UPDATED CRANK-UP PVC TOWER

INSPIRATION

I've always kept my eyes open for ideas on equipment that could help our club during emergency responses. Especially better ways to get our antennas into the air. As with any ECOMM response, you can't always be sure that there are any trees, towers or other types of structures that can be used to support even a simple antenna. So, I've always had the goal of self-sufficiency.

A few years ago, I ran across an ARRL news feature article on a crank up PVC tower by David Sheaffer K8DMS ex KC8MAY. Having caught my attention, I spent a weekend building the tower according to Dave's specifications. The only change I made at this point was to use the full 10-foot sections of pipe. This made my tower a maximum of 26 feet high instead of Dave's 23 feet maximum height.

IMPROVEMENTS

The tower built to Dave's design worked as described but there were some problem areas I thought needed some attention. First, the pulley mounting system wasn't very solid. Any stress on the pulleys would cause them to twist out of alignment. Next, the steel cable wanted to coil and kink inside the PVC pipes if there was any slack in the cables. In some cases to get the cable straightened out the tower would have to be taken apart. Finally, the top section would bind as it was being raised because the cable was only pulling the pipe up from one side.

In the current design, you'll see that I've corrected most of these problems and added some more improvements of my own. Over the years as I've built and rebuilt these towers I've tried to make them easier to construct and use but there's always room for improvement right?

CONSTRUCTION

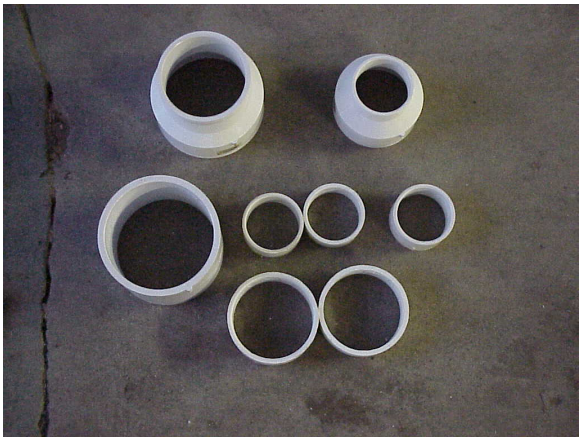
In keeping with Dave's construction ideas, all of the materials are readily available from your local hardware or construction supply house.

Parts required for assembling the crank up PVC tower

All of the PVC components are schedule 40. Also, no special tools are required to complete this project though some power tools are to be preferred over using hand tools. The first task is to remove the ridges on the inside of the pipe couplers and reducers. The goal is to allow the PVC pipes to slide smoothly through the holes but not to allow too much play. On the first tower I put together, I removed the ridges by hand with a rounded D file. Although doing it this way worked, it was definitely a slow and time-consuming process. On my next attempt, I used a milling bit in a drill press. I built a jig that allowed me to rotate the pieces to be milled into the cutting bit. This process was much better than trying to work the pieces by hand but it's probably still not the best way to do this kind of work. I feel that some sort of lathe setup would work the best.

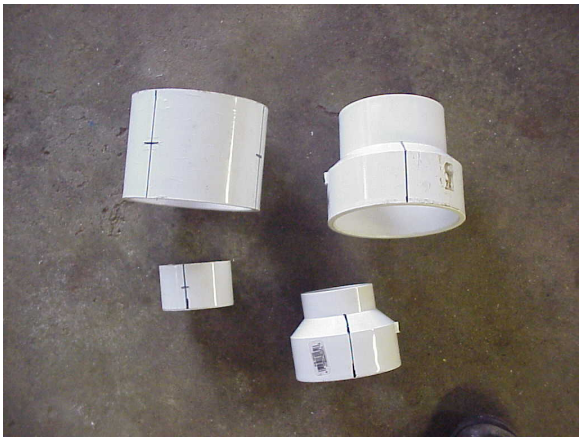
Milling Jigs and Setup

One thing I did learn about these PVC pieces is that they are slightly tapered rather than being straight on the inside so it is necessary work from the top down to make sure the to have a uniform diameter for the pipe to slide through.



Reducers and couplers with ridges removed

My understanding is the PVC parts are available without the ridges but they aren't stock items at most hardware and home improvement stores. But you might want to check in your area for these special parts in that you can save some time and effort.
Next, the reducers must be marked 180 degrees apart for the rope path. Now is the time to drill a ¼ inch vertical hole on shoulder of the reducers at each 180-degree mark.
A 4-inch and a 2-inch coupling must be trisected to mount the support rings for attaching the guy supports. I also marked a 2-inch coupler and a 3-inch coupler half way between the top and bottom so they can be split to be used as the stops on the 2 and 3-inch pipes.



