MY BIG VERTICAL ANTENNA PROJECT

This memorandum describes my Fall antenna project, specifically a DX-Engineering, Model DXE-MBVE-1, 43 foot mono pole vertical antenna.

Restraints Imposed by Location and Other Factors:

I have a rather small suburban back yard, 100 feet wide (N-S) and 55 feet deep (E-W). I have only one really useful wire-antenna-supporting tree located in the Northwest corner of the lot. My wife would rather I put up a 55 foot tower, than drill holes in the roof. (OK, that may be a limitation, but hardly a problem, and seems fair enough to me.)

I have a couple of 40 foot masts that can hold dipoles or other wire antennas. Heretofore, my dipole antennas get me on the air and with OK coverage off most of the US, but not the farthest states, such as CA, OR, or ME, or WA – and pull in rather little foreign DX. My wife is not too crazy about digging holes or trenches in the yard, but understands and supports the hobby, even if that becomes necessary. Understandably, she favors a solution with low visual impact and small footprint over larger, more obvious solutions Pretty cool, eh?

Design Selection Considerations:

I selected this antenna for several reasons, not the least of which is because it is substantially less involved, and less expensive, to erect than a self-supporting tower. Another reason is because it covers the lower HF bands with an outboard tuner, whereas other, tuned trap vertical antennas typically cover only 40 meters and some higher bands, but have little application, and typically no application on 160 meters. Either they do not cover those lower bands, or they have such an unreasonably narrow useable bandwidth as to be nearly useless thereon.

I do not believe I can raise a wire dipole antenna higher than 40 feet at present - at least not without installing a tower or some other tall support structure in the yard or on the roof of my home.

Therefore, I decided to erect a large vertical mono pole antenna after considering NEC charts and related studies, from which I concluded a large vertical antenna can be expected to have a somewhat lower takeoff angle, and, therefore, be better suited for pursuing DX and reaching the farthest corners of North America, than, say, the typical low hanging dipole, doublet, G5RV and the like.

I strongly considered the various trap dipole designs, and small vertical dipoles including those produced by Hustler, Butternut, Mosley, Hy-Gain, Force-12, Zero-Five, and SteppIR, and several other manufacturers. I even considered constructing a home brew vertical of various designs.

To this end, I ordered and carefully reviewed a detailed report, *"HF Vertical Performance Test Method and Results."* published by Champion Radio Products (N0AX and K7LXC, Authors).
You can Order it here: http://www.championradio.com/publications.html

After pouring over all the test results, I made a significant observation. All of the antennas in the test group were compared to a particular "reference antenna," the classic quarter-wave monopole antenna, with radial ground screen. In the all the various tests, the reference antenna acquitted itself rather well and, in my view, was the best overall performer. Some of the verticals in the test group performed slightly better than the reference antenna on the upper bands (i.e. 20, 15, 10 m), but only by a very small margin. Most of them, however, performed substantially worse than the reference antenna on the lower bands (i.e. 80, 40, 20 m), by a comparatively larger margin. Overall, however, the reference antenna was better than all the others on the lower bands, and only just slightly worse on the upper bands. I concluded that makes it the better overall performer, (at least according to these test results.)

I shared and discussed the report's findings with several operators whose opinion I respect. A friendly and helpful operator, Bill AA4NU, and a friend from the local Friday Lunch Bunch, Rick W8IMA, each prepared NEC analyses comparing several different antenna models which could be installed at my location.

I discussed my observation with my Elmer friends, and the technicians at DX Engineering, which sells both type of antenna, as well as other hams, including one of the operators who authored the test report. The consensus was that my observation was a reasonable conclusion based upon the test results.

Therefore, this particular design moved higher in the selection process. As it appears I could operate on the lowest bands, including 160, 80, and 40 on the reference antenna, whereas it would be nearly impossible to operate on 160, and only marginally possible to operate on 80/75 meters within a very narrow bandwidth on the other types of antenna in the test group, I decided to erect the reference type antenna.

