

BONDING AND GROUNDING

Best Practices

Introduction

Flammable and combustible liquids (e.g., aliphatic and aromatic hydrocarbons, alcohols, ethers, ketones, esters, etc.) present [fire and explosion hazards](#). They are commonly found in research laboratories for a variety of uses such as distillation, liquid chromatography, etc.

When these liquids are transferred (i.e., poured, pumped, or agitated) from one metal container or a special conductive plastic container to another, the movement of the liquid may generate static electricity. The buildup of static electricity can form a spark where the solvent exits the container, which can result in a fire or explosion, if there is sufficient flammable mixture of chemical vapor fuel, and air.

This risk can be significantly minimized by bonding and grounding. This technique safely drains the static electricity built up during the liquid transfer into the ground by creating an electrical pathway between a dispensing container, a receiving container, and the earth ground.

It must be noted that bonding and grounding are required for the containers that conduct electricity, such as those made from metal or conductive plastics. If a container is made from a material that does not conduct electricity, such as polyethylene plastic or glass, bonding or grounding may not be required. Also, if dispensing a flammable/combustible chemical from a ≤ 1 gallon (4L) container (e.g., glass) then grounding and bonding is not required. Ideally this dispensing should be performed in a certified chemical fume hood and the researcher should wear [appropriate PPE](#).

[Cal/OSHA 5490 “Bonding and Grounding”](#) states that liquefied hydrogen containers and associated piping shall be electrically bonded and grounded.

Definitions

Definitions as per Cal/OSHA Standard 5415:

- **Flammable liquids** have a flash point at or below 199.4°F (93°C).
- **Combustible liquids** have a flash point greater than 199.4°F (93°C).
- **Flash point** is the minimum temperature at which a liquid forms a vapor above its surface in sufficient concentration that it can be ignited.

General definitions:

- **Bonding** is connecting all conductive components (i.e., containers, piping, pumps, funnels, etc.) in the dispensing process by means of a conductor to ensure that they carry the same electrical potential but are not necessarily at the same potential as the earth.
- **Grounding/Earthing** is the process of carrying the electric charge to “earth” or “ground” so that all objects are at zero electrical potential. Indoor dispensing locations can tap into grounded building systems, such as electrical distribution systems, to carry the charge to ground.



Figure 1: Flammable liquids pictogram on chemical Safety Data Sheets (SDS) and labels

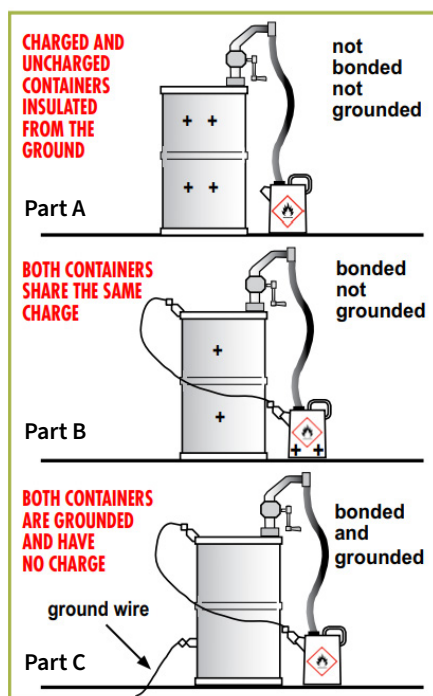


Figure 2: Bonding and grounding

Part A shows a container that is not bonded and grounded, and depicts **static electricity**, shown as “+”, generated in a flammable/combustible liquid container.

Part B represents **bonding**, which eliminates the electrical potential between 2 containers–note equal “+” symbols.

Part C shows how **grounding** eliminates the difference in static potential charge between the conductive object and the ground.

How to Bond and Ground

1. Always perform bonding and grounding in a well-ventilated area.
2. Do not perform near open flames, heat sources, ignition sources (e.g., Bunsen burners, hot plates, electrical outlets, etc.), or around electrically charged equipment.
3. Use appropriate bonding and grounding cables such as plastic coated 10’ coiled grounding cable with clamps on both ends, or braided 3’ bonding cable with alligator clips on both ends.
4. Wear non-synthetic clothing and appropriate PPE (i.e., flame resistant lab coat such as Nomex, goggles and face shield, nitrile gloves, closed toe static dissipating shoes) when transferring material. Pouring larger volumes may require additional PPE.
5. Ensure you are connecting to appropriate earth ground (e.g., copper water lines). **Do not connect to fire sprinkler lines!**
6. Ensure good metal to metal connection by removing any dirt, debris, paint, etc.
7. Connect the dispensing vessel to the earth ground.
8. Place the receiving vessel in a secondary container or on a bonding metallic floor plate.
9. Connect the bonding cable from the receiving vessel to the dispensing vessel or floor plate (metal to metal connection). **Note:** *If the receiving container is too small, does not have a metal connection, or you do not have a metal floor plate, provide a grounding rod. Use care that it does not tip over.*



Figure 3: Shows two examples of bonding and grounding. The image on right shows dispensing into a glass container with a ground rod inserted into the funnel.

10. Discharge yourself by touching the ground after making connections and before starting any transfers.
11. Once properly connected, proceed with the transfer.
12. Dispense liquids slowly and carefully, minimizing any splashing which could produce static electricity.
13. When complete, slowly disconnect all bonding and grounding cables and remove the grounding rod, if applicable.
14. Clean all equipment and properly transport the material to the laboratory.
15. Reach out to Stanford EH&S at (650) 723-0448 for an assessment prior to conducting any grounding or bonding.

Resources

[Cal/OSHA - General Industry](#)

[Cal/OSHA - Flammable and Combustible Liquid Definition](#)

[Stanford EH&S Flammable and Combustible Liquids Definitions](#)

[Stanford University SOP - Flammable and Combustible Liquids](#)

[Stanford University EH&S Ethanol Fact Sheet](#)

References

1. Oregon Occupational Safety and Health. Flammable and combustible liquids. State of Oregon. (n.d.-b). <https://osha.oregon.gov/pages/topics/flammable-and-combustible-liquids.aspx>
2. University of Berkeley. Flammable liquid transfer guidelines. Office of Environment, Health & Safety. (n.d.). <https://ehs.berkeley.edu/safety-subject/fire-safety/flammable-liquid-transfer-guidelines>
3. University of California San Diego. Flammable and combustible liquids storage requirements. EHS (n.d.). <https://blink.ucsd.edu/safety/research-lab/chemical/liquids/storage/index.html#Bonding-and-grounding>
4. University of Washington. Grounding and bonding focus sheet. EHS. (n.d.). <https://www.ehs.washington.edu/resource/grounding-and-bonding-focus-sheet-1173>
5. Wayne State University. Safe transfer of flammable liquids: Grounding and bonding. Office of Environmental Health and Safety (n.d.). <https://research.wayne.edu/oehs/lab-safety/grounding-bonding#:~:text=Grounding%20and%20bonding%20is%20an,container%2C%20and%20an%20earth%20ground>