2m and 70cm Portable Beam for ARES

The Amateur Radio Emergency Services (ARES) is a group of licensed amateurs who volunteer their time and equipment for communications activity in support of public service agencies. ARES trains with the expectation that electrical power and telephones will be inoperative during a real disaster. ARES drills frequently include the use of simplex communications from remote locations in our operating area.

During a recent drill, we discovered standard omni directional mobile antenna were insufficient to hit our Emergency Operations Center from a remote location. Fortunately, we had a version of the 2m beam antenna described by WB0CMT in April 1993 edition of QST. This proved to be a far superior alternative to standard mobile equipment.

This article discusses the construction of an inexpensive, portable, 2m and 70cm Yagi antenna for ARES field operations. This is designed for stationary use. ***Do not use this antenna while driving.*** If you need to relocate, disassemble the antenna and store it inside your vehicle during transit. The entire antenna can be built for less than $50.

Figure 1: Easy to Use Dual-band Beam

Materials

All of the materials for this project were purchased at a local Radio Shack and Hardware store. The bill of materials and tools you will need are:

Materials	Qty	Unit	RS Part Number
1 inch PVC	20	ft	
1 inch PVC T connector	6	ea	
1 inch PVC end caps	2	ea	
36in by 1/8 in bronze brazing rod	6	rods	
6' RG-58 BNC cable	1	ea	278-964
BNC T-adapter (female-female-female)	1	ea	278-111
PL-259 to BNC adapter (optional)	1	ea	278-120

Tools
1/8" Drill Bit
Drill Press or Portable Drill
Heavy-duty Soldering Iron & Solder
Tape Measure
Multi-colored Electrical Tape
Permanent Marker
PVC Cleaner and Cement
PVC Cutting Tool

Figure 2: Portable 2m and 70cm Beam

Figure 3: Packed and Ready for Travel

Pedestal

To assemble the pedestal, cut 8 17 inch sections of 1 inch PVC. Clean and glue two each of these onto four of the 1 inch Ts.

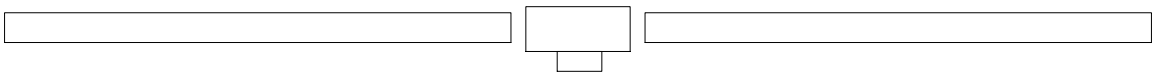

Figure 4: Pedestal Assembly

When done, you should have four of these interchangeable pedestal units. This will become the base for your portable antenna. If you need additional height, you could make one of these longer or just skip one assembly and use a longer section of 1 inch PVC.

During one of our drills, we used a comparable pedestal like this on top of a stationary vehicle. Assemble the antenna, put on top of the vehicle and put some weight on top of the pedestal to keep it from falling. This works very well for remote tactical stations.

Figure 5: Assembled Pedestal

Boom

Read this entire section before continuing. There are some key assembly points that must be followed.

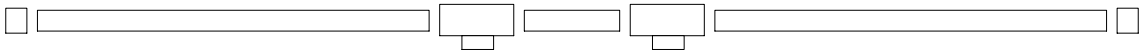

Figure 6: Boom Assembly

Cut two 18.5 inch and one 4.5 inch lengths of 1 inch PVC. Glue one end of the 18.5 inch into one of the Ts. Glue the 4.5 inch length into the other side of the T. The finished component should resemble the leftmost part of **Figure 6: Boom Assembly**. Do not worry about the end caps for now.

If you want to use antenna for satellite or fox hunting, I recommend making the leftmost 18.5 inch section longer to give you a handgrip to manually hold the antenna not requiring the pedestal.

Figure 7: Boom Detail

The next T should be glued to the other end of the 4.5 inch section at right angles to the first T. If the first T is facing down, the second T should be facing left or up assuming we are working from left to right. Be sure to align this T 90 degrees counterclockwise from the first T. This will define polarization for the 2m and 70cm antenna.

Glue the final 18.5 inch section onto the end of the T. The finished assemble should resemble Figure 6: Boom Assembly. Leave off the end-caps until you are done drilling the holes.

