PROACTIVE LIGHTNING PROTECTION
FOR
PETROLEUM TERMINAL FACILITIES

Overall Site

While Brazos Midstream was building its Miller facility, two nearby production sites were struck and damaged by lightning. This led the management team at Brazos to ask a lot of hard questions about the need for lightning protection at their terminals. The damaged sites had no protection at all. The strikes took place to fiberglass tanks. According to Justin Beto, Vice President of Engineering for Brazos, “What really opened our eyes was the way the insurance companies responded to paying claims on the sites that had no lightning protection.” Brazos management decided that, although the likelihood of a damaging strike to one of its terminals may be relatively low, the consequence of damage with associated down time was unacceptably high. This led to the decision to investigate different protection options and to secure protection.

Mr. Beto began the process. While he was with other companies, he had looked at several different approaches. He did not want to use conventional Franklin lightning rod technology, because, as he put it, "I am not a fan of technology that attracts lightning. The problem is not handling the direct strike, but in controlling the different forms of collateral damage. We needed to take a more proactive approach." Arcing and induced current in data lines from secondary and electromagnetic pulse (EMP) of a strike were the real culprits in damaging equipment, particularly microprocessor-based control equipment.

"I particularly liked the Lightning Master approach. Their system uses the underlying designs of NFPA 780, UL 96A and API 545 and 2003 to create a basis. When it comes to the lightning rods, they use their streamer-delaying air terminals. These are UL Listed lightning rods with small wire electrodes extending from their tips. A lot of our guys call them 'Fuzzy Ball' lightning rods." This design uses the principles of point-discharge to delay the formation of lightning-completing streamers. If they become saturated, they revert to conventional lightning rods and intercept the strike. "I would rather at least take a shot at avoiding the direct strike. If they work to avoid the strike, great. If not, they act like regular lightning rods. This way, we get the best of both worlds."

Air Terminals on Exhaust Stack

"Lightning Master offers the gold-plated Cadillac of lightning protection. However, my approach is not to spend large amounts of money to eliminate 100% of all lightning problems. If we can spend a reasonable amount to eliminate 70%, we are ahead. Lightning protection is a cost item for us. It does not make the terminal work better or move more product. Therefore, I appreciate Lightning Master's menu approach, where we can buy the protection we determine that we need, and get more bang for the buck."

Overall lightning protection consists of three interrelated sub-systems: bonding and grounding, surge suppression, and structural lightning protection. As the Brazos terminals are new, the grounding systems are well designed. They are designed to contemporary standards, and have experienced no degradation. AC power surge suppression was installed as part of the original electrical installation. Additional surge suppression on data lines was not deemed necessary.

However, the Brazos stations did require structural lightning protection. When we think of structural lightning protection, we think of lightning rods on the roof of a building. Instead of ordinary buildings, the structures at these sites consist of processing equipment, external floating roof (EFR) storage tanks, MCC and control buildings, a communications tower, and site lighting poles. Therefore, design of structural lightning protection becomes a little more complicated. As a combination of structures requires protection, we apply several different standards in combination to secure the desired protection. These standards include NFPA 780, UL 96A, API 545 and API 2003, as appropriate. As NFPA 780 was originally designed to protect wood houses and barns, it does not apply directly to structures in a process control plant or terminal. However, the principles involved may be applied to determine air terminal coverage. There are three separate methods of determining air terminal layout in NFPA 780: layout, angle, and rolling sphere. Calculating air terminal layout on industrial structures often requires the use of multiple methods or combination of methods.

This is fairly straight forward when designing a layout for a simple structure, such as a MCC shelter.

Structural Lightning Protection on MCC Shelter

It becomes a little more complicated when applied to an open roof tank. The lightning protection standards require air terminals to be located on the center of the tank. However, this is not possible on an EFR tank. Therefore, we calculate the total number of air terminals that would be required on an ordinary structure, and install that number around the perimeter with reduced spacing.

Structural Lightning Protection on EFR Tank

It becomes even more complicated when air terminals are installed on a production or processing battery.

The rolling sphere method does not lend itself particularly well to these structures. So we use a combination of the layout and angle methods. The layout method is based on the roofline of an ordinary structure with projections such as dormers and chimneys. The principles that determine air terminal layout on an ordinary structure actually apply fairly well and simply to these production sites. The center piping is analogous to the peak of the roof. This determines the need for air terminals down the peak (center piping) and outside edges of the individual tanks. Lateral piping and elevated pressure/suction relief valves appear to be dormers and chimneys. As a check, we also apply the angle method, allowing different angles of protection to be projected by air terminals at different elevations above grade.

