Ground Screen Replace / Compliment a Radial System

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NCØB

We don't all have space for a 200 x 200 foot ground system = 0.9 acres.

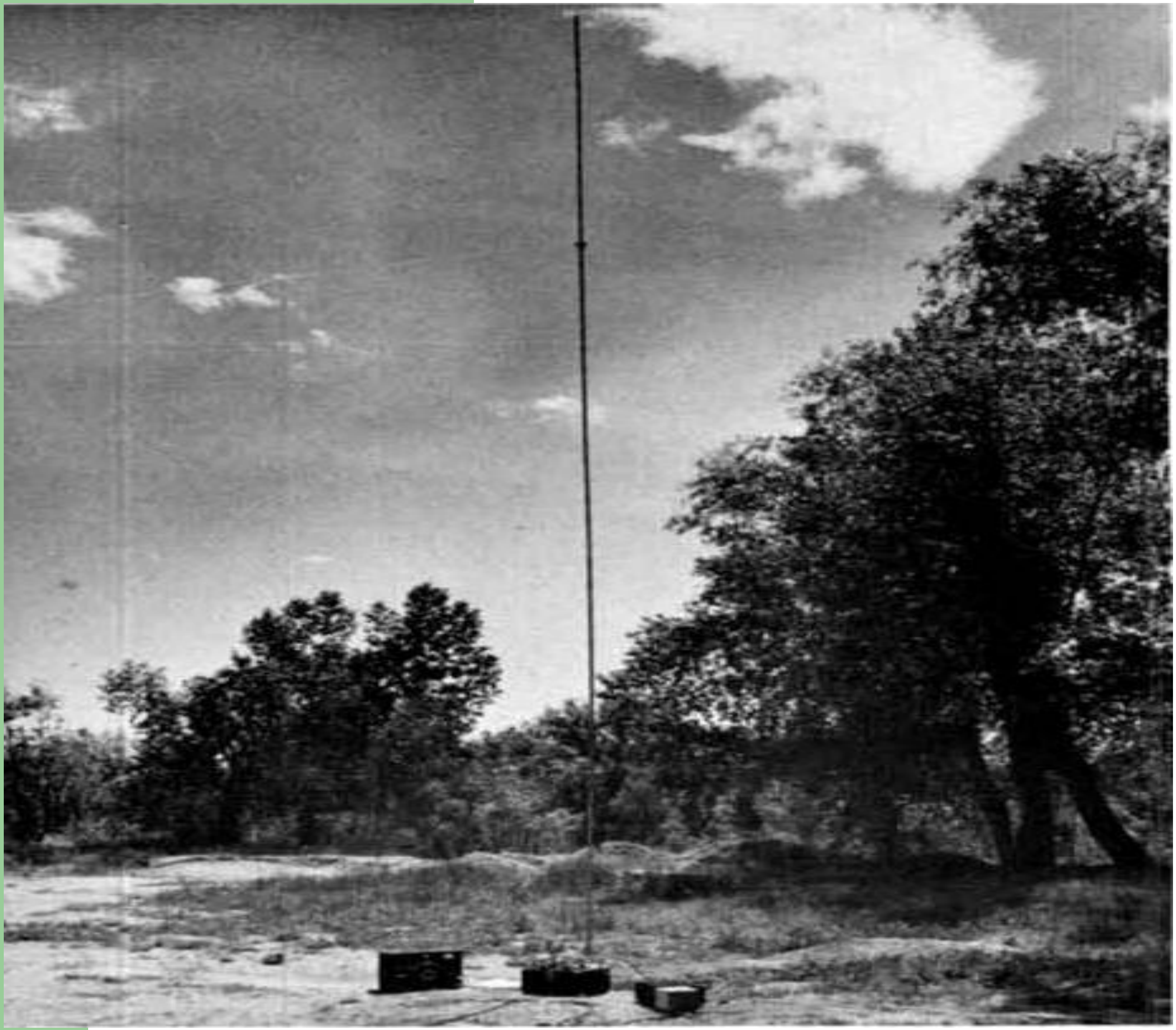
Base - Insulated Tower – 1964 at age 17

- Tower between two driveways 20 feet apart.
- No room for radials except north and south.
- Put a strip of welded fence on each side of tower base – 4 feet X 25 feet as my ground.
- I have no idea where I got the idea.
- Top loaded the 70 foot radiator with a 100 foot wire, as my 160 meter antenna.
- It worked much better than tying the feeders together on my 40-meter 2-half waves in phase that I used on 40 and 80 meters.

My Denver House & Antenna

- Purchased house in 1971
- No money for a tower
- **Put up 48 foot vertical on side of house**
- Lot size is only 62 x 120 feet
- Installed six 25 to 40-foot radials in semicircle.
- Antenna barely worked & I had RF in the shack !