Measure and Drill the Holes

Remember, measure twice, cut once. This is very important in this part of the process. Note the spacing of the elements in the following diagrams. It is crucial that you locate the center elements between the Ts and measure all the remaining elements to fit.

2m Measurements

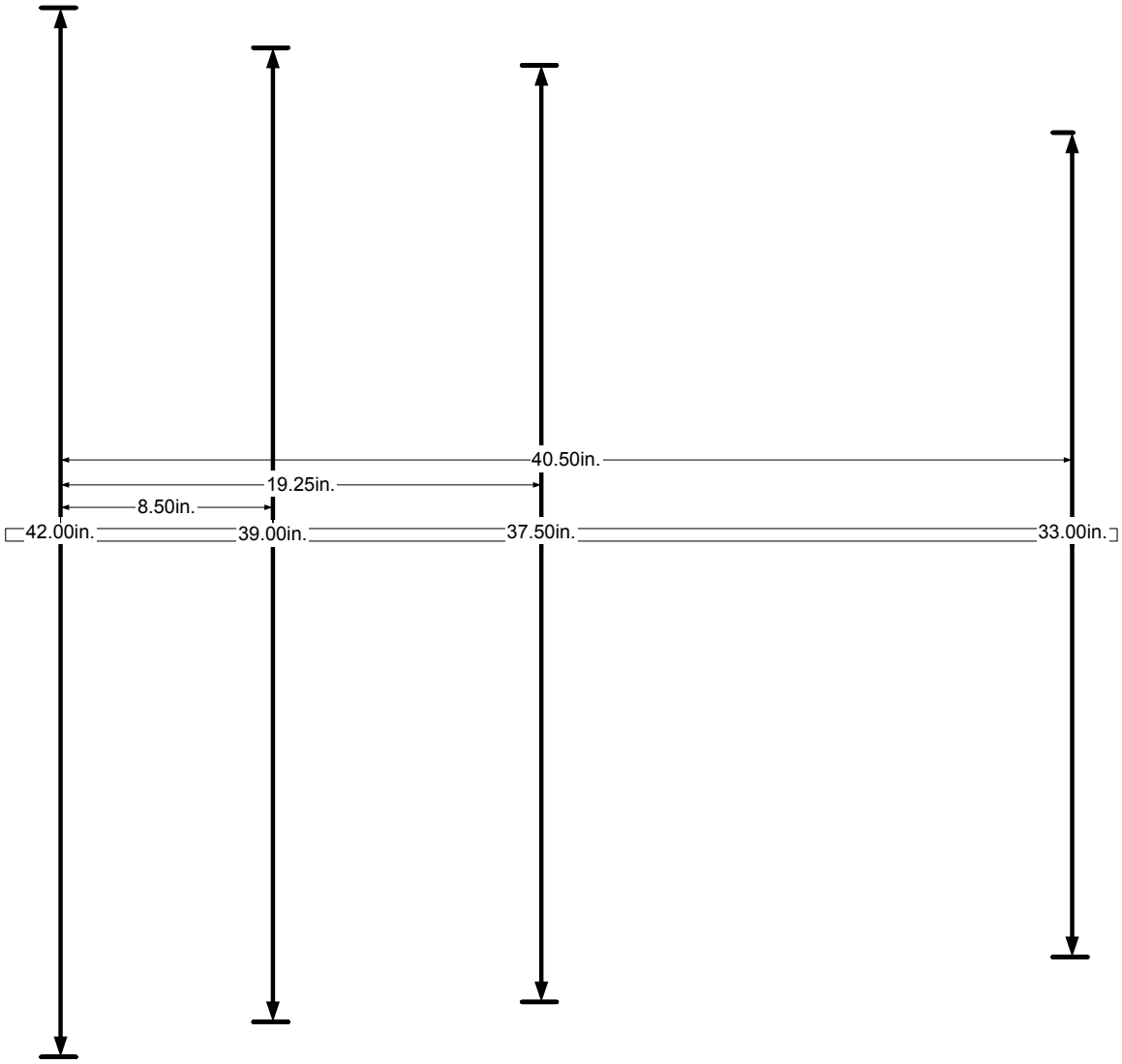

Figure 8: 2m Spacing and Length

Position the beam so the leftmost T is facing downward. Use a permanent marker to write **2m** on the top of the T. Next, mark a point about ½ inches to the right of the leftmost T. Mark a point on the top of the PVC. This is the position of the 19.25 inch element. Measure from this mark to the left and make another mark 19.25 inches. This

is the position of the Reflector. Measure 8.5 inches from the reflector to the right. Mark this position for the driven element. Measure 40.5 inches from the reflector to the right. This is the position for the final directed element.