I strongly considered the Hy-Gain Hi-Tower (AV-18HT) because it can operate on the lowest bands, and with a relatively wider bandwidth than the other antennas in the test group (and others of similar design and capabilities,) and because is inherently tuned for the several bands it covers, mostly eliminating the need for an outboard antenna transmatch/tuner. But the prospect of pouring a large concrete base and assembling a tower structure of even that magnitude did not appeal to me (even though it is not a large tower compared with the typical self-supporting tower supporting a beam antenna.) I also considered the fact I could complete this antenna project for approximately 1/3 the cost of a Hi-Tower, I ultimately decided upon the mono pole vertical as my next antenna project.

Note: The various modeling programs were of no help in selecting a single pole vertical like the reference antenna, compared with the tuned trap vertical antennas in the test group. The modeling programs seemed, to me at least, to treat all verticals the same as far as patterns go.

In this regard, I agonized over this model versus the Hustler 6BTV, wondering whether a tuned trapped design would radiate better than a larger radiator, tamed with a tuner. Other than a few test reports, and a lot of conflicting and dubious anecdotal commentary by other operators, I could not find any definitive or quantitative answer to this question. Lots of guys like these antennas, as well as the similar big vertical antennas made by Force-12 (Hy-Gain recently announced it will sell a 43 foot vertical mono pole antenna, also.)

Therefore, I decided the bottom line was to select the antenna I thought could allow me to work the lower bands over the wintertime, which is, more of a priority to me than it may be for other operators. There is nothing happening on 10 or 6 meters anyway, so I decided not to put up a large 20/15/10 m beam, and I have another plan for covering 10 and 6 meters, which will constitute another project for another weekend. I mostly seek to work 20/40/80 meters, and occasionally 160 meters, so this seemed like the one antenna that would most likely accomplish my goals within a reasonable budget, and fit within my rather small suburban back yard.

This Option Can Also Support Other Options:

Besides, I can very easily substitute a Hustler 6BTV or other vertical antenna for the big vertical at any time without serious expense or inconvenience. Other vertical antennas can mount directly to the DX Engineering Tilt Plate and can use the same radial ground plane laid out for the big vertical, except in some cases, I would bypass the big DXE RF Transformer/balun installed at the base of the big vertical. I figure I could remove the big vertical DXE element, and replace it with another type of vertical antenna, in about an hour, not including the time it takes to assemble the replacement antenna.

Or, I could clip a light-to-medium gauge wire to the tip of the big vertical and run it away horizontally for maybe 100 feet, more or less, and transform it into an inverted “L” antenna to work the lower bands. Or, I could erect a Hy-Gain Hi-Tower over the same radial field and try that.

Thus, I think this option gives me the best chance for operation on the lower bands in my smallish back yard, while permitting me to experiment with other products at any time with no serious price or performance penalty.

Shipping and Arrival of Antenna Kit:

DX-Engineering sells the big vertical antenna as a complete kit, with certain items as optional extras. The entire kit, including the large numeral 4:1 RF transformer/balun, arrived in 2 large boxes. It arrived within two days of ordering.

Most of the parts came in the larger box.

The mast tubing came in the longer box.

Constructing the Base Support:

Materials you will need:

- One - 5-foot long 2-inch galvanized steel water pipe
- Threes bags - 80 lb. pre-mix cement
- Bucket of water for obvious reasons

Tools you will need:

- Rented 2-man 12-inch auger machine
- A sturdy friend or neighbor crazy enough to help you
- Tub /container for mixing cement
- Ice chopper tool for mixing cement by hand
- Spade/Shovel
- Level to Keep Vertical – (Check it often while pouring cement into the hole…)

I dug a three-foot deep, 12 inch diameter hole with a 12-inch, two-man gas-powered auger. My wife helped at first, but my neighbor offered to help, so I took him up on it. It was a good plan. Thanks, Joe.

I mixed the cement carefully, one half bag at a time, and poured the mix into the hole. (I was not able to mix all the cement at once, so I mixed it in half bag increments.) I also filled the galvanized water pipe with cement on the suggestion of a friend who is a licensed plumber. He said it would make it all the more solid.

I strapped a 3-foot long level to the galvanized water pipe, and strapped a length of angle iron perpendicular to the water pipe to assure the base type remained vertical and plumb as I poured each incremental quantity of cement until I filled the hole around the pipe even with the level of the soil.