Guy rings trisected and reducers marked to mount pulleys

To finish up the guy rings, I used a rotary tool with a cutoff wheel to round out the slots to seat the metal guy rings. Using the correct sized hose clamps, secure the guy rings to the couplers.

Completed upper guy ring

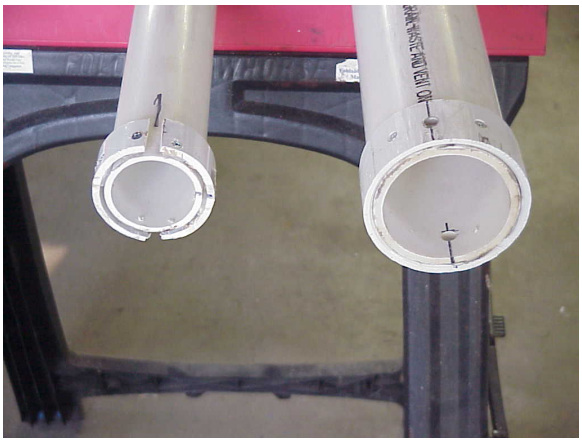
Completed lower guy ring

The upper and lower stops on the 2-inch pipe are made from one 2-inch coupler split in half making two rings thus saving material. The same thing happens for the upper and lower stops on the 3-inch pipe. The upper stops are placed 2 feet from the bottom of the 3-inch and 2 inch pipes.

Upper stops mounted on the 2-inch and 3-inch pipes

This allows for a good overlap and removes most of the flex at the joints. I used short flat head countersunk screws for this stage of the construction. These parts could be glued with PVC pipe glue but I like the idea of being able to change things if needed.
With the pipe I used, it is necessary to pad the bottom guide on the 2-inch pipe. Split the bottom coupler in two (180 degrees apart). You can use any soft plastic material between the pipe and coupler so that the bottom of the 2 inch pipe slides smoothly into the 3 inch pipe without a lot of play. In my case, it was not necessary to pad the 3-inch pipe to fit smoothly and snugly into the 4-inch pipe.

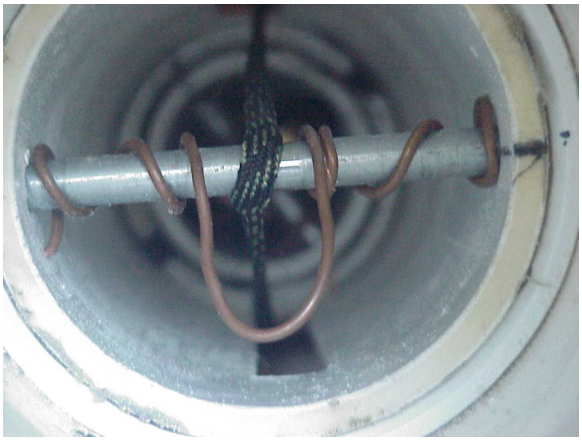
Also, notice the ¼ inch holes in the bottom of each pipe. These holes are for the rods that are used as the lift points for these sections.



Lower guides mounted on the 2-inch and 3-inch pipes

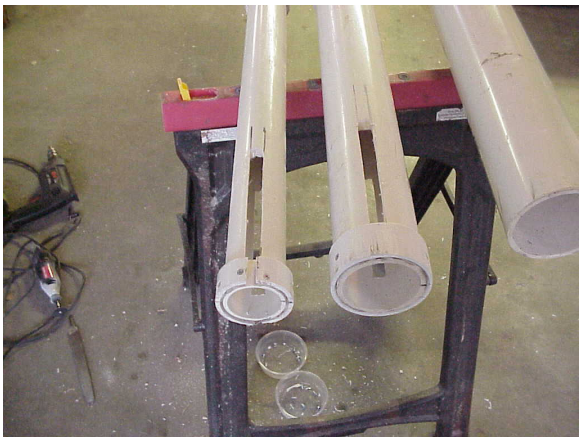
On the original, I used nuts and bolts but found that this system deformed the ends of the pipe. I found that a piece of smooth ¼ rod worked better. Drill the holes 180 degrees apart. Again, I used countersunk short flat-headed screws to secure all of the stops and guides.

