New Zealand Helicopter Association

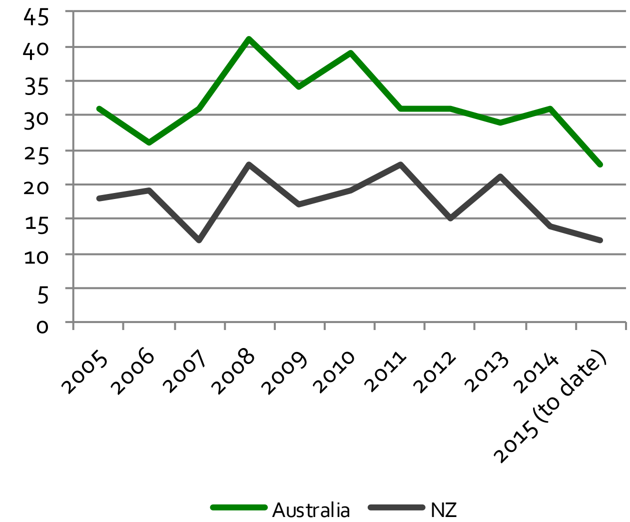
Safety Bulletin 5

Safety information from Australia; new occurrence report form; and dynamic rollover

NZHA SAFETY BULLETINS SB 5

AUSTRALIAN SAFETY DATA - The CAA recently downloaded Australia's helicopter accident data from the website of the Australian Transport Safety Board to see if there were any lessons we could take from it. The International Helicopter Safety Team's accident analysis categories have been used to group the accident types, and to make comparisons with the NZ data. The time period covered is 2005 - present.

TOTAL ACCIDENTS ANNUALLY



The Australians use slightly different categories for operation types but comparisons can still be made. The safety performance of different sectors is pretty similar, with the exception of the agricultural sectors:

NUMBER OF ACCIDENTS BY OPERATION TYPE

Operation Type	NZ	% Total	Australia	% Total
Private	58	30.0%	121	34.9%
Agricultural	53	27.5%	30	8.7%
Aerial Work	33	17.1%	119	34.3%
Transport	26	13.5%	33	9.5%
Training	22	11.4%	39	11.2%
EMS	2	1.0%	5	1.4%
Grand Total	193		347	

Their main contributor to the aerial work accidents are aerial mustering accidents, which make up 46% of aerial work accidents.

ACCIDENTS BY HELICOPTER TYPE

Manufacturer	Australia	% Total	NZ	% Total
Robinson Helicopter Co	205	59.1%	94	47.2%
Bell Helicopter Co	63	18.2%	16	8.0%
Hughes Helicopters	28	8.1%	48	24.1%
Aerospatiale Industries	20	5.8%	25	12.6%
Amateur Built Aircraft	12	3.5%	6	3.0%
Other Manufacturer	0	3.2%	7	3.5%
Eurocopter	4	1.2%	1	0.5%
Kawasaki Heavy Industries	4	1.2%	2	1.0%

The data reflect the different numbers of helicopter types between NZ and Australia. For example, 51% of registered helicopters in Australia are Robinsons, while these make up 37% of the NZ register.

ACCIDENT TYPES - CATEGORIES FOR HELICOPTERS

The USA-based members of the International Helicopter Safety Team have developed categories that sort helicopter accidents and incidents by 'type'. This is the helicopter industry's version ICAO's data categories that have been instrumental in driving data-driven safety improvement in the commercial aviation sector. The categories are based on what happened in the accident or incident. They are designed to make it really clear what took place, and to help identify what should be implemented in order to tackle the different accident types. A list of the most common ones are given as an appendix at the end of this bulletin.

The most common type of accident was Loss of Control - performance management, where insufficient rotor RPM is maintained for the conditions. This is basically the same as unrealistic power expectation accidents we covered in an earlier bulletin: http://www.aia.org.nz/site/aianz/NZHA%20safety%20bulletin%20number%202.pdf

After loss of control accidents the main category were object collisions, mainly wirestrikes and striking trees while conducting low-level operations, particularly aerial mustering.