Upon reflection, next time I will stop pouring cement 6 inches below ground level, and fill in the hole with soil which will allow me to someday cut the support pipe, and leave the cement base hidden under ground, in the event I want to remove or hide the installation – such as if and when I move to another location, it could be "removed" with no apparent signs. Of course, we all know the value of hindsight...

I oriented the water pipe with threaded ends up, and installed galvanized end cap in order to keep water and snow out of it. I allowed the structure to cure for 2 days before commencing the next step.

Mounting the Antenna Base:

I mounted the DX-Engineering Radial Plate, Model DXE-RADP-1, and Tilt Base to the galvanized water pipe support.

Tools You Will Need:

- *Several Open End Wrenches – (two sets are helpful as some of the nuts need to be held while others are tightened and locked against them.)*
- *Large Screw Straight Blade Standard Driver*

Notice: Water pipe is measured and sold according to its inside diameter measurement. Unfortunately, the DX-Engineering instructions most often made reference to a "2-inch pipe" without specifying inside or outside diameter. Only in one place in the instruction guidelines did it mention 2 inch "OD" which is, of course, unfortunate, because tubing, and not water pipe, comes with outside diameter measurements, whereas water pipe typically is identified by inside diameter measurements. To confound matters, I specifically asked the salesman whether I could use a 2 inch water pipe for the support, and he said, "Yes."

Unfortunately, the cleverly designed V-bolt saddle clamps which come with the kit, can only accommodate a 2 inch "OD" pipe, so I had to drill out additional holes in the Radial Plate, and the Tilt Plate, and purchase larger U-bolts to accommodate my 2-inch water pipe. I called DX-Engineering and suggested they modified their instructions to be consistent and specifying 2 inch "OD" pipe, or some smaller diameter pipe that would include acceptable inside diameter and outside diameter pipe selections. That way, they would not speak in terms of tubing measurements in one place, and pipe measurements in another, and prevent other customers from encountering this problem.

Other than having to modify the plates to accept larger U-bolts, mounting the Radial Plates and Tilt Plate was a snap. I put a fair amount of Anti-Seize goop on all of the stainless steel hardware as recommended by the manufacturer.

Assembling the Vertical Radiator:

Tools You Will Need:

- *Large Screw Straight Blade Standard Driver*
- *Possibly a file or other de-burring tool if you encounter rough cut edges*

(I had no problems with burs, and did not have to do this at all, but it may be necessary on the tubes you get, so be prepared, just in case.)

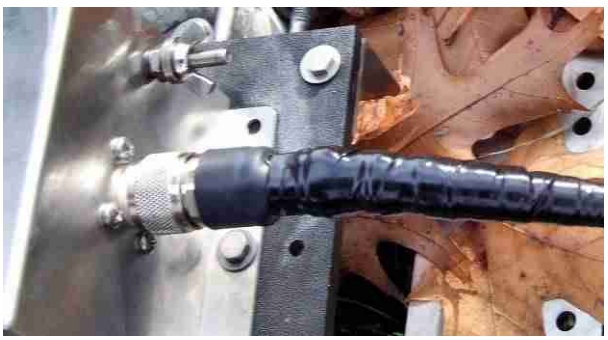
Assembly of the vertical radiator was relatively painless and easy, using the supplied stainless steal pipe clamps. There are sixteen, three-foot sections in all. I applied a liberal amount of Penetrox-A Anti-Oxidant joint compound to the business end of each tube section to assure high conductivity and to displace moisture, preventing corrosion or oxidation between the metal parts of the telescoping aluminum tubing.

Preparing the Feed Line:

Tools You Will Need:

- *Wide flat head shovel or similar tool*
- *Hand trowel or similar tool*
- *Good direct burial coax cable like Times Microwave LMR-400-DB*
- *Good silver plated coax connectors suitable for LMR-400-DB cable*
- *Solder Iron and Solder*
- *Pliers, third hand, or similar tools*
- *Coax cable cutting or stripping tool*
- *Leaf Rake for clearing the area if doing this in the Fall like I did*

I used Times Microwave LMR 400 - DB (direct-bury) coaxial cable for the feed line. This should be substantial enough to handle high power with low loss the approximately 60 foot run from the shack to the antenna location.



I bet you don't have a picture of YOUR wife digging a trench for YOUR coax feed line!

