Flying High

A look at some of the hazards inherent in high-altitude takeoffs and landings

*This article was adapted and reproduced from **Flight Safety Australia** who in turn adapted it from "Fickle Winds and High Altitude Operations" and "Helicopter Mountain Flying", both published in the Australian DFS-ADF **Flying Safety Special: Operations in Tropical Mountainous Areas** (Fourth Edition, 2000).*

Introduction

It is one of life's unfortunate facts that aircraft performance diminishes with density altitude. For helicopter pilots who work in mountainous areas, it's just another consideration that must be added to a long list of other factors, which can include severe turbulence, unpredictable weather, unfriendly landing sites and hostile terrain. While it's a combination of hazards that many operators learn to manage, some don't – and occasionally the consequences can be fatal.

What are some of the mistakes that have been made in the past, and how can we learn from them?

The following Australian accident, which occurred several years ago, is typical of the type of accident that can occur if proper consideration is not given to the hazards of mountain flying.

Landing Short

The pilot had a total of 2000 hours flying time, of which 150 had been logged in helicopters. His first mission in a mountainous area as pilot-in-command required him to locate some supplies that had fallen into an inaccessible area.

The pilot spotted the supplies and requested further instructions from his superiors. He was asked to land, if possible, and send two men to recover the cargo. The closest accessible landing site seemed to be a clearing near an alpine shelter at 6000 feet amsl. The pilot radioed headquarters that he was initiating landing procedures.

He made two passes over the chosen area, verifying the wind speed and nature of the terrain. He then opted for a flat approach pattern toward a point where he could hover with sufficient power. His speed decreased to 30 knots, 50 to 100 feet above the ground just before the landing site.

As the helicopter transitioned to the hover, the pilot increased power and the machine began to settle, with the rotor rpm beginning to decay. The pilot informed his passengers of the imminent landing and raised the collective pitch to its maximum.

The helicopter touched down rather violently almost 200 feet before the chosen site and came to rest on a 15-degree incline.

Basic Rules for Mountain Approaches

While at first glance it appears that the pilot did not commit any glaring errors, it's worth reviewing his actions according to some basic rules of mountain approaches:

- Maintain constant awareness of the direction and estimated speed of the wind.
- Take into account the temperature, keeping in mind that it may increase as you approach ground level.
- Plan the approach in such a way that you retain the option of discontinuing it at your convenience – the approach should be along a slope and preferably into the wind, so as not to gain altitude.
- If the wind is light, choose a summit or an elevation as your landing site in order to be able to anticipate and counteract every possible wind activity.
- If you are not familiar with a landing site, execute a minimum of two passes over the area.
- Identify any obstacles near the landing site.
- Do not select a landing site solely on the basis of its suitability for unloading cargo.
- Carry out power checks to determine that you have the power required for the desired landing.
- Where possible, the approach to a mountainous summit should be made along the ridge – not from the perpendicular – to provide an escape route. On the final approach use a soft touch on the controls – over-controlling can lead to a loss of rotor rpm.

Power and Density Altitude

Circling above the area, the pilot had estimated the wind conditions to be calm but had not taken the temperature into consideration, noting merely that it was rather warm. Subsequent calculations revealed that the density altitude was in fact 8000 feet. Nor did the pilot check the power. Had he done so he would have realised that the conditions during the approach pattern required all the power that was available.

The approach flight path was too flat to permit an overshoot if any unexpected difficulties arose. These are all small but important details which, when disregarded, turned a potentially safe approach and landing into a manoeuvre that taxed the capability of the machine beyond its limits.

The pilot involved, confirmed that conclusion. "In my opinion the accident could have been avoided had I refused to land. Once the supplies had been spotted and localised, the urgency of the operation was reduced. Unfortunately this was not communicated to me. I thought I had carried out all the necessary operations, without in effect knowing that I was operating at the limits of the helicopter's operating capabilities. Had I made a simulated approach at a higher altitude, I would have realised how much power I really lacked for an eventual approach and landing."

Wind Speed and Direction

Another trap, which can complicate matters for pilots new to mountain operations, is the discrepancy between indicated airspeed and true airspeed at altitude.

