

Antenna Building: Theory and Practice – Part 1, by Hooper

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As an introduction, I started building Vertical & Yagi Beam antennas in the early 1980s for CB radio. When the FCC dropped the ‘Morse Code’ requirement in 2007, many ‘tone deaf’ people like myself, transitioned to ham radio. My entire family are either General or Extra Class hams. Having this license and operating ability is an essential ‘Life Skill’, like the ability to read, write and speak the native language.

No tool is useful, in unskilled hands – unless you’re planning on selling/bartering it away, right? Our family and I have taught Technician, General, and Extra classes – but, none of us consider ourselves Super Duper hams nor engineers, just dedicated hams. Show us a radio, and any one of us can get on the air, make contacts, work a Contest, pass mail, and train others to do the same. That’s what hobbies are about, having fun, bringing in others, sharpening the skills, and in the case of ham radio, or Distance Exchange (DX), like Short Wave Listening (SWL) – you’ll need to train your ears and brain to effectively operate / communicate / carry on a conversation. CB radio is Grade School, ham radio is High School.

In layman’s language, everything has a Resonant Frequency. Like a Tuning Fork, when struck, emits a certain Frequency of Sound, we want to image that in the radio world, both transmitting and receiving.

If the Antenna is cut / tuned for the right Frequency, then *two* things happen:

- It will ‘HEAR’ that frequency better than anything else, as well as the associated Harmonics (don’t worry about Harmonics, yet.)
- It will NOT hear unwanted frequencies as well – or NULL those, like being Deaf to the unwanted Frequencies or Radio Signals. (This is very, very important!).

Our goal is to build something that ‘gathers’ the radio waves that **we want**, and ignore or reject the junk & interference. Interference can be the neighbor’s pole transformer, your dishwasher motor, computer monitor, another close by station, anything that seems to clutter up your listening frequency. Sometimes that interference is a Harmonic, electrical, sometimes it’s your Coax Cable leading to the antenna, sometimes it’s just poor grounding – there are ways to clean that up too.

Okay, I live in Virginia, but I want to listen to 700AM, WLW from Cincinnati, Ohio. There are Appalachian Mountains between us – absolutely **not** a line-of-sight route. Or, WLS 890AM in Chicago... 750AM WSB in Atlanta? How can we get those signals? Several ways, via the Internet, or via the signal bounce off the Ionosphere layer (up in the sky, under most conditions), – or – via the ground (yup, radio waves can reach you via the ground!). What we want to do is take advantage of Signal Propagation, under good and/or bad conditions. An EMP isn’t the end

of communications as we know it (EOCAWKI?) Another curious thing, Radio Waves will be absorbed by some objects and bounce off of other objects, even though both objects are made out of the SAME material? Back to Resonant Frequency!

Our ears hear frequencies from 20Hz-20,000Hz, that's quite a wide range! Our Broadcast AM frequency ranges from 535,000Hz to 1705,000Hz (also known as Medium Wave, your radio dial probably has it as 540-1600KHz). SW (Short Wave... Oh, it's a shorter wavelength, just above AM Broadcast, but we like to refer to groups of frequency ranges as 'bands' in 'Meters', which is actually the length-of-the-radio-wave. WHY!?! Trust me, to build any antenna for listening or transmitting, the conversion to the Length of the Radio Wave, determines the Length of the Antenna... to make it resonate, receive or transmit effectively. Somehow... we need to match the signal being 'sent' (Broadcast) to our Radio (Receiver / Transceiver... a Transceiver receives & transmits), we need a "System" of a Radio, Transmission Line, and an Antenna.<

Fortunately, we can make the antenna resonate across a rather wide frequency range, by adding 'stuff' to it, changing it's shape or putting other things close to it (coupling, which works FOR and/or AGAINST us.)

Let's start with WLW 700AM, or 700Kz or 700,000Hz... or we'll use this: <https://www.unitconverters.net/frequency-wavelength/kilohertz-to-wavelength-in-metres.htm> Oh, that's about 428.27 meters, the length of the Radio Wave. If you convert that to FEET, 1405ft. My goodness, that's a really LONG antenna! How come we hear stuff with much smaller / shorter antennas? What if the Antenna is 1/2 a wavelength ($1/2w_l$) or $1/4w_l$ or $1/8w_l$ – sure, that'll work, and it'll also match up to other frequencies... but, at least it matches to a 'portion' of that wavelength. Ever notice how *tall* those AM Broadcast antennas are? The whole thing is one big antenna. FM Broadcast antennas are much shorter, because the wavelength is quite short by comparison 88mHz-106mHz, it's also much higher in frequency. Our 1405ft antenna is impractical, way too long, $1/4w_l$ of that is just 351.25ft – hey, we can build that easily!