My wife helped me bury the feed line and lay the radials.
I used a square-shaped shovel to cut the sod, and she lifted the sod, and slid to the coaxial cable about 3 to 4 inches underneath, pressing the side back in place afterwards. Initially, we tried to cut a trench in the dirt using a gas powered lawn edger, but that did not cut deeply enough to bury the cable deep enough so that I would not worry it will could be damaged if someone walked or ran a lawn tractor over it.

Assembling the Matching System:

Tools You Will Need: Small Open End Wrenches

Unless you use a remote tuner, you will need top purchase a mambo-sized DXE Maxi-Core DXE-BAL-200-Series 4:1 Ratio RF Transformer/Balun, which is mounted on the support pipe just above the Radial Plate, and below the Tilt Base holding the antenna element.

SIDEBAR DISCUSSION ON BALUN TYPES:

Based on recommendations from several knowledgeable operators, I suspect I may ultimately install a remote antenna tuner to tame this beast, but for now, I will use the Balun supplied with the kit.

Recent discussions in the Elmer's Forum on eHam.net concerned the balun suggested and/or supplied by Zero-Five with its 43 foot monopole vertical antenna kit. Apparently, Zero-Five supplies a VOLTAGE BALUN made by Array Solutions. It was determined and the consensus view that a CURRENT BALUN, like the one supplied by DX-Engineering with my antenna, is the correct balun-transformer to use. Some suggest a Choke Balun, and the consensus was that it is so closely like a current balun in design and function, that it would not provide any significant advantage over the CSE current balun supplied or recommended for this antenna.

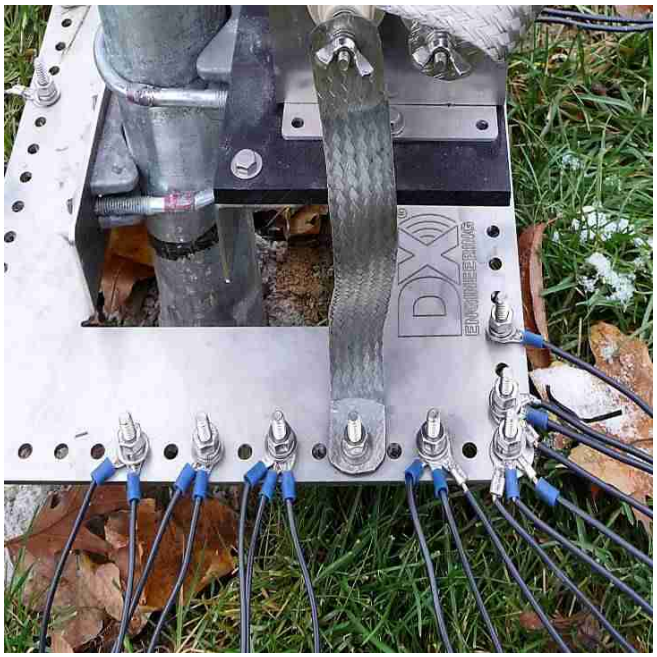
Of course, I found this all quite encouraging. I do not know what Force-12 or Hy-Gain or other vendors supply with their monopole vertical antenna kits, but the fellow who raised the question discussed on the eHam.net forum modified his Zero-Five supplied balun and reported it thereafter came alive and produced excellent results.

Laying the Radials:

Tools You Will Need:

- *Several Open End Wrenches – (two sets are helpful as some of the nuts need to be held while others are tightened and locked against them.)*
- *Wire cutter or lineman's pliers to cut and trim radial wire*
- *Plastic or metal lawn staples or other means of pinning the wire to the turf*
- *(Optional) Lawn edger or other tool to cut trench in turf tor burying or placing the wire below the lawn surface – I did not do this…*

Graphic depicting approximate location of first 27 radials – 50 are planned.



I used a 1000 foot spool of wire purchased from the manufacturer as part of the antenna kit. My wife, Susan, helped me measure and cut 27, approximately 35 foot long radial wires, and we crimped and soldered a supplied metal lug on each.

We stretched and laid each wire out in the yard, and bolted the terminal lugs to the radial plate with the supplied hardware consisting of 1/4 inch nuts, bolts and washers.

