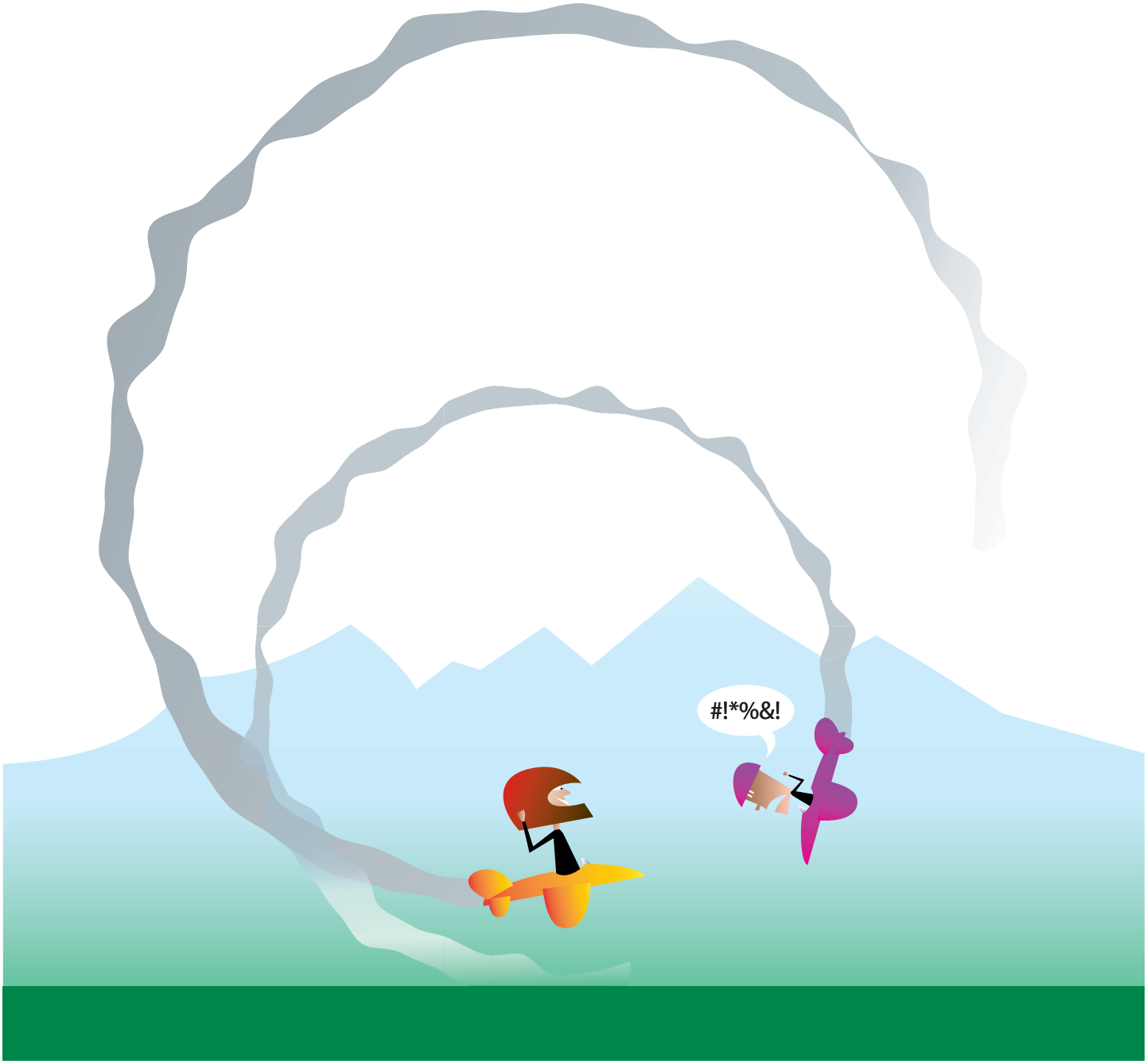
HIGH DENSITY ALTITUDE: THE VOICE OF EXPERIENCE



By Debbie Gary

Years ago, when glider pilot Bob Carlton scheduled his first aerobatic competency evaluation, he asked his ACE, Carl Schmeider, what he should study for the evaluation. "There's nothing to study," Schmeider said. "I'm hoping you already have the information you need."