- On 80 meters the resistive value of a 48 foot vertical with a decent ground system would be 15 to 20 ohms.
- With 6 short radials the R was over 100 ohms.
- Laid down a 3 x 30 foot strip of hardware mesh.
- The antenna now tuned with a reasonable R value. This was my only antenna for 1 year.
- **Time to make some quantitative measurements.**



1977

Test Setup

36 foot vertical, chicken wire ground screen, GR RF bridge, sig gen and receiver.

Measurements on a 36-Foot Vertical

Data from my May 1977 *hr magazine* article.

General Radio 916A RF Bridge

Best numbers with ground screen in an X

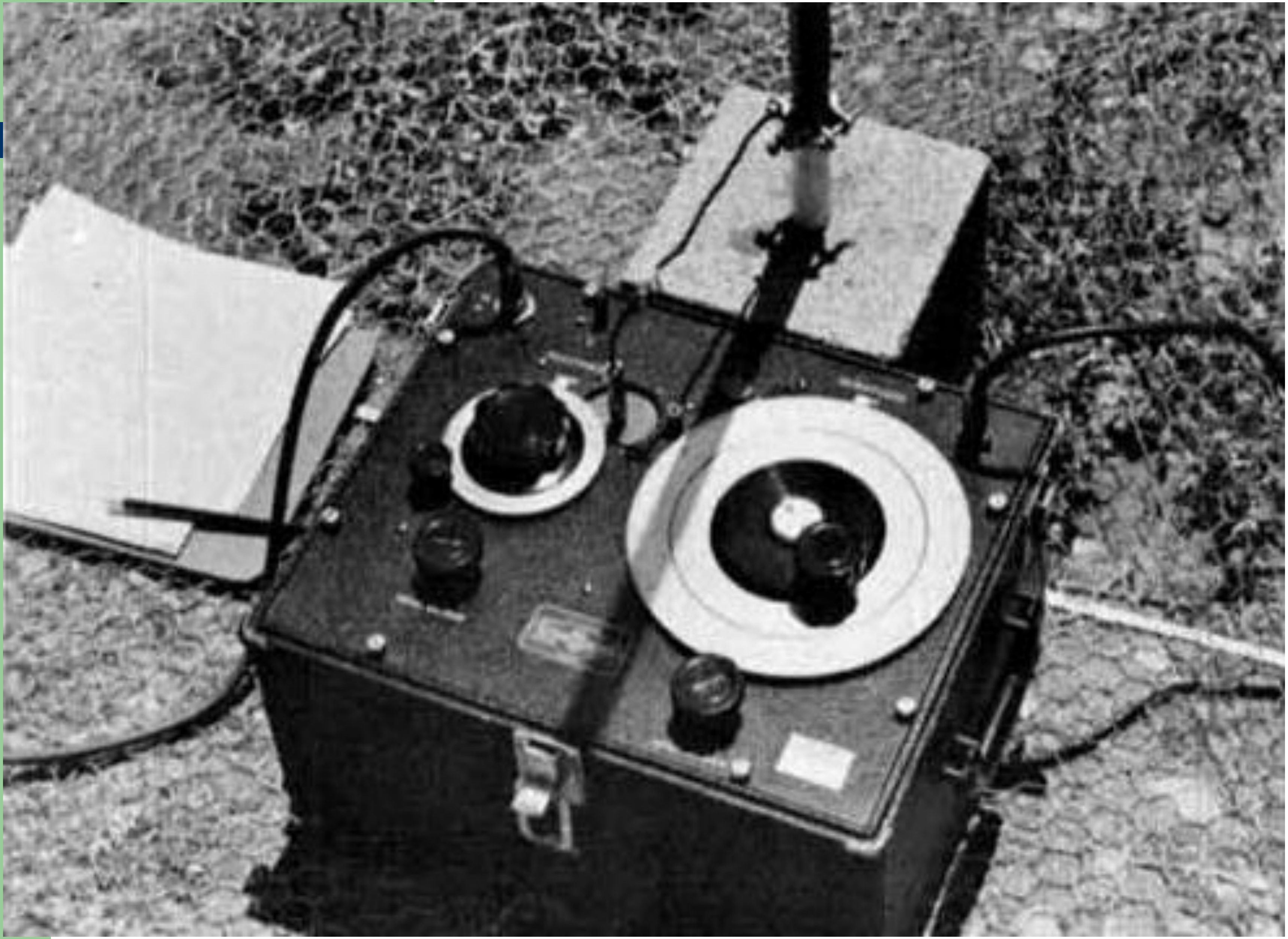
45x2 feet + 25x5 feet at 90 degrees

200 square feet of screen

1.8 MHz Z = 8 ohms –j717.

3.6 MHz Z = 15 ohms –j279

All the data is on my web site: www.nc0b.com



Jump ahead 30 years to new QTH

- Marconi T antenna
- 600+ Square Feet of Ground Screen
- (Dip galvanized hardware cloth / mesh)
- Screen layout in an X at 90 degrees

Ground Screen in Back Yard

Closer Shot of Screen

160 Meter T Antenna

150 or 200 foot flattop strung between two towers

Could use trees or poles

(If one support, flattop wires can angle down)

Vertical downlead attached in the middle of flattop

Vertical section is 60 feet long

Redesign for 80 meters, it could be half this size.

