

Huntsville WFO Tornado Machine Plans

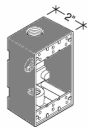
First let us understand that this is not a scientific research tool. It was not designed to replicate the effects of a tornado on trees, houses, automobiles, or mobile homes. It was designed to give the Public a representation of what a tornado looks like. It will draw a crowd to where ever it is displayed. Kids love to stick their hands into the tube to touch a tornado. This allows the individuals who are manning the booth, display, or giving a talk the advantage of presenting more detailed information on the National Weather Service. If two country boys from Alabama can build this, anyone can.



The cost should not exceed \$500.00. The one big item is the 18 inch PVC pipe. We found the PVC only in 13 foot lengths at a cost of about \$13.50 a foot. Try your local Waterworks and see if they might have a scrap piece at least four foot long that they will donate for the project. If you can not find a scrap piece, then start looking at a supply company that deals in pipe. We again used 18 inch PVC sewer pipe, with walls $\frac{3}{4}$ of an inch thick. Most items can be bought at your local hardware or building supply store.

The following is a list of materials:

- 4' X 18" PVC Pipe (Chamber Tube)
- 4' X 4' X $\frac{3}{4}$ " Plywood (Base)
- 2' X 2' X $\frac{1}{4}$ " Masonite board (Top shelf for fan)
- 2" X 4" X 10' (Internal frame)
- 10' X 1 $\frac{1}{4}$ " PVC Pipe
- 1 $\frac{1}{4}$ " PVC End Cap (1)
- 1 $\frac{1}{4}$ " X 1 $\frac{1}{4}$ " PVC Smooth 90 degree elbow
- 1 $\frac{1}{2}$ " to 2" L brackets (6)
- 110 Cubic Feet per Minute (CFM) Bathroom Exhaust Fan
- Light small (Halogen 25W round)
- Box of 14-2 wire (25 feet)
- Power cord (6 to 8 feet)
- Water tight metal electrical switch box (2)



Remodeling or old work plastic electrical switch box (2) (Has tabs on the side for mounting)



Wire Clamps for boxes

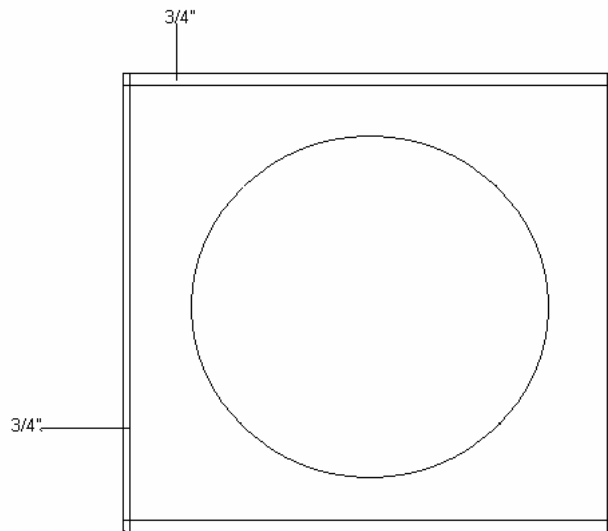


- Speed control switch for a ceiling fan (600W)
- Toggle switch - 2 to 5 amps (2)
- GFI duplex plug
- Standard duplex plug
- Covers – (1) two hole cover – (1) one hole cover – (1) plug duplex cover
- Wire nuts Red (20)
- Screws:
 - Drywall 2" (100)
 - Deck 3" (10)
 - Machine $\frac{1}{2}$ " (20)
- Silicon Sealant (2 tubes) Clear
- 16" diameter pizza pan (small holes)
- 1 $\frac{1}{2}$ " Hose Clamp
- Casters (2)

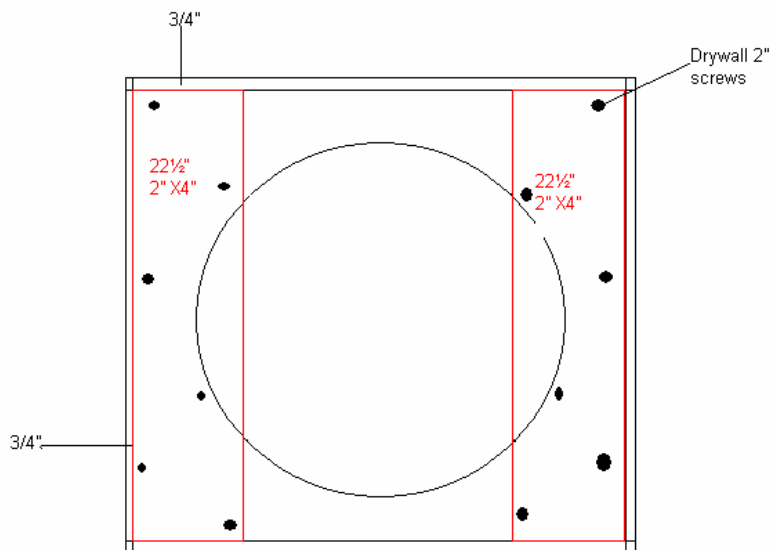
The items above are what we used here in Huntsville. We did not follow any one plan. We got ideas from several plans and used or created what we needed. So be creative and change the parts to suit your office. The basic idea is to create a representation of a tornado. So let's begin.