Just 351.25 feet of wire, hanging out the window, with "favor" or resonate at 700kHz best for our radio! Tie a short rope on each end, so it's not touching a tree or house (gotta insulate, for lightning and a wet tree can become part of the antenna, even if the wire is insulated!). On one end of the 351ft wire, we attach the center of the Coax, the braid or shield that surrounds the coax, attaches to the ground. This is a long wire antenna. The antenna's direction will vary with height, any angle, composition of the ground (rock is generally less conductive than clay or dirt). One thing to note, the wire between the coax and ground, does add to the overall length, which can be quite handy for shortening the antenna, to *raise* its Resonant Frequency.

The other end of the coax, attaches to the radio. Without getting too technical, the length of the Coax also has an effect on how well your Radio, rather your Transmitter will 'Match' or like the Antenna wire. Ham and CB Radios are built for a 50 ohm Antenna. A bedside clock radio, with the 2 screws on the back, likes to see a 300 ohm load / Antenna. Those little black things with 2 wires on one end, and an "F connector" (screws onto Coax), converts the Impedance from 75 Ohms to 300 Ohms. It'll work without it, but it'll work much better with it – besides, they're cheap!

Now, 700AM will typically be the loudest signal on the AM band. We're receive other stations, not quite as loud. If there's a nearby station that's overwhelming the radio, disconnect the ground wire. In my location, nearly 20 miles from any radio tower, we got a station around 530kHz, which is line-of-sight, and broadside to the Antenna wire... Yeah, it's really strong. My options are limited by the Trees available to hang the wire, if I turned it, I'm sacrificing some of the intended signal, nuts! Several options besides reorientation, like narrowing the bandwidth of the antenna, sort of 'sharpening' the frequency it hears by increasing the NULL, deadening frequencies we don't want to hear.

Okay, that's an antenna suspended in the air, is there another way?

Well, a Vertical antenna, follows the same idea, 1/4 wavelength being a good place to start. At this point, you've probably realized the antennas 'hear' broadside, or off the sides best, but not so good off the ENDS. Bingo, that END is also the 'deepest NULL' where the wire antenna is nearly deaf. Then the antenna is capturing electrical energy out of the air, from the Broadcast source. The greater exposure to that Broadcast source, the stronger the signal – or the more voltage (power) is induced or picked up by the wire. We're trying to capture Micro-volts of energy, which the radio receiver will amplify, decode and convert to Audio energy you can hear. The NULL for a Vertical antenna is also off the end, the tip, which points upward. The vertical hears best to the side, but NULL straight up... this is important to keep in mind with any Antenna. Like turning a Rabbit Ear TV antenna to get a station, or spinning a Table top Radio, we're trying to orient the most amount of wire, pipe, structure broadside to the Transmission source.

Voltage, that's what makes an Antenna work, give the receiver enough voltage, it has something to amplify, stick a bunch of 'resistance' between or into the Antenna and the Receiver has *less* voltage to work with. Naturally, you want a good electrical conductor, Silver begin the best, is expensive. Copper and Aluminum are pretty much equal, Steel and Iron suck, Stainless Steel, Chrome – horrible. Gold which is commonly used for "electrical contacts", is not a good conductor, but, it doesn't oxidize, like copper, aluminum, and silver. Why do those Telescopic, chrome-plated, antennas work? They're so short, there isn't a whole lot of accumulated resistance – and when compared to the antennas we described, there's no comparison at all.

Litz Wire and Starlink and Repeater antennas, what do they have in common? All of them are multiple receive Antennas, with matching coax / spaced to a single point. Litz wire, commonly used on Tube TVs (the Yoke around the tube), and Older radios (looks like cloth, wrapped over a whole bunch of very skinny wires), increase the signal strength by folding the signal of each wire on top of each other, into a single point, the end which then connects to the receiver. 60 insulated wires, combined increases overall voltage. Starlink uses a similar technique, instead of a curved Dish, the flat antenna has hundreds or thousands of tiny antennas, all connected together to give a big signal from a very weak satellite (Dang! That Musk is smart!).

