Anti-Static Flooring Requirements in Explosion Hazardous Areas - South Africa

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Introduction

In explosion hazardous areas such as factories handling explosives it is well known that very strict anti static measures are implemented. Little is however done in most areas considered as explosion hazard due to the presence of flammable atmospheres though.

Explosion protected equipment is tested or evaluated for their contribution to electrostatic charge, moving equipment such as conveyer belts and plastic covers and even mobile flow bins (IBCs) are considered before use but what about the flooring?

Anti-static flooring is very often overlooked in hazardous area safety management and I hope to shed some light on the requirement in South Africa. I have to raise caution that I might not be able to find all requirements and the reader must use their own judgment and research to fill in the gaps.

Certified Zone 1 suitable IBC.

I. Overview of the current requirements (in South Africa)

SANS 10086-1 "The installation, inspection and maintenance of equipment used in explosive atmospheres Part 1, Installations including surface installations on mines" has a clause on Static electricity and then refer to SANS 10123 ". SANS 10123 is fairly comprehensive in what anti-static measures can be taken and I`ll try to make some sense of it with regards to explosion prevention in this paper.

Another standard worth taking note of is SANS 6160 (2005) with the title "Electrical resistance of floors", it describes a test technique for the resistance of floors, this standards is also maintained as part of the scope of TC65.

II. Overview of Static Charge

You can skip this section if you already understand the basics.

Static electricity is of common occurrence but often causes danger, discomfort, or inconvenience.

Under some conditions electrostatic voltages can reach a value in excess of the dielectric strength of air (or other medium) and a spark discharge then occurs. Hazardous conditions exist where such a discharge is liable to occur in areas containing flammable materials. In other instances, static electricity does not present a danger but can cause operational problems during manufacturing or handling processes. Articles sticking to each other or neighbouring objects, and the attraction of dust and foreign material are common examples.

Static electricity may indirectly be the cause of serious accidents if involuntary, muscle contractions from a discharge through a person causing entanglement in moving machinery, falls, or similar accidents.

Generation of static charge:

Static electricity is generated when electric charges are separated into equal quantities of opposite polarity by separation or relative movement between contacting surfaces of different physical and/or chemical structure. The surfaces may be of solids or liquids, or of one solid and one liquid. Generation can occur between two substances that are apparently identical but have differing surface properties due to the presence of solid or liquid contaminants.

Generation can occur within one liquid or mass of dust undergoing internal movement because of agitation. Under such conditions equal quantities of charges of opposite polarity may be physically separated and give rise to internal static generation within the liquid or dust.

When two electrostatically charged bodies are separated, an electrical stress (expressed in terms of field strength or potential gradient) is created that tends to reunite the separated charges and opposes further separation. Energy has therefore been applied to the system to bring about this separation and part of the energy is contained in the electric stress so formed. When the electric stress exceeds the breakdown strength of the medium between the separated bodies a static discharge will occur.

Often the generation of static electricity cannot be completely prevented because its intrinsic origins are present at every interface. In many instances the generation goes unnoticed because the resistance between the surfaces is low and allows the charges to recombine as quickly as they are separated. An accumulation of static electricity will result where the rate at which the charges are separated in the generation process exceeds the rate at which the charges recombine.

Electrostatic charges can be induced on a conductive object that is brought into the vicinity of a charged body. The part of the object that is closest to the charged body will exhibit a charge of opposite polarity to that on the body. Under such conditions the overall electrostatic charge on the object is zero, but substantial charges, with their inherent dangers, can be present at particular parts of the object.

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III. Overview of the dangers of fire and explosion

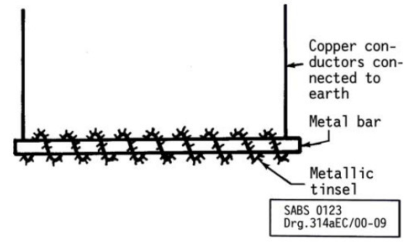
This seem obvious but the standard (SANS 10123) is actually quite clever in addressing this, I would have thought there is one "danger" and that is the *danger of Ignition of an explosive atmosphere* but the standard lists four "dangers" and claim only one needs to be addressed, the stated dangers are:

1) if "an effective means exist for generation of static electricity",
2) if "a means exist for accumulation of the separated charges and attaining sufficient potential difference between them",
3) if "a static discharge, having sufficient energy for ignition, occurs between separated charges", and
4) if "the discharge occurs in or on a flammable material".

In order to make sense of this these "dangers" I listed them below and discussed it in table form:

Dangers	**Discussion**	**How to prevent**
1) What means can exist to generate charge?	Moving materials, either through air or other friction such as mixing of liquids. A moving road tanker carrying non-conductive (high resistance) material is likely to charge due to the movement of the material in the tank.	The standard lists two "Object" types: ➢**Conductive:** ✓**Bonding and Earthing** If the total resistance between the object and earth exceeds 1MΩ, install a separate earth conductor and connect electrically isolated sections/parts by bonding. ✓**Conductive and anti-static flooring** ✓**Mobile apparatus** (read forklift trucks) Conductive mobile apparatus may
2) What can accumulate charge to attain *sufficient* potential?	Any material with a *high* resistance. High resistance materials cannot "move" electric charge and such build-up is then discharged in a spark.	
3) What can	According to SANS 10123 a discharge	

