White Paper

Static grounding protection for Rail Tankers

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In the hazardous process industries, more commonly referred to as the "EX" industries, static electricity is generated virtually all of the time. Various grades of crude oil, refined petroleum products like LPG, and a host of chemicals fall into a category of materials that are often referred to as "static accumulators". Materials in this category are known to be powerful attractors of electrons from other materials and resist "letting go" of electrons they come into contact with. In other words they "accumulate" static charge.

In a typical rail tanker loading operation, the static accumulating product is transferred from a storage tank via a gantry loading system into a receiving rail tanker. We can refer to the equipment involved in the transfer of product collectively as the product "transfer system". As the product makes its way through the transfer system to the rail tanker, the molecules in the product become electrostatically charged.

If the rail tanker does not have a direct connection to earth it will accumulate electrostatic charges on its surface, which will result in the voltage of the rail tanker rising dramatically in a very short space of time. Because the rail tanker is at a high voltage, it will seek to find ways of discharging this excess potential energy and the most efficient way of doing this is to discharge the excess electrons in the form of a spark.

Energy discharged in static sparks.

Grounded objects that are in close proximity to charged objects are good targets for electrostatic sparks and permitting the uncontrolled accumulation of static electricity in an EX atmosphere is no different to having an engine's spark plug exposed to a flammable atmosphere.

If the rail tanker is not grounded, its electrostatic voltage can build up to hazardous levels in less than 20 seconds. Table 1 illustrates how much energy can be discharged by a spark from a rail tanker charged to 20,000 volts.

TankCar charged to 20,000 volts	Potential Spark Energy (mJ)
Tank car	1000

Table 1. Potential energy of sparks from various objects.

When the energy of sparks discharged by static electricity is compared with the minimum ignition energies of a wide range of petroleum products and flammable chemicals, it's easy to see why the rail tanker and any equipment connected to it, like flexible hoses and piping, should be bonded and grounded.

As can be seen in Table 1, electrostatically charged rail tankers can discharge sparks with a huge amount of energy. At these energy levels the prevention of electrostatic shocks to workers is also an important safety consideration. Involuntary physiological reactions caused by electrostatic shocks could lead to trips and falls and could be particularly hazardous when personnel are working above ground level.

Of the several factors that contribute to static charging, the one variable that must definitely be controlled is the grounding of the rail tanker. Grounding the rail tanker ensures that the rail tanker's resistance to the general mass of the earth is maintained at a level that does not impede the safe transfer of static charges from the rail tanker to ground.

In North America the grounding of rail tankers with dedicated static grounding systems is common practice. In Europe, the practice of rail tanker grounding is mixed. Some sites do it, some don't. For sites that do not actively ground rail tankers there is an assumption made that the tank of the rail tanker is well bonded to the chassis and that static charges generated by the product transfer operation can pass from the chassis through the rail tanker's wheels to earth or back to the loading gantry via bonding connections.

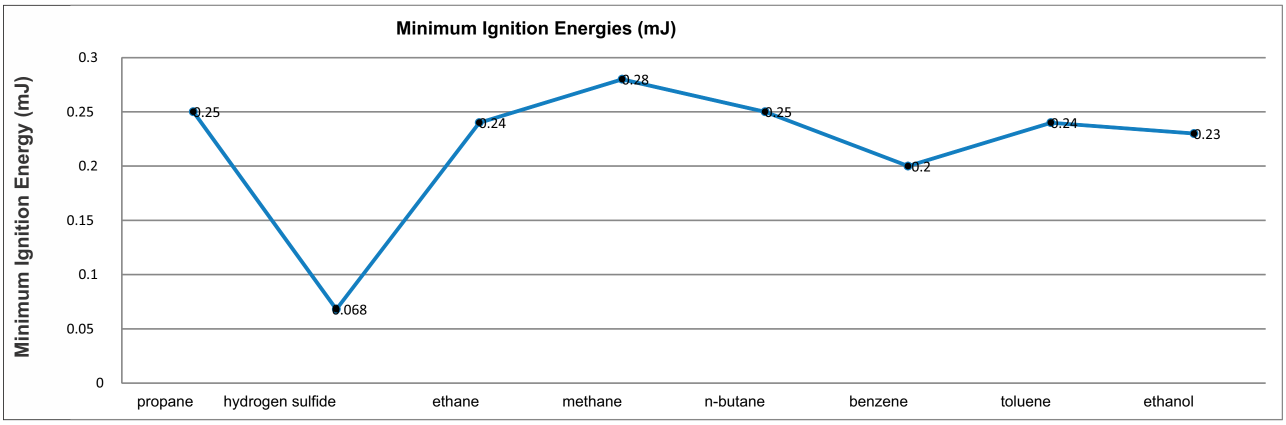

Fig. 1 The MIEs of common petroleum products.