A Repeater antenna usually has 4-5-6 small loop antennas, and a special harness, every wire equal length so the signal from each antenna reaches the focal point at exactly the same time, producing a much stronger signal. You didn't think that 5 watt Baofeng Handi-Talkie (walkie-talkie), really cranked out serious power, did you...? Why can you 'hit and open' a repeater 30-

50 miles away, but can't seem to talk to your hunting buddy 5 miles away...? It's the antenna. Put your "Bad-fang" on one of those repeater antennas (with lots of loops), and it'll make your buddy's 5 watt signal like +100 watts. We're collecting voltage, all we need to do is synchronize all the signals to a single point. This is important, because if the single point is getting signals out-of-phase, then the signal is cancelled.

Cancelled...? Okay, we set up 3 or 4 vertical antennas, identical lengths, and just randomly hook them up with Tee connectors, eventually back to the radio. Signals will come from all different directions, as normal, but because the vertical antennas are spread apart, one antenna is collecting a positive pulse, while the other might be collecting a negative pulse – add in the random Coax lengths, probably got some Cancellation.

(Continued from Part 1.)

A typical Trucker's dual-mount CB antenna has 2 coaxes down to one connection to the radio. We want the signal from **both** antennas, unified exactly for a nice strong signal / in phase voltage pulse, into the radio. Because the antennas are on the sides, like mirror mounts, the strongest, best signal (in phase), will come from the front and rear of the truck, while signals from either side, will cancel each other out (a little bit).

The same thing happens with our Vertical antennas, 2-3-4-5-6-7-8 of them. We want to **get rid** of the noise and interference to hear cleanly in *one* direction. These verticals can be arranged in a circle, straight line, triangle, all kinds of shapes. While most people *think* the signal is being concentrated (it is), the biggest advantage is Nulling out the unwanted junk. By combining the antennas, switching in shorter / longer / equal coaxes which tie them together, we can change the shape of our broadcast / receive signal.

An example...

At a recent Hamfest, we set up three 20-meter vertical antennas. Everyone who commented, said, "That's not gonna pick up anything but that noisy transformer", some 100 feet away. True, you could hear it crackling, like it has a corroded connector. With the right switching, we had 10 different receive / broadcast patterns. Omnidirectional (all directions), Broadside (3 directions), 2 Inline (6 directions). Without looking at the controller, we just rotated the pattern, and in 2 of the positions, the transformer was totally silent. For the rest of the day, we made contact after contact, with ease, the transformer still humming and buzzing away. It's why the NULL is so important! That could spare your relationship with a neighbor who has a cheap TV, lacking proper filtering. By the way, every electronic device is required to be properly filtered to avoid cranking out electrical noise or receiving it outside of its intended frequencies! If the neighbor says you're bleeding over their TV set, and your radio is 'stock', as the manufacturer designed and built – it's *their* problem, not yours. Still, I'd offer them some help fixing, grounding, etc.

That's the fun of ham radio for us, we love building and experimenting, with the minimal tools at our disposal.

What is a “Dipole” Antenna? You’ve probably seen the parallel wires that form a “T” and hook up to a FM radio. We can do the same thing, with a ham band antenna – they get up to 360’ long on 160 meters, but pretty short as the bands / frequency go up... Again, we can combine signals to a single feed point, and tune the antenna to maximize certain frequencies on desired Bands. A Fan Dipole is one such antenna, stacking 2-3-4-5 horizontal wires, each cut for a different band, to maximize desired signal and minimize interference.

What’s interesting about a Dipole antenna, but similar to all antennas, they are Deaf, or NULL when looking at the end, down the length of the wire(s). Strongest signal is broadside – the receive / transmit pattern looks like a figure-8, at a good elevation. The lower the antenna, the more energy is focused directly UP instead of OUT sideways. Dipoles are generally cut as $2 \times \frac{1}{4} \lambda$ antennas, or $\frac{1}{2} \lambda$ overall. Dipoles, like Verticals and Long wires are easy and quick to make.