AUSTRALIAN HELICOPTER ACCIDENTS BY TYPE

Accident Type	Accidents	% of Total
LOSS OF CONTROL	97	28.0%
COLLISION/STRIKE	72	20.7%
COMPONENT/SYSTEM MAL-FUNCTION	39	11.2%
CFIT	30	8.6%
ENGINE POWER LOSS	18	5.2%
OTHER	18	5.2%
FIRE	13	3.7%
FUEL	13	3.7%
AUTOROTATION	11	3.2%
UNKNOWN	11	3.2%
LANDING OCCURRENCE	10	2.9%
ABRUPT MANOUEVRE	6	1.7%
EXTERNAL LOAD	5	1.4%
IN-FLIGHT BREAKUP	4	1.2%
Grand Total	**347**	

NEW ZEALAND HELICOPTER ACCIDENTS BY TYPE

Applying the categories to the New Zealand data shows a similar accident profile, with a couple of differences:

Accident type	Accidents	% of Total
LOSS OF CONTROL	82	42.5%
COLLISION/STRIKE	29	15.0%
COMPONENT/SYSTEM MAL-	19	9.8%
ENGINE POWER LOSS	14	7.3%
CFIT	10	5.2%
OTHER	8	4.1%
UNKNOWN/BEING INVESTI-	8	4.1%
EXTERNAL LOAD	7	3.6%
FUEL	7	3.6%
IN-FLIGHT BREAKUP	4	2.1%
LANDING OCCURRENCE	4	2.1%
FIRE	1	0.5%
Grand Total	**193**	

There are a greater proportion of Loss of Control accidents, although for the NZ data this includes Autorotation and Abrupt Maneuver accidents.

LESSONS LEARNED

The benefit of looking at the Australian data is that we double the amount of information about safety hazards in helicopter operations. There are a lot of good resources that expand our knowledge about accident risks including accident reports released by the ATSB from Australian operators. As an example, you can follow the link below to a recent publication of theirs' covering accident risks in agricultural operations:

https://www.atsb.gov.au/publications/2015/ar-2015-031.aspx

We will use a couple of the Australian examples in the main topic of this bulletin, which is Dynamic Rollover accidents.

HELICOPTER AND AGRICULTURE-SPECIFIC OCCURRENCE REPORT FORM - IT'S HERE!

No more filling out airline-type questions because as discussed in the last update, work has been put into creating a new occurrence report form that is specific to helicopter and agricultural operations and is much more user-friendly for these sectors. It is designed to gather safety information in a way that supports SMS, with a special focus on hazard identification, risk management, and 'lessons learned'. We have designed it to be easier, so the new report is fillable electronically. The new form will be available soon on the CAA website under Forms once it has been properly formatted. A copy is also attached to this email for your use. We are committed to using this information to share lessons learned and to improve safety.

DYNAMIC ROLLOVER ACCIDENTS

In the words of aviation writer Helen Krasner, dynamic rollover involves the following:

"Usually what happens in these cases is that the pilot starts up the machine and then begins to lift the helicopter into a hover as usual. Instead of lifting off, it suddenly and for no apparent reason turns over on to its side and then proceeds to rather expensively thrash itself to bits."

In fact, what is happening is well understood. The helicopter is rolling (or pivoting) around a skid until it reaches its 'critical rollover angle' where the main rotor thrust continues and the helicopter rolls on its side regardless of control inputs made. A complete rollover can happen in seconds making it important to understand how these accidents occur and what to do to prevent them.

Here is an example accident involving an **R22 training flight in February 2015:** A few moments into a session practicing coordinating flight controls, at about 3 ft above ground level, with the student controlling the cyclic and the instructor lightly controlling the pedals and collective, the helicopter began to roll to the right and move rearwards. The student reacted quickly, but moved the cyclic further backwards and to the right, which resulted in an increase in the rearward speed in this direction. The instructor attempted to regain control, but due to the sudden rearward movement of the cyclic, his thumb had bent back behind his wrist. The instructor managed to 'grab' the collective and lift it up a small amount, but by the time any significant control input could be applied, the right skid had struck the ground. The helicopter rolled further to the right, and fell onto the ground. The manner in which the helicopter had pivoted around the right skid and fallen onto its side was described by both the instructor and operator as dynamic rollover. In the image below you can see the accident sequence from start to finish, from the initial skid contact with the ground through to the final result (Source: ATSB report).

