

# VEHICLE MOUNTED STATIC GROUNDING VERIFICATION SYSTEM

By Mike O'Brien

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Vacuum trucks provide an important contribution to the transportation and recovery of flammable and combustible products within the hazardous process industries. Their efficiency and versatility means they can fulfill a broad array of duties ranging from the transfer of chemicals in manufacturing production, to removing waste deposits from storage tanks or performing hazardous material recovery at the site of road & rail traffic incidents.

Equally, truck deliveries within retail gas & petroleum distribution and the food & beverage industry require transportation to locations where static grounding systems may not be installed or verified grounding points may not be present to ground the tanker while it is transferring material.

In the recovery and transportation of flammable & combustible products the generation and build of electrostatic charges can pose a significant flammable hazard to personnel and equipment if correct static grounding precautions are not put into action. The relative motion and interaction of different materials leads to the instantaneous combination and separation of positive and negative charges. If these charges do not have a means to dissipate from the objects or materials they come into contact with, i.e. flow to ground ("true earth") or share charge with available opposite charges, they become "static" and raise the electrical potential difference of the object or material on which they are accumulating.

In essence, this potential difference is equivalent to a stored



**Figure 1.** Static grounding system installed on vacuum truck used to recover flammable waste from storage tanks

source of energy which is immediately seeking to discharge itself in order to return the object to a natural state of electrical equilibrium. If the energy is allowed to discharge in an uncontrolled manner it will do so, in the majority of cases, in the form of an incendive electrostatic spark. Should such an event occur in the presence of a vapor or dust, when they are within their respective ignitable flammable and combustible thresholds, there is a high probability that ignition of the material will occur.

The potential energy stored on an object that can be released in the form of an electrostatic spark is equivalent to:

$$W = 1/2(C).(V)^2$$

The total energy available for discharge, (W), is equal to the product of the object's capacity to store charge (capacitance, C) and the square of the voltage, (V), of the body. The voltage of the object is increased by the generation and accumulation of electrostatic charges. To illustrate, a small object like a metal bucket has a capacitance of around 20 pico-farads. If electrostatic charges are permitted to accumulate on the bucket, raising its voltage by just 10 kilo-volts, 1 mJ of spark energy can be discharged by the object.

One mJ is capable of igniting the majority of flammable vapours and gases. In real world processes the larger

charge storing capacity of equipment like tanks, hoses, lances and trucks (up to 5000 pico-farads), when combined with high potential differences caused by the rapid interaction of liquids and solids, can generate much more significant levels of stored energy ready for uncontrolled discharges.

#### EXAMPLES OF RECORDED INCIDENTS CAUSED BY UNCONTROLLED STATIC IGNITIONS

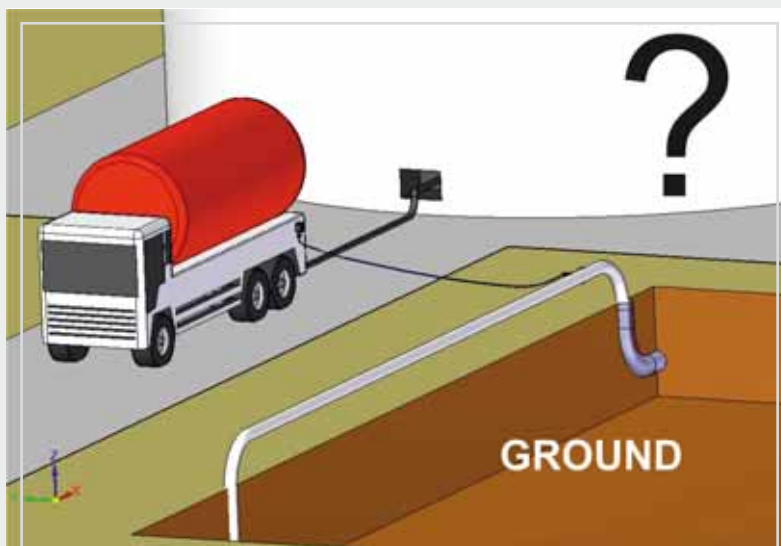
- In 1998 an explosion, and one fatality, occurred when granular polypropylene was being vacuumed from a dust collector into a large vacuum truck. The cause of

the explosion was a static spark that discharged from the lance to the dust collector, because a non-conductive hose was used to connect the lance to the vacuum truck. Because the hose was non-conductive, instead of static charges flowing through the hose to the grounded truck, static charges accumulated on the metal lance, raising its potential difference relative to the dust collector. In order to equalize the potential difference of the lance, the static spark discharged to the dust collector, igniting the combustible atmosphere in the process.