A note on materials and junctions / connectors. Anytime dissimilar metals are stuck together, like Stainless Steel (makes a poor antenna) to copper, there are inherent losses. Each joint, held together by solder, crimped, formed, stainless steel screws, adds to the loss. The ideal antenna is one continuous length of wire, pipe, whatever. There is a thing we call “Skin Effect”. The signal flows over the top layers of the metal, like on the surface. Lower frequencies go deepest into the metal, highest frequencies more on the surface. Before someone suggests, “Oh, my, those losses are so minimal!!!” In 2013, we won 3 divisions in the Virginia QSO party (a contest) with an antenna I built for mobile, cut to tune on a single frequency. After making multiple contacts with QRP (low power, <5 watts), another guy following about a mile or two behind, broke in, “Who are you talking to? I can’t even hear them!” He had a \$500 commercial antenna, a big one which covered ALL the Bands ... poorly.

If you can’t hear ’em, you can’t work ’em! All of these expensive antennas are built by fellow hams, some are good, most are just made to attract buyers. The real performers are built by people like yourselves, who take a little time, understand ‘how it works’, and build accordingly. The test tool we started with was a \$150 Standing Wave Ratio (SWR) meter (a waste of time and money, plotting all those data points of graph paper), and then we purchased a \$500 AIM UHF antenna analyzer (hooks up to a computer). The time-testing and experimenting was compressed from weeks to hours. It did all the graphing, showed us Resonance, Impedance, SWR at the same time, and best of all, we could save and load multiple scans over the top of each other. For the experimenter, the learning curve was immediate, ‘If I do THIS, I see THAT affects this and that... Okay, let’s try this instead...’.

So, each antenna typically has a single ‘sweet spot’, a Resonant frequency, what it’s tuned to, hears the best. SWR is a funny thing, Standing Wave Ratio – the amount of signal reflected **back** from the antenna towards your Transmitting Radio (Transceiver). The Transmitter likes to see a 50 ohm load, but also in phase to the antenna. If we cut the Coax at random lengths, it changes the Impedance the Radio sees, regardless of the actual Impedance of the antenna. That translates into LOSS of signal, or poorer Signal to Noise. We want the signal to be much louder / stronger than the noise, static, snap-crackle-pops.

The ideal SWR is 1.0:1, we can build a good antenna, couple it to a frequency-insensitive Coax, and get performance. The goal is to make the Coax (transmission line) invisible between the Radio and Antenna... then we can use 75 ohm TV coax, or 50 ohm CB/Ham coax – just gotta cut it to the length that favors our Frequency / Band. SHORT is not better, Tuned is better. Another example.

A guy from the UK is calling CQ (hello, is anyone out there?), on 80 meters. I answer him with 4 watts, running to 2x 80 meter verticals, phased and pointed right at him. He's stunned. I confirm, via my SWR/Watt meter (an expensive digital unit), just under 4 watts. "Sounds like several hundred – what you got there?" "Two 80 meter verticals, phased, aimed right towards the Europe and United Kingdom." We talked for a while, but I couldn't hear anyone else north or south of me, the radiation pattern was tight. The antenna spacing, both antennas were right on frequency, the coax was cut for $1/2\lambda$ of the frequency – near perfect match, all my power was aimed right at him, all 4 watts. The point is, give yourself *every* advantage you can, a little knowledge & experimenting can give you a superior system.

What is all this darn Black, sparkly stuff everywhere around the house... I wondered. While hooking up an extension cord for the parents motor home, I pulled out the VOM (volt-ohm-meter), and checked for voltage. One of the leads fell to the ground, the meter immediately showed near 100 volts! The tip was just in the dust, this black dust... Grass didn't like growing in it, but, it makes an excellent 'Ground Plane' (like a grounding system) for Vertical Antennas. Magnetite! A ham's dream come true! It also explained the frequent lightning strikes. This altered or modified a lot of plans – do I fight this terrible ground, or use it to some advantage? I love Vertical Antennas, my ground loves Vertical antennas. Since the trees around the house are +400' away, that's gonna be big wire, lots of weight, and with the Ice Storms, lots of broken wire.

"What works for me, might not work for you, at your location!" No antenna seems 'perfect' for every location.

