

Lightning Protection

Petrochemical industries

Lightning is a natural phenomenon that can have a significant impact on environment, production and people interacting with thermal petrochemical industries. However, these consequences can be avoided with suitable lightning protection. In practice there are two issues:

- **What are the main hazards associated with storage, routing and distribution of combustibles, making them vulnerable to lightning strikes?**
- **How to optimize lightning protection from a technical and economic point of view?**



Tanks explosion in a refinery (France)



1. Storage, routing and distribution of combustibles

In petrochemical industries (refineries, oil terminals,...), large quantities of combustibles are stored in outdoor tanks and are routed by metal pipes to process units in refineries or for distribution. Because of their properties and characteristics of the ambient air, these products generate explosive atmospheres.

The provision of an ignition source may cause the explosion of these combustibles. Lightning can cause damage directly or indirectly, it is a risk that must be taken into account.

Lightning can strike storages, process units or pipes directly but can also cause damage by causing surges on electric lines flowing in or near these dangerous areas, or even penetrating into the tanks.

The same problem was identified on gas stations, where explosive vapors are generated by several facilities : loading station, buried fuel tanks, nozzles, LPG facilities, ...

Risks related to lightning are significant when the annual stored volume dispensed is greater than 3,500 m³ and become important for annual stored volumes exceeding 8,000 m³.

2. Protection optimization: technical and economic aspects

To avoid explosions and consequences for people, environment and production, SEFTIM worked with operators of tens of power plants and oil terminals, and hundreds of filling stations to find solutions.

- **For protection against direct lightning effects**, the use of metal structures such as natural air-termination components and down-conductors was proposed in accordance with the international standard IEC 62305-3 when they have sufficient thickness. The concept of hot spot at the impact point is important and must be taken into account. This is the case of tanks, process units, roofing above the dispenser pumps on filling stations. The specific case of geodesic roof tanks (system to protect tanks against weather conditions) was studied by SEFTIM.



Geodesic roof tanks
www.larco.fr

Lightning Protection

Petrochemical industries

- **For protection against indirect lightning effects**, it was recommended to install Surge Protective Devices (SPD) to protect a few electrical lines. In most of the cases, piperacks and cable ducts (with a few extra precautions) bring sufficient protection to ensure safety of installations. However, if SPDs are the preferred solutions for a limited number of lines protection (for example in gas station), installation and maintenance of these SPDs are expensive on plants such as refineries or oil terminals, where :

- ✓ there are a lot of cables,
- ✓ it is difficult to install new Surge Protective Devices in existing panel boards.

SEFTIM optimizes the protection of cables by using metal cable ducts, or the cable shields with grounding on both sides. Conductors settled above cables routing or directly buried, were also used in order to reduce the stress on the shields. Studies and specific tests were conducted in the SEFTIM laboratory, to allow the use of the armored cables as an alternative for non-shielded cables.



Copper conductor above cables routing, for cable protection

SEFTIM has also taken into account the protection of equipment that are important for safety, especially oil detectors into separators, for example in gas stations. Once again, protection can be improved for these data lines, by using their shields.

In addition, protective means are often rated by SEFTIM for keeping the site operability. For example, on gas stations, SEFTIM has protected data lines between the nozzles and the payment terminal building or the monitoring system of fuel tanks, that are often remotely located.

- **For the protection of people**, two problems have to be taken into account : touch voltage and step voltage. In petrochemical plants like refineries and oil terminals, there are several high rise structures, like chimneys and columns that can sometimes reach 40 m high. These points will act as preferential striking points. There is a risk of side flashes even if a lightning rod is located at the top of these structures. In case of a lightning flash, the lightning current will flow to the ground through the various conductive parts (concrete rebars, metal structure), nearest to the impact point. The risks on these high structures are the same as for down conductors of a lightning rod : touch voltage and step voltage.

It is usually known that without protective measures, people within a radius of 3 m around the conductive parts at ground level are in a potentially dangerous situation (this risk increases of course with height, especially near the striking point). Protection of the technical staff may be addressed by :

- ✓ procedures restricting access to high rise structures,
- ✓ lightning warning systems, which effectively reduces the human risk and also help reducing other risks and thus reduces the lightning protection level required for the plant,
- ✓ an isolation of the earthing system.



High rise structures in a refinery – *lepoint.fr*

- **For the earthing system**, SEFTIM conducted continuity as well as low and high frequency earth measurements to define the characteristics of the existing earthing systems of plants, in order to improve, when needed, the characteristics of the existing protective means. This approach also allows to define the rating of the SPDs when the earthing system has not been designed to carry lightning currents by using existing natural earthing electrodes.



High Frequency earthing impedance meter