The Advantage of the NEC-4 Engine in Antenna Modeling
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In the early 1990s I used NEC/WIRES 2.0 from Brian Beezley, K6STI, for my antenna modeling efforts. It's a DOS program and I still have the 3.5-inch disk. I'm sure I could run it under DOSBox at glacial speed.

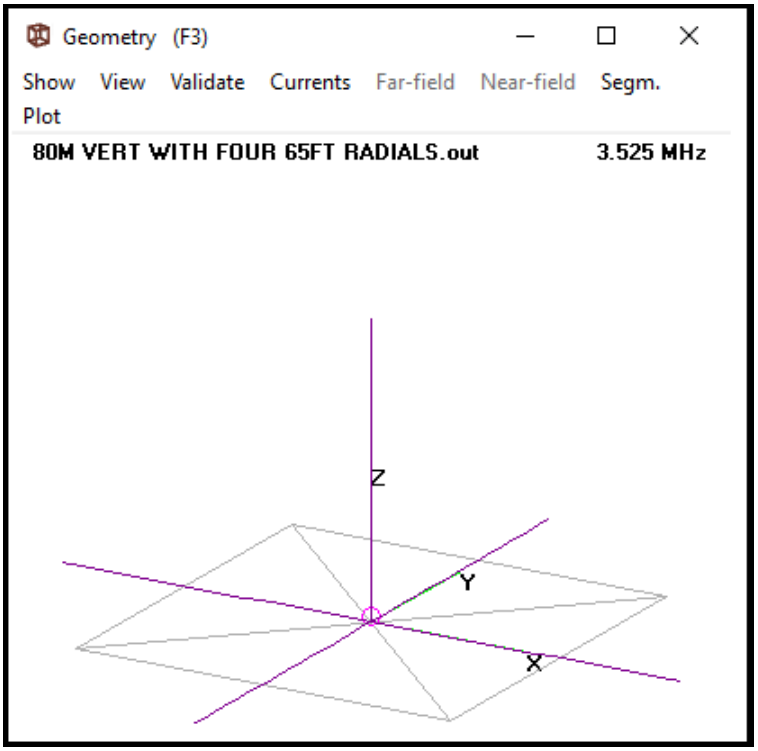
Toward the end of the 1990s I moved to EZNEC Version 2.0 from Roy Lewallen, W7EL. It was also a DOS program on a 3.5-inch disk.

Nowadays I use the Windows program 4nec2 by Arie Voors for my antenna modeling efforts. In addition to the NEC-2 engine that comes as standard, I have the NEC-4 engine [note 1] for modeling Beverages and other antennas that connect wires to lossy ground.

A couple weeks ago I wondered about the advantage of the NEC-4 engine over the NEC-2 engine. So I ran some models to see what the difference is.

My first investigation was for a full-size 80 meter vertical with four 65-foot long elevated radials evenly spaced around the compass. The goal here was to confirm that the NEC-2 engine, compared to the NEC-4 engine, could accurately model wires very close to ground (0.001 λ per L. B. Cebik, W4RNL's, 4-part series titled "A Beginner's Guide to Modeling with NEC" in the November 2000, December 2000, January 2001 and February 2001 issues of QST).

Here's the geometry of this antenna.



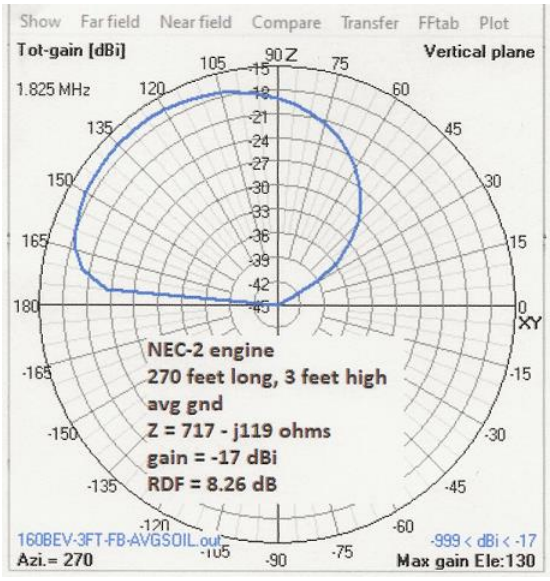
I moved the entire system from a height of 40 feet over average ground using the 'real ground' (Sommerfeld-Norton) option to a height of 0.1 feet (1.2 inches). At each height the length of the vertical portion was varied to maintain resonance near 3.525 MHz. The results were as follows.