Most hams can string 75 feet of wire 30 feet in the air.

Measurements with GR RF Bridge

Initial 200 foot flattop data:

1.8 MHz 36 ohms + j310

1.9 MHz 44 ohms + j363

2.0 MHz 49 ohms + j427

Now add 20 100-foot radials to see how much improvement

1.8 MHz 28 ohms + j305

1.9 MHz 36 ohms + j368

2.0 MHz 42 ohms + j438

The resistive value of the antenna was reduced by 8 ohms

Note: 200 foot dipole lying on the ground resonant 1.9 MHz

Shortened flattop from 200 feet to 150 feet

150 foot flattop data with ground screen and 20 100 foot radials:

1.8 MHz	24 ohms +j161	(R value dropped 4 ohms)
1.9 MHz	29 ohms +j210	(R value dropped 7 ohms)
2.0 MHz	32 ohms +j262	(R value dropped 10 ohms)

Now add 20 more radials for a total of 40 100 foot radials

1.8 MHz	22 ohms +j161	(R value dropped 2 more ohms)
1.9 MHz	27 ohms + j210	The radials did make up
2.0 MHz	30 ohms +j262	for shortening the flattop.

The R value of the antenna decrease an additional 2 ohms

Decreased the resistive value of the antenna 10 ohms with 4000 feet of wire compared to just 600+ square feet of ground screen.

When is the antenna good enough?

- On 160 meters I regularly worked JAs from CO with just the ground screen & 200 ft flattop.
- The screen went 25 feet in 4 directions.
- 100 to 650 square feet of screen have been used over the years at four different QTHs, depending on my yard size.
- I picked up about 1 dB with 4000 feet of radial wire. (This value determined later.)

Tweaking the Antenna

What is the optimum flattop length with a 60 foot vertical?

I ran this by ON4UN who said:

"The ideal length for your T would be the length where the average current in the vertical would be highest, in other words where the current maximum would be about half way up the vertical section (30 ft)."

He modeled vertical wire of 60 ft and a top hat of 75 ft per side, and assuming a 5 Ohm ground loss resistance:

Modeled ON4UN:	1850 kHz = 27.7 +j190 ohms (5 ohm gnd)
Modeled W6XX:	1825 kHz = 27.7 +j190 ohms (20 radials)
Measured:	1850 kHz = 27 +j184 ohms (screen + 20 radials)

Field Strength Measurements

The pattern is almost perfectly circular on 160.

Frequency	Field Strength (mV/M)	
Theoretical	186 mV/M @ 1 mile @ 1 kW	
Typical @ 1.6 MHz	165 mV/M, good soil	(-1.0 dB)
KRXY @ 1.6 MHz	160 mV/M	(-1.3 dB)
NC0B @ 1.9 MHz	130 mV/M	(-3.1 dB)
W7KKD @ 1.8 MHz	110 mV/M *	(-4.6 dB)

* (50-foot vertical, 20-foot top loading hat & 12 radials)

Efficiency with 150 foot flattop @ 1 Mile

40 Radials + Ground Screen		R = 27 ohms
Theoretical	Measured	Difference
186 mV/M	130 mV/M	(-3.1 dB)

@ 400 & 800 feet NEC implies ground losses 7 ohms

20 Radials + Ground Screen		R = 29 ohms
Extrapolate	125 mV/M	(-3.5 dB)

20 radials gnd loss 9 ohm, 40 radials gnd loss 7 ohms

Going from 20 to 40 radials improved signal 0.4 dB

Calculated watts in vertical section

150 foot & 40 radials + screen	741 W	Reference
150 foot & 20 radials + screen	690 W	-0.31 dB
200 foot & 20 radials + screen	750 W	+0.05 dB
200 foot & screen only	614 W	-0.87 dB

