

SAFETY ON THE AIRSHOW DOWNLINE

By Dudley Henriques

Editor's Note: As we went to press, we noticed that the ICAS web-based Ops Bulletin included excerpts from the following article. We are including it here in its full length as we had originally planned.

Usually when I write on aerobatic and/or airshow safety, the area I cover concerns warbirds. I'd like to depart from that format for this article because I believe the issue I want to discuss with you here is one of the most important and dangerous issues facing pilots flying today's ultra high performance aircraft. The issue in discussion here today concerns that area of a display routine we call "The Downline."

It's no secret that over time we have lost all too many pilots to various sources associated with the downline. These losses mostly involve pilots flying high performance aerobatic aircraft capable of extreme gyroscopic maneuvering coming off a vertical line apex followed by a series of maneuvers—mostly energy loss maneuvers—resulting in recovery situations with not enough altitude to avoid ground contact with predictable results.

I realize as I'm writing this that many of you reading it are well aware of the issues involved, but please bear with me as I explain some things that the newbies out there just might be able to use.

Let me be straight with all of you. My interest in writing this is simply to possibly save lives. You old timers out there please feel free to talk these issues up with the newcomers you come across. Bring it up at your safety meetings, and by all means, "buddy up" with other performing pilots. Discuss your routines openly among yourselves without giving away any "secrets." If this article achieves just this, I'll be glad I wrote it.

I'm going to try my best not to lecture with what I'm about to say here. What I'd like to achieve is simply to create an atmosphere where pilots affected by the subject matter will simply think about the issue involved. Pilots thinking about safety are safe pilots!

Okay, so where can we go with this all important downline issue without boring you to death with goodies like Reynolds Numbers, Laminar Flow, Turbulent Flow, airfoil design, and God knows what else I can come up with to bore the hell out of everybody.

Well, there is *one* thing I would like to discuss with you involving

aerodynamics and that would be corner velocity as that relates to a vertical dive recovery.

Let me tell you up front that what I'm concerned about here is losing a pilot because that pilot comes off a vertical up line apex into a downline with a series of energy loss maneuvers, like snaps, and stays in there for one maneuver too many. Know up front that although I'm discussing V_C (or corner velocity) as it relates to a vertical dive recovery, I don't advocate *anybody* putting their airplane into a position where they have to *remember* their corner speed on a downline. If you need to do that, you've already screwed up.

Getting Hypothetical

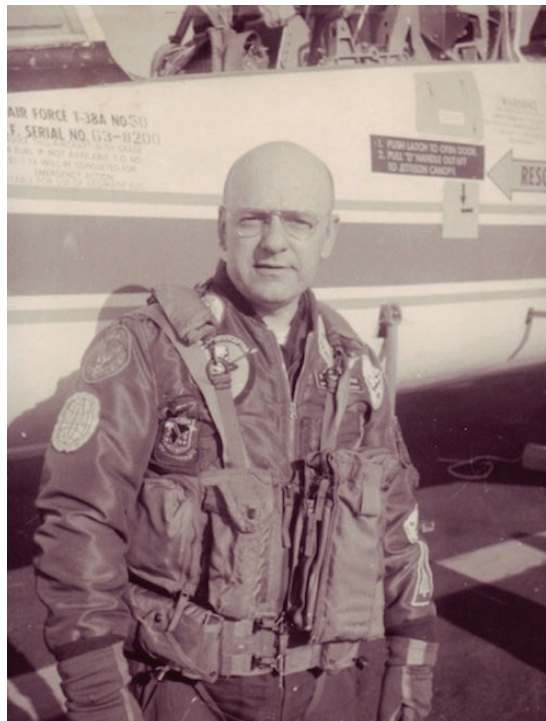
Now let's take a hypothetical, shall we? I'm going to take your nice new Extra (don't fret, I can fly it), and I'm going straight on up a vertical line to what I have determined will be my minimum above-ground high-energy gate. I then plan to do a nice series of snap rolls recovering and coming on down to my level-one waiver altitude in level flight.

