COMMISSION
TIROTIRO AITUA WAKA
INVESTIGATION

AIRCRAFT ACCIDENT REPORT

No. 90-013T

Robinson R22 Beta

ZK-HBW

Near Slaty Peak
Richmond Range, Nelson

23 December 1990

Transport Accident Investigation Commission
Wellington · New Zealand

Price $11.60 (including G.S.T.)

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TRANSPORT ACCIDENT INVESTIGATION COMMISSION

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Aircraft Type, Serial Number and Registration:	Robinson R22 Beta, 787, ZK-HBW
Number and Type of Engines:	One Lycoming O-320-B2C
Year of Manufacture:	1988
Date and Time:	23 December 1990, 0830 hours
Location:	Near Slaty Peak, Richmond Range, Nelson Latitude: 41°30'S Longitude: 173°17'E
Type of Flight:	Air Transport Charter
Persons on Board:	Crew: 1 Passengers: 1
Injuries:	Crew: Nil Passengers: Nil
Damage to Aircraft:	Substantial
Pilot in Command's Licence:	Commercial Pilot Licence – Helicopter
Pilot in Command's Age:	46 years
Pilot in Command's Total Flying Experience:	325 (of which 17 hours were in the last 90 days) all on type
Information Sources:	Transport Accident Investigation Commission field investigation
Investigator in Charge:	Mr D V Zotov

1. NARRATIVE

1.1 The operator was approached by a tramper, who wished to be flown from Nelson Aerodrome to Slaty Peak Hut in the Richmond Range, 24 km south of Nelson. The tramper's map appeared to show the altitude of the hut as about 1450 feet amsl.

1.2 The operator used a number of part-time pilots. The pilot he asked to make the flight had previously been trained by the operator and had held a Commercial Pilot Licence – Helicopter for a little more than a year. The pilot was familiar with ZK-HBW and the operator considered the flight to a low-level hut to be within the capabilities of aircraft and pilot – the more so since the flight was to be in early morning, before rising temperatures could exacerbate performance problems.

1.3 The pilot was briefed by the operator when he collected ZK-HBW from the operator's base to position it at Nelson Aerodrome. At Nelson he met the tramper and assessed the weights to be carried as:

Pilot:	16 stone (102 kg)
Tramper:	12 stone (76 kg)
Pack	60 pounds (27 kg)

The fuel tanks were about 60% full, i.e. about 18 US gallons (68 litres) weighing 108 pounds (49 kg).

The pilot considered these weights to be within the aircraft's capability; he did not give undue thought to the weights because the hut was said to be at low altitude. There was no requirement for a loadsheet to be completed because the Director of Civil Aviation had exempted helicopter pilots from the requirement to complete loadsheets. The pilot stowed some boxes of food from the pack beneath the seats; the pack was then placed at the tramper's feet. A hover check seemed normal: the hover in ground effect (IGE) required an intake manifold pressure (MP) of 24 inches of mercury. The ambient pressure (QNH) was 1017 hPa and the temperature was +13°C.

1.4 The tramper guided the pilot to Slaty Peak Hut. On arrival it was found that the hut was only a short distance from the peak: the height was in fact 1450 m amsl, i.e. 4750 feet. The map was from the recently issued NZMS 260 series, a metricated replacement of the NZMS 1,1:63,360 (one inch to the mile), map series and indicated height in metres.

1.5 There was no helipad at the hut, so the pilot elected to land on a nearby tussock covered saddle. He assessed the wind as calm or light southerly, so planned an approach towards the south, oblique to the ridge, which would permit him to break off the approach or to overshoot should problems arise. A power check at 50 knots showed 19 inches MP, which the pilot considered sufficient for a zero-speed landing.

1.6 The approach was made at a relatively shallow angle, at a power setting of about 22 inches MP. However, at about 15 feet above the landing point the pilot noticed that the dual tachometer (which displayed both engine and main rotor speed) was indicating 97%. (The normal operating range, or "green arc", extended from 97% to 104%). He opened the throttle until it was fully open, but this had no effect on the rpm.

1.7 By this stage the pilot considered he was committed to the landing and controlled the flight path by increasing collective pitch. He was unable to arrest the forward motion completely and touched down heavily at a low groundspeed.

1.8 The aircraft pitched slowly onto its nose, then fell on to its right side. The pilot and passenger, who had been restrained effectively by their lap and diagonal harnesses, opened the door on the upper side and climbed out. They repositioned the emergency locator transmitter (ELT) and then descended to the hut to await rescue.

1.9 The R22 helicopter needed smooth ground for a run-on landing. For landing on other terrain it was necessary to bring the aircraft to a stop in the hover before touchdown, otherwise there was a probability that the aircraft would trip on its skids, as happened in this accident.

