Bonding and grounding

STATIC SITUATIONS

By Grant McCaughey

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When flammable liquids are pumped, or transferred, they can build up their own source of *sudden ignition*

A skilled and experienced machine operator required a solvent to clean machine parts. He went to the flammable -liquids storage room where a solvent composed of 80 per cent methylethylketone (MEK) and 20 per cent toluene was stored and dispensed. The solvent was stored in 45-gallon metal drums that were connected to a grounding strap on the wall.

The Worker planned to transfer some of the solvent from a 45-gallon drum to a four-gallon metal mop pail equipped with plastic wheels, using a pneumatically driven, flammable-liquids transfer pump. He held the pump in the drum with his right hand, with his finger on the valve ready to close it when the paid was full. His left hand was holding the transfer hose in the mop pail, which was placed on the floor.

When the pail was half full, it suddenly burst into flames, engulfing the worker in fire. He suffered second -and third-degree bums to about 35 per cent of his body.

The preliminary investigation determined that the fire started in the vicinity of the worker's right hand, at the inlet to the storage drum. It was speculated that a spark, resulting from a static discharge, ignited the solvent vapours. But how could this have happened since the storage drum was grounded and the pump was suitable for flammable liquids transfer?

Static electricity results from the interaction of dissimilar materials. This can occur when materials are rubbed together, such as in the classic example of walking across a carpet on a dry winter day while wearing woolen socks. However, static charges can also develop when a liquid passes through a pipe or through an opening into a tank.

A static spark is a discharge of electricity across a gap between two points not in contact, resulting from a difference in electrical potential. The spark produced when the electrical charge jumps across the gap usually contains enough energy to ignite flammable vapours if they are in concentrations that will sustain combustion.

The generation of static electricity cannot be totally eliminated because it is normally present at every interface. However, there are ways to reduce the potential for static charge buildup when transferring flammable liquids. The two most important are bonding and grounding.

Note that bonding and grounding are only effective when the objects are conductive. Plastics, for example, can accumulate a significant static electrical charge, but the charge cannot disperse uniformly throughout the material. Because of this bonding and grounding are not effective on non-conductive containers.

IT'S A TRAP

Fires and explosions that are sparked by the discharge of static electricity during pouring and transfer of flammable liquids are actually fairly rare occurrences. And that's one of the factors that makes them dangerous. It's often possible to decant flammable liquids numerous times without ever causing an explosion. This might well have the effect of persuading employers, workers and their supervisors that basic precautions - including bonding and grounding are unnecessary. However, it may be just a matter of time until all of the factors required for an explosion come together. Among the many variables that can determine when and where a liquid transfer explosion and fire takes place are the following:

- the temperature of the liquid (which influences vapour quantity);
- the air temperature;
- the flash point of the liquid;
- the upper and lower explosive limits of the material being transferred (there may be too much or too little vapour to explode when a spark occurs);
- the relative humidity at the time of the transfer (which has a bearing on static buildup);
- the clothing worn by the worker (wool, for example, can generate more static than cotton);
- the type of containers used; and
- whether or not the source container has built up a charge before decanting begins.

Clearly, it's not possible to assess these and other variables each time a liquid transfer takes place; even if unbonded, ungrounded systems have death to install adequate protection before one more worker takes one more chance been used without incident in the past, it may be a matter of life and death to install adequate protection before one more worker takes one more chance.

Bonding

Bonding is done to eliminate the difference in electrical potential between two or more objects. An adequate bond between two or more conductive objects will allow the charges to flow freely between objects, resulting in no difference in electrical potential. The likelihood of a spark between the objects is then essentially eliminated.

Bonding can be accomplished by attaching a conductive wire between the objects. The following are important factors for safe bonding. (See also diagram next page)

- The size of the bonding wire is usually based on mechanical strength rather than on current-carrying capacity. The maximum resistance of the grounding conductor should be less than one megohm to ensure the dissipation of static electricity.
- The attachment point on both objects must be solid and secure and should be made on a bare metal surface.
- Using a pressure clamping device (screw-on or spring-loaded) is a good way to ensure a positive connection. Note that the connection must be made *prior* to beginning the transfer of material between the containers. If the bonding is done after the transfer, the static charge buildup could result in a spark as the bond wire is connected to one of the containers.

If a conductive bonding wire is not used when transferring liquids, ensure that a conductive path is maintained between the container and the filling apparatus. A conductive nozzle on the fill stem that is in constant contact with container will provide a path for the flow of charges (acting as a bond). This will eliminate the potential for static to build up on the container as the fluid is transferred from one body to another. It is paramount to remember that the fill stem must always remain in contact with the container during the transfer process.