Consider a helicopter on an approach to a pad at sea level at an indicated airspeed of 60 knots. If the calibrated airspeed is also 60 knots and the wind speed is zero, then the groundspeed will be 60 knots. Now consider the same approach but to a landing site with a density altitude of 15,000 feet. At the higher altitude, true airspeed and groundspeed increase to the extent that 60 knots indicated airspeed now equates to a groundspeed of 74 knots. If the pilot notices the higher groundspeed on the approach they may conclude that they are landing with a significant tailwind (a logical conclusion for operators at sea level). They abort the approach and set up a landing from the opposite direction.

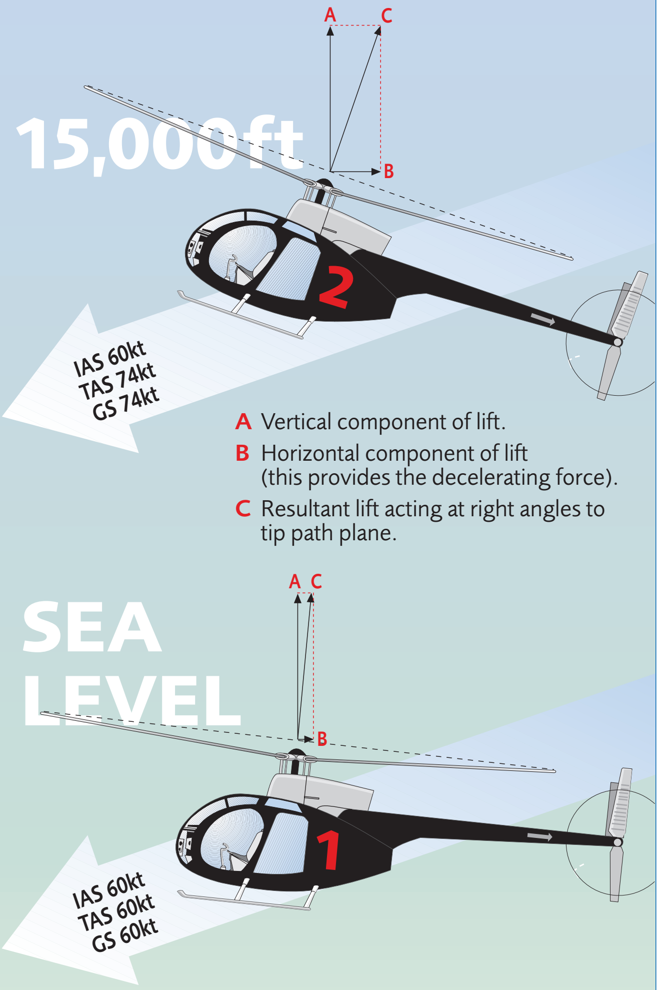
This does not present a problem if there is in fact no wind. But what if the pilot was flying into a 5-knot headwind on the original pass – the groundspeed would still be higher than they would be used to at sea level. If they make the decision to approach from the opposite direction they are unwittingly choosing to land with 5 knots tailwind.

If the same pilot has a gross weight which only allows them to hover in ground-effect (IGE), they are going to pass below effective translational lift short of the touchdown area, over-pitch, and land heavily on whatever happens to be below – unless they have sufficient height to lower the nose and collective to pick up airspeed and rotor rpm. (This could be a couple of hundred feet depending on the rotor rpm decay and aircraft altitude.)

Approach Profile

The type of approach flown is also critical to the safety of operations at altitude. Because the groundspeed is significantly higher at altitude, a greater deceleration is required to bring the helicopter's speed to zero at touchdown than if the approach was flown at sea level.

Power vs Altitude



Helicopter 1 is flying an approach to a sea level landing pad. Helicopter 2 is flying a similar approach but to a landing pad with a density altitude of 15,000ft. At the higher altitude, the true airspeed and groundspeed increase, which means that helicopter 2 must decelerate more over the course of the approach.

To do this the pilot of helicopter 2 tilts the tip path plane further to the rear. This reduces forward speed but also reduces the vertical component of lift. To counter this the pilot must then increase power. If additional power is not available, the helicopter will likely make a heavy landing or crash short of the pad.

At the point in the approach when maximum decelerating attitude is reached (about 30 to 50 feet above ground level), and the pilot starts easing forward cyclic and bringing in power, it is going to take more power to keep the rate of closure constant with the greater deceleration.