10 Log Power1/Power2 = dB

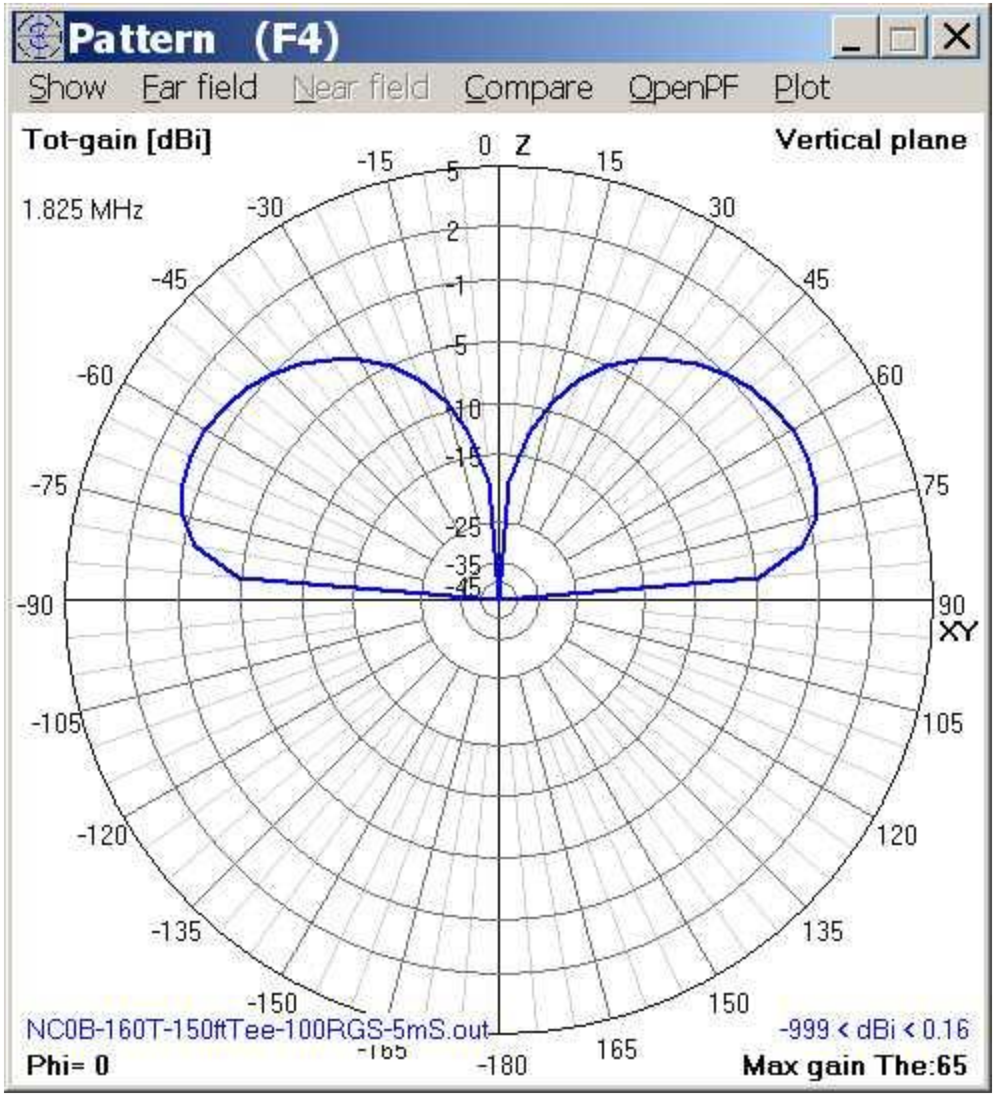
If you don’t have an acre of ground and almost a mile of wire, you can compete by using just a ground screen and a reasonable size top-loaded vertical.

Reality Check – Are Numbers reasonable?

- Paper from NAB 1996, Kintronic Labs, Inc. measurements at Bluff City, TN.

- 0.27* wave tower, 120 radials, 1680 kHz, Ref
- Ground stake only, signal level -2.7 dB
- 0.17^ wave tower, 120 radials, -1.4 dB
- Ground stake only, signal level -5.2 dB
- * 150 feet
- ^ 95 feet

