Another Look at Sidelobe-free FM Antennas

by Richard J. Fry, CPBE

Antennas with reduced sidelobes in their elevation patterns have been proposed as an advance in antenna designs for FM broadcasting. As stated by one of the main proponents of this antenna configuration,[1] reducing or eliminating these sidelobes will:

[a] reduce blanketing interference
[b] better meet applicable ANSI/EPA/FCC requirements regarding RF radiation hazards, and
[c] reduce or eliminate "source-induced multipath" from the sidelobes, which produce destructive interference in regions served by the major lobe of the antenna.[2]

To evaluate the performance to be expected from sidelobe-free antennas, calculations were made by the author to show field strength versus distance for a six-bay, half-wave spaced array having all sidelobes suppressed more than 40dB. ERP was calculated at 0.1 degree intervals in the antenna elevation pattern, and that value was used with the FCC f(50,50) propagation curves to calculate the field strength to be expected at the appropriate distance for a ray of that depression angle and HAAT. The results are plotted in Figure 1, along with superimposed plots for a half-wave spaced array without sidelobe suppression, and a conventional full-wave spaced array. All antennas plotted have the same number of bays, the same maximum ERP and the same HAAT.

Blanketing Interference and RFR Inspection of Figure 1 shows that even for this rather elevated HAAT, the affect of the sidelobes on field strength in the two non-sidelobe-free antennas is confined to fairly short distances from the antenna site. And in fact, at most close distances the two antennas *with sidelobes* have *lower* field strengths than the sidelobe-free antenna. Field strength from the sidelobe-free antenna at some places is more than 20dB above the others. The sidelobe-free antenna has less field strength than the other two only in narrow zones near the ground less than one mile from the tower.

In this example, the non-sidelobe-free antennas actually outperform a sidelobe-free antenna for control of blanketing and RFR between one and about six miles from the antenna site. The reason for this is that for the same number of bays, the main lobe of a sidelobe-free antenna is significantly wider than a non-sidelobe-free antenna, and at modest distances radiates higher ERP toward the ground. It also radiates higher ERP at many angles above the horizontal plane — which increases field strengths at airborne receivers. Both of these results actually are the reverse of popular expectations for the design.

Multipath Can reflections from terrain and objects illuminated by antenna sidelobes cause so-called "source-induced multipath" to areas served by the main lobe of the antenna? To produce serious multipath distortion at a receiver, a reflection must have an amplitude that is within about 10dB of the direct wave, and an RF phase that is

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[1] Dr. Ali Mahnad, Micro-Tek Engineering
[2] *Sidelobe-free Antenna Arrays*, Ali Mahnad Ph.D., E.E. and Leroy C. Granlund

destructive to that of the direct wave. The capture effect of the FM receiver largely ignores co-channel signals not meeting these criteria.

Consider that a reflection from terrain or objects located where sidelobes can illuminate them can be produced only very close to the transmitting site. It is unlikely that sidelobe energy arriving at those locations will have the grazing conditions necessary for highest level reflections toward the horizon, or that such a reflection will have the path geometry required for it to reach a distant point served by the main lobe of the antenna. Such sidelobe reflections likely would be blocked by earth curvature.

Another factor is the reality that a reflecting surface would have to be extremely close to an FM antenna (less than two feet, in general) in order to couple enough energy from the antenna to re-radiate it with only 10dB loss. These conditions likely do not exist for the sidelobes of any antenna at any practical antenna site. And reflections more than about 10dB reduced from the direct ray have little or no affect on an FM receiver.

Most multipath distortion is caused when the direct ray of the main lobe of the transmit antenna is obstructed at the receiving antenna, while a reflected ray from a surface on a nearly identical azimuth and elevation angle toward the transmit antenna develops the magnitude and phase required to interfere with it. Figure 2 illustrates this point.

This article has examined and compared the performance of sidelobe-free antennas with standard antennas having sidelobes. The comparison used a specific set of conditions, but the conclusions will be applicable to most other conditions as well. The data demonstrates that sidelobe-free FM antennas are of less benefit than generally assumed when trying to achieve the results that have been put forward for them.

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Figure 1.

Calculated FCC f(50,50) Field Strength
for Three Six-bay FM Transmitting Antennas
each with 100kW Maximum ERP at 2,500 feet HAAT

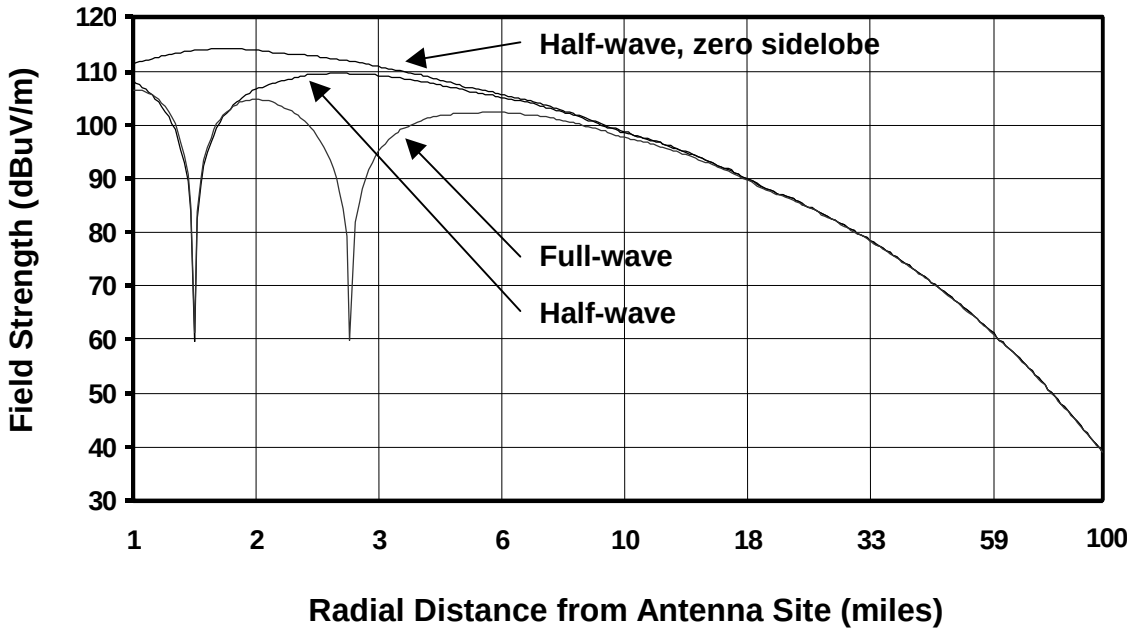

Figure 2. **Typical Multipath Situation**