- A fire in a toluene sump was caused when a static spark discharged from the conductive metal windings of a rubber hose to the metal rim of the sump. Although the conductive windings of the hose were bonded to the truck, the truck itself was not grounded. This caused static charges to accumulate on the windings of the hose, raising its potential difference relative to the sump.

#### THE COMMON DENOMINATOR

The common denominator for these incidents is that the rate of electrostatic charge generation on the components of the system were permitted to exceed the rate of charge dissipation resulting in the accumulation of static charges on some part of the transfer



**Figure 2.** Is grounding point (e.g. underground piping) capable of dissipating electrostatic charges?

system.

The transfer system includes the lance, hose, hose connections, truck collection chamber and the chassis of the truck itself. To remove the risk of an incendive static spark discharges causing a catastrophic accident these components must be correctly bonded and grounded.

#### WHAT DO THE STANDARDS RECOMMEND?

API 2219, entitled "Safe Operation of Vacuum Trucks in Petroleum Service", is probably the most relevant standard to address the hazards of static electricity in vacuum truck operations directly, although valuable information and recommendations can be sourced from CLC/TR: 50404 and NFPA 77. Of the many recommendations outlined in API 2219, the most relevant instruction is to fully ground the truck by connecting it to "a designated, proven ground source", before commencing with transfer operations.

The "ground source" describes an object with a low resistance connection to ground. It is this connection to ground ("true earth") that will guarantee the rapid dissipation of electrostatic charges from the equipment ensuring that personnel and the equipment being used are protected from the risk of fires or explosions. The API standard provides some examples of potentially suitable grounding sources, including large storage tanks or piping that is known to run underground.

The standard also states the importance of confirming that the connection resistance between the truck and the designated grounding point is less than 10 ohms and that this resistance should be verified with the use of an ohmmeter. All conductive and semi-conductive components of the transfer system must be bonded together with a connection resistance not exceeding 10 ohms.

#### PROTECTING PERSONNEL AND EQUIPMENT IN EVERYDAY OPERATIONS

Most chemical processing sites have designated grounding points to which trucks must be connected prior to transferring product. Normally, these sites follow a strict policy of adhering



to the standards whereby electricians periodically check the resistance of the grounding points to ensure they have not degraded because of environmental and industrial life-cycle effects.

In hazardous material recovery operations, for example sucking up spillage from road & rail incidents, designated grounding sources are not available to ground the truck. In such events, the recovery team must bury rods in the ground and take resistance readings of the rods to ensure they have a secure static ground connection.

For retail petroleum and gas distribution and the food and beverage industry, many point-of-delivery destinations do not have static grounding systems installed and the best the transporter can expect is that there is a designated grounding point to which he can connect the delivery truck. However, he will have no means of confirming whether or not the grounding point has a low resistance connection to earth.

The two key conditions for protecting personnel and equipment from incendive static spark discharges depend on:

- Verifying that the resistance value of the ground point (the ground source) to true earth is of a known and verifiable maximum value that is capable of dissipating electrostatic charges.
- Ensuring the connection resistance between the truck and this verified grounding point is less than 10 ohms.

#### VERIFYING THE CONNECTION RESISTANCE OF AN OBJECT TO TRUE EARTH

The most common method of measuring the resistance of objects located in the ground to true earth is the "fall of potential" three point test method. This method is designed to measure the contact resistance of the surface of the electrode to the soil it is in con-

tact with. Soil resistivity levels can vary greatly ranging from very low values of around 2 ohm meters for marshy ground to over 1000 ohm meters for rocky ground.

The 3 point test method is a relatively complicated and time-consuming procedure requiring a certified engineer or electrician, with the requisite level of experience and training, to follow the correct procedure and determine when a reliable, low margin-of-error, resistance reading is established.

