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Improved Lightning Protection for Radio Transmitters

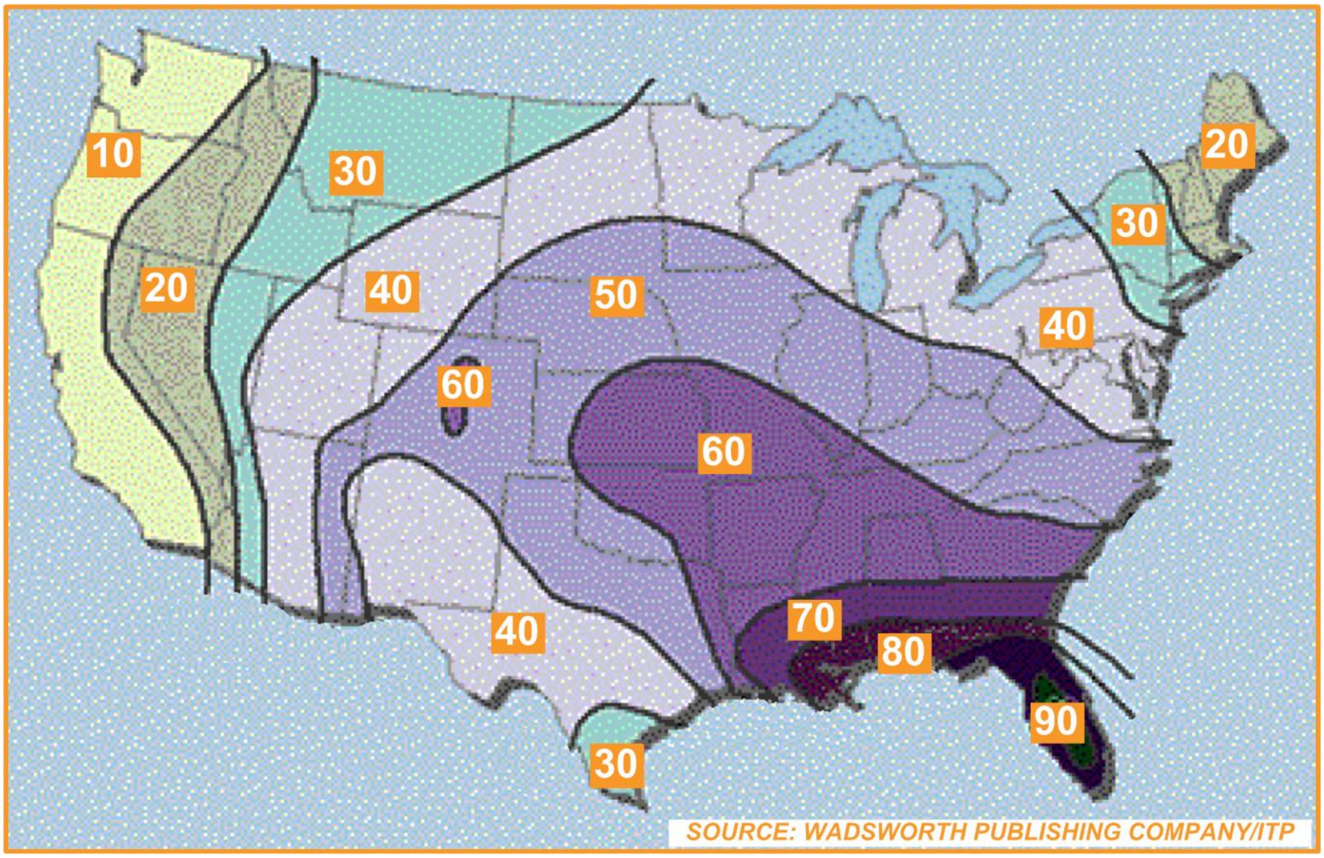
Radio transmitters that utilize tall antenna towers are particularly vulnerable to lightning strikes because these towers closely resemble lightning rods, designed to conduct lightning energy to ground. A session at this year's NAB Broadcast Engineering Conference (BEC, April 18-23, 2009, Las Vegas, NV) entitled "*Towers and Transmission Systems Part II*" included a paper, excerpted here, which presents a simplified summary of lightning data from several technical sources and then goes on to discuss protection principles, concluding with specific system recommendations.

LIGHTNING INCIDENCE AND TYPICAL CHARACTERISTICS – the amount of time, effort and money that should be afforded to lightning protection depends upon a number of factors including the equipment value, the importance of continuity of service and the frequency of lightning storms in the particular geographic region. The incidence of electrical storms without regard to their type for the U.S. is shown in the figure below (numbers and shading indicate mean annual number of days with thunderstorms). It may be seen that in the U.S., peak incidence occurs in central Florida and extending over the southern states.

The main stroke of a lightning strike is characterized by a rapid rise and near-exponential decay of current, essentially from a high impedance source comprised of a long length of ionized air. Presumably the inductance of the air path determines the rate of rise of the current and the resistance determines the current peak value and decay rate. Pulse characteristics vary widely from strike to strike. Rise times of 0.1-20 μs with exponential decays of 20-100 μs have been reported with peak amplitudes between 20,000 and 120,000 amps.

PROTECTION PRINCIPLES – if lightning strikes a radio tower with local grounding either directly (grounded tower) or via a spark gap (insulated tower) then the large current pulse flowing through the local ground impedance would develop a very high potential with respect to ideal ground. For example, with a median current pulse of 20,000 amps and an impedance to ideal ground of 50 ohms, this potential would be one million peak volts. In essence, the entire transmitter site becomes elevated to this potential for the duration of the lightning pulse. If now the antenna local ground is connected via surface cabling to remote grounds, then a substantial part of the discharge current could flow through this path, which generally includes the shield of the antenna feed cable or any other wiring that interconnects the base of the antenna with the transmitter building, straight through the transmitter and into the ac line supply.

Consequently, the first and most important principle is to provide the best possible (lowest impedance) local ground at the base of the antenna. It cannot be assumed that the antenna ground mat has a low impedance to ideal ground. It may function as a good counterpoise-type ground return at the operating RF frequency yet have high resistance to ground. The ground mat must be supplemented by one or more driven ground rods. The second principle is that this current must not flow through the transmitter itself. [Arrangements whereby a safe path is provided through a suitably located surge arrester, into the ac line supply, bypassing the transmitter are shown in the full paper.]



TRANSMITTER BUILDING LAYOUT – the geometry of the interconnections in and around the transmitter building is critical to the effectiveness of the lightning protection system. The ideal arrangement is to bring all electrical conductors that connect to the building in close proximity to each other at a location designated as the station reference ground. Appropriate surge protection devices are installed at this location, providing a safe path for the lightning current that does not include the interior of the building. This technique is commonly used with shielded rooms that are used to test sensitive electronic equipment. Where remedial measures are to be applied to an existing building, it is seldom possible to achieve this ideal arrangement and some sort of compromise is necessary. Although the principles presented in this paper are quite easy to understand, it is often quite confusing when trying to apply them to improve an existing building layout. The author has found it useful to start at the antenna, then to explore all possible paths leading to the ac line supply to assess their destructive potential.

This paper is authored by John R. Pinks, Nautel, and is included in its entirety in the *2009 NAB Broadcast Engineering Conference Proceedings*, available on-line from the NAB Store (www.nabstore.com). Audio recordings of the BEC sessions are also available for purchase – for more information, visit the NAB Show Online Learning Center at http://www.nabshow.com/2009/education/onlinelearningcenter.asp. For additional conference information visit the NAB Show Web page at www.nabshow.com.