PUSHING THE LIMITS

WHILE DOWNWIND TAKEOFFS ARE OFTEN A SAFE AND REASONABLE OPTION, PUSHING THE LIMITS ON THEM CAN GET YOU INTO SERIOUS TROUBLE IF YOU'RE NOT AWARE OF THEIR HIDDEN DANGERS.

by Matt Johnson

It's a familiar setting: you're driving along the highway when the low-fuel light activates in your car, alerting you that you are nearing the end of yet another tank of over-priced gasoline. At this moment, a couple of things usually take place. The first is your significant other reminds you of all the previous exits where you could have stopped to fill up. The second is your mind starts playing games and asking itself intriguing questions: "How much fuel do I have when that light comes on? How far did I drive the last time when that light came on? How many more miles is it to the next exit?"

Why is this relevant to an article about downwind take-offs? Simply put, because this all-too-typical scenario describes yet another human being "pushing the limits." Many people have found themselves coasting into the next gas station on fumes — or worse, stranded on the side of the highway — because they reasoned, "I'll just go a little more this time." This mindset is no different than the trap we can fall into with downwind takeoffs, where we say to ourselves, "I had no problem with a five- to six-knot tailwind takeoff the last time," or "I've taken off with a 10 knot-tailwind, so I don't know why another five knots would hurt anything"… I could go on, but hopefully you get the point!

Our self-rationalization can get us into trouble in a hurry. What was a five-knot tailwind takeoff one day can build progressively until we "accidentally" find out just what that tailwind limit is. As in our low-fuel scenario, it's easy to decide to "just go a little more this time." But while running out of fuel in our cars can leave us humiliated, pushing the limits in the air has the great potential for injury or worse.

I'm not implying that a three- to five-knot tailwind takeoff will get you hurt or killed — downwind takeoffs are accomplished safely all the time. But, they should be made, if at all, with a solid understanding of the aerodynamics involved, and without falling prey to the pushing-the-limits mentality that has frequently been known to find its way inside helicopter cabins.

DOWNWIND TAKEOFFS EXPLAINED

As my Torque Talk counterpart, and business partner, Shawn Coyle often reminds me, "A diagram is worth a thousand explanations." So, let's take a look at the mechanics of downwind takeoffs with a basic graphic representation (Figure 1).

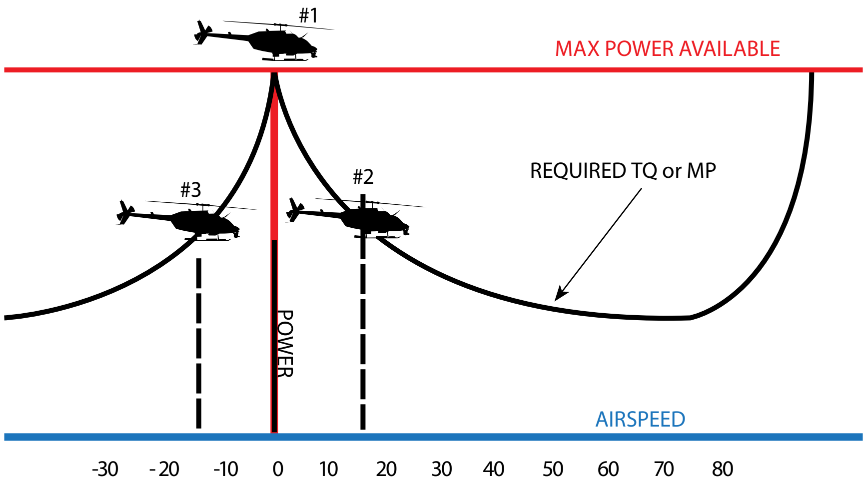
Looking at this generic diagram, we see three different helicopters, each using a certain amount of power according to the airspeed experienced by its main rotor blades. At first glance, this diagram should remind you of a basic power curve diagram, and of the fact that our wonderful machines are the only vehicles known to humanity that take more power to go slower.

The power-required curve could represent torque (TQ) in a turbine-engine helicopter or manifold pressure (MP) in a piston-engine helicopter. You will see that at the bottom of the power-required curve we have the "bucket speed," or the speed at which our power requirements are lowest. This bucket speed should be familiar, as it is also our best endurance speed.

Looking at helicopter No. 1, we see a helicopter at or near the maximum power available while in a zero-airspeed hover (whether that hover is in or out of ground effect makes no difference for this explanation). Granted, it will not always take maximum power to hover, but sometimes it will, and for the purposes of this explanation, let's assume that it does.

Looking at helicopter No. 2, we see it has 15 knots of forward airspeed (or is hovering with a 15-knot headwind), and that consequently it requires substantially less power than does helicopter No. 1. The fact that this helicopter gains aerodynamic efficiency from its forward airspeed shouldn't be surprising, even to fairly novice students. It's helicopter No. 3 where we can run into trouble.

Looking at helicopter No. 3, we see it has 15 knots of "rearward" airspeed (or is hovering with a 15-knot tailwind), and its power required is a mirror image of the power required for helicopter No. 2. That is correct! It takes the same amount of power, in theory, to hover with a 15-knot tailwind as it does a 15-knot headwind. Another way to look at this explanation is that the blades don't care where the 15 knots of wind is coming from: in essence, with a 15-knot tailwind you can simply visualize the advancing and retreating blades as having traded places. Of course, hovering with a tail-



wind puts increased demands on your tail rotor, which in turn requires more power — but for the sake of simplifying our current argument, we'll ignore that for the moment.

(Note: I'm certainly *not* telling you to make a habit of hovering with a tailwind! A host of factors dictate why you shouldn't, including loss of tail rotor effectiveness, and, in turbine machines, turbine outlet temperature and compressor stall issues.)

If you are hovering in helicopter No. 3 and commence a downwind takeoff, the helicopter's main rotor system starts out with the benefit of 15 knots of airflow, but loses that as it "outruns" the tailwind — therefore losing the effective translational lift it had while stationary over the ground. Guess what? That takes more power! As you move forward, your power requirements will increase until you are at the same point on the power-required curve as helicopter No. 1.

At this point, your helicopter has a groundspeed of 15 knots, but the rotor system is experiencing a forward relative airflow of zero; it is getting *no* help from translational lift and will soon begin to descend. Remember where the helicopter is at this point: at or near maximum power. With the helicopter sinking, you add more power, which increases the need for the tail rotor… which robs you of even more power. You may not have enough power and pedal to get "over the hump" of the zero-airspeed point, even if you were hovering downwind just fine.

This is the hidden danger of downwind takeoffs. If you're heavy, operating in less-than-ideal performance conditions, or both, you may not be able to complete a downwind takeoff successfully — and you may not realize that until it's too late.

IN SUMMARY

Pushing the limit with the low fuel light in your car is one thing. Pushing the limit with downwind takeoffs, though, can lead to truly disastrous results. We must resist the temptation to gradually increase our accepted risk level regarding downwind takeoffs. Obviously, with the right power margin and ideal conditions, taking off with a certain amount of tailwind is possible and can be done safely. But we should always avoid the human tendency to "just go a little more this time."

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