1) Building the Base

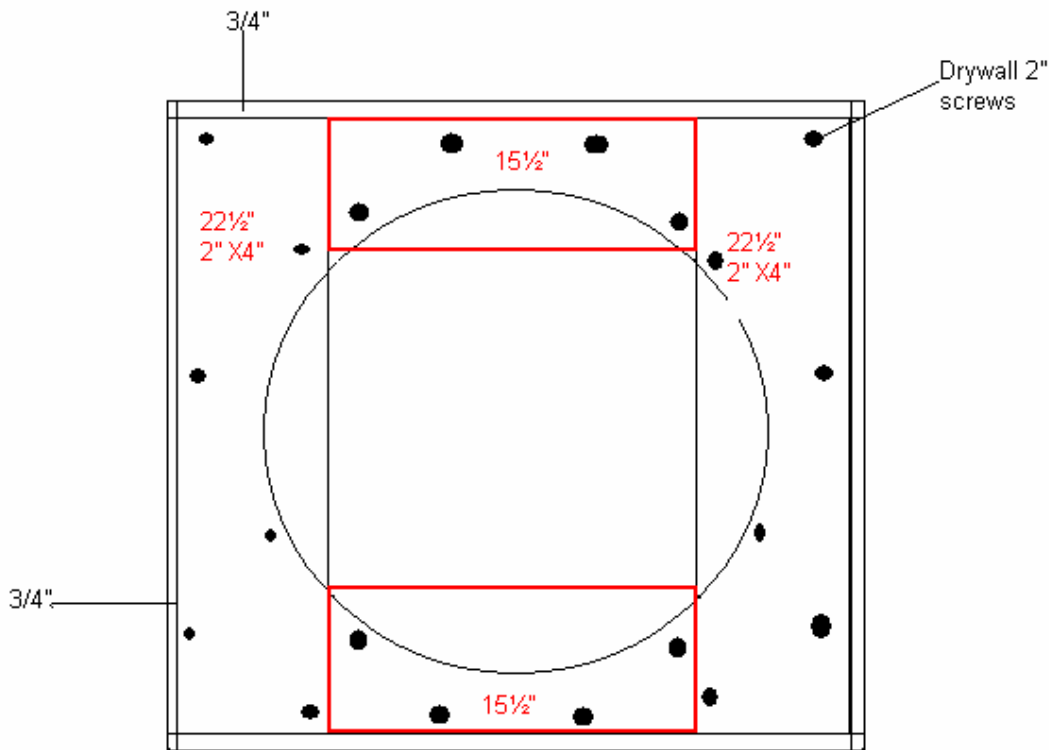
- a) Take the 4' X 4' sheet of Plywood and cut it into two 2' X 4' pieces.
- b) Take one of the 2' X 4' pieces and cut it into two 2' X 2' pieces (top and bottom plates).
- c) Take the other 2' X 4' piece and cut it into four 2' X 11" pieces (four sides).
- d) Now take one of the 2' X 2' and the 18" PVC pipe and do the following:
 - i) Center the PVC pipe on the 2' X 2' plywood.
 - ii) Once the pipe is centered, trace with a pencil, the outer diameter of the pipe onto the 2' X 2' plywood.
 - iii) Remove the pipe and using a saber or jig saw cut out the circle drawn on the 2' X 2' plywood. Stay on the outside of the pencil mark.
 - iv) This will be the top of the base. Do not throw the circle of wood away. It will be used later.
- e) **While we are doing this let us go ahead and cut out the top shelf:**
 - i) Draw a line from one corner to the opposite corner on 2' X 2' X 1/4" Masonite board. Repeat with the other two corners. You should now have a large 'X' on the 2' X 2' X 1/4" Masonite board. This will help later for centering the fan on the shelf.
 - ii) Center the PVC pipe on the 2' X 2' X 1/4" Masonite board.
 - iii) Once the pipe is centered, trace with a pencil, the inner diameter of the pipe onto the 2' X 2' X 1/4" Masonite board.
 - iv) Remove the pipe and using a saber or jig saw cut out the circle drawn on the 2' X 2' X 1/4" Masonite board. Stay on the outside of the pencil mark.
 - v) Take the circle and lay it to the side it will be used later.
- f) **Take the 2' X 2' plywood with the circle cut out and choose the best side for the top.**
- g) **On the other side layout the top of the internal frame work and add the supports.**
 - i) Measure and mark 3/4" from the edge on at least two spots on each side.
 - ii) Now draw a line the full length of the side and your top should look similar to this:



