Here it is….

This info will introduce you to the *full wave circular polarized folded loop*. This modified antenna is the result of continuing efforts, using a few ideas and bits of technology from many other designs, to build high gain portable circular polarized experimental antennas by looping, folding, twisting, and bending of the elements.

Here are some highlights…

- Reduced height and footprint
- Full-sized antenna performance
- Wide bandwidth, NO matching required
- Ground independent
- Can be built using standard hardware store parts

Description

The 2M CPFL, is a full wavelength horizontal and vertical loop. It is not a DC ground or shunt antenna, and no gamma match is required. Reduction of height and width, is accomplished by folding the loop into *three* dimensions. The 2-meter CPFL is so compact it can be placed on a table or bookshelf, and can be connected to your HT for added range and reduced RF at the operating position. It should also provide superior penetration and radiation through walls while operating inside of heavily constructed buildings, using less RF power. Oh, and by the way, when I tweaked and tested the 2M CPFL on the MFJ antenna analyzer @ 147.780 Mhz, the input frequency of the ACARC Club repeater, I kicked the repeater very easily, numerous times, from my apartment!!! I live approximately 6-7 miles away from the hospital…the RF OUTPUT of the MFJ is only 20mW!!! YES, That is only 1/50th of a watt folks!!!

The 2M Circular Polarized Folded Loop Antenna

2Meter CPFL Theory of Operation

The familiar one-wavelength square loop is shown in **Fig. 1** and is fed in the center of one vertical wire. Note that the antenna current in the vertical wires is high while the current in the horizontal wires and is low. The magnetic fields produced by the two vertical wires are high and in-phase, while the magnetic fields produced by the two horizontal wires are out of phase and much lower. Therefore the vertical wires do virtually all of the radiating. Since the horizontal wires don't contribute much to the total radiation, we are free to fold them without greatly affecting the radiation characteristics of the loop. Also note the reduced current near the ends of the vertical wires. These ends can also be folded without greatly affecting the performance.

Fig. 2 shows the one-wavelength loop folded up into a 2M CPFL. The magnetic fields produced by the horizontal wires are 180 degrees out-of-phase and tend to null out. This lowers the radiation resistance and raises the antenna Q. A standard one-wavelength loop has a radiation resistance of 125 ohms. The 2M CPFL radiation resistance is lower and can be adjusted by changing the ratios of the height, width, and depth. The dimensions shown below provide a radiation resistance of approximately 50-52 ohms.