Of course being just a bit stressed out because my team didn't keep a reporter away from me during the 30 minutes I told them not to let anyone bother me, I forgot to factor in a basic Koch Chart adjustment for this real hot day.

So what happens? You guessed it. My apex is a little shy because everything involving density altitude is working against me—both the engine and the aerodynamics outside the airplane.

So what? It isn't all *that* much off as I give a quick check to the altimeter inverted through the top so I go ahead into my best series of snaps coming back down the downline. No big deal right? But as many of you know all too well by now, I've really screwed up. Snaps in an Extra go around pretty fast. I'm watching and counting as usual, but my airplane is getting more and more tired each time it snaps. With each snap I'm losing a bit more of my energy.

Finally, based on my years of prior experience, muscle, and mental memory, and a host of other human factors, I snap the airplane out of its last snap roll. I'm a bit off my show line, but I can make that up easily by applying bank along with positive pitch during my dive recovery. *Wrong!* There's a problem. I've included one snap roll too many



Dudley Henriques (photo courtesy the author)

and the airplane is now very low on energy and literally gasping for air and an angle of attack that can be used for the recovery. I'm a falling brick.

I can add to my problems by using aileron to realign my show line as I'm applying positive pitch. *Wrong again!* Any bank will add asymmetrical G-loading to the recovery.

Enter corner velocity.

Without getting too pedantic, let's just say that your aircraft's corner velocity can be found in the upper left hand corner of your steady-state gross-weight flight envelope.

It can be considered as well as your V_a (maneuvering speed). What makes this speed so special for me and my dive recovery is that (1) I am too low, (2) I have lost way too much energy, and (3) because of that energy loss, I am behind my corner velocity. Now why is this important for me at this moment?

Let's stop for a second and explore corner speed, and exactly why it is very important to me at this moment on the downline.

Corner speed is simply the speed that when maximum available G is applied, will give you your maximum turn rate and minimum turn radius. Simple yes, but insidious for the newbie in trouble on a downline. Remember, you will only get that minimum turn radius at *one speed* and with G applied to your limit load factor. At any other speed, you are either aerodynamically limited (you'll stall—you'll reach CL_{max}) before you have enough G to produce a minimum turn radius, and hopefully avoid ground contact. Or, you could in any other situation besides energy loss be G-limited (you'll tear the wings off the airplane trying to reach your minimum turn radius). Bad juju either way.

What's It Mean?


So what does this mean to me—being behind my corner speed and out of energy? It means that unless I have the room under me to accelerate to my corner speed, I am limited as to how much G I can apply to the airplane for my dive recovery. Oh, I can pull G all right—right up to the point where I go into an accelerated stall, because if you remember, I'm aerodynamically limited to the amount of G I have available to me because I'm below corner velocity, so I'll stall the airplane before I reach the G I need to give me that all important minimum turn radius. After all, a turn is a turn right? So corner speed works the same for my dive recovery as it does in producing a minimum radius turn in level flight. (Assume please we are not talking sustained turn here for the purpose of this article.)

So you see, your life on the downline boils down to two ways of thinking: (1) You want to have a working knowledge of corner speed and how that affects your aircraft. (2) You *never, ever* want to find yourself on a downline in a position where you need to remember what we've discussed here about corner velocity.

I sincerely hope that this article hasn't insulted anyone's intelligence, as many of you reading this are some of the finest pilots on the planet. Just do me a favor please. Those of you in the know help the new pilots coming up the ladder. We're all part of the same family and none of us want to see anyone hurt when we could have helped in some way.


My best to all of you. Enjoy aerobatics. And above all, stay safe!

Dudley Henriques hails from the UK and is a former fighter pilot, a former airshow display pilot, a retired CFI and aerobatics instructor, and is now a safety consultant to the airshow and aerobatic community.



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