1.10 The maximum all-up weight permitted for the R22 was 1370 pounds (622 kg). The empty weight of ZK-HBW was 840 pounds (381 kg) so that the all up weight at take-off (using the pilot's estimates) was 1400 pound (635 kg). The aircraft was thus loaded substantially in excess of the maximum authorised weight at take-off from Nelson. The effect of the high weight would have been to require high power to bring the aircraft to the hover. An MP of 24 inches was required to hover the aircraft in ground effect; at 4750 feet the available manifold pressure was 23.1 inches, so insufficient power was available.

1.11 Even had all of the load from the pack been stowed under the seats the centre of gravity would have been about 25 mm ahead of the forward limit; in practice it must have been further forward. As fuel was consumed, the centre of gravity moved yet further forward, since the fuel tanks were toward the rear of the aircraft.

1.12 The effects of the forward centre of gravity were to require an aft cyclic pitch position in the hover and to make it difficult to bring the aircraft to a stop prior to landing especially in calm or tailwind conditions.

1.13 In the absence of standard load sheets, the pilot should have determined, from the weight and balance data in the aircraft's flight manual, the actual weight at last weighing, the maximum authorised weight, the centre of gravity limits and the moment arms of the various loads. He then had to compute the all-up weight and centre of gravity and compare them with the limits. This procedure was laborious and in day to day flying, it was not performed. As carriage of significant items in the area adjacent to the passenger's feet was not approved there was no information on the "arm" to be used for computing the effect of such loads on the aircraft's balance.

1.14 In some types of operations, such as scenic flights, it could be assured by standard procedures that the weight and balance would always remain within limits. However, in other situations an accurate check of weight and balance was required. It had been argued that such a check was unnecessary in helicopter operations because a hover check would warn the pilot if the aircraft was overweight or out of trim. A hover check might be sufficient for aerial work, where there was no risk to the public, but this accident demonstrated that the argument was not valid for air transport operations. It was the pilot's responsibility to devise some convenient means to calculate weight and balance in day to day operations and the operator's responsibility to ensure that pilots

had devised such a system and were using it. As pilots could not be expected to guess weights with sufficient accuracy, where scales were not available at the point of loading, it was necessary to carry a set in the aircraft.

1.15 It was recommended to the Director of Civil Aviation Safety that proper calculation of weight and balance be addressed during Safety Audits by the Air Transport Division.

1.16 The Pilot's Operating Handbook contained the following warning:

"SAFETY NOTICE SN-4

1.0 Landings at high density altitudes

Several accidents have occurred at high density altitudes when the pilots allowed their rpm to get low during the approach. Power available is directly proportional to rpm. If your rpm is 10% low, you have 10% less power and if you are operating at or near the hover out of ground effect ceiling of the helicopter, you will probably start to settle. If you raise the collective to stop the ship from settling, you will pull the rpm down even lower and settle even faster. If you continue to raise the collective, the rpm will continue to decrease until there is a loss of directional control and the main rotor blades finally stall.

The correct recovery procedure is to momentarily lower the collective while adding throttle to recover the rpm and power (even though you will lose some altitude) and then slowly raise the collective to stop the descent without allowing the rpm to decrease. This procedure is known among helicopter pilots as 'milking the collective'".

1.17 The power check performed by the pilot at 50 knots prior to landing was a military technique which had been demonstrated by the Flight Testing Officer at the time of the flight test for the pilot's Commercial Pilot Licence - Helicopter. The intention was to estimate the power required to hover, either in ground effect (by adding 5 inches MP) or out of ground effect (by adding 6 inches MP). It was then necessary to open the throttle briefly to confirm that this manifold pressure was available. Had the pilot made this calculation he would have found that 24 inches MP was required but only 23 inches was available.

1.18 The pilot had been taught to attempt to establish a hover out of ground effect (OGE), if he was over terrain where he would have room to lose height and accelerate through translation speed (about 15 knots) if the aircraft started to settle. This check needed to be performed sufficiently close to terrain for movement of the aircraft to be established visually. Such a check would have demonstrated that there was no margin of power: the aircraft was above the OGE hover ceiling.

1.19 There was a potential warning of an overload condition in the hover check at Nelson. The power required to hover was one inch of manifold pressure below the maximum permitted, but the pilot did not appreciate the significance of this. Had he been alerted to the potential overload, a number of steps were open to him:

(a) He could have defuelled to the minimum required for the flight: this would have reduced the weight by about 23 kg, which would have had the effect of raising the OGE hover ceiling by about 700 feet. Had the aircraft been at no more than maximum all-up weight to start with, this might have restored the power to weight ratio sufficiently for a safe landing to have been performed. However, the aircraft was initially overloaded and defuelling would not, of itself, have been sufficient to restore the required performance margin.