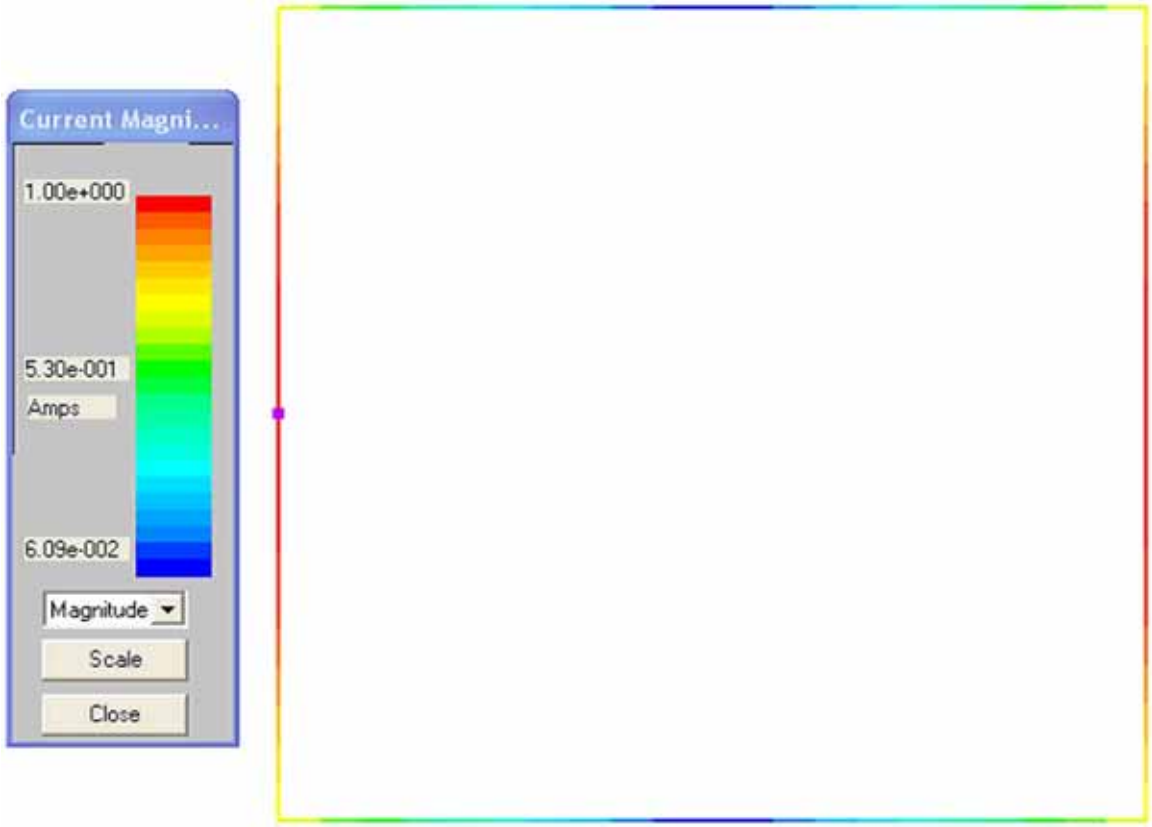

Fig. 1

Radiation Pattern and Polarization

The 2M CPFL free-space three dimensional radiation pattern is shown in **Fig. 3**. Since all parts of the antenna radiate to some degree, the pattern is nearly isotropic with a front-to side ratio of only 1.6 dB. The free-space broadside gain of a standard one-wavelength loop is 3.3 dBi while the broadside gain of the 2M CPFL is 1.6 dBi. The 1.7 dB gain difference is due to the CPFL radiating 360 degrees in all directions. Since both the vertical and horizontal portions radiate to some degree, the electric field polarization is a mixture of vertical and horizontal polarization. Therefore, the 2M CPFL can be considered to have a 360-degree *elliptical circular* polarization, which means it radiates 360 degrees into any plane or axis, of space.

