Insight: Bonding & Grounding for Static Electricity

Recognizing the Risk

Missing or poorly maintained bonding and grounding systems cause numerous serious fires and explosions at manufacturing facilities each year. In the U.S. one report indicates 280 related incidents are reported annually. This is said to be even higher in Europe with more than 400 annual reported incidents.[1] A 2011 study by the National Institute of Occupational Safety and Health of Japan found that 153 industrial accidents were attributed to static electricity with approximately 70% involving flammable vapor atmospheres.[2]

Basically speaking, static electricity is a stored electrical charge at rest - like a battery. When static electricity is generated and built up, electrostatic discharge (ESD) can occur, releasing the stored energy. It happens through electron transfer which creates a spark. Most have experienced this on a personal level when touching a metal doorknob after walking across carpet. On a bigger scale, a good example is a storm with the ESD being the lightning strike.

All materials can generate static electricity. Static charges are generated in people and nearly every motion of a production process but typically are dissipated safely to ground. The risk comes when the static electricity charge is allowed to build and the ESD occurs as an ignition source in areas with highly combustible materials such as flammable gases, vapors, and combustible dusts. When this happens, a potentially dangerous situation that is often hidden develops and can result in significant risk in the form of fire or explosion. While very low current, a single ESD spark **can generate up to 3000 volts of electricity**. And the human body, for example, can have an equivalent stored charge as high as 25,000 volts- with 500-2,500v during a normal workday.

The goal of bonding and grounding systems are to dissipate developing static charges, or the potential charge between two objects, so energy does not build-up to create an ESD spark (the fire/explosion ignition source).

Bonding is when two or more conductive objects are connected together to maintain the same electrical potential as each other (i.e.no electrical charge differential means no spark can be generated). This is typically seen as a wire clamped between two vessels during fluid transfer.

Grounding, often called earthing, is when objects are connected to an electrical earthen ground to discharge the static electricity so a spark-producing build-up can't occur. This is, commonly seen in use with flammable liquids drums e.g. the drum is connected to a copper rod that is driven into the earth. Sometimes where there are multiple drums and liquids transfer, both bonding and grounding systems will be utilized.

One of the biggest challenges in managing static electricity through bonding and grounding is that they typically are not part of formal building plan review or fire department risk assessment tour. Another challenge is that risk conditions can change quickly when process, equipment and materials change. In fact, the inherent risk fluctuates with weather- at lower relative humidity, static electricity building up potential can increase as temperatures rise, humidity drops, and the environment becomes drier. For bonding and grounding to be effective, a metal-to-metal connection must be maintained between system clamps, wires and the containers. These are conditions not always recognized or associated with static electricity risk leading to systems not being properly maintained.

Controlling the Hazard

Where applicable the process of properly managing bonding and grounding systems starts with an analysis of area conditions for potential risk, continues with installing the correct bonding and grounding systems, and ends with system inspections and testing through the life of the system. AIG follows NFPA 77* as the primary resource for recommended

practices concerning these systems supported by added AIG recommendations specific for this hazard. The additional recommendations include:

- Manage static discharge hazards from areas with ignitable mixtures of gas, vapor, or dust following NFPA 77* with AIG specific-application recommendations. Requirements can also be found in NFPA 30* and NFPA 70 Article 250*.
- Use non-insulated, braided steel bonding/grounding wires sized based on requirements for mechanical strength.
- Use U.L. Listed, FM Approved, and or ATEX Certified clamps for coated metal material connections- other clamps can be used for uncoated or cleaned surfaces.
- Modify processes, materials, and/or products to reduce charge generation and/or accumulation where possible such as slowing line speed, reducing flow rates, and/or replacing conductive materials.
- Neutralize the static charge where possible by methods other than bonding and grounding such as by modifying area humidification, implementing antistatic treatments, and installing alternative static eliminating systems.
- Exclude sprinkler system piping including underground mains as a grounding electrode- except for lightening protection grounding systems both NFPA 13 and NFPA 24 prohibit this type of connection. All underground piping equipped with cathodic protection also should not be used as the grounding system.
- Implementing NFPA 77* recommended periodic inspection and testing of bonding and grounding systems. This includes regular recorded visual inspections, annual resistance testing and replacement of identified damaged parts. Self-testing bonding systems are an acceptable substitute for regular resistance testing.

References & Resources

https://www.plantengineering.com/articles/static-grounding-dangerous-preventable/

U.S. Chemical Safety and Hazard Investigation Board No. 2008-02-I-IA

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NFPA 13: Standard for the Installation of Sprinkler Systems

NFPA 24: Standard for the Installation of Private Fire Service Mains and Their Appurtenances

NFPA 30: Flammable and Combustible Liquids Code

NFPA 70: National Electrical Code (NEC)

NFPA 77: Recommended Practice on Static Electricity

*While NFPA documents are the global standard used by AIG, international equivalents may be acceptable.

For more information, contact your local AIG Risk Engineer.

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