DSEAR: Earthing & Bonding in Hazardous Areas

Sigma-HSE

Introduction to hazardous areas

In an industrial plant where flammable liquids, gases and vapours, combustible dust or powders are handled, processed or generated, there are inherent risks from fire or explosions. To have a fire or an explosion, there must be fuel present, the fuel must be mixed with an oxidant (typically the oxygen in the air) and an ignition source.

Hazardous areas and the legislation

Any UK site that manages a significant quantity of flammable gas, vapour, or combustible dust or powders that have the potential to form an explosive atmosphere will fall under the Dangerous Substances and Explosive Atmospheres Regulations (DSEAR).

DSEAR 2002 (as amended 2015) requires employers in the UK to control the risks associated with explosions, fires and substances corrosive to metals. DSEAR was passed in the UK in 2002 as a result of two European Directives: The Chemical Agents Directive (98/24/EC) and the Explosive Atmospheres Directive (99/92/EC). From 2015, DSEAR also covers gases under pressure and substances that are corrosive to metals.

To follow DSEAR, all of the risk assessments should be considered to follow the hierarchical approach to ATEX/DSEAR:

1. Do not have a flammable atmosphere, but if you do…
2. Do not ignite it, but if you do…
3. Do not hurt anyone.

Where hazardous areas are found, all equipment, both electrical and non-electrical, should be suitable for use in that zone. This can be completed either by certification and the purchasing of properly certified ATEX-rated equipment or by undertaking a Non-electrical Equipment Ignition Risk Assessment (NEIRA).

As DSEAR requires employers to put control measures in place to either remove or control fire and explosion risks. Any electrical sources of ignition should be managed by:

- the choice of explosion-protected (Ex) equipment and/or systems
- avoidance of hazards due to static electricity by bonding all conductors together and to the earth
- installation of lightning protection systems proper to the construction and contents of structures
- detuning structures capable of acting as RF antennae in explosive atmospheres within the vulnerable zones of transmitters
- application of a protective coating to cathodic protection isolating joints to prevent accidental contact.

Navigating both earthing and bonding of electrical systems can be a challenge. There are accepted codes of practice that outline how earthing and bonding should be completed in hazardous zones.

BS 7671, Requirements for Electrical Installations, for example, is intended to be applied to electrical installations, but, in certain cases, they may need to be supplemented by the requirements or recommendations of other standards or by other working requirements. Such cases may include the following:

- Electrical apparatus for explosive gas atmospheres – BS EN 60079
- Electrical apparatus for use in the presence of combustible dust – BS EN 50281

While these standards can be followed and best practices integrated into a process, how can we ensure that safety systems and processes continue to work at their full potential?

This document supplies various hypothetical work-based scenarios and raises questions that should be asked when designing, implementing or maintaining equipment that requires earthing or grounding in hazardous zones.

Note that for the purpose of this white paper, the terms antistatic and static dissipative are considered the same. Although antistatic is a general term, static 'dissipative' is a defined term (an item that falls within a specific range of resistance).

Material classification	Volume resistivity, (ρ) Ω.m	Surface resistivity, (λ), Ω/sq.
Conductive	$\rho < \mathbf{10^2}$	$\boldsymbol{\lambda < 10^5}$
Dissipative	$10^2 \leq \boldsymbol{\rho < 10^9}$	$10^5 \leq \boldsymbol{\lambda < 10^{12}}$
Insulating	$\rho \geq \mathbf{10^9}$	$\boldsymbol{\lambda \geq 10^{12}}$

What is earthing?

Earthing is a safety feature used for electrical equipment to provide a safe alternative route for electricity to pass if there is a problem with a particular electrical installation.

In electrical wiring systems, the conductor known as ground or earth serves as a safeguard against dangerous voltages on machinery. While grounding is the term used in North American standards (NEC, IEEE, ANSI, UL), earthing is more often used in British and European standards.

An earthing system is, at its most basic level, the configuration by which an electrical installation is connected to a method of earthing. Because electricity uses the body as a channel to the earth, if there is an electrical installation mistake, a person could receive an electric shock through contact with a live metal part. Therefore, a fault current must have another way to reach earth, this is through earthing.

What is bonding?

The process of electrical bonding involves connecting all exposed metallic objects in a space that is not intended to send electricity with the use of a protective bonding conductor. It lowers the potential voltage that might have existed to prevent electric shock in case of an electrical malfunction.

This implies that there would not be any power accumulating in one piece of equipment or between two pieces of equipment. Because the potential of two linked bodies is the same, no current can pass between them. Limiting current flow between pieces of equipment at various potentials safeguards both the equipment and the operator.

Bonding is used to reduce the risk of electric shock to anyone who may touch two separate metal parts when there is a fault somewhere in the supply of an electrical installation.

Why do earthing and bonding matter concerning DSEAR and hazardous areas?

A frequent source of fire ignition in the workplace is electrical equipment. Combustible components of electrical equipment and wiring can be ignited by faulty or inadequately connected equipment that overheats, smoulders, or sparks. Even in cases when fire damage is minimal, the loss of essential power sources can cause prolonged disruptions in processing operations.

Furthermore, the incorrect bonding and earthing of certified equipment (if necessary) can cause a large amount of financial expense in terms of designing, buying and maintaining this in hazardous areas.

Conductive Flooring

As electricity can move through a material if it is conductive, resistance is needed to restrict flow when an electrical current should not pass through a substance. Instead of acting as an electrical conductor in this scenario, the conductive flooring would act as an insulator. In essence, antistatic/static dissipative flooring removes charge from persons or objects to prevent them from becoming a source of ignition.