To keep the rope centered at the lift points for both 2 inch and 3 inch pipes I used a piece of heavy copper wire loosely shaped around the lift rod. This keeps the lift tension equal when raising the sections.



Lift point guide

Once the bottom stops are mounted, using my rotary tool I cut two slots 1 inch wide by 1 foot long starting just above the stops in both the 2 inch and 3 inch pipes. These slots are perpendicular to the lift rods. These slots allow a better path for the rope to travel to the lift points.



Rope guide slots

The only parts used from the pulleys from the hardware store was the pulley wheel and hub along with the locking pin. The support bracket is fabricated from two 4-inch L brackets. Bend one side of each bracket so it is 90 degrees from the other side. Bend the other bracket 90 degrees from the other side and make it a mirror image of the first bracket. Bend the lower part of the L brackets to match the curve of the plastic reducers. I used a scrap board to space the pulley assembly part way up on the largest part of the reducer. Align center of the pulley bracket with one of the 180-degree marks that have been made on the reducer. Drill holes in the reducer and bolt the pulley bracket to the reducer.

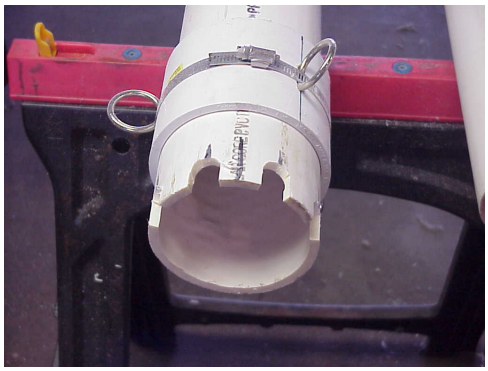
Forming pulley bracket

Positioning pulley bracket

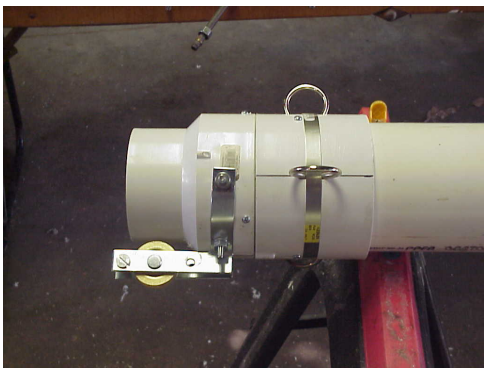
The L brackets have pre-drilled holes and I used the second holes from the top of the L bracket to mount the pulley wheel. It may be necessary to enlarge these holes depending on the size of pulley hub. I placed a bolt and used piece of copper tubing as spacer in the top holes in the L bracket. This bolt and spacer also keep the lift rope from jumping off of the pulley.

Finished upper pulley assembly

On the first tower I countersunk the pulley mounting screws so the reducers would slide over the pipes. On later versions I found it was easier to use regular bolts to mount the pulleys and notch the tops of the pipes to allow the reducers to seat properly.



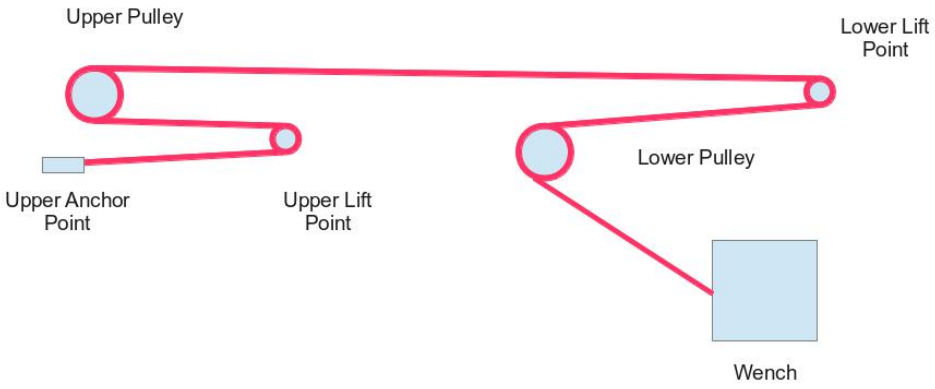
Slots cut to seat reducer/pulley assembly