In order to dissipate static charges from the rail tanker, there is an expectation that the tracks on which the rail tanker is sitting has a direct connection to earth or is bonded to the loading gantry, thus equalising the potential difference between the gantry the filling arm) and the rail tanker. If this is the case the electrical continuity from the rail tanker back to the loading gantry, via the safety critical bonding connections between the track and the loading gantry, should be verified frequently, preferably prior to every transfer. Bond verification operations can be conducted by an electrician with a meter or the bonded connections can be verified automatically with a gantry mounted static grounding system. So instead of relying on a passive circuit to bond the rail tanker to the loading gantry, either method described above will ensure isolated rails on which the rail tanker may be resting and/or broken track-to-loading gantry bond connections are identified before loading commences.

However, there are many rail tanker loading sites in Europe where these assumptions cannot be taken for granted, especially when there are concerns regarding the track's connection to earth. Some sites simply do not own the tracks that are present onsite which precludes engineers from conducting fall of potential tests on the tracks in order to determine if the tracks have a connection to earth. Because the site does not own the tracks their engineers are also limited by how much they can "interfere" with track, i.e. install their own bonding wires from the track back onto their property. Instead, the site will connect the rail tankers to the loading gantry with static grounding systems. The gantry itself should be earthed, hence any static present on the rail tanker will be dissipated to earth via the loading gantry.

Other sites across Europe choose to ground their rail tankers because the ground on which the network of tracks resist does not have a reliable connection to earth, hence they choose to ground the rail tankers with static grounding systems as a matter of good practice.

Industry codes of practice related to the static grounding of rail tankers in EX atmospheres:

Working on the assumption that there is good electrical continuity from the tank to the wheels of rail tankers, the sections regarding rail tanker grounding in IEC 60079-32 and TRGS 727:2016-01 recommend a bonded connection between the rail tracks and the loading gantry not exceeding 1 meg-ohm. However, the vast majority of conductors that are used to connect rail tracks and to the loading gantry will be heavy duty metal conductors, –therefore a benchmark value of 1 meg-ohm seems unreliable as anything above 10 ohms would indicate a potential fault somewhere in the circuit.

North American associations like the National Fire Protection Association and the American Petroleum Institute each publish their own codes of practice for controlling the risks associated with rail tanker loading in EX/HAZLOC areas.

NFPA 77 "Recommended Practice on Static Electricity" (2014) and API RP 2003 "Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents" (2008) are publications written by committees of EX industry professionals who are recognised experts in the area of static control for hazardous areas. Where the grounding of rail tankers is referenced these publications do highlight the risk of non-conductive wear pads and bearings which could prevent static electricity passing from the tank to the wheels of the railcar, hence resulting in the hazardous accumulation of static electricity on the tank of the railcar.

What is clear from the recommendations of NFPA 77 and API RP 2003 is that 10 ohms in the grounding and bonding circuit is the maximum resistance recommended for equipment at risk of electrostatic charging in EX atmospheres. While API RP 2003 goes one step further in recommending 1 ohm or less, if a grounding system with ground status indicators is in use, 10 ohms is satisfactory. This is because the grounding system is continuously monitoring the resistance in the grounding circuit, so that if it rises above 10 ohms, the grounding system can signal this potential hazard to the operator of the loading gantry. Another important recommendation is to use interlocks wherever possible, to ensure the transfer does not take place if grounding is not present. By halting the movement of product, the charge generation source is eliminated thus preventing additional charging of the rail tanker.

Specifying a Static Grounding System for rail tanker loading/unloading operations.

One of the main problems with static electricity is that it is not something the operators can see, smell or hear. This characteristic of static electricity can, unfortunately, promote an attitude of "it can't happen to me" or "it doesn't exist" amongst personnel operating loading gantry systems. A grounding system that combines a simple visual "GO / NO GO" communication via a traffic light model of indication with interlock control capability is the most effective means of controlling the risk of ignitions caused by static electricity during rail tanker product transfer operations. Interlocking the transfer system with the grounding system is probably the ultimate layer of protection equipment specifiers and designers can take to ensure the rail tanker is grounded.

