

Shortened Verticals: experiments

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In a mailing list, ham radio operator Tom W8JIT described a controlled experiment that he performed with a vertical antenna built in an open field. He compared the field strengths produced by a set of ground radials suspended 8 feet above the earth with the same set of radials sitting on the surface of the soil.

Interestingly, the elevated system produced better results when there were only 4 radials. As the number of radials increased, the differences between the elevated and ground-level systems decreased.

"First I added four radials, and measured FS [field strength] at just over one mile and recorded that value. Then I went back, lowered the radials and antenna, and pegged the bare wire to the dirt with little hooks.

"I repeated this with 8, 16, and 60 radials. Here's what I measured. The percentage and dB reading is referenced to the highest FS I measured, NOT to a theoretically perfect system:"

| | 8 foot high counterpoise | | | ground mounted radials | | |
|----------|--------------------------|----------|---------|------------------------|----------|---------|
| 4 wires | 37 % | -4.3 dB | 20.1 mV | 28 % | -5.5 dB | 17.5 mV |
| 8 wires | 58 % | -2.38 dB | 25 mV | 53 % | -2.73 dB | 24 mV |
| 16 wires | 86 % | -.63 dB | 28.7 mV | 74 % | -1.3 dB | 28.4 mV |
| 60 wires | 96 % | -.18 dB | 32.5 mV | 100 % | 0 dB | 33 mV |

Data in the table below is extracted from the article "Ground Systems as a Factor in Antenna Efficiency" by G.H. Brown, R.F. Lewis, and J. Epstein, in *Proceedings of the Institute of Radio Engineers*, vol.25, no.6, June 1937, pages 753-787. This is one of the most thorough scientific experiments to date. The table gives actual field strength measurements in dB referenced to a theoretical ideal vertical antenna.

| radial length | number of radials | 1/4-wave vertical | 1/8-wave vertical | 1/16-wave vertical |
|---------------|-------------------|-------------------|-------------------|--------------------|
|---------------|-------------------|-------------------|-------------------|--------------------|

.14-wave 2 -4.2 -6.3 -10.6

" 15 -2.3 -3.6 -5.5

" 60 -2.1 -3.1 -4.8

.27-wave 2 -4.2 -6.1 -10.7

" 15 -2.1 -2.4 -4.7

" 60 -0.8 -1.2 -2.7

.41-wave 2 -3.9 -5.6 -10.0

" 15 -1.8 -2.2 -3.8

" 60 -0.5 -1.0 -2.3

This experiment showed that 120 radials nearly $1/2$ wavelength long, combined with a $1/4$ wave vertical radiator, came very close to the performance of the ideal $1/4$ -wave vertical antenna over perfect ground. Shorter vertical radiators, shorter ground radials, and fewer radials all resulted in lower field strengths at the monitoring points.