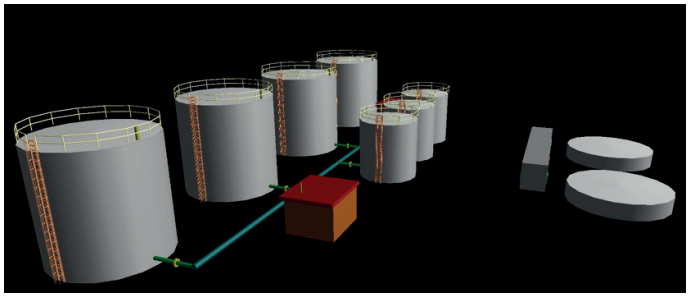
# LIGHTNING PROTECTION FOR FIBERGLASS REINFORCED PLASTIC STORAGE

There has been a rapidly growing trend for petroleum, water/wastewater and chemical industries to utilise fiberglass reinforced plastic (FRP) storage tanks. FRP storage tanks are common for these industries due to their non-corrosive properties compared to standard metal storage tanks.

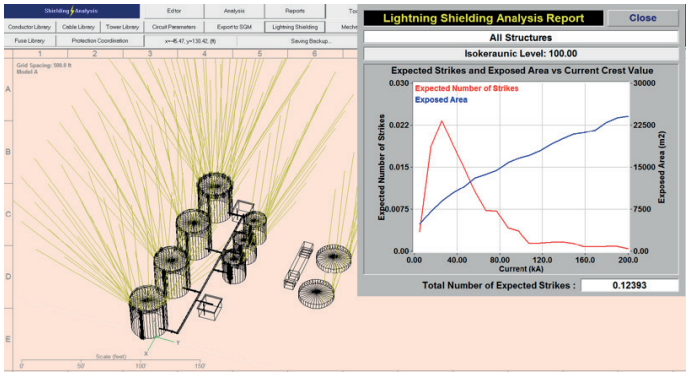
However, these FRP storage tanks are still exposed to lightning and are a potential fire hazard. The non-conductive property of FRP materials creates additional resistance to the fast lightning current impulses, creating intense heat at the point of impact. Fires starting at a single FRP tank can engulf an entire facility.

Even in the case of an indirect lightning strike, it may also be considered that an unequal ion discharge rate between an insulated FRP tank and a nearby grounded/bonded metallic structure can cause the development of a difference of electrical potential, creating a spark which could lead to a tank explosion and fire.

Downtime and recovery costs from lightning strikes can be very expensive and have safety consequences for personnel, strategic infrastructure and critical storage tanks. Tank replacement costs, losses due to operational shutdowns, and safety liability issues can be minimised with the appropriate use of modern lightning protection methods.



Modeled three-dimensional views




Lightning strike analysis for 15 kA return stroke current

## LIGHTNING RISK ANALYSIS

Historical lightning data can be compiled to create an Isokeraunic map showing the statistical average number of thunderstorm days per year, for any area of the world.

A three dimensional model can then be developed for a typical FRP storage tank facility. Using electro-geometric modelling applied to the 3-dimensional representation of the facility, all of the lightning attachment points are calculated and displayed visually.

The probability of a direct lightning strike to the storage tank facility is determined with consideration of its relative location. The chart below shows the total number of expected strikes per year for the modeled facility located at two different Isokeraunic values.

The standalone direct lightning strike probability should not be the only consideration for effective lightning protection design and implementation, as indirect lightning strikes may also cause sparking or flashover to vapor and/or contents that are stored within the facility.

Of course, the modelled facility may have a greater or fewer number of tanks than any existing or proposed FRP storage tank facility under consideration. The relationship between lightning strike probability and

| State | Isokeraunic Value | Total number of expected strikes per year | Direct Lightning Strike probability to the Facility |
|---|---|---|---|
| Florida | 100 | 0.124 | Once every 8.0 years |
| Texas/Kansas/Oklahoma | 60 | 0.0743 | Once every 13.5 years |

the number of tanks is very linear, the change in risk doubles each time the number of tanks doubles. For example, if an owner/operator maintains 14 times the number of tanks shown, in Texas, then they can expect one tank to suffer a direct strike every year. Since it cannot be known beforehand which tank will be struck, it's highly suggested that all tanks be protected.

#### LIGHTNING PROTECTION AND GROUNDING SYSTEM SOLUTIONS

ALLTEC has observed that most fiberglass storage tank facilities implement bonding and grounding sufficient for electrostatic charge dissipation. It is very important to prevent a discharge of an accumulation of static electricity from a storage tank to the ground or to another charged object of different voltage, which can be the cause of a fire or an explosion if it takes place in the presence of readily flammable materials or combustible vapour and air mixtures. ALLTEC recommends that existing bonding and grounding at FRP battery/tank farms should be inspected and any incompliances to NFPA 77 'Recommended practice on static electricity' should be identified and corrected. Proper bonding guidelines should be followed as per recommended practice.