Radiation Pattern courtesy W6XX

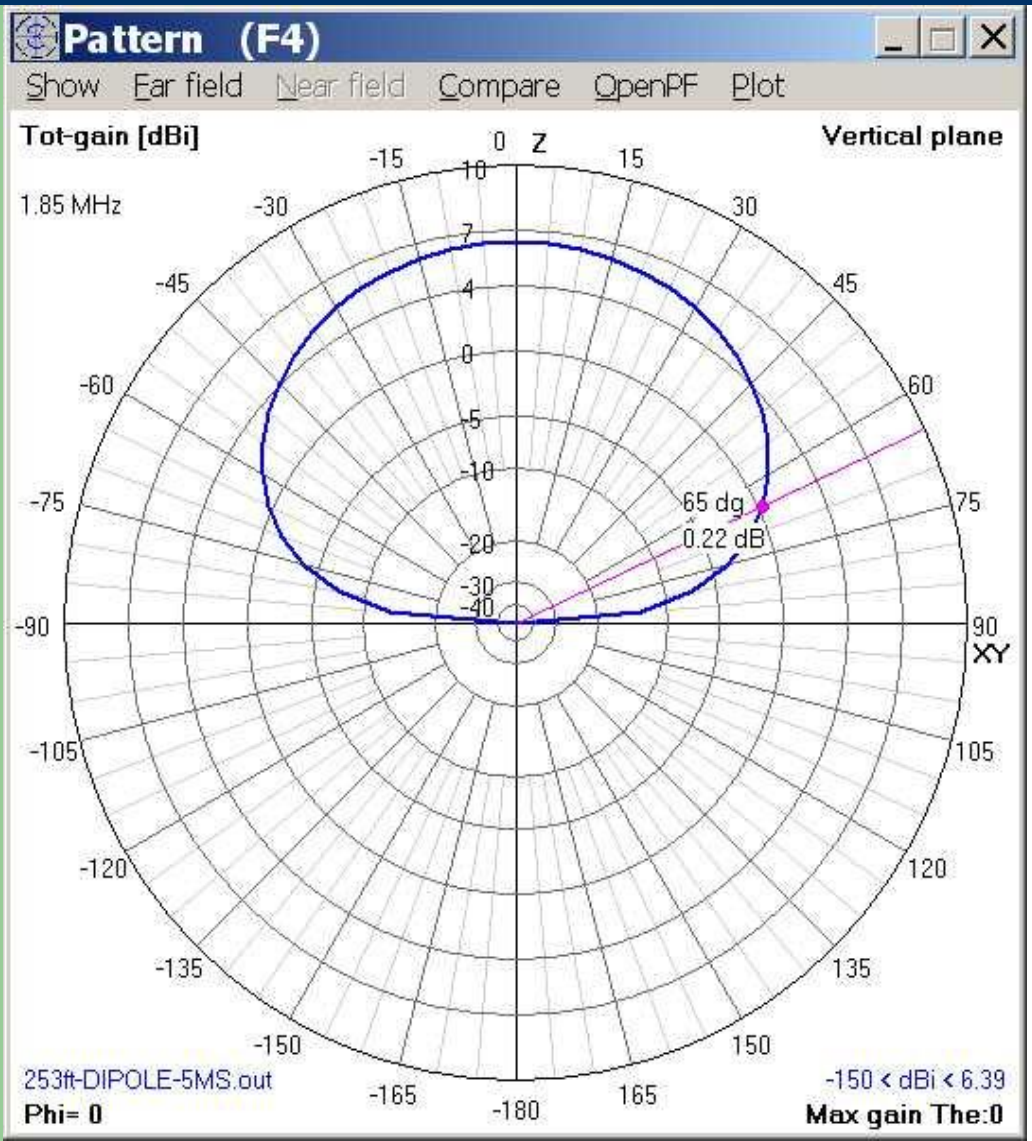


160 meter peak radiation near 30 degrees.

1 dB down at 15 degrees above the horizon.

Note: Not a cloud warmer, down 10 dB at 75 degrees above the horizon.