This is what we all said to the pilots we evaluated; you need to know it already. They were supposed to learn from aerobatic instructors, contest flying, their experience, trial and error, hangar flying, aerobatic books, memoirs, accident reports and videos. It is what the rest of us did, after all. We assumed that if you wanted the knowledge badly enough, then you would find it somewhere.

However, we also thought it would be great to have a way to cover gaps in their knowledge, great to collect stories, insights, knowledge and lessons from experienced air show pilots, and great to pass these on to show pilots coming up behind us.

So, last spring, during a conversation I had at Sun 'n Fun with ICAS President John Cudahy and air show performer and former ICAS Board Chairman Jim Peitz, we decided that somebody needed to fill those gaps and cover the topics addressed in the ground portion of the Aerobatic Competency Evaluation. Based on my career as an air show pilot and my experience as a writer, we agreed that I was the best candidate. And I decided I would do it by interviewing as many air show pilots as I could over the course of the summer.

Meanwhile, along the way, I found an ICAS document, prepared about twenty years ago, that already covers the evaluation topics. It is called the Safety and Operations Manual. It is written test pilot style, packed with graphs, formulas and theories. Some people will want to read it for technical and mathematical advice.

But my vision is the opposite of test pilot style, so I decided to compile something with a different tone and a different purpose. I wanted something simple to understand, something practical, something easy to translate into action. Consequently, this new document is based on air show flying experience recorded in a collection of interviews with pilots who have been performing anywhere from 15 to 50 years on the circuit.

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It is about how things work, how they feel, how they look, what we learned, and how we learned it by doing it right and doing it wrong. It contains information that you visualize, that you remember easily, that you bring into the cockpit with you and apply without mental gymnastics. It includes many different viewpoints. I trust that, as we learn more and find gaps in the material, we will update and improve it.

To give you a sense of what the final product will look like, we're offering this segment on one particular issue: density altitude:

Density altitude (DA) is the height where an airplane thinks it is flying. It increases as temperature, pressure and humidity increase. This increase diminishes the performance of the airplane, the engine and the pilot. It adds complications to air show flying. The air is thin and true airspeeds are higher. Pilots become fatigued and dehydrated more easily. Engines lag. Airplanes gobble up altitude. Everything you do takes more time and more space.

The air show sequence you fly so impeccably and comfortably at sea level needs modifications when you're flying in high density altitude conditions. It needs escape routes. It needs enormous amounts of on-site practice to condition yourself to these hot, high-altitude days. Here are stories and advice from some of our most experienced air show performers.

Michael Goulian

Michael Goulian says: "The best piece of advice I ever got in the air show business was in El Paso, Texas in 1995. The Eagles were doing one of their last shows and Gene Soucy came up to me and said, 'Hey, have you ever flown a high altitude show?' 'Nope,' I said. 'Remember one thing', he said. 'Indicated is indicated. If you need 200 knots at sea level, you need 200 knots at 5,000 feet. It takes a lot longer to get there, but indicated is indicated.' And that is *almost* everything you need to know about high DA flying.

"It is harder for the airplane. It takes a lot longer to get to whatever speed you need at high DA, and there are all these other idiosyncrasies. You've got to pull less. The airplane is happier tumbling and it stays hooked up more. All kinds of things like that.

"If you are really going to do it right, you go to Reno, or wherever, five or six days early, because everything is different. Visually, it is different, especially if you come from the east coast. *When you are at 3,000 feet AGL, it looks like you are next to the ground.*

"When I first practice [in a high DA environment], I just start with a loop, a hammerhead, a loop with a snap roll on top and a roll down. And I pull from the ground into a stall to see, Where is the buffet? Where is the stall?

"Another thing people don't know is that the difference between 80 degrees and 90 is like the flick of a switch. You can kind of survive high altitude at less than 80 degrees, but – as soon as it gets to 90 – all of the sudden you go from flying the most amazing aerobatic airplane ever to a Cessna 172. *What the heck happened to my airplane?!* So, I always listen to the ATIS and get the DA before I take off.

"The airplane is happier in a tumble. So, if you normally do two rotations in a tumble, at high density altitude, it will allow you to do three.

"The torque roll can kill you because the airplane will stay there. It will back up further and, when it flips ends, you come out down low with zero airspeed. So I don't actually do

Bob Carlton | Michael Goulian | Sean Tucker | Bill Stein

a torque roll at high DA. Or, if I do, I don't let it slide all the way back.