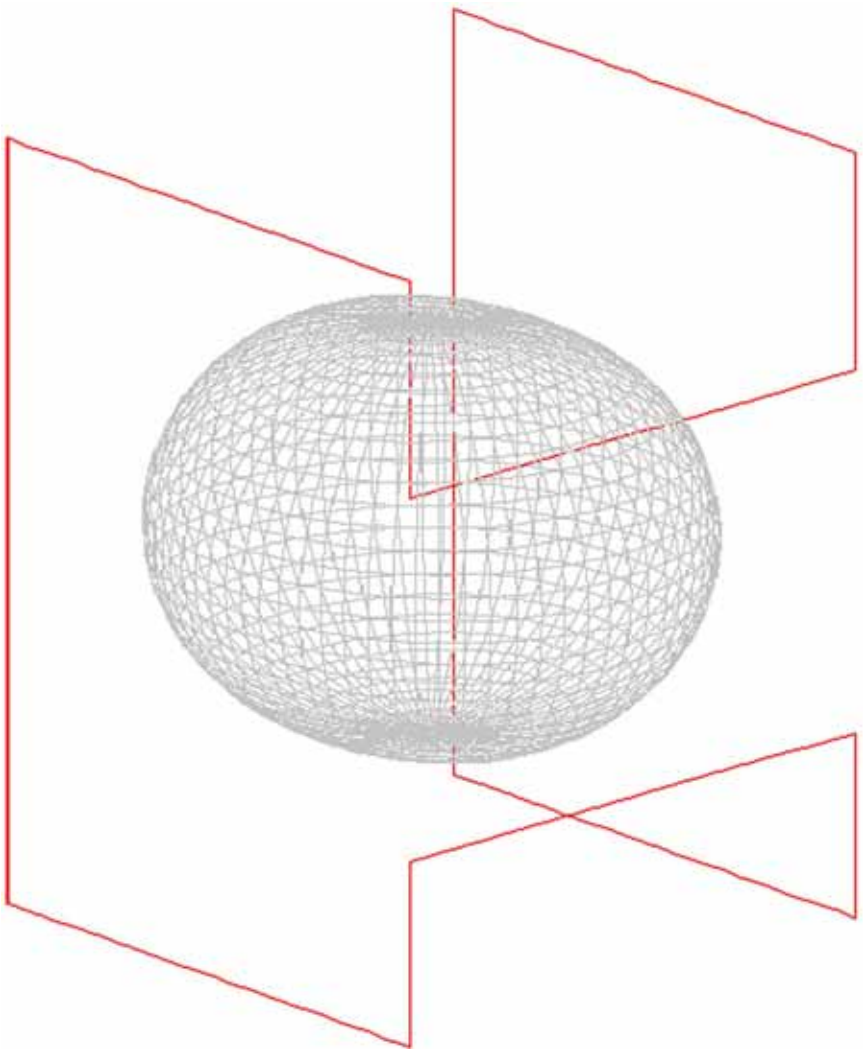

Fig. 3

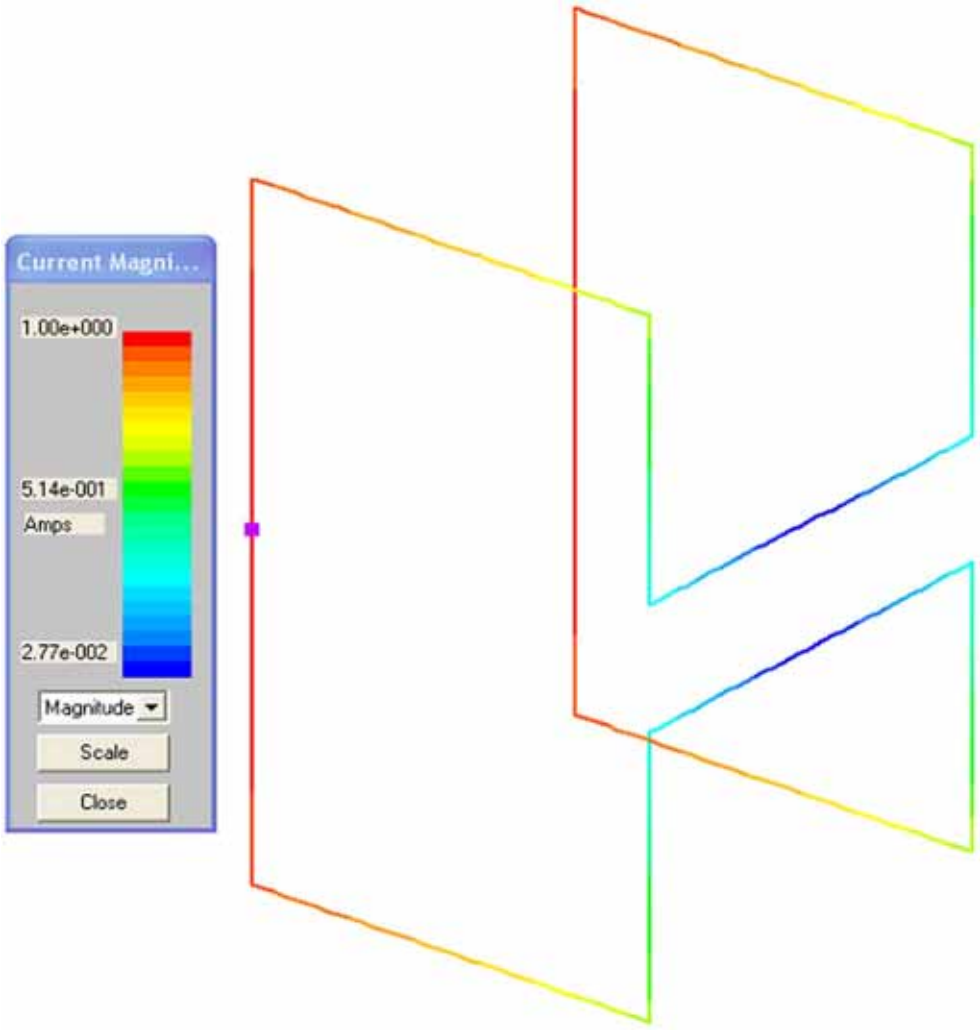
Current Magni...
1.00e+000
5.14e-001
Amps
2.77e-002
Magnitude
Scale
Close

