



A Health and Safety Guideline for Your Workplace

Static Electricity

What is static electricity? What causes it? How is it hazardous? And, most importantly, how can it be controlled? All of these questions will be answered in this health and safety guideline.

What is Static Electricity?

At it's simplest, static electricity is an electrical charge that cannot move. It is created when two objects or materials that have been in contact with each other are separated. When in contact, the surface electrical charges of the objects try to balance each other. This happens by the free flow of electrons (negatively charged particles) from one object to the other. When the objects separate, they are left with either an excess or a shortage of electrons. This causes both objects to become electrically charged.

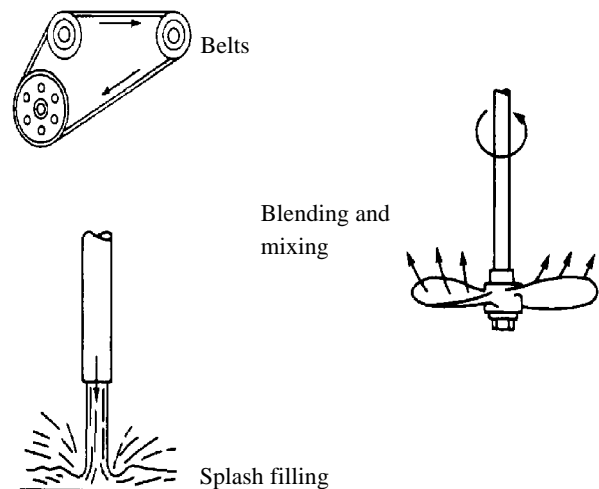
If these charges don't have a path to the ground, they are unable to move and become "static". If static electricity is not rapidly eliminated, the charge will build up. It will eventually develop enough energy to jump as a spark to some nearby grounded or less highly charged object in an attempt to balance the charge. A good example of this in everyday life is lightning. Lightning is produced by a discharge of electricity from one cloud across an air gap to another cloud or between a cloud and the earth.

What Are Some Sources of Static Electricity?

Static electricity is commonly produced when:

- z liquid flows through a pipe or hose, or through an opening in a pipe or hose
- z spraying or coating
- z blending or mixing
- z filling tanks, drums, cans or pails
- z dry powdered material passes through chutes or pneumatic conveyors
- z non-conductive conveyor belts or drive belts are moving
- z appliances are plugged into electrical outlets

Figure 1: Common Sources of Static Electricity



People can also accumulate static charges generated by clothing or footwear. This is most likely to happen in dry atmospheres, such as heated buildings in winter, or when walking across carpets and then touching a metal frame or door.

What Are the Hazards of Static Electricity?

The main hazard of static electricity is the creation of sparks in an explosive or flammable atmosphere. These sparks can set off an explosion or fire. The danger is greatest when flammable liquids are being poured or transferred.

For static electricity to be a hazard, four conditions must be met:

1. There must be a means for a static charge to develop.
2. Enough energy must build up to cause ignition.
3. There must be a discharge of this energy (a spark).
4. The spark must occur in an ignitable vapour or dust mixture.

How Can Static Electricity Be Controlled?

Most static electricity control measures provide ways for the static charges to dissipate harmlessly before sparks occur.

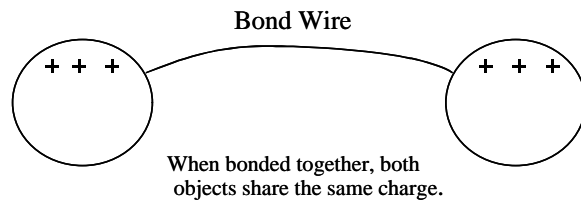
Some ways to prevent static charges from accumulating on materials are:

- z bonding and grounding
- z humidification
- z static collectors
- z additives

Bonding and grounding

Bonding and grounding are common controls for static electricity. Bonding is connecting two or more conductive objects with a conductor, such as a copper wire, that equalizes the potential charge between them. (See Figure 2.) Bonding is also connecting various parts of equipment and containers that are electrically separated by, for example, gaskets or caulking compounds. Note that bonding does not eliminate the static charge.

Figure 2: Bonding Two Conductive Objects



Grounding is connecting one or more conductive objects directly to the earth using ground rods, cold water copper pipes, or building steel. Unlike bonding, grounding drains the static charges away as quickly as they are produced.

Static grounds must not be made to:

- z electrical conduit systems
- z plastic pipes
- z gas or steam pipes
- z dry pipe sprinkler systems
- z lightning rods
- z metal storage racks
- z building support beams

A designated ground source is preferred.