70cm Measurements

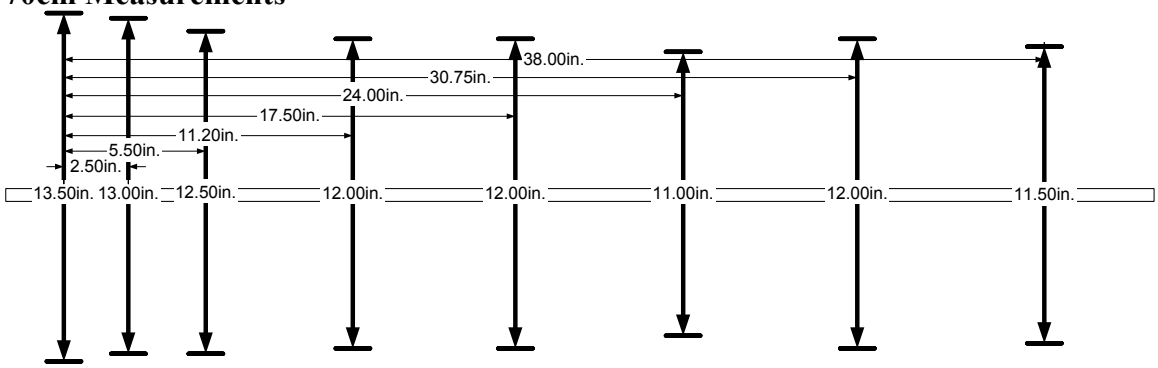

Figure 9: 70 cm Spacing and Length

Position the beam so the Rightmost T is facing downward. Use a permanent marker and make a mark about 1 inch to the right of the left T. This should be about ½ inches to the left of the 2m element hole. *Make sure these two holes DO NOT overlap.* This is the position of the 24 inch element. Measure left from this position 24 inches to define the position of the reflector. Once the reflector location is found, mark the remaining element positions as defined in **Figure 9: 70 cm Spacing and Length**. If any of your marks are on one of the Ts, re-center the marks until they do not overlap the Ts.

Drilling the Holes

Use a 1/8 drill bit to make the holes for the elements. A 1/8 bit is a tight fit for each of the brazing rods. Be careful to align and center the holes for the length of the boom. Drill all the holes through the top and bottom center of the PVC. I found it helpful to use a jig to keep the pipe centered under the drill.

Figure 10: Pipe Drilling Jig

Drill the holes as marked. For each Driven element, we will need to drill a second hole to the right (facing toward the directed elements) of the center hole. This should be

about ½ inches to the right facing downward. I reamed this (only this) hole a little to make it easier to assemble the elements later.

Cutting the Elements

Start with the 70cm elements. Cut the lengths of the reflector and director elements as specified in Figure 9: 70 cm Spacing and Length. It is possible to cut 3-12 inch lengths from one rod, the 13.5, 11.5, and 11 inch lengths from another rod. Cut the 12.5 inch element from the final rod. Keep the remaining rod for the 13 inch driven element.

Insert each element onto the boom when you have cut to make sure it is not lost. Initially, these will be a tight fit. Over time, they will become looser. Center each element onto the boom so you have equal lengths above and below the boom.

Using a piece of brazing rod that is at least 20 inches long, measure and mark a point 13 inches from one end. Bend the rod so this point is at the top and the bend is parallel to the 13 inch length. Make sure the parallel spacing is 3/8 inches.