Fig. 2

Modeling the 2M CPFL

NEC-2 will accurately model this antenna. The only limitation is the large Wire (1/2 inch tubing) diameter used for the actual 2-meter antenna. NEC-2 requires that the minimum segment length be equal to or preferably much longer than the wire diameter.

NEC-2 Model Parameters, 146 MHz 2M CPFL, lengths in inches

Wire	Seg.	X1	Y1	Z1	X2	Y2	Z2	Dia.	Conduct	Src/Ld
1	20	0	0	0	0	0	12.25	0.625	Copper	1/0
2	13	0	0	12.25	8.375	0	12.25	0.625	Copper	0/0
3	6	8.375	0	12.25	8.375	0	8.75	0.625	Copper	0/0
4	13	8.375	0	8.75	8.375	8.375	8.75	0.625	Copper	0/0
5	6	8.375	8.375	8.75	8.375	8.375	12.25	0.625	Copper	0/0
6	13	8.375	8.375	12.25	0	8.375	12.25	0.625	Copper	0/0
7	20	0	8.375	12.25	0	8.375	0	0.625	Copper	0/0
8	13	0	8.375	0	8.375	8.375	0	0.625	Copper	0/0
9	6	8.375	8.375	0	8.375	8.375	3	0.625	Copper	0/0
10	13	8.375	8.375	3	8.375	0	3	0.625	Copper	0/0
11	6	8.375	0	3	8.375	0	0	0.625	Copper	0/0
12	13	8.375	0	0	0	0	0	0.625	Copper	0/0

Table 1

Ratios and Formulas

Designing a folded loop with NEC-2 requires a bit of cut-and-try. The ratios between the lengths of the various sections determine the radiation resistance and gain. And there is no perimeter formula that works for all combinations of length ratios and wire diameters. However, a starting point is to make the height 0.15 wavelengths and the total wire length (in inches) calculated by (L=13000 / Freq. MHz).

The 2-meter CPFL

The 2-meter CPFL is a great addition to any HT, and provides several dB of gain over a Rubber Duck. To build the 2M CPFL, costs only ten to fifteen dollars for parts and materials. In addition to being more efficient, the 2M CPFL can be placed away from the operator to reduce RF at the operating position. It works perfectly for SSB, and the antenna is small enough to be placed on a table or a bookshelf.

Construction and Assembly

The 2-meter CPFL can be built using standard copper tubing available at most hardware stores. The materials are shown in **Table 2**, the cutting dimensions in **Table 3**, and the final antenna dimensions in **Table 4**. Don't worry if your antenna dimensions are somewhat incorrect. The final tuning adjustment will take care of it. The 50-ohm coaxial feedline is connected to the center of the split vertical section. This vertical section is made of two equal length copper tubes joined by a PVC coupler. You can assemble the parts and secure the joints using pop rivets, self-taping screws, or solder. Leave the bottom short vertical tubes unsecured so that tuning adjustments can be made. Cut three sets of two bottom short vertical sections. (2.0",1.5",1.0") for the low, medium, and high portions of the 2 meter band. The velocity factor has been calculated into the design.

