STATIC PROTECTION on Plastic Planes

**Don Johnston, Panama City, FL, Velocity guy wrote:**

*“I stopped by the GRT booth to get some additional information about upgrading my "Legacy" dual AHRS/Magnetometer to the new Adaptive AHRS/Magnetometer. (BTW, if you have the old AHRS, upgrading is less than $1,000). While talking with Mark, suggested installing static wicks.  And I once again explained that I've got a Velocity which has a non-conductive surface. He made the point that A) static only forms on non-conductive surfaces and B) Paint is non-conductive no matter what is underneath. I have to admit, both of those points appear to be valid. So now, I don't know what to think.”*

**Mike Eide, Severn, MD, Velocity guy responded:**

*“The GRT rep needs to go back and study his physics.  By his reasoning a metal aircraft would have no need for static discharge wicks since a conductive metal skin could not have a problem with static.  But almost all of the non-composite (metal) aircraft I have flown had some type of static wicks, whether they were painted or not.

Static wicks are used to dissipate electrical charges at a low voltage before they reach a high enough voltage to create arcing.  On a non-conductive structure the electrons that are accumulated remain "trapped" at the accumulation site.  However, the accumulated electrons can flow through a metal structure to build up extremely high voltages. This high voltage continues to build up until dissipated to another nearby structure or to the atmosphere.

Discharging voltage to other nearby structures can cause severe RF interference.  This is prevented by electrically bonding all metal panels and structures to a common point.

Discharging to the atmosphere requires extremely high voltages (10,000-30,000 volts).  The voltage required is dependent on the radius of the discharging surface.  This is why a large diameter metal ball on the top of a Van DeGraaff  generator can prevent discharges up to several hundred thousand volts.  This is also why static discharge wicks have sharp metal points or many small filaments to encourage the discharge at the lowest possible voltage.

Bottom line is that a static discharge wick on a composite aircraft would serve no purpose.  The accumulate charge will remain fully distributed on the surface and should never reach a discharge potential.  But any large metal surfaces (firewall, engine, engine mount, metal props, etc.) should all be electrically bonded together to prevent internal arcing.” (Note:* “I wouldn't worry too much about the wire gauge for bonding various metal components together.  The idea is to avoid the arcing between to close metal objects that might be at different potentials.  The current is almost insignificant.  I would just use a wire size that was flexible and compatible with the connectors. There is probably no wire size big enough to handle the full current of a lightening strike (look at the size cables on lightening rods on a building), so sizing the wire for a static discharge wick doesn't need to consider lightening currents. Typically a lightening strike does hit a discharge wick anyway, so it isn't really an issue.  I would tend toward smaller gauges for discharge wicks so they would fail with less damage to the surrounding structure if the wick was hit.”

**Eric Panning, Velocity builder, Portland OR:** *“There is plenty of mystery to static charges... Cirrus and Diamond when to great lengths to create an electrically bonded airframe with buried conductors and ground connections to wicks near control surfaces.

I think part of this is to minimize the risk of a lightening discharge welding the controls together. It also is to reduce radio noise. Cirrus has been tracing static related issues for years and often the issue is very plane specific.

Another example is boots have a conductive paint at the edge to better bond with the airframe in a metal plane. The risk is pinholing the rubber and causing a leak.

Velocity and similar should probably have wicks if they were bonded. Since they are not you are counting on the overall insulation properties and relatively low risk of encountering high static conditions. Charge on an insulator trends to stay trapped and accumulates in place at modest voltages whereas with metal it will conduct to the most favorable place to discharge.

If you do encounter blowing snow, dust, etc at altitude and it is impacting radios, take action to get out of there as it can get progressively worse. Also quickly align on lost coms with center so that everyone is on the same page as to where you are going, etc.  I have encountered it before in a SR22 .I am not planning to put any on my SE 173.”*

**Beagle’s Comments:** We had Dick Kreidel describe his event, flying his Long EZ IFR in thunderstorms in New Orleans about 32 years ago – he first had St. Elmo’s Fire in the cockpit ahead of his face, then he got a lightening strike that zapped to his leg from the control rod on the right side of the leg space. His radios went out for some time and then suddenly came back on. On the ground he found a pinhole in the right winglet and a pinhole in the left winglet. I had his talk on videotape at one time. Not sure it is still in the Squadron library. We talked about bonding all the metal back then too. When fueling, I still assume the charge is built up on/in the tank – despite fuel lines, etc. I clamp the ground to the fuel cap and then remove it (I have a chain that drops to the floor of the tank – long enough to reach the fuel with the plane nose down. I presume a spark cannot ignite fuel in the tank anyway. Your thoughts?

**Mike Eide, Severn Maryland:** *“I have been struck by lightening three times in my flying career.  The high incidence of events is because of the type of research and development flying I was doing where we needed to fly near thunderstorms for weather radar development flights.  Luckily these were all metal aircraft.  Usually the damage was minimal, but in one case we had enough internal damage to a Radome that it had to be completely replaced. I have also seen the St. Elmo's Fire, but this was in a USN attack aircraft at night behind an aircraft carrier.  The St. Elmo's event was quickly followed by all my pitot static instruments failing; so it was not a good night. I do something similar to your approach for fueling static control.  My plane has both fueling cap chains connected to a wire that connects to my tie-down points.  I connect the refueling station ground wire to the tie-down, which should keep fuel tanks at the same potential as the fuel hose.”*

William Batten, Columbus, IN:
“I started a new job working for 3M about 6 months ago. This past week I participated in some technical training regarding the products that 3M offers. As it turns out - I do not work in the Aerospace Industry - but had the pleasure of meeting one of our scientists who develops materials for Boeing, Airbus and even Cirrus. He was very knowledgeable about Lightning Protection and Electrical Static Discharge. I will try to share some of my learning from him.

- Eric is correct, unless we have gone to the trouble of laying conductive material over the fiberglass and under the paint - there is no reason to add Static Wicks.

- Boeing uses a conductive primer paint on their Nose Gear Doors of the Dreamliner - rather than conductive material. However, since the conductive paint has a much higher resistance than the traditional conductive materials - Conductive Primer probably has a maximum usable distance of 6-8 feet. Therefore, it is not really a good alternative for the entire aircraft.

- The paint thickness matters A LOT! Thinner is better because the static electricity must transit through the paint for the conductive materials to do their job. He suggested a maximum of 400um - this includes Primer & Top Coat.

- Cirrus chose not to cover the entire aircraft with the conductive material - to save both weight and cost. They ended up with a solution of conductive strips - rather than full coverage. He suggested that a Cirrus aircraft is on the edge of acceptable lightning protection and Electrical Static Charge build-up with this approach.

- He confirmed that Snow is one of the most likely times for a Static Electric Build-up. Again, Eric was spot-on, if you encounter Snow - be prepared for an Electrical Static Discharge event.

- Speed also matters - the faster you go - the more likely to have an Electric Static Discharge event.

-  So, during my recent Electric Static Discharge event, I was descending in a cloud, about 195 knots in snow. In the future, if I must descend through snow - I will slow down and have the back-up instruments in the scan.

- The take-a-way for me was: Without a full conductive material layed onto the fiberglass - there is not a lot that we as Velocity owners can do to eliminate Electrical Static Discharge.”