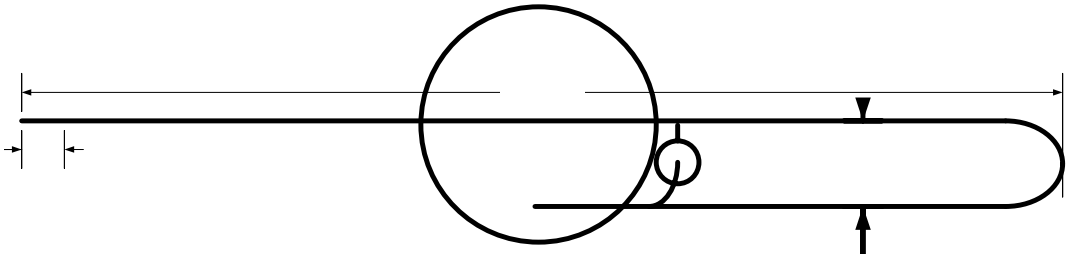

Figure 11: 70 cm Driven Element Detail

Insert the elements into the boom assembly from the top down.

Adjusting and Marking the Elements

Center each element so equal lengths are above and below the boom. Using the soldering iron, place a wad of solder at the point where the element enters the top of the boom. This is the "stopper" that helps you re-center the elements each time you reassemble the antenna.

Solder the Coax

Measure a ¼ wave length of coax. The velocity factor for RG58 is approximately 0.66. Measure one end of the 6' Coax and cut at approximately 6 inches. Strip 1.5 inches off the end of the coax and thread the inner and outer cables. Solder the cables onto the driven element as shown in **Figure 11: 70 cm Driven Element Detail**.

Flip the Boom to the other T and begin assembling the 2m elements. Cut the shortest directed element at 33 inches as shown in **Figure 8: 2m Spacing and Length**. Insert and center this element onto the rightmost end of the boom.

Trim Here
for SWR

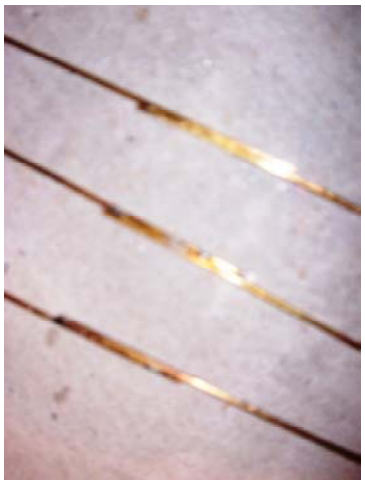

Figure 12: Extended Brazing Rods

The remaining elements are longer than the stock 36 inch lengths and must be extended. Using some scrap from the 70cm elements, clean and solder a length of scrap element to the end of two 36 inch rods so they are longer than the lengths specified in Figure 8: 2m Spacing and Length. Join two 36 inch rods for the driven element. Overlap the rods 2 to 3 inches and solder the entire length of the overlap.

Cut the reflected and driven element lengths as specified. The finished results are shown in **Figure 12: Extended Brazing Rods**.

Adjusting and Marking the Elements

Center each element so equal lengths are above and below the boom. Using the soldering iron, place a wad of solder at the point where the element enters the top of the boom. This is the "stopper" that helps you re-center the elements each time you re-assemble the antenna.

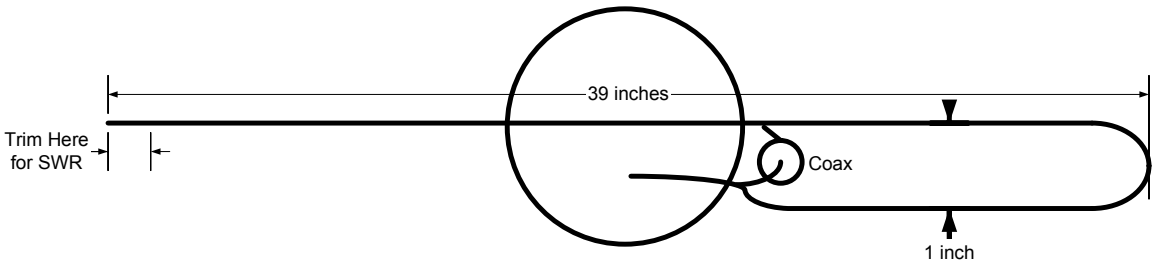

Figure 13: 2m Driven Element Detail

Bend the 2m driven element as shown in **Figure 13: 2m Driven Element Detail**. Insert into the boom, place a wad of solder to reset the element in the center position.