NEW ZEALAND DYNAMIC ROLLOVERS ANNUALLY:

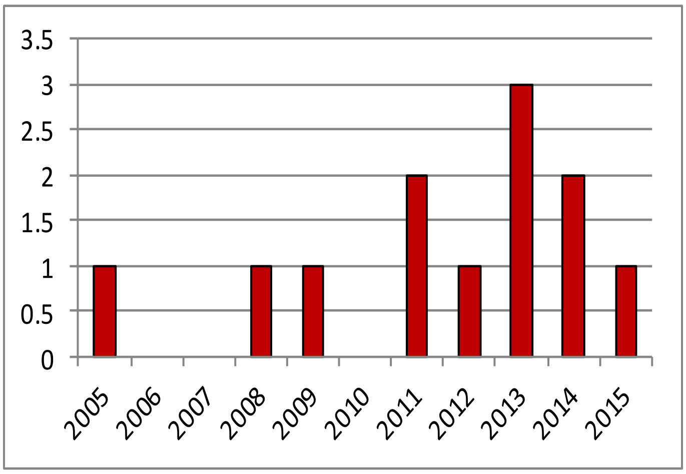


Figure 1: VH-YLP showing initial contact point

Source: Operator

The accident example from the ATSB sets out clearly the sequence of event that tend to occur in dynamic rollover accidents. These are (generally):

- Lateral movement;
- Contact with surface
- Pivoting around the contact point.

The other key element is that the helicopter is usually at liftoff thrust or 'light on the skids' at the time.

The operator concluded from their investigation into the accident that the most likely reason for the lateral movement was the applied collective pitch. When the helicopter moved rearward, the student was instructed to correct the unwanted movement. Initially the student applied incorrect aft cyclic, which increased the velocity of the unwanted movement and a subsequent sink off the 'ground cushion' created by the downwash from the rotor blades. The company also identified that the hover height for the session was too low.

DYNAMIC ROLLOVER IN NEW ZEALAND

The accident data indicates that there have been 18 dynamic rollover accidents from 2000 - present which have resulted in 1 fatality and 1 serious injury:

Flight type	Dynamic rollover accidents
Transport	6
Training	5
Private	4
Agricultural	2
Test	1

What causes lateral movement, or drift, resulting in contact at takeoff or landing? The accident data we have show there are a couple of recurring causal factors: a change in the center of gravity not being compensated for by the pilot's control inputs, and a loss of situation awareness/ground reference leading to contact and rollover. Below is an example of CoG change not being managed in a training accident:

December 2008, R22 Training Flight: the instructor had exited the helicopter for the student to embark on their first solo flight. The student did not apply sufficient lateral cyclic during the takeoff to counter the lateral CoG change, the helicopter drifted, caught ground, and suffered dynamic rollover.

Changes in CoG like this have resulted in some devastating loss of control accidents. One of New Zealand's worst dynamic rollover accidents occurred in 1986 off the coast of North Canterbury. An SA315B Lama was being used to upload some crew members working to refloat a grounded fishing trawler. While in the hover, two crew members boarded the skid simultaneously causing the helicopter to drift right. The pilot had applied full left cyclic but the machine continued to drift and became lodged under part of the ship. Rapid dynamic rollover occurred and two crew members were killed instantly when they were struck by the main rotor blades. Accidents like this - where crew or passengers compromise the weight and balance of the helicopter leading to loss of control - are very unforgiving and examples like this highlight the importance of flight planning and properly briefing crew and passengers about how their actions can affect the performance of the helicopter.

DYNAMIC ROLLOVER AND SITUATION AWARENESS

Situation awareness - knowing exactly where the helicopter is relative to the terrain and other hazards around it - is one of the single biggest factors in helicopter accidents, so it is no surprise that it crops up in the dynamic rollover category as well. One way this can happen is in takeoffs and landings on surfaces of ice and snow. The proximity of the surface can be inaccurately perceived by the pilot in flat light and/or white out conditions. An example of how this can lead to dynamic rollover occurred in 2012:

November 2012, Squirrel on Transport Flight: While attempting a landing of four passengers on the glacier, the pilot encountered some difficulty maintaining positive ground reference due mainly to blowing snow on the surface. The decision was made to abort the landing however before this could be executed the skid contacted the surface and the helicopter rolled over.

