More On Static

*In 1998 we featured two articles on static electricity build-up during refuelling, "Static in the Fuel?" in **Vector** 1998, Issue 4 and "Static in the Operation" in Issue 5. We have since had a query from a reader about current bonding practice and equipment. This item focuses on the practical steps to take to ensure safe bonding.*

Static Build-up

First, we will quickly recap on the situations which foster static build-up that makes bonding necessary.

- **Fine filters.** The use of fine filters is unavoidable within the aviation industry. The effect of having a fine filter in a fuel line is to bring more fuel in contact with a dissimilar material of the filter, resulting in higher charge separation.
- **Flow rate.** The flow rate has an effect; higher speeds result in greater charge separation and also more fuel splashing.
- **Splashing.** If splashing or spraying occurs during the refuelling process (most likely during top-loading of a tank) a charged mist or foam can be produced.
- **Hot and dry.** Hot and dry conditions pose the greatest atmospheric risk.

The fuel pump nozzle should be kept in contact with the side of the filler neck at all times while fuel is being delivered. This ensures that a potential difference does not develop between the area surrounding the filler neck and the nozzle.

Bonding and Grounding

The first article referred to bonding the aircraft, ie, "connecting the metal structure of the aircraft to earth – via a cable or other conducting path." The diagram accompanying that article showed three bonding or grounding connections: from the refuelling vehicle to earth, from the aircraft to earth, and between the refuelling vehicle and the aircraft.

Fuel company safety procedures generally have a statement along the lines, "the aircraft, fuelling vehicles, fuelling cabinets, hose trigger nozzles and funnels must be electrically bonded together throughout the fuelling operation, to ensure that no difference in electrical potential exists between the units." A similar statement is included in a GAP (Good Aviation Practice) booklet on aircraft refuelling which is currently under preparation and which includes some advice formerly given in the old CASO 5.

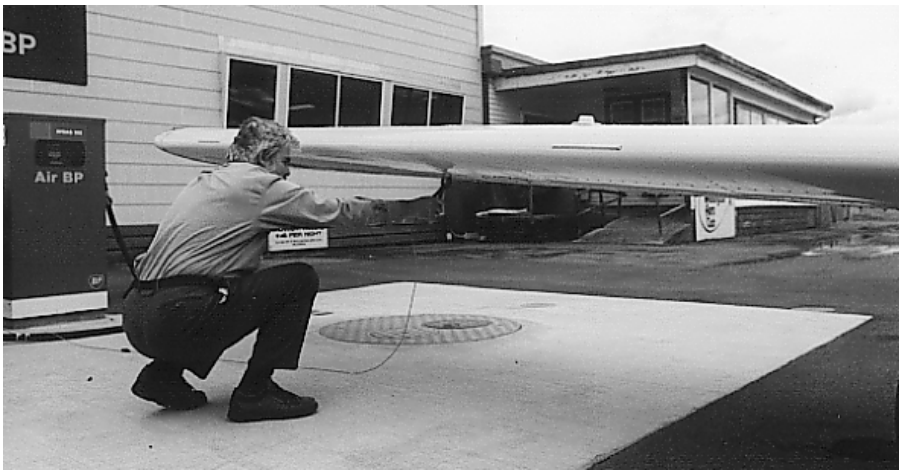
In recent years there has been a change in philosophy and practice with regard to grounding. In the 1990 edition of the [US] National Fire Protection Association Standard for Aircraft Fuel Servicing (NFPA 407), the requirements for grounding were deleted and requirements for bonding clarified.

The Standard notes that the primary electrostatic generator is the filter-separator, which increases the level of charge on a fuel by a factor of 100 or more compared with flow rate. Splashing, spraying or free-falling of the fuel will further enhance the charge. When charged fuel arrives at the receiving tank, either the charge will relax harmlessly to ground, or, if the charge is sufficiently high, a spark discharge may occur. Whether or not ignition will follow will depend on the energy (and duration) of the discharge and the composition of the fuel-air mixture in the vapour space, ie, whether or not it is in the flammable range.

No amount of bonding or grounding will prevent discharges from occurring inside a fuel tank. Bonding will ensure that the fuelling equipment and the receiving tank are at the same potential and provide for the charges separated in the fuel transfer system (primarily the filter-separator) to combine with and neutralise the charges in the fuel. Also, in overwing fuelling, bonding will ensure that the fuel nozzle is at the same potential as the receiving tank, so that a spark will not occur when the nozzle is inserted into the tank opening. For this reason, the bonding wire must be connected before the tank is opened.

The NFPA 407 standard outlines that grounding is no longer required because it will not prevent sparking at the fuel's surface. Also, the static wire may not be able to conduct the current in the event of an electrical fault in the ground-support equipment connected to the aircraft (eg, a ground-power unit or generator), and this could constitute an ignition source if the wire fuses. (Separate grounding connections must be made for equipment that requires electrical earthing.) Static electrical grounding points may have high resistances and therefore are unsuitable for grounding.

The draft GAP booklet reflects these changes.