Early on, we built OMTA 40-20-15 meter Vertical Antennas. 3 Bands, a rather unique arrangement. Just one of the verticals are actually tied to the Coax, the other 2 verticals are free floating, but spaced at the optimal distance to 're-radiate' their signal into the other antenna. These are tremendous performers for us. We've talked around the Globe on all 3 Bands, Thousands of contacts. All Aluminum pipe. They work Great at my QTH (home location), but utterly suck at another location – didn't make sense... I've got good ground for antennas, he has Rock... everywhere. So bad, we gave up on the Vertical, and tried a 160 meter Horizontal Loop, also known as a "Cloud Burner". "Hey man, you gotta try this!!!" I did, and it sucked at my QTH (my house). To help him with correct matching, we had to build a Balun, a RF Transformer. At the time, I had a bunch of 10 gauge Silver wire, with a Teflon insulation – it came from a MRI Imaging machine install. This transformer weighed close to 10lbs, and had to hang in the air. He liked to run 'lots of power'. One fateful night, he calls me on the phone, "It blew up! The Balun blew up! I looked out the window, noticed a strange red/orange glow while transmitting (excess power), and "BANG!!!" I thought that Balun / Transformer could handle 5Kw (5000 watts), sure it could, when 'on frequency'. Closer examination, the Loop broke, one

end hit the ground, nothing was working as intended, he was lucky his massive Amplifier was still intact.

The lesson: There are limits to everyone and everything, with the exception of Jesus Christ.

Okay, so that's the idea, how about the nuts and bolts, how to build something inexpensive for my CB radio, that performs like a \$250 antenna...? Yes, we can do that! The main point to remember, Build for Resonance, SWR is the match (can be done later), and use Coax that's invisible to the system, (Cable TV coax has some real advantages!)

(Continued from Part 2. This concludes the article.)

In Part 1 and Part 2, we hit a few of the "How it works" or "Why it works" stuff. Proven by experience, or our family ham antenna business would have failed immediately. So, what do you have laying around the house, farm, garage – that can be turned into a high performance antenna for just listening?

In the basement / garage, Metallic stuff, old copper pipe that burst from freezing, Telephone wire, cable TV wire, Ethernet cable (4,6,8 strand stuff), Iron pipe... will work, again not as good. Old extension cords! The longer the lengths, the better! No need to strip wire or separate multi-wire cables, but, a 16awg x 100' extension cord, whew, that's a lot of long wire! Even a 20' tattered Extension cord can make a very nice 20 meter dipole antenna. a 10' extension cord can become a CB Antenna! Don't run out and buy one, hit the rummage sales, look around for junk that can be turned into treasure!

On the farm, or barn, aluminum electric fence wire. Stainless woven stuff does work... not as good though, a roll of barbed wire... again, will work, just not as good. Old Telephone wire that once strung between poles. There is no such thing as old-useless-pipe, a television antenna mast (the pole), that won't work as an antenna, even a flag pole!

Are you stuck living in an apartment complex, a HOA development, or a heavily-restricted community? We can get you on-the-air with stick-on copper foil, attached to a wall, window, or glass patio door. It looks like you've got a burglar alarm, but it's really an antenna... and with a variable capacitor, it's tunable! Got a big old flag pole in the front yard, say 50' away... how about that for an antenna!? A half dozen wraps of wire around the base, connected to coax, stealthily buried in the grass back to your soon-to-be Radio Shack! Again, with a variable capacitor, salvaged from an old radio (the tuning knob thingy, that's a variable capacitor!), it could be an excellent antenna, covering multiple bands! Metal Rain gutters / downspouts – don't drill holes, use a little clamp to make the connection. As a last resort, a portable, collapsible Antenna can be zip-tied to a porch railing, pull it up at night, drop it down in the early hours. The same thing can be done with a **thin** wire, preferably Black (hardest to see from a distance), or wire that matches the color of the apartment. Really desperate? Throw a wire over the roof of the building. Or... talk to the maintenance man (I was one, once), see if he'll allow you to put a long wire in the attic, or a full-blown antenna!

We pulled the van into an overlook, on the Blue Ridge Parkway. Set up a couple of antennas. Our daughters (teenagers) started operating, making contacts. The Park Rangers descended upon us, like ants to a picnic, "What are you doing?" Quick thinking, "We're using a Ham Radio contest to advertise the Blue Ridge Parkway." as one of the girls is describing the wild turkey, deer and amazing variety of birds running around. "Oh...! That's a great idea! Just clean up and leave it like you found it." – and left us. Nothing like a bunch of kids having fun, doing something constructive!