"A lot of these things you don't know until you have a ground coach watching you, because, if the airplane is tumbling, it feels like it is climbing when it is sinking a lot. The first one might be climbing, the second one is level and the third one is already coming back downhill. People don't feel that and they don't know it because the nose is still high. So, if somebody is not watching you on the ground or if you haven't watched other people do it, you don't understand it.

"I never do snap rolls going down at high DA. I do them in my normal show, but I will take all those out and turn them into aileron rolls. So, it is all about keeping energy.

"People think, 'Hey, I can do this. I can fly the same show at 5,000 feet that I can at sea level.' And they think, 'The laws don't apply to me.' But the laws apply to everybody! Your ego, that is the biggest thing. You have to put your ego aside. *I want to go to Reno and I want to fly the most crazy, kick-ass air show I've ever flown in my life.* Truth is that you can't. It's just the way it is. You could have triple the horsepower and it still wouldn't matter."

Sean Tucker

Sean Tucker talks about his experience in high density altitude conditions: "Over the years, I've figured out that my average air show in the summertime is at a density altitude of 3,000 to 3,800 feet on an 85 degree day with 800 to 1,000 foot elevation. That is my baseline.

"Then, when you get up to 5,000 foot density altitude performances, you notice you are losing 100 feet here, 200 feet there. And all performers, I'm sure, keep a critical altitude where they won't go over the top of a looping type maneuver unless they have a certain amount of altitude. They won't initiate the maneuver unless they have the correct airspeed, and so you start working your way up to the Renos of the world.

"Stead Airport in Reno is above 5,000 foot elevation and I've seen days out there when we had 10,000 foot density altitude. When I go into that arena, I go in with at least 20 practice flights at an adjacent airport, on the surface, to gain the confidence and understanding of my abilities at that altitude. Density altitude flying raises the stakes by significant factors. It is, at least, twice as dangerous. It takes time to gain composure in the cockpit with those kinds of stakes.

Density altitude flying raises the stakes by significant factors. It is, at least, twice as dangerous.

"I get out to Stead a week before the event and I start pulling, and it amazes me how fearful I am at the start of that, saying, 'There is no way in the world I can do this.' I have never not said that to myself when I first get to those altitudes. 'This airplane won't do it.' Then you keep working toward getting understanding.

"At first, I do individual figures to get the indicated airspeed to see if the figure will work. And I adjust the G to complete the figure, but I always have the indicated airspeed and the figure works. Then, I slowly work my way down to the surface, gaining confidence down at the surface.

"Any gyroscopic maneuver low to the ground is dangerous. The margins are narrow and the plane snaps in a different way. So, I take all the dangerous moves out and get used to the ground rush, get used to how much G to put in to complete the figure, and get used to it all before I put the gyroscopics back in. Then I'll put everything together.

"To fly at high DA, you need to have the ultimate confidence in your ability to be in the low level environment. You have to be acutely aware of your situation at all times, what is working and what is not. And you have to be calm, because – if you are not calm – you cannot make cognitive decisions correctly.

"At high density altitudes, the airplane snaps like it never snapped before. It lets loose so much quicker and with less G. It's a whole different touch, a different feel.

"Also for me, at high density altitudes, dehydration is a big deal, so you need to hydrate more. Your body is working harder. It is more of an athletic event. It is harder to breathe. Your heart is working harder. It is easier to become fatigued. Science says it takes seven to ten days to have your body acclimate to a higher altitude and that seems about right."

Bob Carlton

In New Mexico, where Bob Carlton lives, high altitudes are the norm. He points out: "There is a lot of general information about how an airplane performs at high DA, but

there is nothing about aerobatics at high DA.

"We had a string of accidents years ago, three or four of them, where somebody obviously did not understand the effects of doing a show at 4,000 feet or higher. [In one instance, the pilot] was doing a square loop that started at something like 300 feet. He started on a down line, then tried to pull out. The plane was still descending, but it was twitching, which is what you would expect when it is basically in pancake mode. Investigators saw the twitching and said they suspected there was a problem with the controls making it twitch. They said it *couldn't* be stalled because the nose was down. That shows how little understanding most people have of aerobatic flight.

