Pacific Gas and
Electric Company

Lightning Protection

Each year, lightning strikes cost millions of dollars in damage for utilities and their customers. Lightning cannot be prevented; it can only be intercepted or diverted to a path that will, if well designed and constructed, not result in damage. While there is no single technology that can completely eliminate the risk of a direct strike and/or overvoltage transients, a holistic approach to total facility protection can help safeguard almost any facility, equipment or person.

In northern and central California, the incidence of lightning is fairly low. Along the coast the frequency of lightning is lowest and in the mountainous areas it is highest. Still California's highest frequency of lightning zones is a fraction of the rate along the gulf coast from Texas to Florida.

A plan to minimize exposure to damage can be divided into six steps:

1) capturing the direct lightning strike;
2) conducting the lightning current safely to ground;
3) dissipating the energy into the ground;
4) eliminating earth loops and differentials;
5) protecting equipment from surges and transients on power lines; and
6) protecting equipment from surges and transients on communications and signal lines.

Capturing the Strike

The first step is to capture the lightning strike at the preferred strike point. This point generally is the highest point on a structure and is equipped with lightning protection air terminals. The use of air terminals may increase the frequency of lightning strokes at a specific location. The lightning is directed away from other important equipment to minimize damage from the direct force and energy of the strike. Air terminal design is discussed in *ANSI/NFPA 78*, the Lightning Protection Code.

Conduct the energy to ground

Once captured, the energy must be conveyed to the ground via a specially designed down conductor.

Dissipate energy to ground

Thirdly, once the energy is at ground, a low impedance earth is essential to dissipate the lightning energy into the earth mass as effectively as possible. This differs from a low resistance earth system because lightning currents are short in duration but great in energy. While the NEC allows ground impedance up to 25 ohms, lightning protection specification usually state a value up to 1 or 2 ohms. To get this low value may require multiple issues. The ground rod should be copper bonded instead of galvanized to reduce resistance and longer life. The installation will probably require multiple ground rods. The ground rods need to be permanently bonded together as a common grid, generally with large stranded copper and all connections are generally cad-welded. When the soil is rocky, special fill material in the ground rod holes may be required to provide a low-resistance and non-corrosive medium. The fill material should maintain its high conductivity in wet or dry soil, not leach into the soil, and not dissolve or decompose over time.

Eliminate earth loops and differentials

The fourth step involves bonding all separate earth points and metal objects together to create one common equipotential ground plane. During a lightning strike when earth potential rises, all the equipment will rise to the same potential, ensuring no equipment-damaging differential voltages exist. Aircraft are struck by lightning frequently, but because of the whole aircraft is bonded as one unit, there is no differential.

Protect equipment from surges or transients on incoming AC power or communication lines

For the fifth and sixth points, all service entry points of the facility should be protected, including all outside lines that feed into the structure. These lines include the AC power feeders that run into the facility. Each should be outfitted with a suitable surge protection device. Please refer to our power note on Surge Suppressors when selecting one.

Also, to prevent damage and downtime, it is important to safeguard equipment from surges and transients that travel on incoming telecommunications and signal lines. These lines include telephone lines, antenna coaxial feeders from roof-mounted antennas, or computer lines linked to a wide area network.

Bonding

An essential element in the above system is the electrical component bonding between each step. Electrical connectors must be very low impedance and permanent. Generally, special components are required that are manufactured by specialty firms in the lightning protection field.

References:

ANSI/NFPA 70-1996, National Electrical Code

ANSI/NFPA 78-1989, Lightning Protection Code

ANSI/IEEE 142-1991, IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems

Revised: July 2018