2-Meter CPFL Material List
1 Section of ½-inch 10ft. length Type "L" Copper Tubing…(77 inches is used)
12 pieces ½-inch copper 90degree elbows
1 PVC coupler for ½-inch copper tubing, or a Carlon PVC conduit access box with ½ inch tubing adaptors.
4 PVC ½ inch self-clamping tubing hangers (feet), (available @ Craft Hardware).
Table 3

You can use solid brass wing nuts and bolts to make portable/collapsible 2M CPFL antennas. Do not use iron or steel based components due to increased inductive reactance. It is recommended that you use a propane torch and solder the sections together with silver based solder and flux. Be sure to clean the ends of each piece of copper inside and out with a brass wire brush. DO NOT USE LEAD SOLDER!!! You do NOT want lead poisoning! Always wear protective eyewear and heavy leather gloves! DON'T GET BURNED!!! You may use brass rivets or screws instead of soldering.

2-Meter CPFL Tubing Cutting Table
QTY MATERIAL Type "L" Copper Tubing
1 ½-inch copper tubing 12" Vertical, long
2 ½-inch copper tubing 5.875" Vertical tubes, feed line
6 ½-inch copper tubing 7.5" Horizontal
2 ½-inch copper tubing 3.0" (2.5" nominal) Vertical, short top
2 ½-inch copper tubing 2.0" Vertical, short bottom tuning sections
2 ½-inch copper tubing 1.5" Vertical short bottom tuning sections
2 ½-inch copper tubing 1.0" Vertical short bottom tuning sections
Table 3

2-meter CPFL Final Dimensions, tubing center-to-center
Height 12.25"
Width 8.375"
Depth 8.375"
Folded Sections 3.0" & 3.5"
Table 4

Need a Balun?

A balun it not needed to obtain good performance from the CPFL. A NEC-2 simulation reveals that the current, on the shield of a ¼-wavelength coaxial cable, is about 30 dB below the maximum antenna current. Actual testing showed that the coaxial cable could even be taped to the vertical feed tube with very little affect. So, simply attach the coaxial cable directly to the feed point and route it as needed. An antenna match is not needed for the 2M CPFL either!!! However, if you want to tweak the antenna to perfection, you can install two variable capacitors separately in series…one with the RF input wire, and one with the ground wire. Each variable capacitor should have a value of 0-100 or 0-150 pF, and MUST be rated at a high enough voltage and amperage to handle the antenna current! The 2M CPFL is a RESONANT antenna, with HIGH antenna current folks!

Tune-up

With a 2:1 VSWR bandwidth of 8 MHz, the 2-meter CPFL can be built per the cutting table and it will probably work just fine. But, if you want it tuned exactly the length of the short vertical tubes can be adjusted for resonance at the desired frequency. Tune-up requires a 2-meter rig and an SWR meter. Alternatively, an MFJ antenna analyzer can be used.