Essentially, three electrodes, including the one to be tested, are inserted into the ground and a range of readings are taken until uniform and consistent values of resistance are obtained. Skilled interpretation and interpolation of the acquired data is required to ensure that the readings are not taken at "face value".

To illustrate, there are specific depths to which rods should be buried in relation to their respective distances from each other and the person con-

ducting the test must know where to position the rods to ensure the soil resistance between the electrodes do not overlap and distort the readings. The rods must also be buried in a straight line relative to each other.

In some cases, it may be necessary to introduce extra rods to smooth out resistance readings; however, their corresponding depth of insertion can be reduced. This can be useful in situations where the soil hardness impedes the insertion of rods to their normal depths. The tester must also ensure the meter(s) used to measure the required values of resistance, current and voltage in the circuit does not suffer any electrical noise distortion either due to the close proximity of the cables measuring the circuit or the presence of an external electrical network. These are technical nuances that untrained or unqualified personnel can miss when trying to determine whether the ground point being tested will safely dissipate static charges.

Another factor that must be taken into consideration when using fall of potential meters, is that they require high voltage inputs to break down the resistance of the soil. Extreme caution should be taken when readings are being taken in potentially flammable and combustible atmospheres.

From a technical standpoint, the fall of potential method offers a reliable means of estimating the contact resistance of the desired grounding point to true earth. The major drawback, however, is that it requires a qualified and experienced engineer or electrician to determine whether or not the static grounding point will function as intended.

For processing sites that place heavy demands on their electrical and mechanical maintenance resources, delays to production, recovery and cleaning operations can occur if electricians are not available to measure and verify the grounding points to which the trucks must be connected.

## VEHICLE MOUNTED STATIC GROUNDING VERIFICATION SYSTEM

Responding to the demands of engineers and companies engaged in the transfer and recovery of flammable and combustible products, Newson Gale is conducting the last phase of "real-world" trials of a new truck mounted static grounding system that is capable of demonstrating full compliance with the API 2219 standard. The Mobile Ground Verification system (MGV for short) has been designed in conjunction with hazardous material handling specialists, emergency responders and chemical manufacturing sites where limited access to electricians can delay hazardous material transfer operations.

The grounding system performs two primary functions that match the requirements outlined in the API 2219 standard. The first primary function is designed to automatically verify if the truck is connected to a ground point with a low enough resistance connection to true earth that is capable of

dissipating static charges safely.

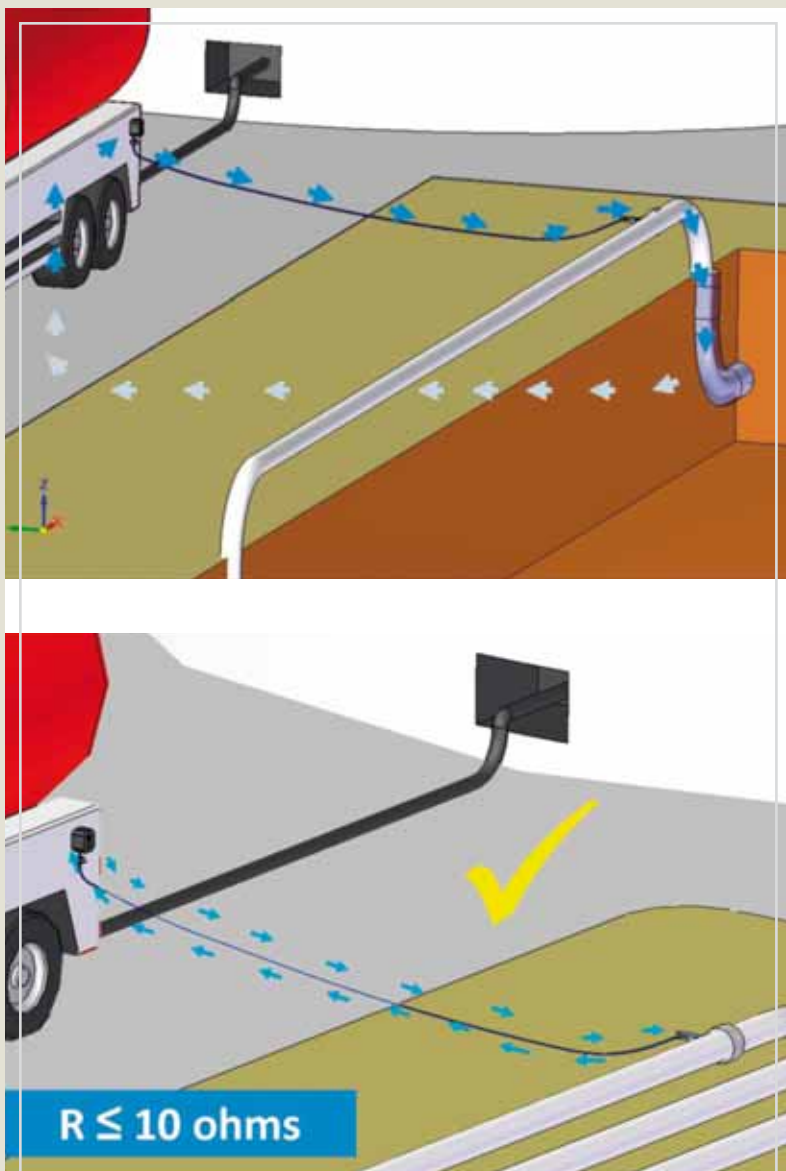
The second primary function verifies that the connection between the truck and the verified ground point is less than 10 ohms for the duration of the material transfer process.