We have portable antennas designed and built, just for POTA Parks-on-the-air, or SOTA Summits-on-the-air, use. Some of the best ideas come from non-hams, "Say, is there anything that could be used for...?" Conversely speaking, nobody can throw ice water on project and shut it down faster than a Broadcast Engineer! Just go ahead and experiment, that's what the entire Radio Hobby is about, experimenting and learning – not everything has been "invented" yet.

With a string and a fishing weight, a length of coax cable can be used as an 11-meter (yes, that's CB Radio) antenna. Strip back the outer plastic-rubber-poly coating, the black stuff, about 9 feet worth. Slide back the braided shield as far as you can, and stick a pencil/pen in between the braided wires, then gradually pull the insulated center out the hole the pen/pencil made. Now you've got what looks like a coax with a "T" on the end, about 9' on each side (the braided end, once stretched, will be a little longer). This is a $1/2\lambda$ dipole antenna, untuned, but I'll work for CB (11 meters). A little bit shorter, and it'll do 10-meter band, longer it'd do 12 meter band.

Once it's cut, you've gotta live with it. However, if the end is **folded** back tightly (insulated or bare wire), the Resonant Frequency can be raised, tuned, etc. On one end, make a loop, run your string, fishing line, rope through the loop, a little weight on the end of the string, thrown over a tree limb – pull it up, and get-on-the-air (receiving or transmitting). If the antenna is vertical, we call that a $1/2$ wave vertical (polarized). Stretch the antenna between 2 trees, and it becomes a $1/2$ wave horizontal (polarized). Vertical antennas talk to other verticals the best, and vice versa. While the radio signal does 'rotate' over long distances, even holding your little Handi-talkie ("Bad-fang" hand-held) so the antenna is UP & vertical, does affect how well it'll reach repeaters & other similar radios, handheld & mobiles. Verticals *like* other verticals. To adjust or completely change your coax wire antenna, shorten or lengthen it by the loops on the ends. Once it is cut, you're done. Shrink Tubing is great for keeping the folded wire tight to the rest of the wire!\

Oh, that old hay baler / rake / sickle bar mower is just rusting away. Or that silly HOA has a stupid looking old Tractor at the entrance. Think "Potential Antenna". Coupling is your friend, Inducing a signal, in/out of any metal object, is easy, fun and can increase your signal strength! What you'll need is a hunk of Coax, strip the antenna end back a few inches, attach an alligator clip to each conductor (center conductor & braided shield). Now you'll need a length of any wire, say, 5'-20' long. Here's the simple part, wind the loose wire around the object, anywhere on it, axel on an old truck, Flag Pole, you name it, this is the experimental part, clip the wire onto the coax leads. Hook the other end up to the Radio and if it's a ham radio, with a tuner (hit the tune button) try the 20 / 40 meter bands first, because that's where the most activity will be. Seriously, a club in Bristol, Tennessee fired up a bridge over a river this way! I've livened up a Flag Pole in downtown Roanoke during a Family Day event – we had a great time! (and the

kids learned all about mutual inductance, transformers, etc). What you've created is a Transformer, with wire wrapped around a 'metal core', the signal is 'Induced' into the 'metal core' / flag pole, bridge, abandoned truck, etc. It works in reverse too, your reception also improves.

Forget the line-of-sight nonsense for the ham bands. We made dozens of contacts mobile, while in a Granite Canyon, and at the Music Center on the Blue Ridge Parkway! No need to be on the top-of-the-world to hear and talk to the world. Really interesting, in both cases, in a canyon or a bowl of surrounding hills – all of our portable antennas performed excellent, with less 'noise' and static interference. The main drawback to a high elevation is ... you hear everything unwanted. Another interesting occurrence, while cruising mobile (contesting on 40 meters), we passed through several downpours, so strong, the rain hitting the little Subaru was too loud. We'd get out of the rain, and signals just lit up the radio from all over the place! As we rolled down the now dry road, signals faded away. Hence, bad weather might improve your reception — just when a radio is needed the most, it performs wonderfully!

Another trick for the coax and loose wire: Add a metal stake for grounding. Not those huge 8' ground rods, but a little 2' wire like the utility workers use, those little flags (made of cheap, stiff wire). Clip the center conductor to the metal object, the braided shield to the little wire, and stick it in the ground a few inches. A few inches. A group of hams conducted an experiment years ago, just how *deep* does a grounding system (Radials) need to be? 6" performed no better than just laying a wire on the top of the ground. Really? This brings us to a very interesting antenna, few people deploy, but really has a very long range.