discharge sufficient energy for ignition.	of around 200uJ is dangerous but we know from other codes that 20uJ is already enough to ignite gasses such as hydrogen and acetylene.	become charged. If it operates on an antistatic or conductive floor, ensure that there is a conductive path between the axle of each wheel, castor, or roller and the surface normally in contact with the floor. When such apparatus operates on a floor that is not anti-static or conductive, firmly attach a suitable lead to the apparatus and to earth. ✓ **Rotating shafts** ➢ **Non-conductive:** Note: this cannot (in general) be corrected by earthing or bonding alone but by placing an earthed conductive body in contact with (or near to) the non-conductive object can increase the capacitance between the two and decrease the energy of the system. ✓ **Increasing the conductivity of the object** The surfaces of some materials can be rendered conductive by wetting them with a conductive liquid. ✓ **Arranging metal strips in contact with the non-conductor.** It is absolutely essential that the conductive material is electrically continuous and earthed. ✓ **Increasing the humidity of the air.** Note: Some limitations exist here. ✓ **Ionization of air** Ionization of the air provides a supply of ions that neutralize the accumulated charge on a non-conductive object to a greater or lesser extent. One of the methods are using "static combs" that is placed close to the charged materials and reduce the field strength of the objects.
4) Where can discharge occur on flammable materials.	This is interesting, if a liquid is charged such charges are likely to discharge from an "interruption" in the surface. For a charged non-conductive surface such discharge will occur where contaminants enter or where a metal (or other) part interrupts the surface.	

		 Typical construction of static comb

Slightly off-topic for this paper but the question often arises what about **Persons** entering the potentially explosive areas and Static Charge, SANS 10123 "thought" about that too:

"The human body is a conductor and, when insulated from earth, can become electrostatically charged.

Unless other means of earthing personnel and mobile apparatus are employed, install an anti-static or conductive floor having a resistance to earth not exceeding 1 MΩ when measured across two electrodes with a diameter of 60mm placed 1m apart. Each have a specified weight (2kg) and is covered in tin foil. "

Does this mean that unless personnel and mobile devices are earthed the floor have to comply with this requirement, it seems that way.

It goes ahead to state that:

"if electrical apparatus is used in a room, install an anti-static floor, having a resistance to earth of at least 50 kΩ, to reduce the danger to personnel of electrocution."

An unearthed floor will, of course, reduce even further the danger of electrocution but does nothing for reducing static hazards.

"Where the danger of electrocution does not exist, e.g. because of the complete absence at all times of electrical apparatus, a conductive floor, having no lower limit of resistance to earth, may be used", this is the flammable store outside your plant with no light or other electrical equipment.

"To combat static electricity, the floor need not be earthed and sufficient safeguard is provided if the resistance between two electrodes (described above), does not exceed 1 MΩ (and, in the case of an anti-static floor, is at least 50 000 Ω), in which case equalization of charges will occur".

So in short the floor resistance should to be between 50kΩ and 1MΩ.

How does this compare with other prescribed "anti-static" measures:

In SANS 60079-0 "avoidance of electrostatic build-up on non-metallic materials" specifies a test where a conditioned sample must have a surface resistance of more than 10GΩ between two conductive strips painted onto the surface (over about 1000mm^2) measured at 50% relative humidity. This requirement is not comparable to the requirement for floors, but include plastic materials that might experience completely different charging mechanisms.

SANS 10086-1 have a clause on static electricity but mainly refer to SANS 10123 and refer to the requirement to avoid static charging of non-metallic enclosures during cleaning (normally a warning to "wipe/clean with a damp cloth" is included on such equipment enclosures).

SANS 6160 is an interesting twist in the story, it specifies in detail a measuring device with three contact electrodes. This device is then placed on the factory floor and the resistance is measured over the floor between the electrodes and the "place where the floor is earthed" (SANS 10123 states that the floor need not be earthed?). A resistance measured in this way must not be outside the range of 200kΩ-10MΩ (with an average of 500kΩ-5MΩ) measured over the entire surface of the floor every 5m^2, so this is somewhat in line with SANS 10123 except for the earth point.

In summery the requirements per standard document:

Code	Discussion on the requirement.
SANS 10142-1	Not much mentioned except a Note: "Prevention of the build-up of static electricity is recommended".
SANS 10086-1	Just refer to SANS10123.
SANS 10123	Floors must have a resistance of between **50kΩ** and **1MΩ** measured over 1m using the specified aluminium foil covered electrodes.
SANS 6160	Floors must have a resistance of between **200kΩ** and **10MΩ** (with an average of between 500kΩ-5MΩ) measured every $5m^2$ (every 2,2m apart?) using the specified electrode and the floor earth point (that might not exist).
SANS 60079-0	10GΩ over 1 $000mm^2$, but for non-metallic materials measured and conditioned in a Laboratory, not specifically intended for floors.

IV. Conclusion:

SANS 10123 is a useful standard to study if you want to know the requirements for anti-static flooring and I am of the opinion that it is very often overlooked (in South Africa) anyway and might need a serious re-visit.

V. References:

SANS 10142-1 "The wiring of premises, Part 1: Low-voltage installations".

SANS 10086-1 “The installation, inspection and maintenance of equipment used in explosive atmospheres, Part 1: Installations including surface installations on mines”.

SANS 10123 "The control of undesirable static electricity".

SANS 6160 "Electrical resistance of floors"

I sincerely hope this was useful, let me know what you think,

Vriendelike Groete/ Kind Regards, Jaco Venter.