Securely attaching the bonding wire to a non-painted metallic surface (one that can convey an electrical charge to or from the aircraft fuel tank) before refuelling begins will equalise any potential difference that exists between the aircraft and the fuel pump.

Bonding Procedure

So, what are the practical steps to ensure adequate bonding when refuelling?

Fuelling from a tanker is normally carried out by qualified oil company personnel. Refuelling by pilots is mostly carried out from a fixed cabinet.

Fixed Cabinet

- Unreel the bonding cable supplied beside the cabinet and connect the clip to a bare piece of metal on your aircraft. This should be completed before any hoses are connected or tank filler caps are opened.
- Equalise electrical potential by touching the nozzle to the metal wing surface or fuel cap **before** opening the cap. (Nozzle clips are no longer supplied at Avgas pumps, as fuel flow rates are low – the current oil company requirement for a nozzle-bonding wire is for flow rates exceeding 200 litres/minute.)
- Keep the nozzle in contact with the side of the filler neck while refuelling. (To avoid scratching the paint on the wing, use a mat, or take care to hold the nozzle clear and not rest it on the wing.)
- Keep the flow rate down in situations that you think may warrant further precautions (eg, hot and dry conditions).

Helicopters are sometimes refuelled while sitting on wooden trolleys. Other refuelling situations sometimes occur, such as refuelling in the field from small trailer tankers, drums or portable containers. In all situations, careful attention to bonding and to the other precautions listed above is essential. It is important that specific instructions are available (preferably at the point of fuelling) appropriate to the type of refuelling taking place.

Portable Containers

Some small aircraft, such as microlights and some homebuilts, can be fuelled with mogas. (The following advice is also applicable when you are at a service station filling cans for your outboard motor, lawnmower, etc.)

- Turn off the vehicle engine, and extinguish cigarettes.
- Use an approved container.
- Place the container on the ground.
- Keep the nozzle in contact with the container inlet during fuel transfer. (This is particularly important when refuelling jet-skis, etc, that have to remain on a trailer.)
- Keep the rate of flow down; never lock the nozzle trigger in the open position.
- Do not fill the container more than 95 percent full.

Similar precautions should be taken when draining fuel. Draining should be done outside, not in a hangar.

Funnels

The US Standard (NFPA 407) states that plastic funnels or other non-conducting materials can increase static charge generation. The use of chamois as a filter is extremely hazardous.

Composite Aircraft

A composite aircraft is more likely to develop and sustain a static charge because of the low conductivity of the fibreglass structure. Many homebuilders attach an internal grounding wire from the tank filler neck to an appropriate metal point on the aircraft that is able to have a grounding clip attached. It is also wise to take the precaution of touching the hose nozzle to the metal filler neck or cap **before** removing the tank cap. Keep the nozzle in continuous contact with the filler cap.

Recent research in the United States has shown that wiping a water-soaked rag over the wing surface around the fuel cap of a composite aircraft – where static charge is likely – will dissipate the charge. ■

Tech Logs Again

*The following are some additional points in relation to the recent article on aircraft technical logs that appeared in **Vector** 1999, Issue 1. It may be helpful to refer to that article while reading this.*

Maintenance Due

Pilots should always carefully check what 'out of phase' maintenance and inspections are due (eg next magneto overhaul, ELT battery replacement, and propeller overhaul) in the 'Inspections Due' and 'Maintenance Due' panels of Section 1 during the pre-flight inspection. All maintenance that is due prior to the date the aircraft is to be flown **must** be clearly signed off in Section 3 'Maintenance Arising' and Section 4 'Rectification or Deferral Action'. If this is not the case, the aircraft is **not** airworthy and can not be flown.

If you have just flown an aircraft which has developed a mechanical problem (eg. a lower-than-normal oil pressure reading), then it is your responsibility, as pilot-in-command, to ensure that the nature of the defect is entered in the 'Maintenance Arising' panel along with the date and your initials. This way another unsuspecting pilot (who has no way of detecting the problem during their pre-flight) will not attempt to fly the defective aircraft. This pilot-in-command responsibility is no different to that of checking the Inspections Due' and 'Maintenance Due' panels before flying an aircraft.

Retention of Tech Logs

Tech logs form a part of an aircraft's maintenance records and must therefore be retained for a specific period of time under the Civil Aviation Rules. Rule 91.631 *Retention of records* requires that tech logs be retained "…until the work is repeated or superseded by other work of equivalent scope and detail, or for two years after the work is performed, whichever occurs first…". Rule 91.631 also requires that all current maintenance logs be kept for six months after the aircraft has been withdrawn from service.

As each tech log is filled up, the hours flown are normally transferred to the aircraft logbook and the tech log retained (often in the aircraft logbook itself) as part of that aircraft's maintenance record.

Tech logs may, however, be discarded provided that their contents can be completely transferred to the aircraft logbook and signed for by the same LAME who carried out the maintenance in the first place. This is sometimes not possible as the LAME performing the maintenance may not always have access to the aircraft logbook. ■