Connectors for bonding and grounding, such as copper wire and clamps, must provide a good conductive path. To ensure this:

- z remove all dirt, paint, rust, or corrosion from areas where connections are to be made
- z use connectors that are strong enough for the job
- z use flexible connectors where there is vibration or continuous movement
- z connect **metal to metal**

Figure 3 shows some typical examples of connectors. See Table 1 for minimum specifications for bonding and grounding equipment. For more information, consult your safety supplier.

Figure 3: Some Examples of Connectors

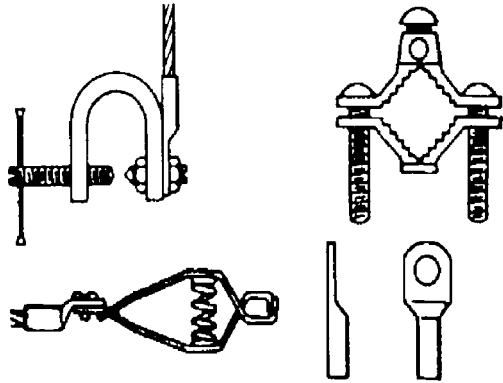


Table 1: Minimum Specifications for Bonding and Grounding Equipment

Bonding Wires	4.1 mm (#6 AWG) copper wire
Bonding Connectors	12.7 mm (1/2") copper bonding straps, solder lugs, pressure connectors or bolts and star washer
Bonding Conductors	19 mm (3/4") copper braid with pressure-type ground clamps
Grounding Wires	5.2 mm (#4 AWG) copper wire
Ground Connectors	At the equipment: approved connectors securely bolted to the machine. Solder lugs are acceptable, but pressure connectors are preferable At the earth: an approved ground clamp attached to a ground electrode

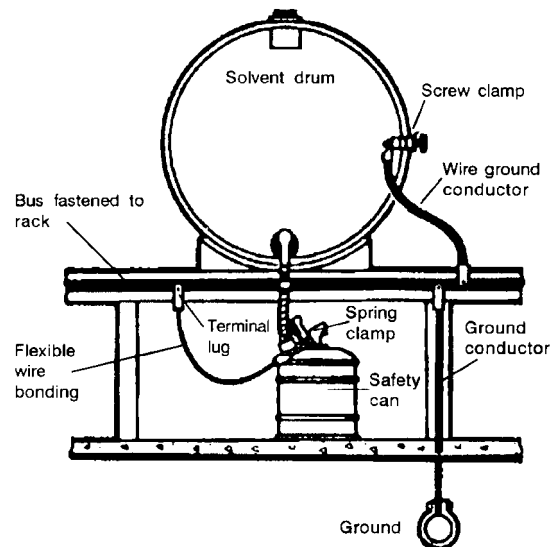
(Source: Ontario Ministry of Labour, Engineering Data Sheet 10-0 "Static Electricity," June 1987)

Where liquids are dispensed from their original shipping containers using portable pumps or by gravity through self-closing valves, the pumps or valves must be designed in conformance with good engineering practice. Products tested and

listed by recognized agencies (for example, Canadian Standards Association, Factory Mutual, Underwriters Laboratories of Canada) are considered to meet this requirement.

When dispensing flammable liquids, both bonding and grounding are required. Ensure that the receiving container is bonded to the dispensing container before pouring the liquid, and that the dispensing container is grounded (see Figures 4 and 5).

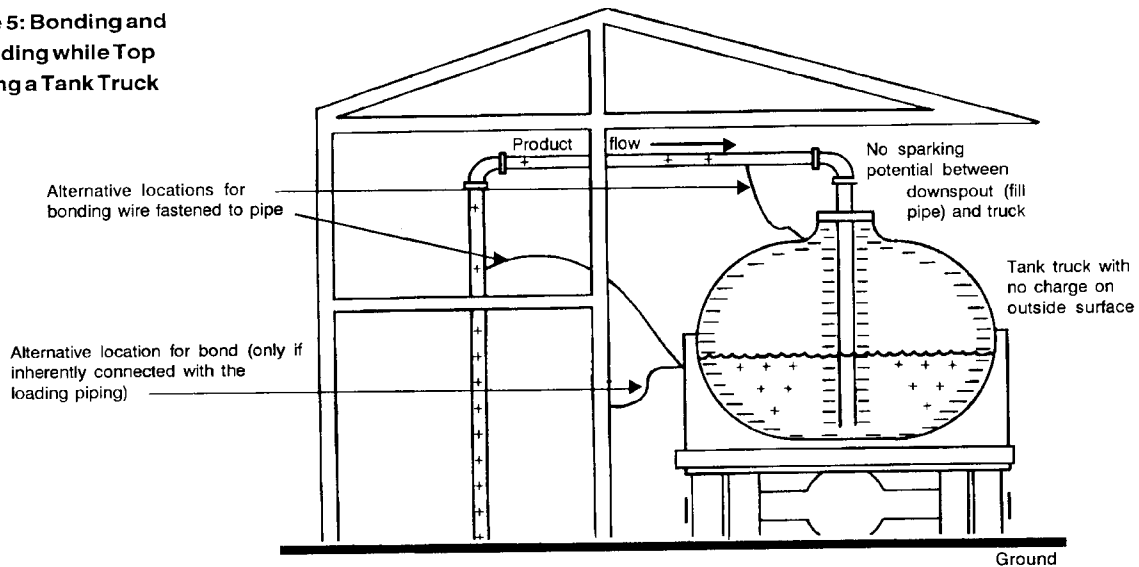
Figure 4: Bonding and Grounding while Dispensing