### User Friendly Interface and Operation:

The MGV system has a user friendly operator interface which indicates when transfer operations are safe to begin. The grounding system is con-



Figure 3. The Earth-Rite MGV truck mounted static grounding system



**Figure 4 and Figure 5.** The MGVS system confirms the pipe is connected to ground and also confirms that the truck is connected to this point for the duration of the transfer operation

nected, with a quick release static grounding clamp, to either buried structural metal work or to rods that are hammered into the ground.

When the operator connects the clamp to the object believed to have a low resistance ground connection, the MGVS system immediately verifies whether or not the contact resistance of the object to earth is sufficiently low enough to dissipate static charges that could build up on the truck's transfer system. This function is referred to as "Static Ground Verification".

The system also confirms that the truck's connection to the proven ground point is less than 10 ohms and monitors the health of this connection

for the duration of the transfer process.

This function is referred to as "Continuous Ground Loop Monitoring". This function ensures that static charges generated on the transfer system have a clear, low resistance path to the MGVS's verified ground point.

When both conditions are positive, a cluster of attention grabbing green LEDs pulse continuously, informing operators that they are in a safe position to start material transfer operations. A strobe light, which can be mounted at an elevated position on the truck, provides a wider field of vision to the operators when they are fully engaged in the transfer operation. Should the clamp be disconnected

during transfer the system will shut down the LEDs and the elevated strobe light.

An additional factor of safety can be introduced by interlocking the pump with the grounding system so that if the truck loses its ground connection, the system shuts down the transfer process, thereby cancelling out the generation of electrostatic charges.

### Simple Visual Diagnostic Informs Operator when a Poor Ground is Detected or Resistance in the Ground Loop is Greater than 10 Ohms:

If the system remains in a non-permissive state when the clamp is connected to the grounding point, a simple and effective visual diagnostic tells the operator if this condition is due to the ground point not having a sufficiently low enough contact resistance to true earth or if the truck's connection to the ground point, via the grounding clamp, is greater than 10 ohms.

If the ground connection resistance to true earth is negative, the operator may reattach the clamp to another buried structure. If grounding rods are being used, the operator may spread a conductive solution around the rod, enhancing the conductivity of the soil, relocate the grounding rod, or bury additional grounding rods to lower the system's overall resistance to earth. If the ground loop monitoring 10 ohm resistance reading is negative, the operator may need to "jig" the clamp to enable the teeth to bite through contact resistance inhibitors, particularly if the grounding point is covered in protective coatings, rust or dirt. The system will then register if the clamp has achieved a connection resistance of less than 10 ohms.

### Easy Installation

This system is permanently fitted to the truck and is powered by the trucks' 12V or 24V battery power supply. The system PCB is protected in a robust IP66 GRP enclosure and is supplied with an ATEX / Factory Mutual approved grounding clamp and a range of quick releasing Hytrel protected 2 conductor cable options. ■