(b) He could have decided to make two trips, the first to locate the hut and leave the tramper there and the second to bring the pack from Nelson.

(c) He could have referred the problem to the operator.

Any of these options entailed commercial penalties: it was unlikely that fuel drained from the tank could be reused; a double trip, or a return to base to refer the flight to another operator would have resulted in unprofitable transit flying.

1.20 The pilot might have been alerted to the forward centre of gravity by the aft position of the cyclic control, but with himself and another person on board, the centre of gravity of an R22 would have been towards the forward limit in any event. He would thus have come to regard an aft cyclic control position as normal, so the discrepancy on the accident flight passed unnoticed.

1.21 The forward centre of gravity could have been corrected by hanging the pack from the belly hook. This would have had the added advantage that, when the power limited condition was discovered at a critical stage, the pack could have been jettisoned to restore aircraft performance sufficiently to escape.

1.22 The pilot had been misled as to the height of the hut to which he was to take the tramper. Because he believed the hut was at lower level he had not given particular attention to weight and performance considerations. Therefore, when it transpired that the hut was in fact near the top of a high ridge, the difference between expected and actual conditions might have alerted the pilot to the need for caution, in that the aircraft might be performance limited. In the event, however, the pilot was not alerted by the discrepancy, confining himself to planning approach and overshoot routes which offered escape paths.

1.23 Had the pilot been alerted to the potential inadequacy of power at the height of the proposed landing he could have taken the time to perform a full hover check of the power available, which would have made it apparent immediately that a safe landing was not practicable. He could then have considered alternatives such as landing the pack in a valley, to retrieve it after landing the tramper.

1.24 At a height above the proposed landing site which the pilot estimated as 15 feet, he noticed that the rotor and engine rpm were "at the bottom of the green", i.e. 97%. This was below the recommended rpm (104%) and the already limited power of the R22 was reduced by some 7% in consequence. The pilot attempted to restore the rpm to the appropriate level by opening the throttle, but as the aircraft was at full throttle height this could have little effect. The pilot then attempted to control the approach path with collective pitch, with the inevitable consequences.

1.25 Had the pilot been more familiar with handling the aircraft in power limited situations, he might have been able to restore rpm by lowering the collective and slowly raising it again; though even this procedure would not have permitted a safe landing, the aircraft would have remained under control and could have overshot. However, the proper course of action on encountering a power-limited condition would have been to have accelerated so that the rotor entered the translational lift regime, whereon the power required would have been reduced by about 5 inches MP. The pilot could then have considered alternative courses of action, at leisure.

1.26 The pilot had been trained to CPL standard and had passed an independent flight test a year previously in which the skills required to make this flight safely were tested. That the pilot did not recognise a number of warning signs and that on recognising the low rpm condition he took the wrong action to recover, reflected a lack of recent flying and continuation training. The pilot's recent experience was 17 hours in the last 90 days. Accident statistics suggested that the accident rate for pilots with this order of recent experience could be three times higher than for those who flew 40 hours or so per quarter. A study by the Federal Aviation Administration (FAA) of the United States on pilot skill retention, showed a marked loss of skills after 8 months when those skills were not practised; cognitive (procedural) skills were particularly affected. That study concluded that continuation training needed to be skill-specific: the pilot of ZK-HBW had not performed a high-altitude landing since gaining his CPL-H some 14 months previously.

1.27 On 7 October 1990, the pilot flew with the operator (who was an "A" category helicopter instructor) for 30 minutes, performing a number of exercises to the operator's satisfaction. These exercises did not include a high altitude landing.

1.28 It was tempting for the operator to use such part time pilots, i.e. pilots not in the full-time employment of the operator, since they needed to be paid only when there was work to be done. The corollary, however, was that there was an obligation on such an operator to ensure that his pilots received sufficient continuation training to remain competent. This imposed an additional cost, which had to be offset against the saving made by using part time pilots. To ensure that no operator sought to minimise costs by minimising recurrent training, continuation training requirements should have been stipulated by the regulatory authority in the operators' training manual. It was therefore recommended to the Director of Civil Aviation Safety that this be required.

1.29 A properly conducted check under Regulation 76 for continued competency should have ensured that the areas of skill loss which needed to be addressed by recurrent training were disclosed. However, the results of the FAA study suggested that an annual check might be too infrequent for part time pilots. It was recommended to the Director of Civil Aviation Safety that the time interval allowed between such checks be reviewed.