Newson Gale recommends the Earth-Rite® PLUS for bonding rail tankers to rail tanker loading gantries. Along with demonstrating the full range of ATEX and IECEx certification for all gas and liquid vapour groups, it also ensures there is a 10 ohm, or less, connection between the rail tanker and the product transfer system. By simply connecting the grounding clamp to the rail tanker the Earth-Rite® PLUS automatically verifies if the rail tanker is connected to the loading gantry by delivering an Intrinsically Safe monitoring circuit to the system's Factory Mutual approved grounding clamp. The Factory Mutual approved stainless steel heavy duty grounding clamp ensures that a strong initial connection, via a pair of tungsten carbide teeth, is made to the rail tanker, and is then maintained for the duration of the product transfer operation, resisting movement caused by vibration or accidental dislodging.

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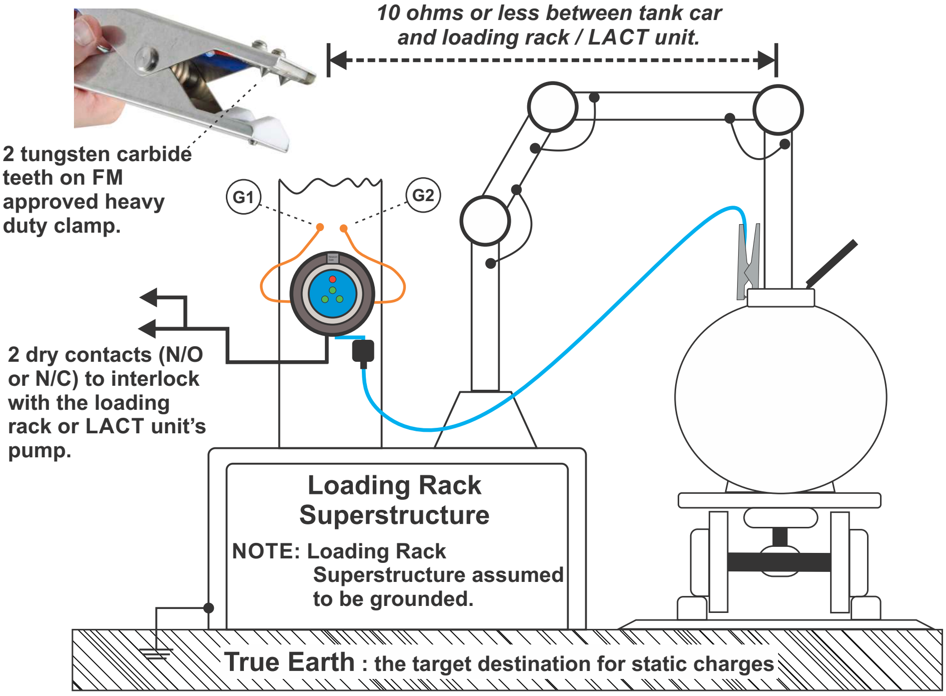

Fig. 2 The Earth-Rite® PLUS uses an intrinsically safe signal (Zone 0 / Zone 20) to ensure there is continuity through the tank of the railcar, through the chassis, through the wheels, through the bonded connection back to the gantry The signal returns to the Earth-Rite® PLUS via the G1/G2 connections to the gantry. The entire circuit is monitored for the duration of the transfer operation ensuring there is a continuous dissipation path between the tank of the railcar and the earthed gantry

Unlike standard grounding systems that rely on the their non-monitored electrical ground connection to dissipate the static charges generated by the transfer, the Earth-Rite® PLUS ensures that its dedicated static grounding connection to the loading gantry is always monitored, via the static ground connections G1 and G2 (ref. Fig. 2). This ensures there is a monitored connection directly between the rail tanker and the loading gantry. This is an important feature as we are depending on the loading gantry's verified ground connection to dissipate static charges from the rail tanker to the general mass of earth.

When the Earth-Rite® PLUS verifies the rail tanker is connected to the loading gantry superstructure, a cluster of attention grabbing green LEDs pulse continuously to inform the operator that the system is actively monitoring the integrity of the ground loop.

A pair of volt-free double pole, double throw, contacts can be interlocked with the power delivered to the pump or PLCs to halt the product transfer operation if the Earth-Rite® PLUS detects a resistance of more than 10 ohms in the ground loop between the rail tanker and the product transfer system. Shutting down the transfer operation ensures the generation of static electricity is stopped thereby eliminating the risk of the rail tanker accumulating a voltage and discharging a static spark which could ignite combustible flammable or dust atmospheres present in the spark discharge gap.

Fig. 3 Earth-Rite® PLUS ground status indicators pulse continuously when grounding is in place.

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