Horizontal dipole @ 1/8th wave length

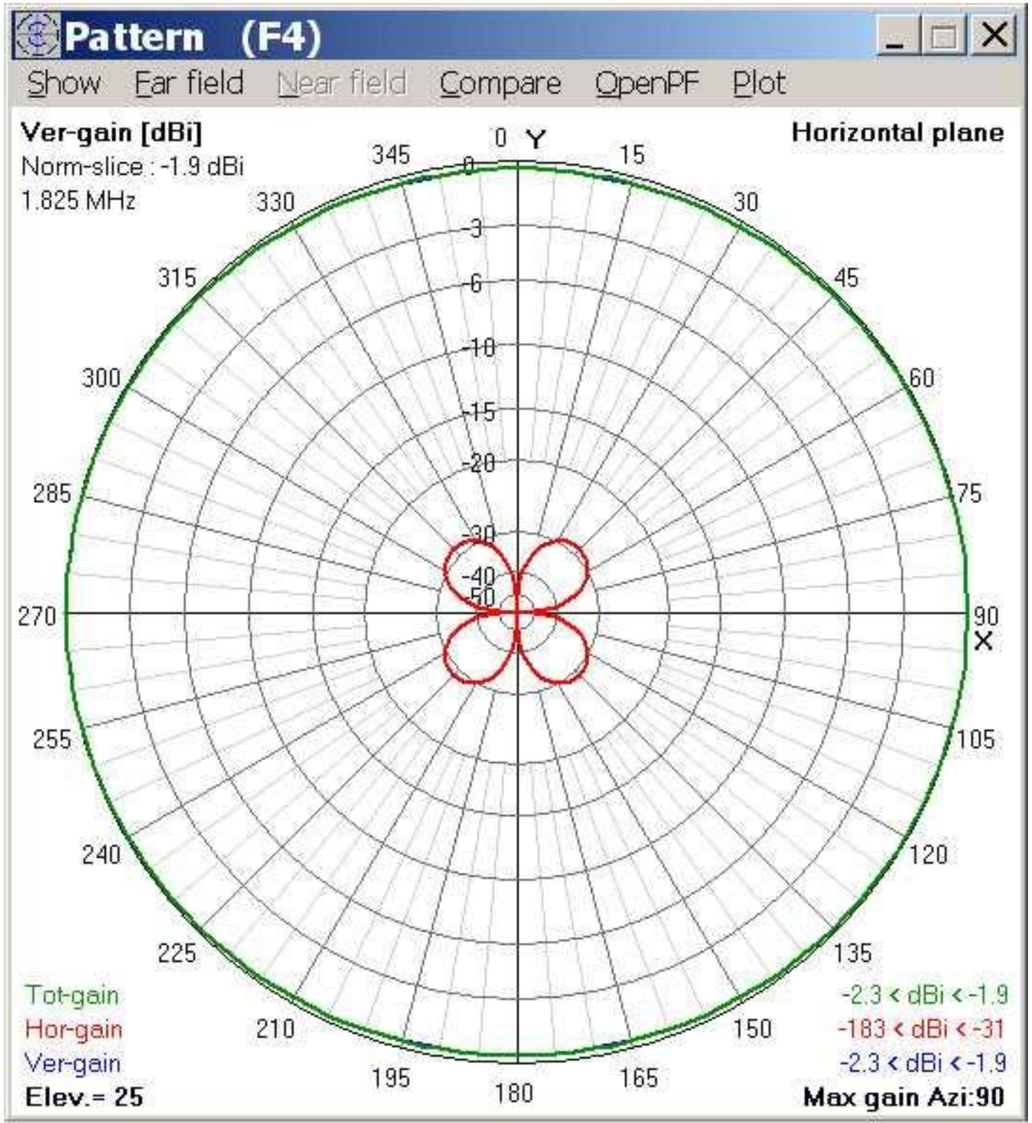


Horizontal is efficient.

Favors short skip, making DX weaker by comparison to state-side QRM.

10 dB down at 15 degrees.

