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AIRSHOWNEWS



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Team Oracle



There's Hidden Danger in the Mirror Pass



Airshow display flying as we all know it is only as safe as the display pilot or pilots make it. With this in mind, I would like to refresh a few points about mirror passes – these being passes flown by two team pilots displaying aircraft parallel to the show line in close formation with one aircraft inverted. Naturally, I assume that most pilots flying these types of passes already know what they are doing, but a well-intentioned gentle reminder, about a small but absolute

critical detail that many of us have a tendency to forget, never hurts the cause.

I'd like to say a few words about axis systems and how they interface with that all-important half-roll back to level flight that must be performed at the end of the pass by the pilot flying the inverted aircraft in the pair. There is a hidden dragon riding with you in this maneuver, and you want to make damn sure this dragon is well fed and happy as you initiate that half roll back from your inverted position back around to level flight.

We all know our aircraft has an axis system. We deal with it all the time. We have an X axis through the fuselage, a Y axis through the wings, and a Z axis straight through the center of gravity vertically. These three axes form the main body axis system, but we have other axis systems in our equation that we might not be thinking about as much as we should when we enter into an inverted close formation mirror pass with another aircraft.

When in flight and maneuvering, our planes have both an inertia axis and an aerodynamic or "wind" axis system. It's the aerodynamic axis system I'd like all of you reading this data point to think about and think about *seriously!*

Why is focusing our attention on the aerodynamic axis system so important? It's because when we initiate that half roll from inverted to level flight after a mirror pass, our aircraft is rolling NOT on its fixed (body) axis, but rather on its aerodynamic (wind) axis. That aerodynamic axis might not produce the exact roll arc the pilot rolling the aircraft is expecting. I don't need

to explain how dangerous *that* could be when factoring in the chance for a mid-air collision with a close formation partner.

What happens is this. The inverted aircraft, while in inverted level flight, will be flying at some degree of angle of attack, so right off the bat, we have an angular difference (alpha) in pitch between the velocity vector and the airplane's main body X axis on the X-Z plane. Throw in a bit of wind correction and we again have an angular difference between the aircraft body Y axis and the velocity vector on the X-Y plane. This is called beta or sideslip. So, we have angular differences between the aircraft's main body axis system and the aircraft's aerodynamic axis system being created in varying degrees in real time while the aircraft is in flight. It is exactly this scenario that is in play for both aircraft on a mirror pass, but it can prove extremely critical for the inverted aircraft as recovery back to level flight is initiated.

Why is this important? It's critical because when the inverted pilot initiates the half roll recovery to level flight, the aircraft will

initiate *on the aerodynamic axis system*, creating a roll arc based on whatever degree of angular differences are present on both the X-Z and X-Y planes for that aircraft *at that instant in time*, but NOT on the airplane's body axis system, which might be what the inverted pilot is expecting. The resulting roll arc can be well off what the rolling pilot is expecting and has visualized, and in close formation, this can be a fatal mistake.

Remember, the trick in recovering from inverted flight off of a mirror pass is for the rolling pilot to separate enough from the

upright aircraft before initiating the roll to allow for any offsets in the roll arc the aerodynamic (wind) axis system might produce during the roll-out back to level flight. This at first glance might seem to be quite basic and obvious, but trust me on this, *many* pilots, even highly experienced pilots, have a tendency to visualize roll as roll on the body axis system of the aircraft and not on the aerodynamic (wind) axis, as is the actual case.

Please feel free to distribute this information at safety briefings and anywhere in the community where the information might help the safety cause.

Photo: The USAF Thunderbirds Calypso is one of the most famous mirror pass formations (file photo by Jim Froneberger).