It is important to note that bonding and grounding implementations sufficient for electrostatic charge dissipation are not adequate for lightning protection grounding systems.

Existing bonding and grounding systems at FRP storage facilities should be further enhanced by the implementation of code compliant lightning protection bonding and grounding. All metal ladders, overhead piping, and vents should be properly bonded and grounded. Properly designed and installed lightning protection is essential, as closed top metallic tanks may have flammable atmospheres at their vents, and fiberglass tanks receiving a direct lightning strike may rupture violently. The high level of lightning protection required by a fiberglass tank facility is best provided by a mix of technologies and a selection of methods drawn from a range of globally accepted standards.

For instance, API-2003, 'Protection against ignitions arising out of static, lightning, and stray current: Appendix C', describes charge dissipation terminals (CDT) as one of the lightning protection technologies used to mitigate the path of an incoming lightning stroke. In addition, NFPA 780, IEC 62305 and other standards for lightning protection actually describe minimum requirements for lightning protection system design and installation. Designs utilising CDTs meet or exceed those standards, while offering the enhanced performance provided by CDT technology.

ALLTEC can model any existing or new/proposed external ground system by creating a soil model using tested soil resistivity values to meet any low impedance ground reference solution requirement. The resulting data is entered into specialised integrated grounding software that accurately calculates soil resistivity at various depths. ALLTEC provides an array of grounding products, including TerraDyne electrolytic ground electrodes, TerraFill low resistive backfill material, and the TerraWeld exothermic welding system to supply and install effective grounding systems.

#### SURGE PROTECTION SOLUTIONS

In addition to proper grounding and bonding, it is crucial to install SPDs at key points throughout a facility to adequately protect today's sophisticated microprocessor based electronic equipment.

It is strongly recommended that a comprehensive network of quality surge protective devices (SPDs) are installed throughout the tank farm's power distribution to protect critical equipment loads against hardware damage and from surge and electrical noise related operational disruptions, resulting from lightning and non-lightning related surge and noise anomalies.

Noise on a power line is generically defined as low amplitude disturbances that are distinguishable by an identifiable frequency pattern. A transient surge is a momentary burst of energy whose duration extends into the millisecond range. While surge anomalies are far more likely to interrupt equipment operation and damage electronic hardware, transient induced noise interference can also disrupt sensitive equipment operations.

A cascaded network of SPDs, designed to work in tandem with each other, should be installed on main distribution panels and motor control centers to protect against externally generated surge activity. They should also be installed at branch panels and other sub panels that supply power to critical equipment loads to protect them from surges originating from within the tank farm.

It is also advisable to individually protect equipment loads that are electrically located further than 50 feet from a protected point within the electrical distribution. These SPDs should incorporate common mode suppression components to shunt lightning induced surge current to the electrical distribution's ground circuit. They should also employ normal mode suppression circuits to distribute internally generated surge current between power phases; and between the phase and neutral conductors on the AC power service. At the very least, any and all control and data lines entering and exiting a structure should incorporate proper SPD protection.

Implementing these recommendations will bolster tank farm equipment surge and noise immunity levels to the highest possible thresholds to extend their operational life expectancies, increase efficiency levels, and reduce maintenance, repair, and replacement costs.

#### THE 'PROTECTION PYRAMID'

ALLTEC specialises in engineered solutions that reduce the risks associated with direct and indirect lightning strikes, as well as diminishing the hidden effects of surge events. Offering decades of knowledge and experience, ALLTEC's recommendations advise the best methods for risk mitigation, and ultimately apply these evaluations as comprehensively engineered solutions.

ALLTEC calls the methodology used for visualising, designing, and implementing its unique and industry leading three-tier comprehensive facility protection approach for grounding, surge suppression and lightning protection, the ALLTEC protection pyramid.

It is important to realise the interrelationship and interdependence of the three tiers in protecting any facility. Without proper grounding, neither the surge suppression nor lightning protection will function correctly. Without surge suppression, equipment is exposed to the secondary effects of lightning as well as internally generated transient voltages. Direct strike lightning protection protects the physical structure and its contents. These three subsystems interlock into a very robust and stable whole.

This approach looks at all aspects of a facility and works in a holistic fashion to make sure all areas are protected with an effectively interlocking defense.

#### FOR MORE INFORMATION

online-info@alltecglobal.com, www.alltecglobal.com.