It is not just snow and ice surfaces that threaten situation awareness. In a 2011 dynamic rollover accident that killed the pilot and seriously injured the passenger, the rollover was caused by the skid's snow shoe digging into the rough ground of the landing site while the pilot was repositioning it for the landing. The accident investigation found that:

"The horizontal penetration could be explained as a result of the pilot attempting to reset the position of the helicopter on the landing site. The pilot's seating position being on the right hand side would have prevented him from seeing the proximity of the snow shoe in relation to the banked edge of the landing site."

If you take a look at the photo of the accident site below, you can see how rough and marked it was: with the rocks, tussock, and raised dirt banks on either side, any lateral drift while landing or taking off here meant that the chances of rollover were always going to be high. Adding to the risk was the fact that the site was in a valley susceptible to gusty wind conditions. So what you have is a number of ingredients coming together, resulting in a tragic, fatal dynamic rollover accident.

DYNAMIC ROLLOVER AND STROPS HOOKING OVER SKIDS

Another common cause of dynamic rollover accidents is a lifting strop hooking over the skid. When the pilot goes to lift off, this has exactly the same affect as the skid nudging into an obstacle on the ground while drifting sideways. On the next page is an example of this occurring, where the pilot really ended up in the shit.

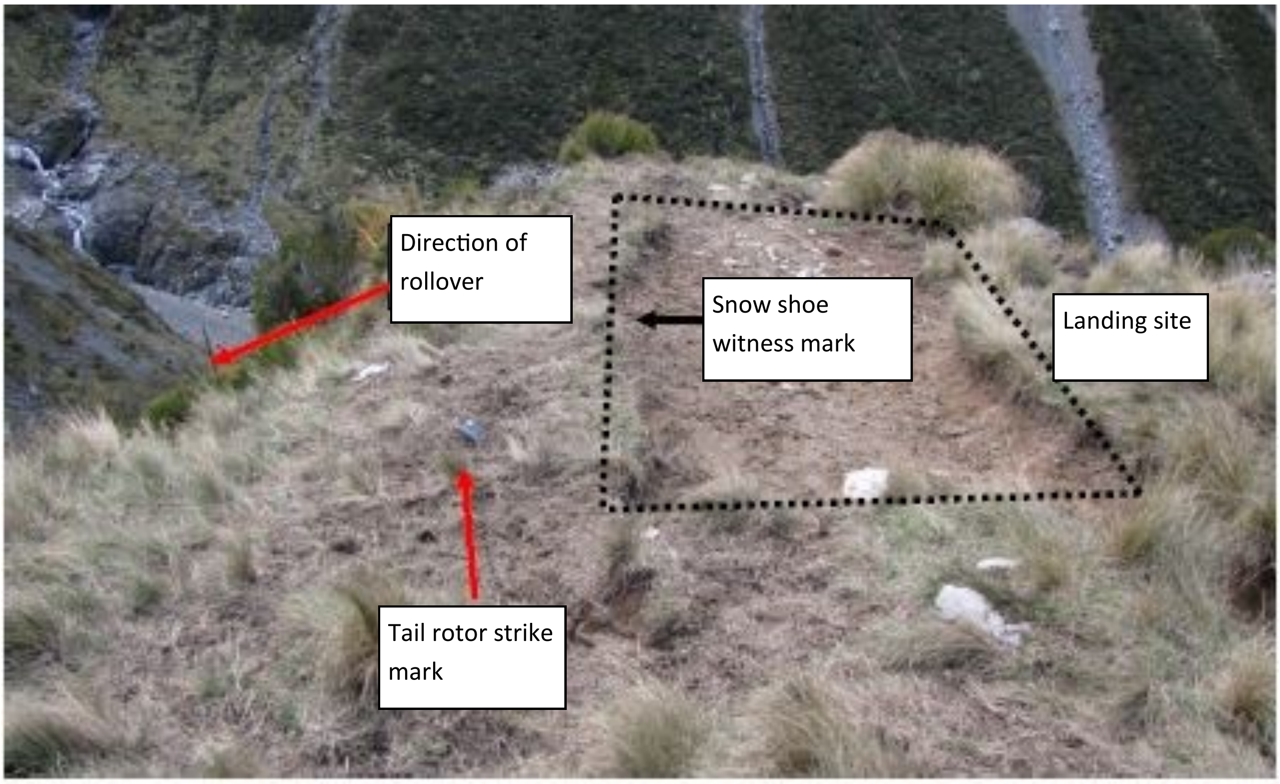


Figure 1: Landing site situated at 3800ft AGL

The pilot of a Longranger was using a monsoon bucket to spread the contents of an effluent settling-pond. For the first 3 loads the bucket was filled by lowering it into the pond with the door open. For the fourth load the pilot dropped the bucket into the pond and dragged it along sideways to enable it to fill more rapidly from the top.

When the bucket was full, he executed a hovering left turn into the wind, but when he raised collective the helicopter rolled rapidly rest and came to rest - inverted - in the pond.

During the hovering turn one of the 2 lifting strops had become hooked onto the rear of the right skid, leading to the dynamic rollover.

Upside-down in an effluent pond is a place no one wants to be. Here's a picture if you need a hand imagining the pilot's escape:

This reminds us that dynamic rollover is a major risk during external load operations, and that maintaining full awareness of the position of the strops relative to the skids is critical. It's also important to note that a load catching onto an obstacle on the ground can also induce rollover.

RESILIENCE AGAINST THE RISK

- Always lift off slowly, and "feel" the helicopter into the air. It will tell you if it's going to go sideways. The half-second you save getting airborne rapidly will be the very same half second you will wish you could have over again if the undercarriage catches on something.