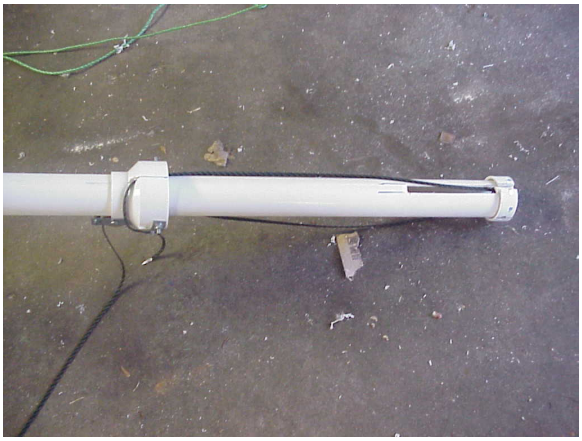
Pulley assembly and guy ring in position

Now is the time to figure out rope path for lifting the pipe sections. Looking at the diagram and starting at the wench the rope goes on the outside to the pulley on the 4 inch to 3 inch reducer. The rope travels down the inside of the 4 inch pipe, through the slot in the 3 inch pipe, to the bottom of the 3 inch pipe, back through the other slot and through the hole at the top opposite the pulley on the 4 inch to 3 inch reducer.

The rope continues on the outside to the pulley on the 3 inch to 2 inch reducer. The rope travels down the inside of the 3 inch pipe, through the slot in the 2 inch pipe, to the bottom of the 2 inch pipe, back through the other slot and through the hole at the top opposite the pulley on the 2 inch to 2 inch reducer were the rope is tied off to one of the upper pulley mounting bolts.



To actually install the rope we have to work in reverse so we start with the 2 inch pipe. Slide the 3 inch to 2 inch reducer onto the 2 inch pipe. Thread the rope through the hole in the reducer opposite the pulley, down to the lift point and then back to the pulley.

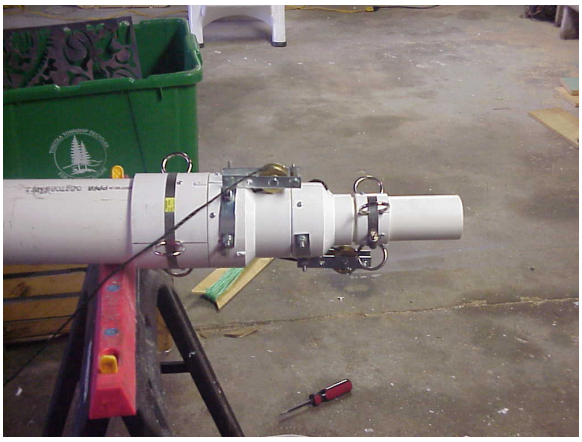


Installing lift rope

Now slide this assembly into the 3 inch pipe and firmly seat the 3 inch to 2 inch reducer on to the 3 inch pipe making sure the bolt heads fit into the slots cut into the 3 inch pipe. Repeat the procedure by sliding the 4 inch to 3 inch reducer on to the 3 inch pipe. Thread the rope through the hole in the reducer opposite the pulley, down to the lift point and then back to the pulley. Slide the full assembly into the 4 inch pipe and firmly seat the 4 inch to 3 inch reducer on to the 4 inch pipe making sure the bolt heads fit into the slots cut into the 4 inch pipe.

Final assembly of the reducers/pulleys and lift rope

I mounted the top guy ring down a couple of inches from the top of the 2-inch pipe. This allows room to mount a small rotator if desired. Make sure that the guy points on the top guy ring line up with the guy points on the bottom guy ring. That way we can use the same guy points without twisting the tower.

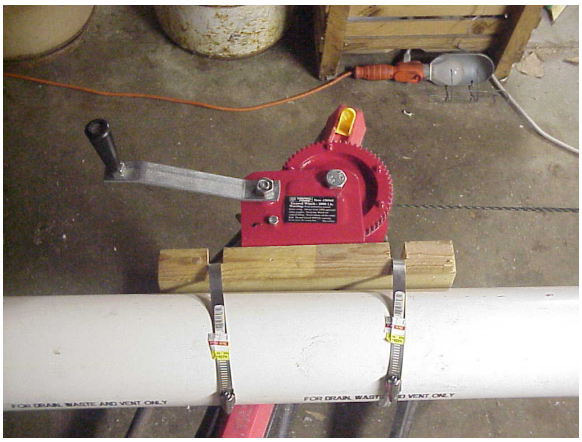


Upper guy ring mounted to final assembly

The tail assembly consists of a 4-inch coupler with a 4 inch to 1-inch reducer installed. The reduction down to 1 inch allows the use of a metal stake to be used as a kingpin to keep the base of the tower from shifting when it is deployed.