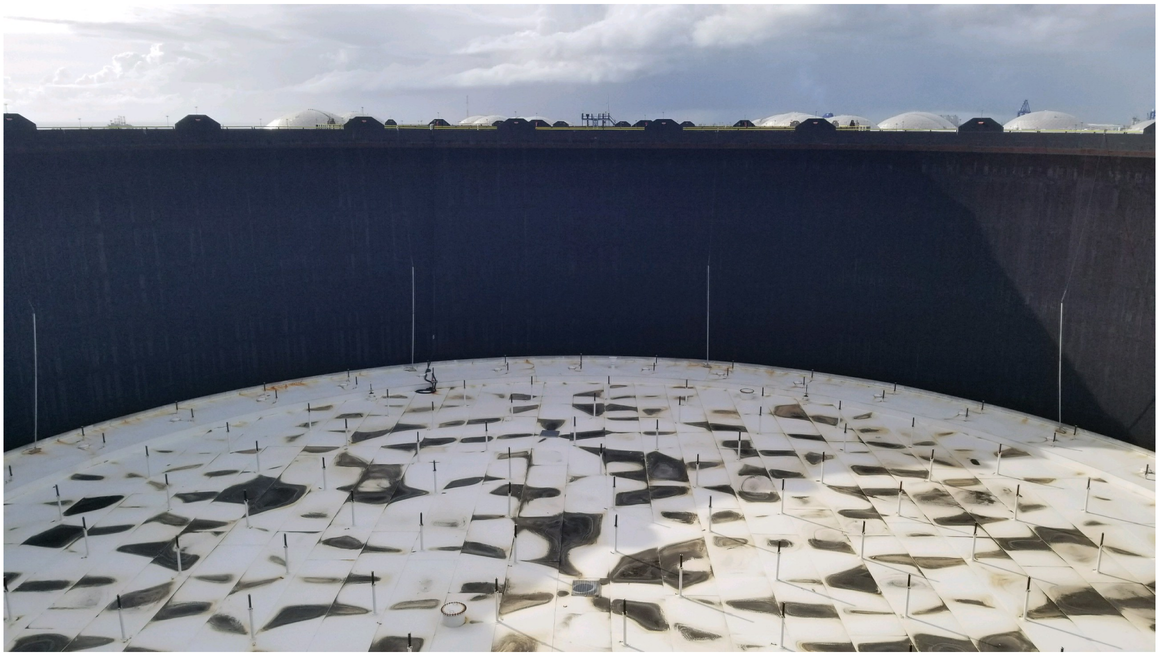
Structural Lightning Protection on Tank Battery

For external floating roof (EFR) tanks, both NFPA 780 and API 545 contain an additional bonding requirement. Both require the installation of bypass conductors to provide an electrical bond between the floating roof and tank shell. A bypass conductor is simply a low-resistance conductor run between the floating roof and the tank shell. A lightning strike contains two distinct components of current flow, plus an intermediate transition. The first component is high current, and very short duration. This is normally handled by the roof to tank shell shunts spaced around the perimeter of the floating roof and riding up and down on the inside of the tank shell. Alternately, it may be handled by the metallic primary shoe seals, if installed. The second component is longer in duration and much lower current, typically 200-300 amps. It turns out that the second component is responsible for most ignitions. The effect is similar to passing your finger through the flame of a candle. If you move it through quickly (the first component), nothing much happens. If you hold it in the flame longer (the second component), you get burned. The solution is to install bypass conductors spaced evenly around the perimeter of the floating roof at intervals not to exceed 100'.

There will always be arcing with sliding conductors, such as shunts or primary metallic shoe seals. However, the low-resistance bypass conductors quench this arcing before ignition occurs.

There are several methods of providing this bond ranging from a simple welding cable attached to the tank rim at one end and to the floating roof at the other. Although this meets the requirement, it does not hold up in field service, as it tends to become fouled on tank appurtenances and broken. Lightning Master has developed a simple, gravity powered system called a Movable Arm Grounding System (MAGS) to solve this problem and meet the requirements of both standards.

It consists of a mast system that guides the conductor around and between appurtenances such as legs, vents and hatches.



MAGS System (white masts) on EFR Tank

Protecting against lightning damage or ignition at these sites present a challenge. One of the biggest challenges is keeping up with changes and modifications to the sites. If tanks are added or piping configuration is changed, air terminal layout is affected. If gauging systems are added or modified, bonding requirements are changed. It stands to reason that any time a site undergoes changes, the lightning protection system should be modified as needed.

“Knock on wood, we have had years of successful experience with these systems. No protection is 100% effective, but we are more than happy with the track record we have achieved.”