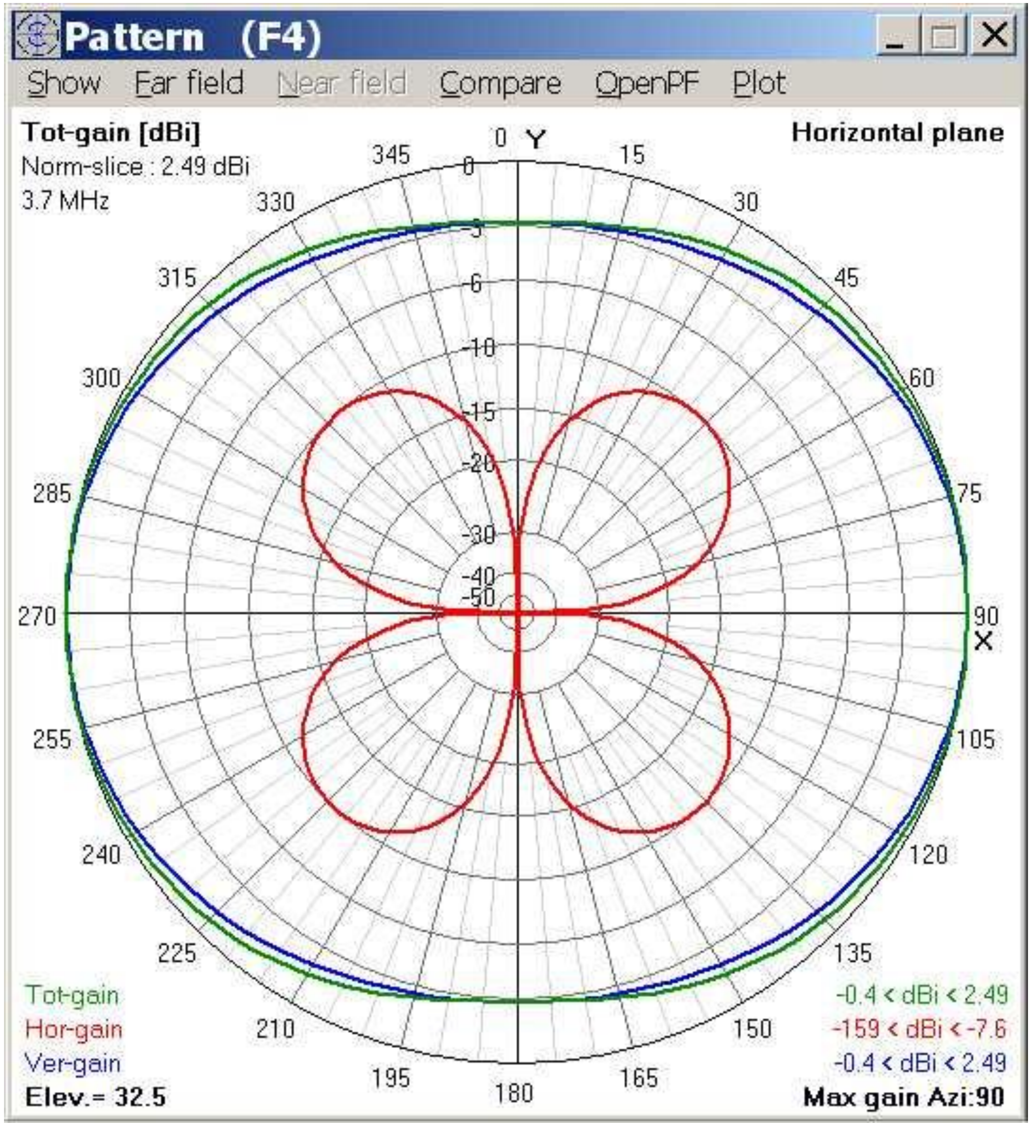
Radiation Pattern 160 Meters by W6XX



Red = Horizontal

Down 29 dB or more from the vertical radiation pattern.

How does it work on 80 meters?



Red = Horizontal

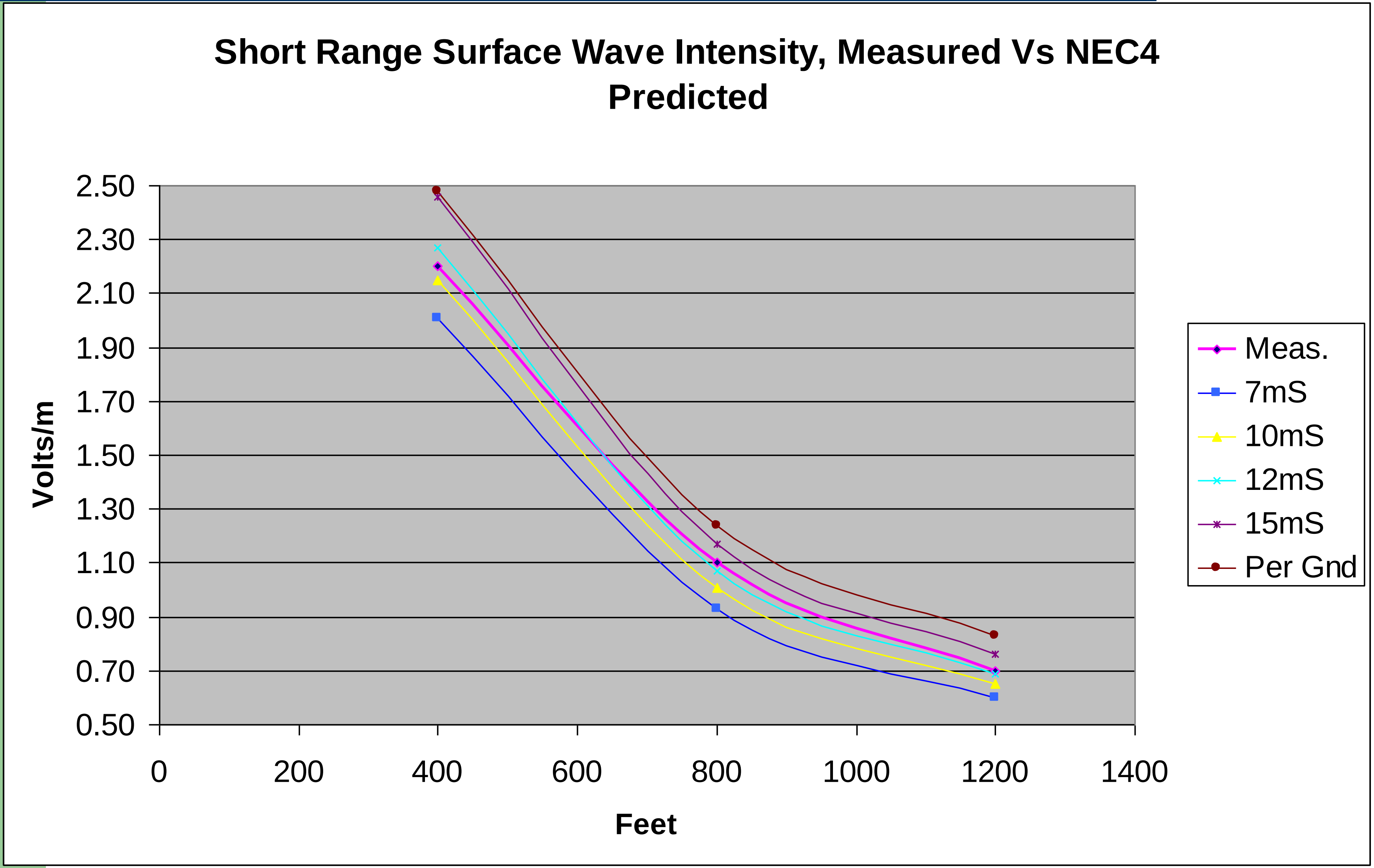
Down 10 dB or more from the vertical radiation pattern.