gnd	engine	radial height in feet	radial length in feet	vertical length in feet for resonance at approx 3525 KHz	Z in ohms	Eff in % *	Radiat-eff in %	Radiat-eff in dB (10 log Radiat-eff)	gain in dBi and angle in degrees
avg	NEC4	40	65	71	26.1 - j1.18	100	25.08	-6.0	+0.39 @ 15
avg	NEC2	40	65	71	26.3 - j1.75	100	24.87	-6.0	+0.36 @ 15
avg	NEC4	20	65	71	32.7 + j0.36	100	29.52	-5.3	+0.39 @ 20
avg	NEC2	20	65	71	33.0 - j0.25	100	29.22	-5.3	+0.35 @ 20
avg	NEC4	10	65	70.5	36.8 - j0.99	100	31.05	-5.1	+0.24 @ 25
avg	NEC2	10	65	70.5	37.2 - j1.67	100	30.77	-5.1	+0.20 @ 25
avg	NEC4	1	65	68.5	40.5 - j0.99	100	30.44	-5.2	0.00 @ 25
avg	NEC2	1	65	68.5	40.8 - j0.75	100	30.24	-5.2	-0.10 @ 25
avg	NEC4	0.5	65	67.6	40.1 - j0.80	100	29.79	-5.3	-0.20 @ 25
avg	NEC2	0.5	65	67.6	40.6 + j0.28	100	29.43	-5.3	-0.20 @ 25
avg	NEC4	0.1	65	64.2	45.0 - j0.12	100	23.22	-6.3	-1.30 @ 25
avg	NEC2	0.1	65	63.8	47.2 - j0.87	100	21.77	-6.6	-1.50 at 25
	* all wires are perfect conductors								
	* no lossy loads								

The 0.001 λ limit translates to 0.279 feet at 3.525 MHz (3.35 inches). Thus my last run at 0.1 feet was below the limit.

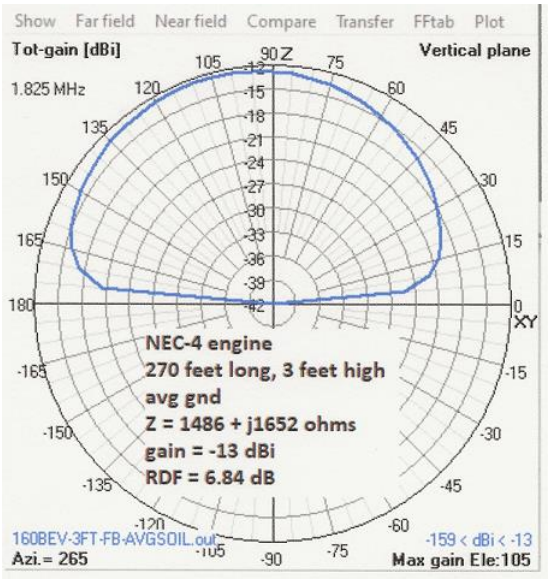
As can be seen by the data, the NEC-2 engine does a credible job compared to the NEC-4 engine down to the 0.001 λ limit. For the run below that limit, the NEC-2 engine starts to diverge from the NEC-4 engine.

My second investigation was for a 270-foot long Beverage at 3 feet above average ground (again using the 'real ground' option). The feed end and the termination end of the Beverage were connected to ground in the model. Here's the elevation pattern, the impedance, the gain and the RDF for the run with the NEC-2 engine.



The F/B ratio (front-to-back) looks good and the RDF is good. This isn't bad for a short Beverage (if it's true!). But the back half of the elevation pattern looks kind of funny.

Now let's look at the same antenna using the NEC-4 engine.



Big difference. There's hardly any F/B ratio, the RDF has decreased and the impedance is radically different. Now the pattern looks more reasonable for a short 270 foot Beverage.

Summary

The NEC-2 engine appears to work just as good as the NEC-4 engine when wires are very close to ground. But if you connect any wires to lossy ground, you better use the NEC-4 engine for accurate results.

Perhaps there are ways around connecting wires to lossy ground with the NEC-2 engine. If there are, I'd love to hear about them.

Note 1

I have NEC-4.1, which uses the GN2 ground code. There is an update to NEC-4.1 named NEC-4.2, which uses an improved GN3 ground code. Recently NEC-5 was released, and you can read about it at https://ipo.llnl.gov/technologies/software/nec-v50-numerical-electromagnetic-code.