We pinned the wires to the grass with biodegradable "plastic" staples which were part of the “radial kit” purchased from DX-Engineering as part of the antenna kit.

The staples are made of recycled PLA (polyactide resin) and, depending upon weather conditions, are supposed to biodegrade in about one year. They are easily installed and hold the radial wires in place rather well. The radial wires should all disappear into the thatch of the lawn in about three to four weeks, once the grass begins to grow again in the Spring.

Notice: I used this technique with success a year ago to deploy several ground radials to enhance an Alpha-Delta sloper antenna. It SHOULD take approximately 4 to 6 weeks for the wires to disappear into the thatch of the lawn. It takes substantially longer, however, if your overly enthusiastic lawn service guy picks them up each week before he mows the lawn, and replaces them afterwards, because it is "No problem” -- that is, until you explain that is IS a problem, and how the disappearing act works. Therefore, I recommend you either mow your own lawn, or advise your lawn service in advance to leave them in place and work around them until they disappear into the thatch, lest it take forever to accomplish.

Installing a Feed Line Pass-Through:

Tools You Will Need:

- *Power Drill*
- *5/8 inch drill bit – maybe six to seven inches long – thick enough to go through the wall of your home*

Materials You Will Need:

- *6 inch UHF – SO-239 bulkhead connector*
- *Larger than typical 5/8 inch nuts for bulkhead connector*
- *Blank clear plastic, metal, or wood switch plate cover*
- *Screwdriver*
- *Rubber sheeting for weather sealing*

To complete the project, I installed a 6-inch long UHF (SO-239) bulkhead connector to bring the feed line into the shack. I use a 3-foot RG-213 or heavier coax patch cord from the inside connector to the antenna tuner-transmatch. This means the coaxial cable feed line is easily replaced.

Installing this was easy, using a six inch long 5/8 inch drill bit. I drilled a 5/8 inch hole in a plastic electrical face plate for a nice finished look on the inside, and used an over-sized nut and round rubber gasket to finish it off on the outside where the bulkhead connector protrudes through the exterior siding. It was so easy, and has such a nice clean look, that I wonder why I did not do this before for my other antenna feed lines. You could use a large lug and heavy gauge cable to connect it to your station ground if you like.

(I leave a discussion of grounding the antenna or coax feeder for another day...My recommendation is to follow the manufacturer's instructions.)

Performance:

Initial testing during the ARRL Sweepstakes Contest, using only 17 radials, provided good results, allowing me to contact several states, including California, Colorado, Washington, Florida, and Arizona, in several minutes, usually getting through on the 1st or 2nd try. After adding 13 more radial wires, for a total of 30, 35-foot ground radials, I tried the antenna on 40 meters and 75 meters SSB, and was getting good signal reports from each end of the country, and all points in between, and worked several states in about an hour.

These are but preliminary tests, but my initial impression is that I have made a good investment of time and money. It is as good a receiving antenna as any of my long dipoles, without any excessive noise vertical antennas are sometimes prone to pick up. Vertical antennas are notoriously more noisy than dipoles. This seems to be a good radiator. I am getting good signal reports from all over. I anticipate it will perform much better once I have laid a total of 50 or more radials.