If the antenna is scaled to 80 meters, then it is a perfectly good antenna on 80 & 40 meters.

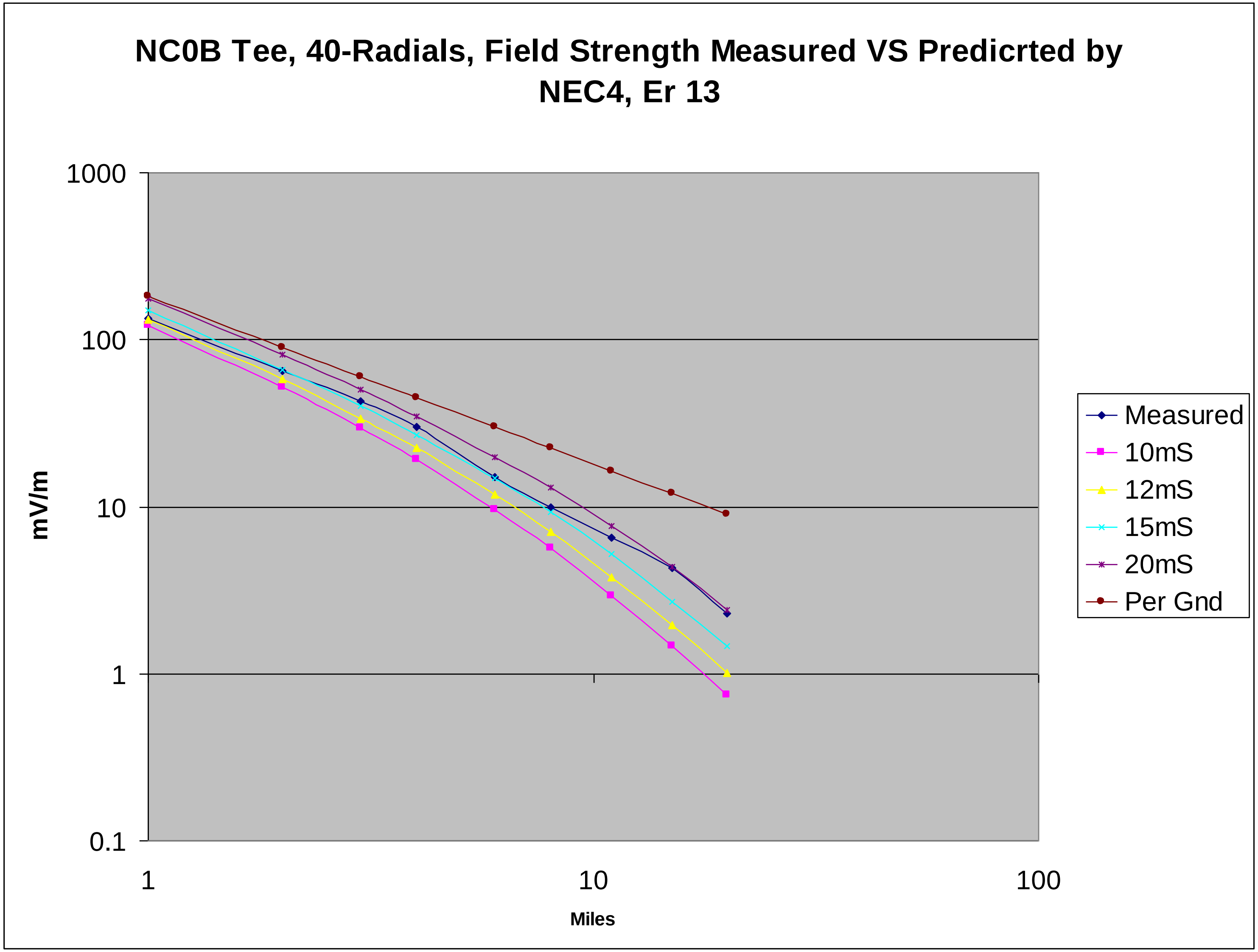
Field Strength on 80 Meters

- Voltage fed: 2400 ohms + j4000 !
- Field Strength @ 1 mile & 1 kW
- 80 mV/meter in line with flattop
- 45 mV/meter 90 degrees to flattop
- More groundwave loss on 80 vs. 160 meters.

Radial Field Strength 400/800/1200 Ft – W6XX



Radial Field Strength 1 to 20 Miles - W6XX



Summary

- What's practical for your QTH?
- Ground screen better than a few radials.
- Broadcasters use a screen + radials.
- Limited space? Use a ground screen.
- How much? Shoot for 400 square feet.
- Don't recommend less than 100 sq ft.
- Add radials? 16 or more, or don't bother.
- 4 radials do virtually nothing.

Sherwood Engineering

http://www.NC0B.com

Thanks to W6XX and K0ELM for their invaluable assistance