The pitch angle will also have to be increased to provide the lift required to support the weight of the aircraft, because the tip path plane is tilted further to the rear, and the vertical component of lift, which governs our rate of descent, is less (see accompanying diagram). This additional power may not be available, and it usually results in over-pitching and one of the following:

- Arrival on the pad with the seats set lower in the aircraft and the skids level with the floor;
- A new helicopter-shaped terrain feature short of the pad; or
- An aborted landing – if the pilot is lucky and recognises the problem soon enough to allow sufficient altitude for recovery.

Continued over …

... continued from previous page

So, how should we fly the approach in these conditions? A long shallow approach to the forward (upwind) edge of the usable area has several advantages. It minimises the rate of descent, ensuring that valuable power is not expended while reducing vertical momentum. It also minimises the required change in fuselage attitude and the rotor disc plane, so that excessive power is not used to reduce forward momentum. However, shallow approaches can be used only in light (or zero) wind conditions. The approach profile should be steepened with wind strength to avoid turbulence.

Points to Note

- For pinnacle and ridgeline landings, never approach straight in or at right angles – fly at an angle that allows an escape route to a lower altitude in case of an abort.
- When landing in a new area for the first time, plan your load so that the helicopter can be hovered OGE, with some reserve power.
- Before takeoff, determine the density altitude at your intended landing point, the maximum weight for hover IGE and OGE, and the maximum torque or manifold pressure. Work out the maximum weight you can carry to hover OGE (for first landing) and IGE. Also work out the maximum torque or manifold pressure you will get.
- Make sure the aircraft is loaded to the minimum possible weight to complete the mission, but include a survival kit.
- On arrival in the area of intended landing, perform a full-power check at or above the level of the pad. And note the torque setting or manifold pressure. Check this against the performance data.
- Assess wind direction carefully allowing for higher true airspeeds at altitude.
- Execute a practice approach, maintaining approximately 40 knots, and overfly the intended touchdown point as low as is safely possible to check for slope, size, shape, and firmness of the intended touchdown point.
- Carry out the final approach all the way to the ground, paying particular attention to the rate of closure and descent.
- If an approach is not going to plan, abort as early as possible. Do not try to salvage a poor approach. Consider returning when conditions improve or you have reduced your payload.

The Trouble with Takeoffs

Takeoffs at altitude can also be problematic. The following accounts illustrate some of the hazards.

"Because of the loads we were lifting, we could just get a three-foot hover at full throttle, and anything over this caused over-pitching. Our takeoffs were made with a very gradual acceleration, and, after passing through translational lift, a reduction of power was normally made to give a reserve of power if needed. This was also intended to leave the aircraft at an altitude where it was IGE if the wind gusts dropped the airspeed back below effective translational lift before the aircraft could accelerate to a reasonable climb speed."

"The pilot took off to the east, picked up a gust that put him above effective translational lift, and caused the helicopter to climb 15 to 20 feet; then, the wind dropped momentarily, and he was back below translational lift and starting to sink back towards earth. He was already at full power, and when he pulled pitch to stop the sink, over-pitching occurred and the aircraft struck the ground."

On another occasion, a pilot confronted with deteriorating weather was faced with the option of overloading the aircraft against his better judgement, or leaving one man to spend a wet bleak night on a mountain top without adequate protection. As he had a slight down-slope run over low scrub for takeoff, he decided to load the extra man. As a result, the whole party, plus a bent aircraft, spent a miserable night without adequate protection.

What factors should be considered when making a departure from a mountain pad? An adequate power margin at the hover is essential. As long as altitude can be traded for airspeed, takeoffs from pinnacles, ridgelines or other sites with clear areas below, offer the fewest problems.

Takeoffs from sites that have some obstacles either slightly below, level with, or higher than the takeoff point, require thorough ground reconnaissance and planning. The helicopter must be backed up into the far corner of the usable area and an abort point worked out. If effective translational lift, or an adequate climb angle, is not reached by the abort point, the pilot then knows that the takeoff can be discontinued with sufficient clear ground left for deceleration.

Takeoffs from gullies or ravines, where higher obstacles exist behind those immediately ahead of the takeoff run, also require ground reconnaissance so that turns can be anticipated. (The high reconnaissance before landing should have just about determined the takeoff run with some degree of certainty.)

If over-pitching or rotor rpm bleed off occurs at full power before reaching effective translational lift, or if any limits are exceeded, the takeoff should be aborted. Remember, translational lift will occur at a higher groundspeed than at sea level, and acceleration will be slower.