The measured VSWR is shown in **Fig. 4.**

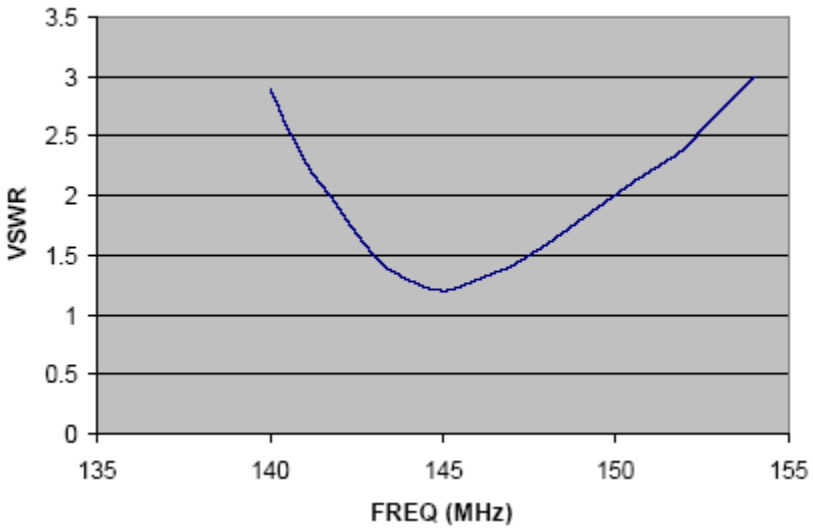

Fig. 4

Ground Independent?

Being a loop, the CPFL does not require a counterpoise or a ground connection. This is not to say that it is immune to earth losses. When placed near earth ground, some of the antenna field passes through the earth, resulting in some loss. The CPFL will work well when placed only one foot above earth ground, but performance will improve as the height is increased. Gain as a function of height over average ground, for three different take-off angles, is shown in **Fig. 5a**. For best DX performance the base can be placed about 10-15 feet above earth ground.