- When hovering close to the ground, do so at the height that gives a reasonable clearance from the ground and nearby obstacles. This doesn't mean hovering around up in no-man's land, but a slightly higher skid height greatly improves the margin for error.
- Train ground crew to always check they haven't left a strop or something similar over a skid.
- Think about configuring your mirrors so you can see the skids. Whether you are flying an external load or during takeoff/landing, a quick peek in the mirror gives you an instant double-check on whether things are looking okay. Those stick-on blind spot mirrors for cars do a pretty amazing job of increasing field of view very inexpensively.
- In flight, learn to maneuver so that there is no risk of getting the skids tangled in the underslung load. Be especially vigilant if hovering out of wind.

RECENT OCCURRENCE REPORTS

Recent issues that have emerged from reports are:

RPAS/UNMANNED AERIAL VEHICLES

These are a concern for a lot of the aviation community right now. Recently a report was received of an RPAS coming into proximity with an R22 on a training flight. There was a good outcome: the RPAS owner was located by the airstrip manager and told to cease operations there. This highlights the role pilots and other personnel have in managing the RPAS risks: it is important not only to report the incidents but also to try and locate the RPAS operators to make sure they stay out of airspace they are not meant to be in, especially around aerodromes.

FUEL

A couple of incident and accident reports submitted this year (note that the investigations are not yet complete on these) have highlighted the importance for operators to ensure that their fuel is securely stored so that it is protected against both contaminants and access by unapproved persons, and that proper pre-flight fuel checks are conducted. Please be vigilant about this.

Appendix: The Main IHST Accident 'Type' Categories and Definitions

ACCIDENT CATEGORY	SUB-CATEGORY/DEFINITION
LOSS OF CONTROL Accidents in which the helicopter was put in a flight condition that was beyond the skill level of the pilot to control or was outside the performance limits of the aircraft	Performance management (insufficient rotor RPM in the conditions) Exceeding operating limitations (operating at the edge of the performance envelope) Dynamic rollover Loss of tail rotor authority/effectiveness (uncommanded yaw) Settling with power Control interference
COLLISION/STRIKE Colliding with or striking any object	Wire Tree Other
SYSTEM/COMPONENT FAILURE Failure of any system or component on the aircraft	Engine Non-powerplant Mission equipment
CFIT	Unintended contact with ground or water while in controlled flight
FUEL Adequate fuel not provided to the powerplant	Exhaustion Starvation Contamination
ABRUPT MANOUEVRE	An 'abnormal maneuver', or an abrupt control input
EXTERNAL LOAD	Accident or incident involves an external load
ABNORMAL RUNWAY CONTACT	The equivalent of 'Landing Occurrence', including hard landings. Encompasses any landing surface