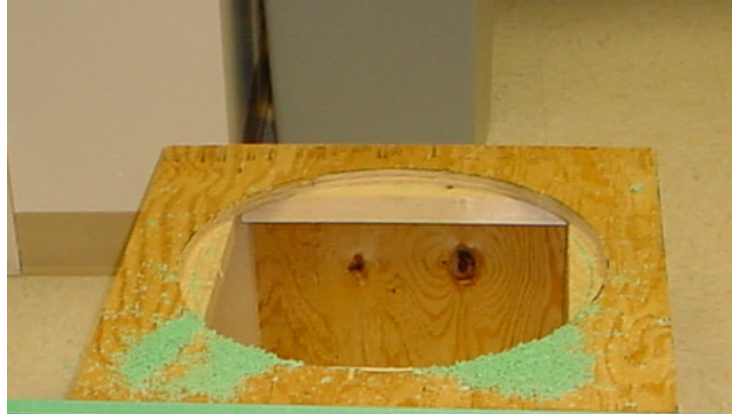
- iii) The $\frac{3}{4}$ " edge is for placing the sides flush with the top for support and to locate the 2" X 4"s.
- iv) Now if everything is measured and cut correctly, you should have $22\frac{1}{2}$ "s between the lines, but lets measure and make sure.
- v) Take your measurement and cut two 2" X 4"s to length. (approx. $22\frac{1}{2}$ "s)
- vi) Next place them on the top as shown in the drawing below and using the Drywall 2" screws, attach the 2" X 4"s to the top. Be sure to place the board on or just to the inside of the $\frac{3}{4}$ " line. You can follow the pattern I have placed on the drawing or use your own pattern, but 6 screws per board should be enough. (NOTE: I am not the greatest artist in the world so take it easy on the artwork.) Do not over tighten the drywall screws or they will protrude through the top.



- vii) Once the two 2" X 4"s are attached we will need to cut two more. Again if everything is measured and cut correctly, you should have 15½"s between the boards, but lets measure and make sure.
- viii) Take your measurement and cut two 2" X 4"s to length. (approx. 15½"s)
- ix) Next place them on the top as shown in the drawing below and using the Drywall 2" screws, attach the 2" X 4"s to the top. Be sure that the outer edge of the boards are flush the end of the 22½" board. If they are not it will cause problems when attaching the side boards later. You can follow the pattern I have placed on the drawing or use your own pattern, but 4 screws per board should be enough. Do not over tighten the drywall screws or they will protrude through the top. To increase the strength of the joint between the 15½" and 22½" boards, drill two pilot holes of 45 degrees or greater for the Drywall 2" screws. Now run the screws into the pilot holes.



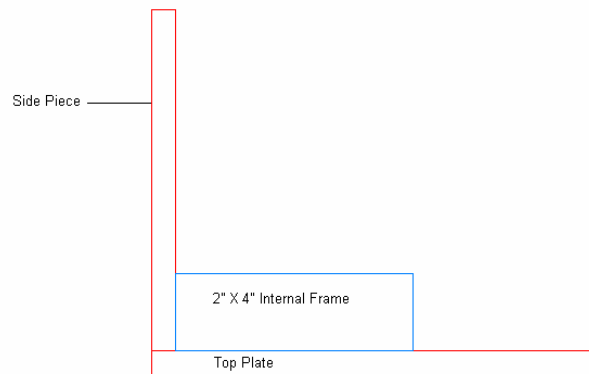
- x) If everything worked out if you flip the top over it should look similar to the picture below (except for the green particles):



