

## **TOLERANCE AND DEHYDRATION: WHAT YOU DON'T KNOW MIGHT HURT YOU**

In part one of our G tolerance article in the Warbirdsafety.com site, we discussed the fundamentals of G tolerance. The bottom line is that the brain needs oxygen to operate optimally. Blood transports oxygen, so anything that reduces blood flow to the brain, reduces blood pressure or reduces the blood's ability to transport oxygen molecules will reduce G tolerance.

Dehydration, by its very nature, causes a thickening of the blood in much the same way that simmering on the stove will thicken gravy. The thicker the blood, the more difficult it is for the heart to pump it to the brain. With less blood flow to the brain comes reduced G tolerance. During the course of a typical day on the ramp, it is not uncommon for pilots to spend between three and five hours in the sun and wind. Access to shade and water is typically limited. Both situations can lead to dehydration.

Most of the research on dehydration in healthy individuals comes from sports medicine. Given the time we spend in the sun and the conditions involved, it is not unreasonable to use long distance running for a comparison.

On a warm day out on the ramp, it would not be unusual for a pilot to lose more than a pound of water per hour. One pound of water is roughly equivalent to a pint. On hot days on the ramp, a person can lose as much as 5 pounds per hour. Unfortunately, our body's digestive system can only absorb so much water per hour, roughly one 16 ounce water bottle every 20 minutes. That means that we can only replenish about 1.5 quarts or three pounds per hour. In those conditions, it is imperative to get out of the heat and out of the sun. If you stay in the sun, you can't replenish water fast enough to keep up with the effects of dehydration.

Serious dehydration... resulted in a 40% reduction in sustained G tolerance

Our bodies, not unlike our airplanes, can operate a little low on fluids, but more significant dehydration leads to serious loss of G tolerance. Studies done in the centrifuge more than 20 years ago showed that heat combined with dehydration will have a marked impact on G tolerance. Heat alone caused a reduction in G tolerance of 0.3 G's. More serious dehydration, in the area of a 3% loss of body weight due to fluid loss, resulted in a 40% reduction in sustained G tolerance. (From 60 seconds at 7 G's to 35 seconds).

G tolerance based on onset rate was also examined. Heat-induced G tolerance loss appears roughly the same regardless of G onset rate. Dehydration effects are more pronounced with higher G onset rates which are more like the onset rates seen in air show flying.

Some might argue that centrifuge tests are not a great representation of the type of G force onset rates experienced in aerobatic demonstration flying. While this might be true, they do serve as a baseline to verify what we have always known. Dehydration reduces G tolerance. If you don't need to stop by the restroom before you fly then you are already dehydrated. Fly accordingly.