A Beverage Antenna takes just a little preparation ahead of time, and a whole lot of insulated wire. Hundreds of feet... mine are 880' of wire, which are wound up on a roll / bobbin. Each end of the wire gets a 50 ohm resistor with a little bit of wire beyond that, put an alligator clip on each end. You'll also need 2 stiff wires for grounding. This works because the radio waves travel **slower** through the ground, than through the air, and the same radio waves travel faster down a copper wire. Velocity Factor... just how *fast* is that wire? n. A typical 50 ohm coax varies from .52 to .84 VLF – higher the VLF, the faster the Radio Wave moves through the wires/coax.

Anytime power moves, it can be 'tapped' between two points. Taking advantage of the slower ground and faster wire – we 'aim' our Beverage antenna towards... Europe! Stick a stake/wire in the ground on each end, and hook up the Coax back side to the wire and ground stake. We're gonna induce a very small signal into the wire because of the VLF. This signal will be weak, but really, really clear. Lots of atmospheric static, thunderstorms, etc? A Beverage Antenna is a great listening Antenna.

Speaking of Loops, there's an interesting antenna, it transmits/receives bi-directionally, front & back, with deep NULLS on both sides. Again, the broadest exposure of wire is where the signal is strongest. Taking that loose wire, a string & fishing weight (say..2oz on a 30' of string), sling it over a tree branch – a branch that's got a CLEAR opening below it. Elevation does *not* matter, just so it's off the ground enough to move it around. We attach the coax to the wire loop we've hung from the tree – a **big** loop, and open it up, like a Triangle or Diamond. Where the Coax

attaches, on one of the sides of the antenna. A tuner might be needed, but time to get-on-the-air! If you don't like what you hear, then physically **turn** the wire loop (it's hanging off the tree), 60-90 degrees. Now the antenna is oriented in a different direction. Changing the overall shape of the Antenna will affect reception (you *can* transmit on these antennas!) The rule of thumb on Loop antennas, enclose as much area within the loop as possible, open it up!

So, the farmer next door has Irrigation tubing, and darn it, some of it just leaking so much, he's ready to scrap it. Can you imagine what a 40' x 3" piece of super light weight Aluminum pipe can do as an antenna? I'm talking all over the world, after it was cut down to 33' in length. Take a PVC reducing coupling / plug 4" to 2", about 2' of 2" PVC which will be used to insulate the base of the antenna from the ground. Rebar, or old fence post, pound it into the ground, till 2' is left exposed... 4' post is fine. Slip the Aluminum pipe over the PVC insulator, slide it all over the rebar. These irrigation pipes are so light that one person can easily handle a 33' chunk of it. Attach the center conductor to the Aluminum pipe, the braided coax will both attach to the Rebar, and 4 or more 'Radials'.

Radials are used to improve bad ground. Radials are the other half of a Ground Plane antenna. The length **can** be random, but, if cut just slightly longer than the vertical part, they often perform best.

You've got a CB, needs a ground plane antenna, big time. Do you just happen to have an old Aluminum television antenna mast, steel pipe or Copper pipe? Lo, and behold, it's 9 1/2 ft long too! Figure out a way to insulate that pipe from the ground, stick a wooden Dowel into it, sharpen the end and shove it into the ground. Those old 10' Ethernet cables? Yeah, there's your Radials! Strip the outside insulation off, at the base of the pipe spread the 4 pairs of wires out, 90 degrees from each other (or all in one direction, if that's the *only* direction you wish to talk). Hook the center conductor to the vertical pipe, the braided shield to the 'Radials' made from the Ethernet cable. If the CB has a tuner, you're ready to go. If no tuner, then start cutting pipe until the SWR looks good. Don't throw away the cut-offs, make a mistake and cut too much, just slit the end of either pipe and stick it back together. Use a hose clamp to lock it in place.

The last antenna that I'll mention is a different kind of Beverage Antenna. Save those aluminum cans. Make a hole in the bottom of each one. Feed a bungie cord through the cans, pull it snug, and tie a knot on the ends to keep the cans touching each other. Do the same for the Radials, at least one radial is needed. Clip the Coax onto the cans. if hanging off a tree, it's a Vertical, feed a rope through all the cans, suspend the whole mess, and it's a Horizontal Dipole. Yes... it does work. That's what makes ham Radio fun, experimenting with sometimes crazy ideas.