The flooring present in hazardous areas should be static dissipative with a leakage resistance between 100kΩ to 100 MΩ. This is set out by the BS EN 60079-32 standard.

If the flooring is found not to be static dissipative, then, static dissipative mats should be used which must be suitably earthed. An example could be through the use of a crocodile clamp and earthing block. Earthing continuity checks should be untaken, especially once installation and maintenance activities are completed.

Trialling Earthing & Bonding Systems

Choosing earthing straps

In this scenario, electrical contractors are installing an earthing and bonding system. This requires electrical contractors to remove the coating from a selected area of steel piping and to secure a clamp to the "clean" metal via a metal strap.

There are two distinct kinds of straps used in this trial: a polished steel strap with a limited length and a worm drive hose clip strap with a length range of up to three metres. To give a path to the earth, the first clamp in line was attached to structural metalwork before clamps/straps are connected using proper earth wires across duct joints.

This trial must consider the re-verification of the earth bonding post-production and maintenance activities that have the potential to disturb earth bonding equipment. As a result, installation protocols and routine testing procedures must be proved.

Polished Steel Straps

Although more expensive, a polished steel strap may be aesthetically more pleasing. As previously mentioned, the polished steel strap is only a certain length. As a result, it is often necessary to use two polished steel straps and clamps to pass the strap around a duct.

Worm Drive Hose Clip

The worm drive hose clip strap is not as aesthetically pleasing but it does come in 3-metre lengths and so can be used with a single clamp. This makes it significantly cheaper than two polished straps while achieving the same result in passing around the duct.

In this hypothetical scenario, a Worm Drive Hose clip would be the most suitable strop from which to choose. This is due to the length and the financial cost of sourcing this specific material.

Pipe and Ductwork Installation

The following scenario proves the installation protocol for earthing and bonding pipework and ductwork.

Firstly, a suitable earth, via structural steelwork must be proved. Once established the area of bare metal should be assessed to earth to prove that the metal is correctly earthed.

If it fails, another item should be assessed until earthed. If it passes the test (less than 10 Ω, but preferably less than 1 Ω) the figure must be recorded in an electrostatic bonding and earthing installation report table. See Fig.1

Once earthed, a suitable earthing cable must be screwed or bolted into the structure, with the head being on the visible side to reduce the risk of persons catching themselves on it.

If the pipe is bare, a worm drive hose strap, clip and earth cable can be attached. If the pipe is not bare, a test should be undertaken on two points to decide surface continuity. If there is surface continuity, the strap, clip and cable can be attached.

If the surface is insulating, then it should be properly prepared by removing an area of the coating. The strap, clip, and cable can then be attached. However, it should be attached to the left-hand side of the cleaned area. As a result, a column of bare metal to the right of the strap should be left.

The area to the right of the strap should have a test label. These individually numbered circular test point stickers will aid in recording future tests. It must, however, be noted that these stickers should in no way touch the installed strap, clip, or cable.

Example Test Point Sticker/Label

Pipe and Ductwork Installation

- Does the high flow of powder through an insulating discharge hose cause the potential for propagating brush discharge?
- Do the materials generate static or do they have inherent static charges present (depending on their charge relaxation time)
- Is there a potential for explosions to occur?
- Could the installation of earth reinforced wires into the discharge hose (coils) aid in design and maintenance?
- Could orifice plates be installed to slow down the powder flow at the discharge?

Cable Spanning

The following scenario proves how cables can span connections of pipes, providing that the span is no more than one metre.

If there is a short pipe and the distance from the end pipes is less than one metre, it is acceptable to miss the intermediate pipes from the bonding and earthing installation. However, a test point still has to be put onto each section of pipe, regardless of bonding. They must also be individually identifiable.

On installation, a test must be undertaken to record the resistance from the earth to each of the test points. If it passes the test (less than 10 Ω, but preferably less than 1 Ω) the resultant figure is recorded.

If not, understanding why the test failed must be investigated.

Providing that there are no connections of any kind that could affect the integrity of the earthing, then there only has to be one earth point and test point per length of pipework.

Conclusion

Earthing and electrical bonding are necessary to prevent electric shock to persons, and if equipment is present within hazardous zones, to prevent electrical charge build up. Discharge of electrostatic energy (sparks etc) are very likely to ignite flammable atmospheres resulting in fires and explosions. The examples given in this short article gives advice on how to achieve appropriate and effective earthing and electrical continuity.

Record sheet on the installation of electrostatic bonding and earthing system Fig. 1

Fig 1: Electrostatic bonding and earthing installation report table

Test parameter	Target	Actual - Ω	Comments
Steelwork to earth	Less than 10 Ω		
Cable to steelwork earth	Less than 10 Ω		
Test Point 1 to earth	Less than 10 Ω		
Test Point 2 to earth	Less than 10 Ω		
Test Point 3 to earth	Less than 10 Ω		
Test Point 4 to earth	Less than 10 Ω		
Test Point 5 to earth	Less than 10 Ω		
Test Point 6 to earth	Less than 10 Ω		
Test Point 7 to earth	Less than 10 Ω		
Test Point 8 to earth	Less than 10 Ω		
Test Point 9 to earth	Less than 10 Ω		
Test Point 10 to earth	Less than 10 Ω		
Steelwork to earth	Less than 10 Ω		
Cable to steelwork earth	Less than 10 Ω		

If you'd like to learn more about how Sigma-HSE can help you with DSEAR, Hazardous Areas or Electrostatics, check out sigma-hse.com.

Contact Details

Unit 2 Moorside Point,
Moorside Road
Winchester, UK
SO23 7RX
Tel: +44 1962 840570
Email: info@sigma-hse.com