"There are several things someone needs to know about density altitude. It is obvious that your engine is not going to perform as well, that your apparent speed will be higher, that it affects your takeoff, your climb rate and your landing distance.

"Other things are not so obvious, such as, What does it do to the size of your maneuvers? The answer is that the size of your loop can go up as much as 50 percent and I think I calculated these at my home field on a summer day with 8,000 foot density altitude.

"If you are used to doing a loop at 300 feet, you'd better start at 450 feet. Every radius maneuver that you do is going to go up by as much as 50 percent because your true airspeed is higher. Until you get comfortable with high density altitude, you need to start your routine as much as 50 percent higher.

"You need to have break-outs in your routine where, if things aren't right, you need to have a place where you have practiced a knock-it-off, go out and circle, get your thoughts ahead of the airplane again, get a little altitude and start over.

"We tend to tell people to always fly the routine that you practice, but we forget to tell them that you need to practice these knock-it-off points in the routine in three or four different places where, if you come out of a maneuver, you assess whether everything is as it ought to be. And if it is not, the next maneuver is knock-it-off, go out, make a 180, reposition and come back in. We need to stress that, especially at high DA shows.

"You start finding yourself low. In the first maneuver, you come out 100 feet lower than you want to be. In a power plane you think, 'I'm just going to add all the power I've got.' Then you start focusing on your sequence card … I've actually done that. I found myself upside down at 300 feet, not anywhere near the runway. Finally I snapped out of it, rolled upright, did an abbreviated approach and made a landing, but that was in a glider that doesn't have an engine.

"But I was amazed at how long I let myself get farther and farther behind. And, in that overloaded state, all I could do was look at the card and think, 'Do what you practiced, do what you practiced.' I had never practiced breaking out early. So that became something that I put into my routine. I've got several places where I can fly off the end of a maneuver, make a 180 and come back.

"Another thing, people will say, 'I just booked a show at 5,000 feet, so I went up to 5,000 feet and practiced my routine.' In the summer, that is not enough. You need to go to the density altitude that you expect, which might be 8,000 feet, and practice there.

There was nothing wrong with his engine. He just didn't understand how much difference high density altitude was going to make.

"Once, I did a show with Jim Leroy out here in southern New Mexico and he got here early to practice. Afterwards, he called and asked, 'Is there a good engine shop anywhere near here? Something is wrong with my engine.' We talked awhile and it suddenly dawned on me that there was nothing wrong with his engine. He just didn't understand how much difference high density altitude was going to make. The elevation was 5,000 feet and it was a 100 degree summer day."

Bill Stein

Everyone who has flown across North America on the air show circuit for a long time has similar stories. Bill Stein says, "People need to figure out a strategy for practicing ahead of time for high DA shows. Mine was to fly my Pitts at 23 inches and 2450 RPM to simulate low enough performance at sea level so it would seem like Tucumcari or Reno on a hot day.

"There are some drawbacks and I almost died one day practicing. Maybe I had too low a minimum for a torque roll and I just barely made it. I think I came out like ten feet below my minimum altitude.

"The thing is that, if you have less power, you have less torque, and you are more likely to get into that locked up state where you are sliding backwards and you can't do anything about it. So, there I was, kind of perfectly balanced, with no torque, and I got this huge, crazy slide in my Pitts. I was thinking, 'I'm going to back into the ground.' That is how crazy it was. I pulled the power and it did nothing. Finally, I crammed the power back forward. That did enough to unbalance it. It swapped ends and I pulled out. So I tell people, 'Be careful. When you simulate some of this stuff, it changes the behavior of your airplane.'"

As a service to our members and the industry, Deb Gary's series of interviews with more than two dozen different air show pilots on key air show-related piloting issues will be made available to all holders of Statement of Aerobatic Competency cards during the coming months. From formation flying, comedy acts, wingwalking and inverted ribbon cuts to sequence design, induced drag, in-flight emergencies, minimum altitude recoveries and bailing out, the most experienced voices in the air show business today will share the lessons they've learned for the specific purpose of providing insight to their fellow pilots.

Although we expect the finished document to be a valuable information resource and a useful tool, it is not intended to be a how-to document. Low level aerobatic flying is specific to the show site, pilot, aircraft, weather conditions and a host of other factors. This type of first-person narrative will be helpful, but it is intended to complement — not replace — dual instruction, one-on-one coaching, practice, and good judgment.