Grounding

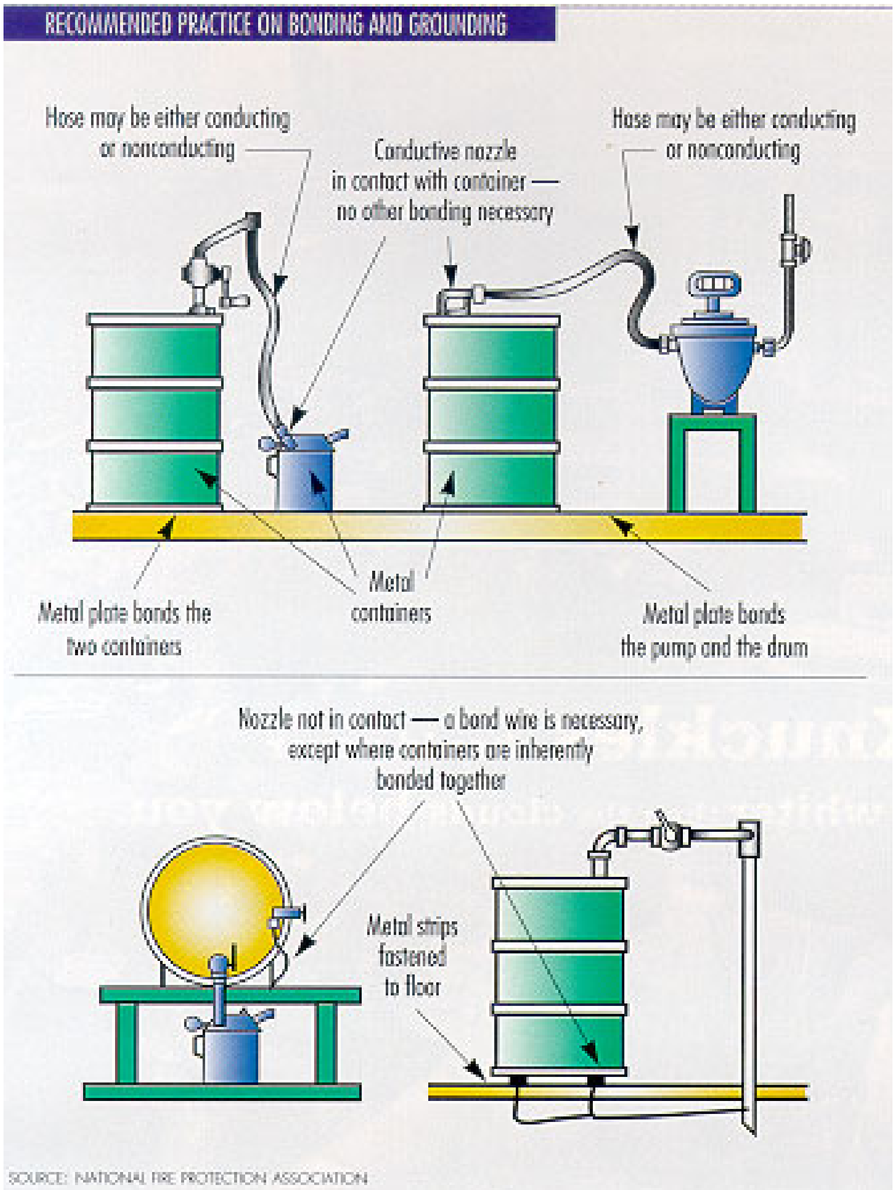
Grounding an object serves a different purpose than bonding. Bonding eliminates the difference in potential between containers that are bonded together, but it will not eliminate the potential difference between an object and the ground. To ensure that a static charge will not create a spark as a result of this difference, a conductive path must be provided to the earth. A proper ground will provide a means for continuously discharging a charged, conductive body to the earth.

It is important that the grounding system be checked to ensure that there is continuity and proper resistance. An underground water main is an ideal grounding point. If this is not available, a proper ground rod or ground cone may be used.

Flammable liquids

Electrical charges can build up in flammable liquids when the liquids flow through piping systems or when they are agitated in their storage containers as a result of mechanical movement or splashing. The proper bonding and grounding of the piping system is often enough to control this static buildup.

However, if rapid flow rates are used to transfer the liquid into a storage tank, high electrical potentials can occur on the surface of the liquid in the tank. The rate of accumulation of static charge may be much greater than the liquid's ability to transfer it to the grounded metal storage vessel. If the accumulated charge in the container builds up enough, a static spark may result when the liquid level approaches a body with a different potential. For example, if a probe is lowered into a large storage tank to check the levels of a product, it may cause a static spark. If the spark is of high enough energy, it can ignite the flammable, air-vapour mixture.



This kind of static situation can be controlled by reducing flow rates, avoiding violent splashing in the tank and allowing for "relaxation" time (simply waiting until the static charges dissipate) before gauging the tank

In the accident described earlier, it was difficult to find an explanation. The 45-gallon storage drum container the solvent was grounded. The conductive transfer pump was assumed to be an adequate means of bonding the drum and metal mop container. However, if the pump and transfer nozzle were not in solid contact during the entire operation, it is possible that the transfer of the flammable liquid into the insulated metal pail could have generated a static charge. If the transfer pump casing was not in contact with the 45 gallon drum for a period of time, then a static spark could have been produced as the pump casing came in closer proximity to the drum wall.

It is important to avoid making assumptions about your safeguards to contain static electrical buildup. Careful and diligent bonding and grounding procedures can protect workers from the danger.

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