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Lightning protection

Explosive storage

Lightning is a natural phenomenon that can of course create large damages on an explosive storage. However these damages can be avoided thanks to a well designed Lightning Protection System. The process to follow is based on three steps :

- **Lightning Risk Assessment to determine accurately the actual risks taking into account various possible scenarios.**
- **Technical Study of the adequate protective means to reduce the risk below the tolerable risk.**
- **Inspection of the LPS when the installation is finalized and periodic inspection to validate efficiency and long term behavior of protective means including the user training.**

1. Scenario study – Lightning Risk Assessment

Fireworks

There are various risks associated to the lighting phenomenon depending on the explosive type, the stored quantity and their use. Main use is for the industry (mining activity …), for entertainment (fireworks …) or for military applications (ammunitions…). Potential problems are listed below :

- Fire risk in the structure, triggered by lightning, that will create an explosion as a consequence
- Direct effect of lightning due to the electromagnetic field, mainly on detonators
- Puncture of a metal sheet or hot spot problem, leading to an explosion when the storage is too close of the metallic enclosure ((container …).
- Sparking over between structure and storage in case of direct lightning strike
- Sparkover due to an overvoltage generated by a service entering the structure and connected to an external line or connected to equipment on the structure or near the structure (camera, lighting …).
- Environmental risk for a few explosives where generated fumes are considered as toxic.

Explosive storage, due to the stored quantity and due to the various materials used for explosives, need a specific analysis especially when there are people in close proximity (operators, public, security team …). When a danger study is already existing for the storage, lightning should be included as a triggering factor or an increasing factor based on the conclusions of this study. When such a danger study doesn't exist, experience will help determining what are the dangerous scenarios.

The analysis must take into account the electromagnetic effects (radiated field …) and this will very often means complex calculations as well as a good knowledge of involved materials and lightning physics. Indirect effects (for example, melting of a metal sheet or spark over on a lighting circuit) should also be considered. Scenarios should be elaborated with competent people. Experience of the lightning expert is also a key factor as there are just a few published publication on that topic. Publications from DDESB (Department of Defense Explosives Safety Board) present a useful source of data for the possible danger scenarios related to explosive. Duration of the storage is also an important factor for risk assessment. Risk analysis methods are in fact based on a permanent industrial activity but a few industrial fields (mining activity, fireworks, ammunition temporary storage) have a variable or even very short duration (fireworks contest for example). A simple calculation according to the existing lightning risk standards cannot be carried out meaningfully. It is then necessary to develop specific methods, based especially on a monthly distribution of lightning impacts.

2. Technical study of the protective measures

As soon as the scenarios have been determined as well as the associated level of risk, it is necessary to implement lightning protection measures taking account of the explosive specificities. First, this study must consider the available thunderstorm warning systems on site. This may be a local storm detector that should then be able to resist to the local environmental stress as well as temperature conditions where the TWS is installed or a national network when such a network exists.

Mining activity

SEFTIM is qualified by Ineris

And certified ISO 9001 by Bureau Véritas Certification

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The efficiency of this thunderstorm warning system (named FTWR in the standard EN 50536/IEC pr62793) must be compatible wit the efficiency determined during the lightning risk assessment.
Based on the storm detector, procedures should be established to reduce the time of presence in dangerous areas in stormy periods and especially to avoid any work or handling of explosives including their transportation from or to the depot.
Explosive transportation should be specifically studied taking care of the fact that protection means are different by nature from those used on depots.

Ammunitions

Direct lightning protection should take into account, as far as possible, natural components (metallic roofing, metallic poles and frames etc.). As soon as the thickness is large enough, metal sheets used on the roof can be used to collect lightning. However, with steel thicknesses between 0,5 and 4 mm, there is a risk of puncture and melting and explosive storage should be at a sufficient distance. Near metallic poles explosive storage should be limited as well.
For other structures, brick and concrete buildings, especially cellular concrete are very stressed. A good solution consists to use an isolated Lightning Protection System to avoid dangerous sparks.
A frequent case is when storage is made into a maritime container. Various studies carried out by DDESB, have shown that when no line enter the container and with specific storage rules, especially near the doors, the container provides a satisfactory protection by itself with additional striking rods and a simplified earthing system.
Overvoltages are known to be an important source of damages, especially as there are much more overvoltages (induced and direct surges) on lines than direct strikes on structures especially as storage structures have generally small dimensions. Type 1 Surge Protective Devices are then mandatory on all entering line connected to remote structures (energy, telecom …) as well as on other lines (lighting on roof or on external poles, intrusion sensors, flashing lights …) when they are too close to the lightning protection system (separation distance concept). Type 1 Surge Protective Devices are equipotential SPDs that are necessary to avoid internal sparking when overvoltages occur on lines.
A few equipment, related to site safety (intrusion, fire …), need an enhance protection provided by additional SPDs (Type 2 SPDs) installed near these equipment in order to ensure low level of protection. End of life of these surge protective devices is an important parameter to consider.

3. Lightning Protection System inspection

Lightning protection means, including the possible thunderstorm warning system and associated procedures, should be inspected by a competent body, following their implementation. As a matter of fact, if mistakes are made when installing the LPS, there is a big risk that a dangerous sparkover occur in case of lightning. Earthing quality, especially at high frequency should be checked.

SPDs require a specific supervision. SPD failure modes must be known and kept under control. The use of an external disconnector is generally required and it should have the same surge withstand the SPD itself. Coordination of this disconnector with short-circuit protection devices used for the electrical must be established.
As soon as the Lightning Protection System is validated, it should be kept in a satisfactory operating state thanks to an inspection performed at least annually. This inspection should consider the lightning earthing system resistance, the visual state of the lightning protection system and the physical state of SPDs. Any alteration to the storage (quantity stored, new process, new entering lines, change in time of presence …) must lead to an update of the lightning study. A specific training is necessary for the users regarding the procedures and the LPS.