The Lightning Phenomenon

As an electrical storm builds, various mechanisms create a stratified charge within the storm cloud, with an electrical charge at the base of the cloud. Since we are mostly concerned with cloud-to-ground lightning, we are concerned primarily with the charge on the base of the storm, as that charge induces a “shadow” of opposite charge on the surface of the earth beneath it.

As the storm charge builds, so does the cloud base charge. Since like charges repel, and opposite charges attract, the cloud base charge induces an opposite charge on the surface of the earth beneath it - it pushes away the same charge and pulls in the opposite charge. The cloud base charge attracts, or pulls, on the ground charge, trying to pull it off the surface of the earth. It is this tendency for the storm base charge and the ground charge to equalize through the intervening air which causes cloud-to-ground lightning.

As the storm cloud travels over the earth’s surface, it drags this ground charge along beneath it. When the ground charge reaches your facility, the storm cloud charge pulls it up on, and begins concentrating ground potential on your facility. If, before the storm cloud travels away, it manages to concentrate enough ground potential on your facility so that the difference in potential between the storm cloud base charge and the charge on your facility exceeds the dielectric strength, or resistance, of the intervening air, the air breaks down electrically, and a potential equalizing arc occurs; a lightning strike.

Since we are concerned with lightning strikes to objects and structures on the surface of the earth, and some 95% of all ground strikes are negative cloud-to ground lightning, for the purpose of this discussion we will describe negative cloud-to-ground lightning.
When the intervening air breaks down, the strike itself begins with the propagation of stepped leaders. Stepped leaders originate within the cloud charge, and extend in jumps of a hundred and fifty feet or so at a time towards the surface of the earth. These are the wispy, downward reaching branches of light you see in a photograph of a strike.

We see a lightning strike in two dimensions. Actually, the area of stepped leaders also has depth, so there is a field of stepped leaders working their way down toward the surface. When the stepped leaders reach to within about five hundred feet of the surface, the attraction between the stepped leader charge and the ground charge becomes so strong that objects on the surface of the earth begin to respond by releasing streamers of ground charge upward toward the stepped leaders. Streamers form off of various objects on the surface: utility poles, fence posts, antennas, building edges, etc.

When a streamer and a stepped leader meet, the ionized channel becomes the path for the main lightning discharge. The other stepped leaders and streamers never mature. Occasionally, two or more will meet simultaneously, and forked or branched lightning will occur.

Once the ionized path is completed, the current discharge occurs. Although a lightning strike appears to be a single flash, it is actually a series of flashes. Lightning flashes on for approximately one one-thousandth of a second then shuts off for about two one-hundredths of a second, flashes on for one one-thousandth of a second then shuts off for about two one-hundredths of a second, repeating the process multiple times. When the potential difference is no longer sufficient to continue the discharge, the lightning strike ends.

About Lightning Master Corporation
Established in 1984, Lightning Master® is a global, full service, static solutions, lightning and surge protection manufacturing company. We serve a wide range of customers including oil, gas, chemical and other industrial facilities. Our complete line of products, systems and consulting services are backed by our worldwide customer service. Our track record of success in the Americas, Asia, Africa, Europe and the Middle East has established LMC as a global authority on lightning and static protection.