Tail assembly with hole for kingpin

To mount the wench I first attached it to a block of 2 by 4 that has been notched for a couple of large hose clamps. Place the wench assembly at a convenient height on the 4-inch pile. Align the wench with the pulley on the 4-inch to 3-inch reducer. Don't over tighten the hose clamps because doing so may deform the pipe and cause the 3 inch pipe to bind as it slides in the 4 inch pipe.



Mounted wench assembly

SUPPORT PACKAGE

The support package to deploy the tower consists of a rod or pipe to act as a kingpin. A guide 16 inches in diameter trisected to place the guy anchor points and a string 10 feet long to set the distance from the center to the guy points. Three dog stakes to act as guy points. Three ratchet straps for the lower guys. Three ratchet straps extended with rope for the upper guys. A 1½ section of pipe to act mount for wire antennas and length of rope pull the wire antenna into position.

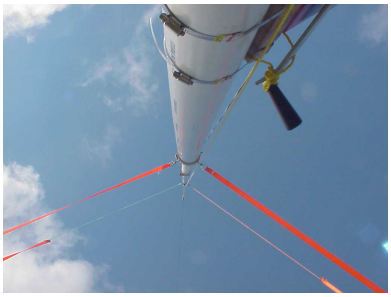
Support package to deploy the crank up PVC tower

DEPLOYMENT

To deploy the tower, first select the location observing all safety precautions. The first time you set up the tower it helps to have some willing hands to assist. First, drive in the rod or pipe to use as the kingpin and set the guy guide over the kingpin. Tie a loop in the piece of string used to set the guy points and place the loop over the kingpin. Now stretch the string out aligning it with the lines marked on the guy guide and set a dog stake at the end of the string. Repeat this process for the remaining two anchor points. The ratchet straps used are 15 feet long and for the lower guys these should be long enough to use without extending them but the ratchet straps for the upper guys will have to be lengthened with rope. I had to add 12 feet of rope to the upper guy ratchet straps. I also replaced the hooks supplied with the ratchet straps with latching hooks. The next steps are done while the tower is lying on the ground. First, attach the three upper ends of lower guy straps to the lower guy rings on the tower and the lower ends of the lower guy straps to each of the guy stakes. Next, attach the three upper ends of the upper guy straps to the upper guy rings on the tower and lower ends of the upper guy straps to the appropriate guy stakes. Now adjust all of the guy straps for their maximum length. Remember to place the 1½ pipe and rope into the end of the 2-inch pipe so you can pull up your antenna when the time comes. With some help, raise the tower and set it on the kingpin. As your helper holds the tower, tighten the lower guy straps to support the tower in the correct vertical position. Now use the wench to raise the tower to its full height. Once the tower is at its full extension, tighten the upper guy straps to maintain the tower's vertical position. You can now use the rope from the top of the tower to hoist your antenna into position.

When it is time to take the tower down, lower your antenna and use the wench to lower the tower sections into the nested position. Now loosen the lower guy straps enough to lift the tower off of the kingpin. Leave the lower and upper guy straps at this set length for storage. The next time you deploy the tower the guy straps will be the correct length so one person can set the tower up. Finally, unclip the guy straps, remove the guy stakes, pull the kingpin and stow the tower and parts away.

Tower deployed at field day



PARTS LIST

The costs listed for the parts are mostly from the local hardware without any scrounging in the parts bins or junk boxes in the garage. By doing a little bit of treasure hunting and judicial shopping you should be able to reduce the cost of this weekend project.

2x10 PVC PIPE	$7.89
3x10 PVC PIPE	$10.99
4x10 PVC PIPE	$14.70
3x2 PIPE REDUCER	$3.79
4x3 PIPE REDUCER	$6.69
2" COUPLING(2)	$3.58
2x1 BUSHING	$2.89
3" CLAMP	$1.99
3" COUPLING	$1.69
4" CLAMP (3)	$7.47
4" COUPLING (2)	$4.98
4x2 BUSHING	$8.19
PARA CORD 100 FT	$5.49
CORNER BRACKETS (4)	$3.59
HOOKS (12)	$15.48
PULLEY (2)	$12.58
RINGS (6)	$8.34
SCREWS	$3.80
STAKES (3)	$3.00
STEEL ROD	$3.89
TIE DOWN (6)	$13.49
WINCH	$19.99
POLY ROPE 100 FT	$9.95
NUTS AND BOLTS	$3.95
TOTAL	$178.40