STATIC ELECTRICITY

What You Should Know About It and Recommendations When Refuelling Aircraft From Containers.

Static electricity is caused by friction between dissimiliar materials, specifically at the molecular level. As the molecules rub together there can be an exchange of protons (+ charge) and electrons (- charge). An uneven exchange of particles can lead to an increase of electrical potential between the objects - a buildup of static electricity. This state of imbalance needs to be rectified. The electrical potential may bleed away slowly, or it might under certain conditions discharge suddenly as a relatively small spark (although still several thousand volts) or as lightning (billions of volts.)

How much static electricity builds up depends on a number of factors, particularly what type of materials are in contact, what types of containers they are stored in, how much friction is generated and prevailing weather conditions. Static electricity becomes more prevalent with decreasing humidity because humid air allows any buildup of static electricity to dissipate quickly. For example, rubbing fabrics containing nylon can produce a dangerous electrical potential in air with a relative humidity below 35%, and below 20% RH even cotton can produce enough charge potential to ignite petrol vapours. This is relevant because in a US study of fires caused by static electricity while refuelling at service stations it was found that in well over half of all incidents, the static electricity built up because people got back into their cars while refuelling was taking place, rubbed against seats etc. and then returned to the fuel nozzle, and touched it, causing a spark to ignite the fuel.

Non-conductive materials, including petrol, and the plastic containers it may be stored in can cause a problem because when a static charge builds up it can take some time to dissipate, and even bonding or grounding/earthing will be ineffective. Putting a metal fuel container on the ground, or even touching it will probably release the electrical potential. Humans are good electrical conductors, damp bare ground is an excellent conductor, dry ground is a good conductor, and concrete and bitumen are reasonable conductors. However most plastic fuel containers are very poor conductors, and if there is an electrical potential inside the plastic container or within the fuel it contains, grounding will probably be ineffective. For this reason, if there is a possibility of a static charge buildup within these containers, for example if the container has just been filled, or has been bouncing around in the boot of a car, it would be prudent to wait a while before using it to refuel. How long do you wait? Your guess is as good as mine, but I would think half an hour would be sufficient.
It is still recommended that plastic fuel containers are placed on the ground when they are being filled however. There is still likely to be *some* earthing effect, and studies have shown that the ability of fuel to retain "capacitance" (store an electrical charge) increases with distance from earth. Isn't physics mysterious and wonderful?

So, what conditions are likely to lead to a buildup of static electricity and adverse factors that we need to be aware of?
1) Low relative humidity. Overseas this is most likely to be experienced during very cold, dry conditions. In Australia this is most likely to occur in very hot weather. This is a double whammy because hot weather is going to exacerbate the second warning sign.
2) The presence of spilled fuel and/or fuel vapour. We've all seen fuel vapour rising from open containers, fuel nozzles etc. on hot days.
3) **Friction.** Fuel that has been sloshing around in it's container has been subjected to **friction.** Fuel that has been pumped has been subjected to large amounts of **friction.** It has travelled along pipes and tubes, through filters, triggers and metering devices and through numerous curves. The longer the hose and the more bends there are in it, the more **friction** there will be.
4) This **friction** also relates to the aircraft. As it travels through the air **friction** creates a static charge buildup within the airframe. With glass reinforced plastic (a very poor conductor) aircraft, grounding the airframe is unlikely to release this electrical potential. It will need time to dissipate. Even wind blowing over a parked aircraft may build up a static charge.
5) Using unearthed/unbonded metal containers and pouring devices.
6) People rubbing against things during the refuelling process.
7) Allowing the possibility of an explosive fuel / air mixture to come in contact with an ignition source. Well, duh! No, allow me to explain. For fuel to ignite, it needs a very specific ratio of fuel to air. A saturated fuel / air mixture will not ignite. Since the most common source of a spark during refuelling is from the nozzle, by placing this nozzle well into the tank, container etc. where there is going to be a saturated fuel / air mixture, any potential spark is unlikely to cause a problem.

Let's look at a possible scenario. It's a hot,dry blue thermal day. The aircraft has been flying for a couple of hours and has just landed. It needs to be refuelled. Luckily Fred has just returned from town where he refilled a jerrycan with unleaded petrol. He pulls it out of the boot and takes it over to Dave who is waiting by the aircraft with a plastic funnel. The funnel goes into the neck of the tank and without earthing the tank or bonding the tank to the jerrycan, Dave starts pouring the fuel into the funnel. A strong breeze laden with dust particles whips across the parked aircraft, causing some of the fuel to spill, so Dave pours faster in an attempt to cut down spillage. Meanwhile, Fred, who has been crawling around in the back seat of his car looking for his water bottle and cap returns to the aircraft just as Dave finishes. He helpfully reaches out to take the plastic funnel from the filler, and.....

RECOMMENDATIONS FOR REFUELLING 'FFQ'

1) Use the earthing wire when refuelling from the jerrycans. This will earth the aircraft fuel tank, the metal jerrycan, and also bond the the jerrycan to the tank.
2) Earth and bond the tank and the jerrycan before opening them.

3) Use the jiggler syphon hose in preference to the funnel. This will cut down on spillage, and the hose will be well into both the tank and the jerrycan.
4) Pour slowly. Studies have shown that a flow rate of less than one metre / second, or dispensing 20 litres over a two minute period is unlikely to build up any significant static charge. The jiggler syphon hose is therefore ideal.
5) Maintain physical contact with the jerrycan and the sythoning hose to equalize any electrical potential. Wherever possible one person should therefore do the entire refuelling operation.
6) If a tingling sensation is felt, e.g hair standing up on arms, slow the dispensing and leave the hose / nozzle etc. inside the vapour space for at least 30 seconds after the fuel flow stops. The risk of static electrical discharge is greatest when the nozzle is being removed from the tank being filled
7) In the event that there is a fire while refuelling, leave the hose or nozzle in the tank, and back away.

There are millions of uneventful refuellings every year. However static electricity is a hazard that needs to be dealt with. If we understand the causes of static electricity and the conditions that can exacerbate it, and take sensible precautions to deal with it, we are unlikely to ever have a problem.