49, RUE DE LA BIENFAISANCE - 94300 VINCENNES - FRANCE
SAS AU CAPITAL DE 155 000 € – RCS CRETEIL B 316 719 855
SIRET 316 719 855 00025 – CODE APE 7112B - TVA : FR54 316719855
TEL. : 33 - (0)1.43.28.10.43 – FAX : 33 – (0)1.43.65.43.37

# Lightning Protection

## Thermal power plants

Lightning is a natural phenomenon that can have a significant impact on environment, production and people interacting with thermal power plants. However, these consequences can be avoided with suitable protection against lightning. There are three issues :

- **How to protect storage facilities used in thermal power plants?**
- **What is the risk for people close to high structures (chimneys) and lightning protection systems?**
- **How to ensure continuity of service and avoid economic losses in case of lightning strike?**

### 1. Storage and combustibles routing

In a thermal power plant, electricity is produced from heat coming from the combustion of products such as gas, coal or fuel-oil. These products are stored on open areas or tanks and are routed to the combustion plants by metal pipes.

Because of their properties and characteristics of the ambient air, these products generate explosive atmospheres : vapors (from gas or oil) or airborne dust (from coal).

Fuel tanks – *energie.edf.com*

Coal storage– *energie.edf.com*

An ignition source such as lightning may cause the explosion of these explosive atmospheres. Lightning can cause damage directly or indirectly and is then a risk that needs to be taken into account.

Lightning can strike storages 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.

To avoid explosions and consequences for people, environment and production, SEFTIM worked with major operators of power plants to find solutions.

- **For protection against direct lightning effects**, the use of metal structures such acting as natural air-termination components and down-conductors for the lightning current was proposed in accordance with the international standard IEC 62305-3 when these natural components have sufficient thickness. The concept of hot spot at the impact point is important and must be considered.

- **For protection against indirect lightning effects,** it was recommended the installation of Surge Protection Devices (SPD) to protect some power lines. In most of the cases, piperacks and cable ducts (with a few additional precautions) bring sufficient protection to ensure safety of installations. Studies and specific tests were conducted, to allow the use of the armored cables as an alternative to shielded cables. Thanks to this solution, cables protection can be optimized, from a technical and economic point of view.

- **For the protection of people**, two problems have to be addressed: touch voltage and step voltage. Solutions to these problems are the same as described below in the next bullet, for people nearby high structures or Lightning Protection Systems. People into the buildings nearby the lightning circuit must also be taken into account.

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### 2. Protection of people nearby high structures and nearby the Lightning Protection System

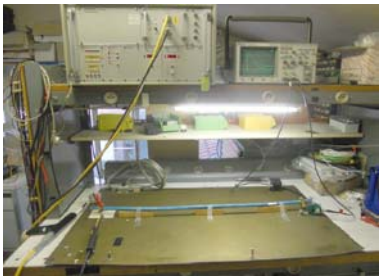
There are several high points in thermal power plants, like chimneys that can sometimes reach 250 meters high. These are the points where lightning will preferentially strike ; for these structures, there is a risk of side flashes even if a lightning rod is settled at the top.
In case of lightning impact, the lightning current will flow to the ground through the various conductive parts (concrete rebars, metal structure), closest to the point of impact. The risks on these high structures are the same as for down conductors of a lightning rod : touch voltage and step voltage, with the added risk of falling concrete blocks.
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 dangerous situation (this risk increases with height, especially near the point of strike). Protection of the technical staff may be considered by :

- ✓ procedures restricting access to high points,
- ✓ lightning warning system, which effectively reduces the risk for human and also reduces other risks and thus reduces the lightning protection level required for the plant,
- ✓ Isolating people from the earthing system.

Chimney – *wikipedia.org*

### 3. Protection of power lines and operability keeping

Armored and shielded cables



Test on cables in our laboratory

The main function of a thermal power plant is to generate electricity, it is essential to ensure the continuity of service, to avoid damage to the users, but also economic losses. Therefore, it is necessary to include the risk of loss of production and economic risk in the lightning risk analysis. Lightning effects are generally observed through the flow of a partial direct lightning current in these lines or through induced voltages.
According to experience feedback, in most of the cases, damages caused by lightning flashes on structures are electrical and electronic damages (because of surges flowing through the lines).
If Surge Protective Devices or Surge Arresters are the preferred solutions when there is a limited number of lines to protect, SEFTIM optimizes the protection of cables by using metal cable ducts, or the cable shields grounded at both sides, on facilities such as power plants, where :

- ✓ there are a lot of cables,
- ✓ it is difficult to settle new protections in existing panel boards.

SEFTIM conducted tests in its electrical and electromagnetic laboratory to evaluate the transfer impedances of various cables and in addition to determine immunity to induced surges especially for unshielded cables, to minimize the number of needed SPDs.

Furthermore, in order to avoid damages caused by potential differences between the various metal parts in the plant, all of these must be connected to a global equipotential earthing system which can dissipate lightning currents.
SEFTIM conducted several continuity tests and low and high frequency earthing measurements to define the characteristics of the existing earthing systems of plants, in order to improve equipotentiality or earthing at the most relevant locations. The aim is to minimize surges flowing through the lines and equipment located in the power plant, without using systematically SPD. The approach also allows the rating of SPDs when the earthing system has not been designed to carry the lightning current, by using available natural earthing electrodes.


High Frequency earthing impedance meter