If you ever require full power and rpm right at the point of bleed off or over-pitching to barely clear the obstacles on climbout – you're cutting it way too fine.

Summary

- Plan the flight carefully.
- Know what power is available and what power is required before commencing an approach or takeoff.
- Understand the environment in which you are operating.
- Avoid excessive control inputs.
- Be prepared to go around if the approach is not working.
- Use every available aid to determine wind speed and direction.
- Leave yourself an escape route on the approach.
- Finally, consider developing standard load charts which show payload capabilities at various fuel loads and pressure altitudes as an aid to planning (up to ISA + 20 conditions). ■

*For further reference, see Good Aviation Practice booklet, **Helicopter Performance**. These booklets are available from your local flight training organisation or CAA Field Safety Adviser.*

How-to… fill the gap

The CAA publishes two series of information booklets.

The **How-to…** series aims to help interested people navigate their way through the aviation system. The following titles have been published so far:

Title	*Latest Version*
How to Be a Pilot	2000
How to Charter an Aircraft	1999
How to Deal With an Aircraft Accident Scene	2001
How to Establish a Small Aerodrome (web only)	2002
How to Get Your Licence Recognised in New Zealand (web only)	2000
How to Navigate the CAA Web Site	2000
How to Report Your Accidents and Incidents	2002

The **GAP** (**G**ood **A**viation **P**ractice) series aim to provide the best safety advice for pilots. The following titles have been published so far:

Title	*Latest Version*
Aircraft Icing Handbook	2000
Bird Hazards	2003
Chief Pilot	2000
Flight Instructor's Guide	2003
Fuel Management	2002
Helicopter Performance	2002
In, Out and Around Milford	2002
In, Out and Around Queenstown	2004
Mountain Flying	1999
Takeoff and Landing Performance	2002
Wake Turbulence	2003
Weight and Balance	1999
Winter Flying	2001

How-to… and **GAP** booklets (except *Flight Instructor's Guide* or *Aircraft Icing Handbook*) are available free from most aero clubs, training schools or from Field Safety Advisers (FSA contact details are usually printed in each issue of *Vector*). Note that *How to be a Pilot* is also available from your local high school.

Bulk orders (except *Flight Instructor's Guide* or *Aircraft Icing Handbook*) can be obtained from:

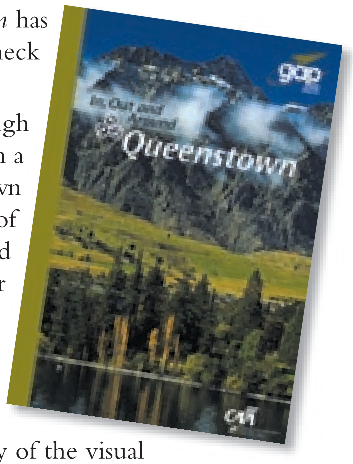
Communications and Safety Education
Civil Aviation Authority
P O Box 31-441, Lower Hutt
Tel: 0–4–560 9400

*The ***Flight Instructor's Guide*** and ***Aircraft Icing Handbook*** can be purchased from either:

- **Expo Digital Document Centre**, P O Box 30–716, Lower Hutt. Tel: 0–4–569 7788, Fax: 0–4–569 2424, Email: expolhutt@expo.co.nz
- **The Colour Guy**, P O Box 30–464, Lower Hutt. Tel: 0800 438 785, Fax: 0–4–570 1299, Email: orders@colourguy.co.nz

In, Out and Around Queenstown

A revised edition of *In, Out and Around Queenstown* has been published. To identify the revised version, check the back cover for "revised in January 2004".



Mountainous terrain, changeable weather, and high density and variety of traffic can make Queenstown a challenging destination. Before flying into the Queenstown area, a pilot should have a thorough understanding of the airspace and local procedures, and have a sound knowledge of basic mountain flying techniques (refer to the *Mountain Flying* GAP).

In, Out and Around Queenstown gives an overview of the airspace and associated activities around Queenstown and details the arrival/departure procedures, which are well illustrated with aerial photographs of many of the visual reporting points. Aerodrome circuit procedures, aircraft performance considerations, and general RTF procedures are also discussed. This booklet will be a useful reference, whether you are a first-time pilot to the area or a regular visitor.

The recent revisions reflect changes in airspace terminology, charts (new VNCs) and publications (new AIP). A few photos are updated. Changes to procedures and other information are only minor. ■