Bonding or grounding will not eliminate the surface charge on vessels holding flammable liquids. To prevent static in these cases, make sure that the nozzle is touching the bottom of the vessel so that the liquid discharges horizontally. Also, lower the rate of flow. These two measures will prevent the free fall and turbulence that generate static.

Non-metallic containers, such as plastic or glass, cannot be grounded. To minimize the build up of static charges near the surface of liquids being poured, limit the filling rate to velocities less than 1 m/s by using a grounded lance or nozzle extension to the bottom of the container to limit free fall, or use antistatic additives. All metal parts on plastic containers must be bonded to the fill pipe on the container being emptied. However, as far as possible, avoid using plastic containers for holding flammable liquids and plastic sheets for wrapping.

Figure 5: Bonding and Grounding while Top Loading a Tank Truck



Humidification

A relative humidity of 60% to 70% at 21°C (70°F) may prevent paper or layers of cloth and fibers from sticking together. A high relative humidity, however, is no guarantee against the accumulation of static electricity. Therefore, don't rely solely on humidification as a control measure in areas where there are flammable liquids, gases, or dusts.

Static collectors

Devices that collect static electricity can be used on moving belts, plastic film, and similar non-conductive materials. Some examples of static collectors include: needle pointed copper combs; spring copper brushes; and metallic tinsel bars.

A static collector works by its closeness to the source that generates the static electricity. If a discharge occurs, it is captured by the highly conductive collector; this prevents long hot sparks. To be effective, collectors must be properly grounded.

Additives

Another control is the use of anti-static additives (as in fuels). The additive increases the conductivity or lowers the resistance of the liquid. It also reduces the time it takes for the static charge to leak through the wall of the container and to the ground.

Controlling static electricity on people

Controls to prevent or reduce static from building up on people include:

- z conductive flooring
- z conductive clothing and footwear (to allow the charge to be conducted away; these items must be free of dirt and other contaminants)
- z cotton or linen clothing instead of wool, silk, or synthetic materials

Checklist

This is a sample inspection checklist for bonding and grounding systems. Modify it to suit your needs.

Department:	Yes	No	Recommended Action
Bonding cables: z in good condition z good contact points			
Bonding clamps: z in good condition z good metal connection			
Grounding conductors: z in good condition z lead to earth			
Static electricity ground: z direct to good earth			
The following are free of static grounds: z electrical conduit systems z plastic pipes z gas or steam pipes z dry pipe sprinkler systems z lightning rods			
Continuity checked			
Conductivity measured			
Safety cans: z bonded and grounded			

Initials of person doing inspection: _____ Date of inspection: _____

Legislation

Ontario Fire Code, O. Reg. 388/97, Part 4, specifically subsection 4.1.8 - Handling of Flammable and Combustible Liquids.

Regulations for Industrial Establishments, O. Reg. 851 as amended, subsection 22(4).

For More Information

American Petroleum Institute, "Protection Against Ignition Arising Out of Static, Lightning and Stray Currents," March 1982.

Ministry of the Solicitor General and Correctional Services, Office of the Fire Marshal, "Commentary on Part 4 of the Ontario Fire Code", August 1998.

National Fire Protection Association, NFPA 77, "Recommended Practice on Static Electricity", 1995.

Ontario Electrical Safety Code, 1998, Section 10 on Grounding and Bonding.

Ontario Ministry of Labour, Engineering Data Sheet 10-0 "Static Electricity," June 1987.

Resources

IAPA Products:

Static Electricity is one in a series of guidelines designed to make your workplace safer and healthier. Other guidelines include:

- z Fire Protection
- z Fire Extinguishers
- z Flammable Liquids Storage

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