1.30 A Regulation 76 check would have been of no value in revealing skill deficiencies if it did not test the specific skills required. The check form incorporated in the Operations Manual did not require a demonstration of skill in a high-altitude landing, yet such landings were a part of the operation. It was recommended to the Director of Civil Aviation Safety that checks for continued competency should test each of the skills likely to be required in the particular operation.

1.31 The pilot could not be expected reasonably, to predict the degradation in his skills due to his lack of current flying experience and recurrent training. This was a matter for supervision by the operator. To some extent the operator was deceived by the change in the display of height on the large scale map, into thinking that the flight was within the pilot's competence because the landing would not be at a high altitude. However, regardless of the landing site, there were other factors which reduced the safety margins, so that the flight was always going to be marginal:

(a) LOADING

A tramper would normally have a pack and the combination of pilot, a passenger and a pack was likely to load the R22 near its limit. Matters could have been improved by despatching the aircraft to Nelson with minimum fuel, so that the additional amount needed for the flight could be calculated and added. An inexperienced pilot should have been briefed on the need to calculate all-up weight with care and to facilitate this, scales should have been sent to Nelson unless some were readily available there. Perhaps most important of all, the operator should have had regard to the pilot's weight and where the all-up weight was going to be critical, he should have used a lighter pilot.

(b) CENTRE OF GRAVITY

With only the pilot and tramper aboard the aircraft, its centre of gravity was going to be close to the forward limit. The operator should have briefed the pilot to hang the tramper's pack from the belly hook, rather than relying on the pilot to work this out for himself. In the event, the pilot's answer, of stowing some of the contents of the pack under the seats, was inadequate to keep the centre of gravity within limits.

(c) POWER

The R22 was not designed to lift heavy loads to high altitudes: it was intended as a training and communications aircraft. Had the operator chosen a more powerful aircraft there could have been a sufficient performance margin and the job could have been completed in safety. It was natural for efficient operators to select the smallest possible helicopter for a job, since the operating cost would be lower. However, the limitations of the R22 were such that they were likely to be exceeded in many ordinary operations.

It was recommended to the Director of Civil Aviation Safety that R22 operators be reminded of the need to observe the aircraft's limitations and that attention be paid to such observance during Safety Audits.

1.32 The accident sequence started when the operator assessed the task as being within the competence of the pilot. The operator was influenced in this judgement, by the apparent low altitude of the hut; combined with the relatively low early morning temperature this suggested that the normally-aspirated engine should not be affected by density altitude problems. The operator was accustomed to the NZMS 1 Series maps on which heights were shown in feet.

(By international convention, heights were stated in feet, in aeronautical usage). Unfortunately, the chart on which the tramper indicated the hut to which he wished to be flown was from the new NZMS 260 series, on which heights were indicated in metres. While there was a warning on the chart's margin that heights were in metres, the warning was not visible when the chart was folded for use.

1.33 The similar scale of the new map and its generally similar appearance, deceived both operator and pilot into believing that heights were quoted in feet: there was little to trigger an inquiry as to whether this previously universal practice had been changed. Mapping bulletins were issued with Notices to Airmen and it would have been a useful safety measure if such potential traps were highlighted in these bulletins.

2. FINDINGS

2.1 The aircraft was loaded in excess of the maximum authorised weight and the centre of gravity was ahead of the forward limit.

2.2 The pilot did not detect the aircraft's weight and balance exceedences.

2.3 The pilot and operator were misled by the metrication of the topographical map, into believing that the landing site was at 1450 feet amsl when in reality it was at 1450 metres, i.e. 4750 feet amsl.

2.4 The helicopter had insufficient power available for the pilot to make a safe landing at 4750 feet amsl.

2.5 The power check performed by the pilot did not alert him to the inadequacy of the power available for the high altitude landing.

2.6 The pilot was unable to avert a heavy landing because he did not respond correctly when he noticed low engine and rotor rpm on the approach to land.

2.7 The aircraft tripped on tussocks, due to its forward motion on impact, causing it to pitch nose-down before falling onto its side.

2.8 The pilot was short of recent flying experience and recurrent training, particularly in high altitude landings.

2.9 There were deficiencies in the operator's briefing and supervision of the pilot.

3. SAFETY RECOMMENDATIONS

3.1 It was recommended to the Director of Civil Aviation Safety that:

Proper calculation of weight and balance be addressed during Safety Audits by the Air Transport Division, and

Continuation training requirements be stipulated in operators' training manuals, and

The frequency of checks under Regulation 76, as applied to helicopter pilots, be reviewed, and

Checks for continued competency should test each of the skills likely to be required in a particular operation, and

R22 operators be reminded of the need to observe the aircraft's limitations and that attention be paid to such observance during Safety Audits.

12 June 1992

M F DUNPHY
Chief Commissioner