a helicopter rotor in autorotation.

1.18.2 The RAF 2000 has a pre-rotator mechanism, which comprises a flexible drive from the engine to the rotor, with a clutch assembly controlled by a lever on the pilot's control column. This enables the pilot to spin up the rotor while the aircraft is stationary, to at least 120 rpm before commencing the take-off roll.

1.18.3 Normal rotor rpm for flight is approximately 300-310 to which the rotor accelerates during the take-off roll. From a standing start, with the rotor speed at least 120 rpm, the pilot applies throttle progressively, with full throttle being applied only once the rotor rpm reaches 180 - 200.

1.18.4 The rotor is a two-bladed, teetering, semi-rigid assembly of 30-foot diameter. The direction of rotation is anticlockwise as viewed from above. Blade movement about the single teeter bolt in the rotor head assembly is known as "flapping". Inbuilt flap stops limit the blades' travel in the flapping sense when the rotor is stationary. At rest, the blades are quite flexible, but at normal rpm, centrifugal effect imparts the rigidity necessary for flight.

1.18.5 If take-off is attempted at too low an rpm setting, a combination of blade flapping and flexing can result in the blades striking the ground and/or the airframe. In addition, the limits of the flap stops will be reached abruptly, with characteristic damage to the stops.

1.18.6 In flight, the rotor blade travelling into the airflow generated by the forward motion of the aircraft is known as the "advancing" blade, and the blade travelling with the airflow is the "retreating" blade. There is a difference in lift produced by the advancing and retreating blade. The advancing blade producing more lift than the retreating blade during forward motion of the aircraft. The blades "flapping to equality" compensate for the dissymmetry of lift resulting from the difference in the speed of the relative airflow over the advancing and retreating blades. The advancing blade rises while the retreating blade descends, respectively decreasing and increasing the angle of attack on each blade.

1.18.7 An additional effect of low rotor rpm can be "retreating blade stall", which has the effect of rolling the aircraft to the left.

1.18.8 An observer acquainted with the pilot indicated that he had been operating the gyrocopter from the airstrip on previous occasions when there was significantly more wind than on the day of the accident. The observer had also noted that on these occasions the pilot had been using almost the entire length of the airstrip before becoming airborne.

1.19 Useful or effective investigation techniques

1.19.1 Nil.

2. Analysis

2.1 Because there were no witnesses to the accident, it was not possible to be absolutely certain about the sequence of events.

2.2 Examination of the wreckage did not reveal any pre-accident failure, and while the engine was assessed as being as much as 40% down on power, this reduction would not have contributed to the cause of the accident.

2.3 The four main rotor blade strike marks found at the southern end of the airstrip were symptomatic of low rotor rpm. Tests showed that the blades contacting the ground would have restricted the tip path travel of the retreating blade. The ground impact would have precluded the blade from flapping down to a height that would have brought it into contact with the fin.

2.4 The gyrocopter appears to have still been in contact with the ground at the end of the strip. This suggests that by this point, the rotor had not accelerated to the rpm required for flight. The pilot would have only two options available: apply full throttle (if he had not already done so) and attempt to lift off with the rotor rpm too low, or attempt to stop the aircraft before it ran into the gully at the end of the strip.

2.5 It was not possible to determine what the pilot attempted at this time, but given the distance the gyrocopter travelled prior to first impact with the ground, it is likely that the pilot did not attempt to stop.

2.6 The initial take-off heading was 186°, which appeared to have changed to about 164° during the take-off roll. This heading change may have been caused by dissymmetry of lift as the result of low rotor rpm and retreating blade stall, the effect of which would cause an uncommanded roll to the left. Another possibility is that the pilot initiated the heading change to head towards the steeper drop-off, giving him more height above ground to sacrifice for rotor rpm increase. The subsequent return to close to the original heading may have been the pilot's attempted correction of an uncommanded roll due to the dissymmetry of lift.

2.7 The accident flight, and the preceding 8.5 hours of flight by the pilot, were conducted without the authorisation or supervision of a microlight instructor. As far as could be determined, the pilot had not arranged for instructor supervision after he relocated the aircraft from Tauranga to his neighbour's property.

2.8 The instructor who accompanied the pilot on the relocation flight had advised him specifically that the airstrip where the aircraft was to be based was suitable for use only by experienced pilots.

2.9 Previous flights from the airstrip were conducted when there was significantly more wind than on the day of the accident. Successful take-offs on these occasions may have led to a false expectation by the pilot that the strip would be suitable for his use in no-wind conditions.

3. Conclusions

3.1 The pilot was qualified only for flight under dual instruction or solo flight under the direct supervision of a microlight instructor.

3.2 Each solo flight required specific authorisation by an instructor.

3.3 It could not be established that the pilot had arranged such supervision or authorisation after relocating the aircraft to his home area.

3.4 The pilot had been advised that the airstrip was unsuitable for his use.

3.5 There was no evidence of pre-accident medical incapacitation of the pilot.

3.6 The gyrocopter had a valid Recreational Aircraft Association Microlight Flight Permit.

3.7 There was no evidence any pre-accident defects that would have contributed to the accident.

3.8 The pilot attempted to take off in a situation unsuited to his level of experience.

4. Safety recommendations

As a result of this investigation and as suggestions to improve the knowledge of novice gyrocopter pilots to preclude similar accidents, it was recommended to RAANZ that:

4.1 The Recreational Aircraft Association reviews the syllabus for gyrocopter novice pilot flight instruction to ensure that adequate emphasis is applied to the understanding of the aerodynamics associated with attempting low rotor rpm take offs and the consequences of doing so.

4.2 The Recreational Aircraft Association reviews the syllabus for novice pilot instruction to ensure that, prior to solo flight, the novice pilot understands the aerodynamic effects of wind on take off distances for gyrocopters.

RAANZ responded as follows:

"*4.1 After consultation with a number of senior gyrocopter flight instructors we submit that an understanding, by the novice, of the aerodynamics of low rotor rpm is a fundamental requirement in the training of gyrocopter pilots.*

4.2 As above, we submit that the understanding of the aerodynamic effects of wind on take-off distances is a basic requirement of the novice pilot prior to solo flight.

In the light of this accident RAANZ has taken steps to expand the theory training of all gyrocopter pilots by adopting a technical gyrocopter flight-training manual as a key requirement in the training of pilots.

However, novice pilots are required to fly under the direct supervision of a flight-training instructor. This includes the specific authorisation of all solo flights. We submit that the

most significant factor in this accident was that the pilot elected to proceed with a flight without the advice, guidance or authorisation of his instructor. His level of skill was such that he was unable to accurately access all the factors influencing the proposed flight.

RAANZ will continue to draw to the attention of all novice pilots, their responsibilities with regard to all solo flights under the supervision of their instructor."

(Signed)

Richard White
Manager Safety Investigation

22 June 2001