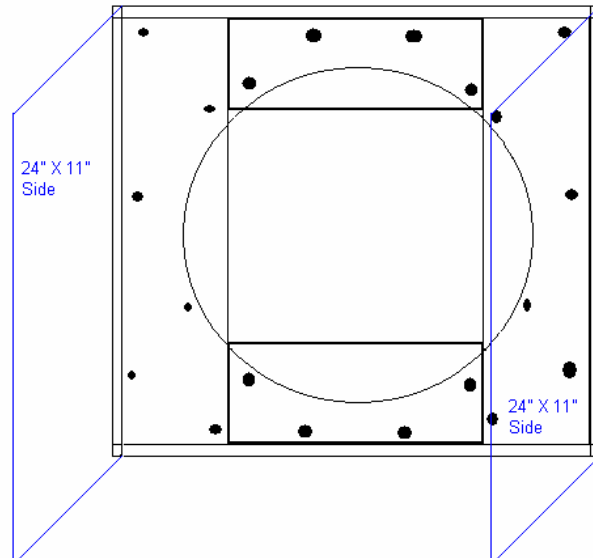
h) Now that the top is complete let's add the sides.

i) Take the top and lay it with the internal frame supports facing up. Retrieve two of the 2' X 11" (24" X 11") side pieces.

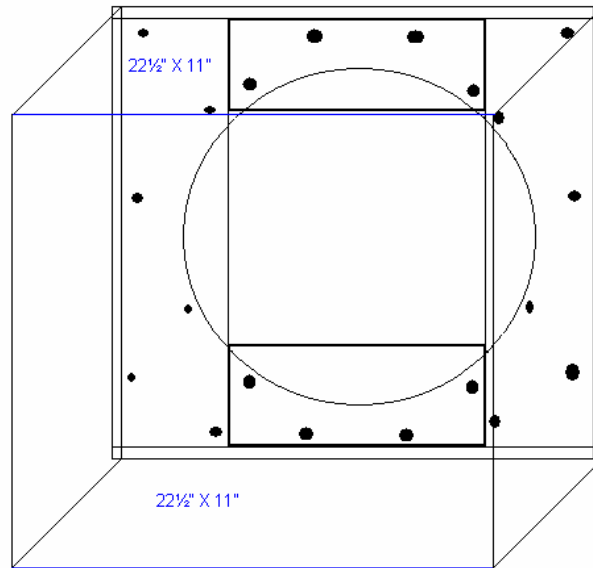
- i) Choose two sides opposite of each other on the top. Take one of the side pieces and place it against one of the 2" X 4"s of one of the sides you have chosen. Check the 24" length of the side piece. You may need to trim the piece. Mark an 'X' on the 2" X 4" and the side piece. Now check the other side piece with the other side and trim if necessary. DO NOT MARK this side. Drawing below shows proper placement.



- ii) Now that we have marked, measured, and trimmed, let's put the two sides on.
- iii) Run a good bead of silicon sealant in the corner where the 2" X 4" (marked with an 'X') and the top plate $\frac{3}{4}$ " edge meet. Take the side (marked with an 'X') and align it as per the drawing above. Ensure the edges of the side piece are flush with the edges of the top plate. Take 6 to 8 Drywall 2" screws and secure the side piece to the 2" X 4". Clean off the excess silicon sealant.
- iv) Repeat the process for the other side. When you have completed both sides you should have something similar to the drawing below.