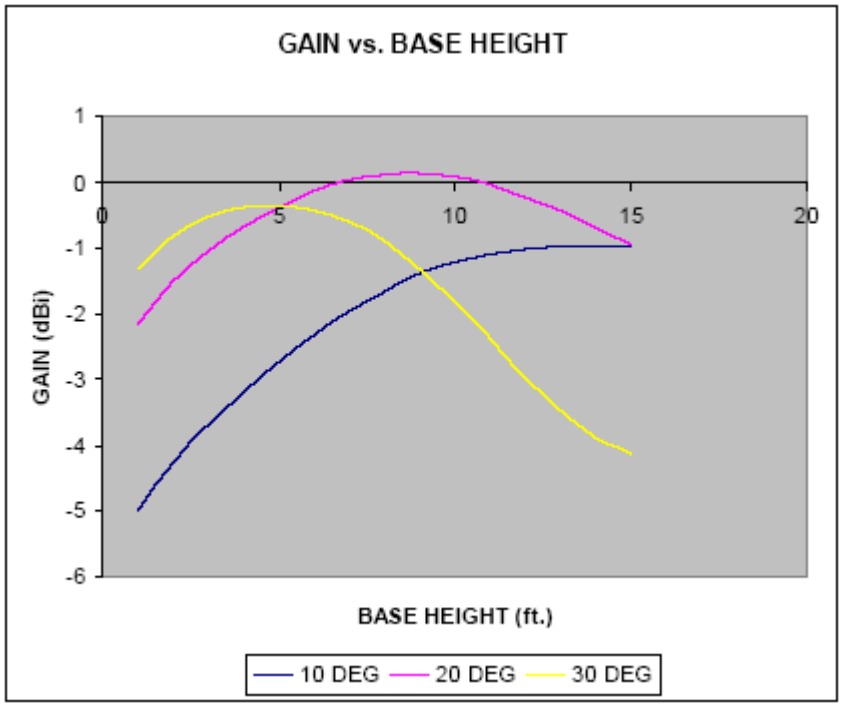

Fig. 5a

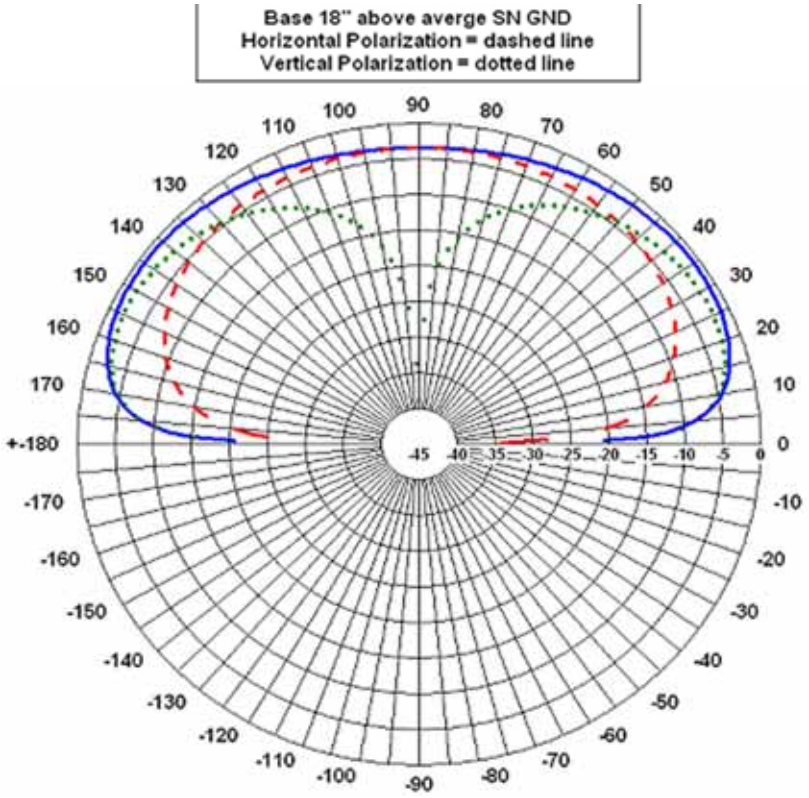

Fig. 5b

Radiation Resistance and Height

Interaction with earth ground does affect the radiation resistance of the CPFL. As shown in **Fig. 5c**, the radiation resistance increases as the antenna is brought closer to ground. The antenna can be designed to provide an input impedance of 50-52 ohms at any height above the ground.

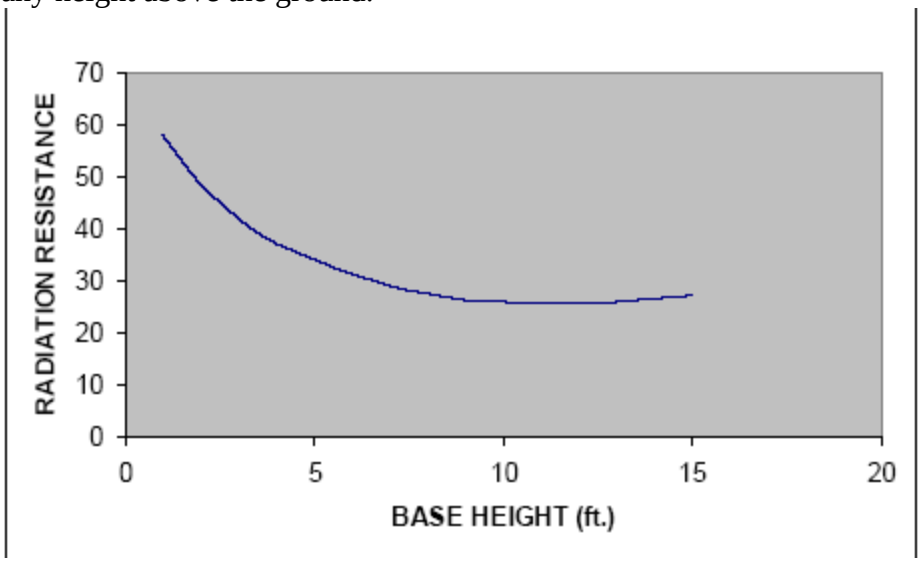

Fig.5c

Scaling to Other Bands

Electrically the 2M CPFL can be scaled to any frequency, just convert and configure the full wavelength in inches or in Centimeters, and adjust the dimensions to fit the design.

That's about it…be safe and have fun! You can stack the 2M CPFL in multiples of two (2,4,6,8) @ 5/8 ^ apart from each other center to center, (use a co-phased matched coax harness for each pair…MUST be exactly the same length to prevent phase shifting and a resultant directional pattern), and watch the dB gain go sky high!

73's

See you on the air folks!

GANGWAY! Bu-Bu is hungry and pissed off!!!