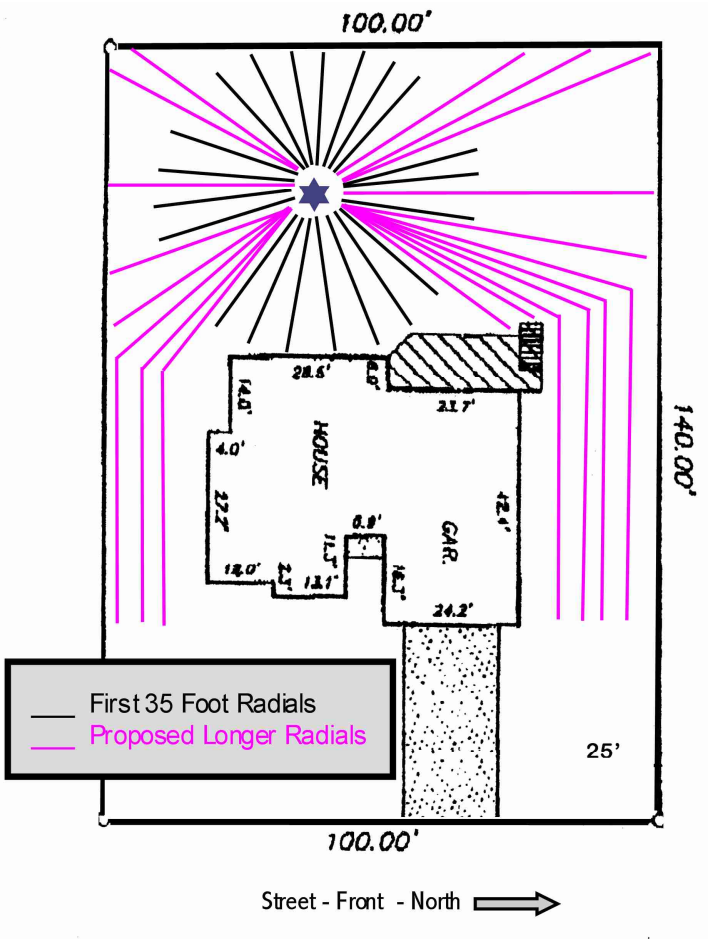
This antenna is resonant on a frequency (I presume all antennas are resonant on *some* frequency or other. The rub is that that frequency does not fall within any of the amateur HF bands. The is, therefore, gong to be a substantial SWR, impedance, etc., mismatch, more or less, *no matter where you tune up.*

Therefore, you *WILL* need a substantial outboard antenna tuner (transmatch) like a Palstar AT2k, MFJ-969, Ameritron ATR-30, Ten-Tec 238B, or similar. Some, but not all, internal automatic tuners (ATU) will be able to tame this beast. It is possible an internal ATU would be sufficient on some frequencies, and not others, depending on the frequency, SWR, and all that impedance, reactance, and inductance jazz. My Ten-Tec Omni VII internal ATU is purported to be able to handle a range of 10:1 SWR impedance mismatch and has (so far) been able to tame beast on 80, 40, and 20 meters (all the band I have tried so far…,) but that means going barefoot and foregoing additional power from an amplifier. My Palstar AT2K has handles the task on all bands with apparent ease. It seems no more difficult than tuning a non-resonant doublet or dipole cut for another frequency than the one in use.

I presume a heavy duty outboard automatic antenna tuner, such as the Palstar AT-Auto, LDG AT-1000Pro, MFJ-998, or the like would be sufficient to the task, whether or not one runs power with an amplifier. I believe one would want this type of heavy duty tuner, whether of the automatic or manual variety, to be assured it can handle the fairly large SWR and impedance mismatch.

Apparent Impact of Ground Radials on Performance :

I tested the antenna on 40 meters, after installing fourteen, 35 foot long radials, made of stranded 14 gauge THHN wire, on the ground, laid on the ground exclusively in the Northeast quadrant surrounding the antenna. The antenna performed well – as well or better than my home brew 40 meter half-wave antenna that once hung in the same space in the yard. I took the dipole down to accommodate and not crowd the new vertical, so I was unable to make a direct A-B comparison, but I promptly made contacts in several distant States on each respective coast (ME, OR, WA, and CA) which had been theretofore nearly impossible to reach on any of my dipoles or other antennas. I was, of course, thrilled.



Since then, I have added a total of 36 radials, each approximately 35 feet long. I will add a few more of that length to fill in and balance the initial circular pattern, and will later add several longer radials, perhaps as long as 100 feet more or less, which will be stretched and laid to run to the far diagonal corners of the yard, and

run along the side of the house, toward the street front, as far as practicable. I do not seriously anticipate this will provide any substantial advantage, but I figure it might improve performance on the lower bands to have some really long radials in the mix. My research, and the anecdotal empirical observations of others who have also deployed similar patterns compels me to conclude "it couldn't hurt…"

Conclusion:

I hope I have provided some helpful information herein, such that others may be encouraged to try this type of antenna (sold variously by DX-Engineering, Force-12, Zero-Five, Hy-Gain, and others.)

James -- K8JHR

Of course, it snowed while we were installing the feed line and radial field! That should insure it works well !