Solder the Coax

Measure a ¼ wave length of coax. The velocity factor for RG58 is approximately 0.66. The Measure the remaining end of the 6' Coax and cut at approximately 14 inches. Strip 1.5 inches off the end of the coax and thread the inner and outer cables. Solder the cables onto the driven element as shown in **Figure 13: 2m Driven Element Detail**.

Tuning the Antenna

Insert the T-connector to the two lengths of coax. Tune your antenna by snipping sections of the opposite end of the driven element for the desired SWR.

Finishing the project

I added had some multi-colored electrical tape to various elements to facilitate reassembly. It is conceivable to use solder wads or some alternate method for identifying the element order.

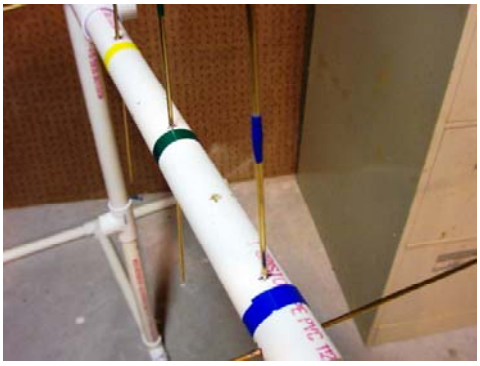

Figure 14: Use Color for Quick Reassembly

Glue one end-cap onto the boom. This ensures the elements do not fall out when stowed. Remove the elements and store them inside the boom. Finish with the remaining end cap.

Theoretical Performance

You can expect about 8db gain on the 4 element, 2m section of the antenna. The 8 element, 70 cm antenna exhibits approximately 12 db gain on the 70 cm section.

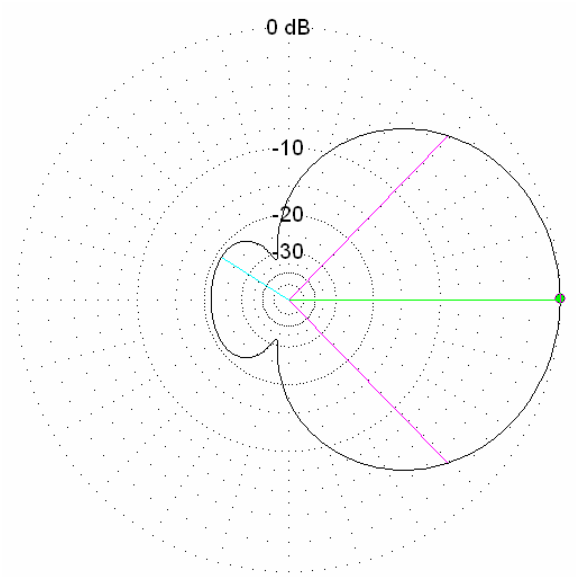

Figure 15: 2m Smith Chart

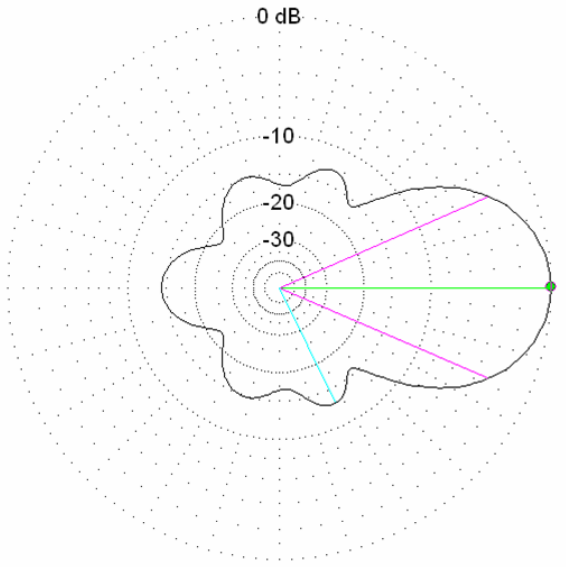

Figure 16: 70cm Smith Chart