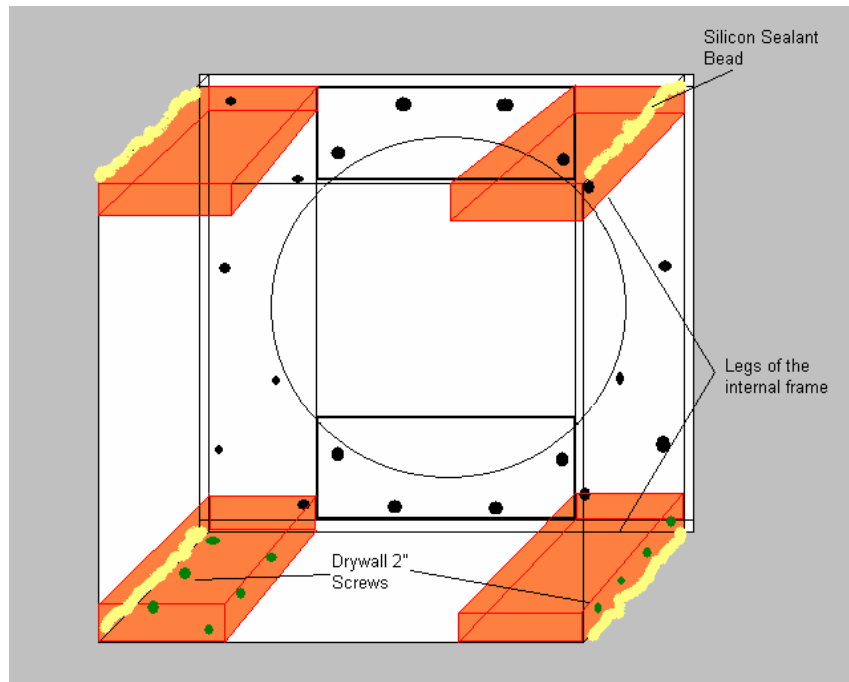
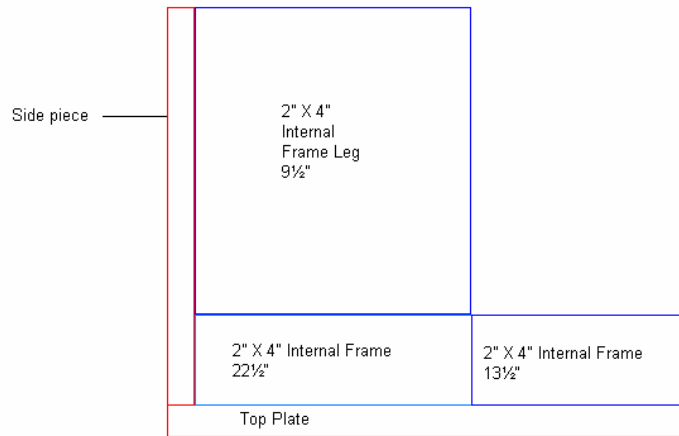


- j) Now let's put the other two sides on. Take a measurement of one of the openings between the two sides that are in place. Measure at or on the top plate $\frac{3}{4}$ " edge. Mark an 'X' on the 2" X 4". (Measurement should be approx. 22 $\frac{1}{2}$ ")**
- i)** Next take one of the remaining 24" X 11" sides and trim it to your measurement (marked with an 'X').
 - ii)** Place the trimmed side piece between the two sides where the 2" X 4" has been marked with an 'X' to ensure a proper fit. If you need to further trim the piece, repeat this step until satisfied.
 - iii)** When you are satisfied with the fit, lay the side piece aside. Run a good bead of silicon sealant in the corner where the 2" X 4" (marked with an 'X') and the top plate $\frac{1}{2}$ " edge meet. Take the side piece you just trimmed and align it as per the drawing above in Step 1.h.i. Ensure the edges of the side piece are flush with the edges of the top plate. Take 6 Drywall 2" screws and secure the side piece to the 2" X 4". Clean off the excess silicon sealant.
 - iv)** Repeat the process for the other side. When you have completed both sides you should have something similar to the drawing below.



k) Now let's finish the internal frame. In each corner measure from the top of the 2" X 4" to the top of the sides. (Measurement should be approx. 9 1/2")

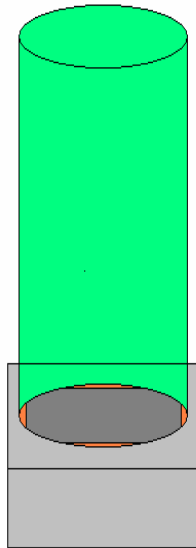
- i) Take and compare the four measurements. There should not be more than 1/16" difference between the tallest corner and the shortest corner. If there is you need to stop and discover why there is a difference.
- ii) Cut four 2" X 4" boards to the shortest length measured in the step above. These will become the legs of the internal frame.
- iii) These next steps will become very untidy. With the top plate down and the open end of the base up, run a good size bead of silicon sealant in one corner of the base where the sides meet from the top plate to the open end. Use the drawings below for reference. Now make sure the two side edges are flush and make a 90 degree corner.
- iv) Take one of the 2" X 4" boards you just cut and place it according to the drawings below. Be sure the leg is firmly against the 22 1/2" 2" X 4" board. On the plywood side, run a couple of Drywall 2" screws into the 4" side of the 2" X 4" to hold the leg in place. Now check the alignment of the corner and when satisfied, from the plywood side, run a couple of Drywall 2" screws into the 2" side of the 2" X 4".
- v) If everything is aligned properly and you have a nice sharp flush corner, finish putting the screws in and wipe off the excess silicon.
- vi) It is not necessary, but I pre drilled two holes in the leg at the joint where the two 2" X 4" boards meet and ran a Drywall 2" screws in each hole.
- vii) Now that you know what you are doing repeat the steps above for the other three legs.



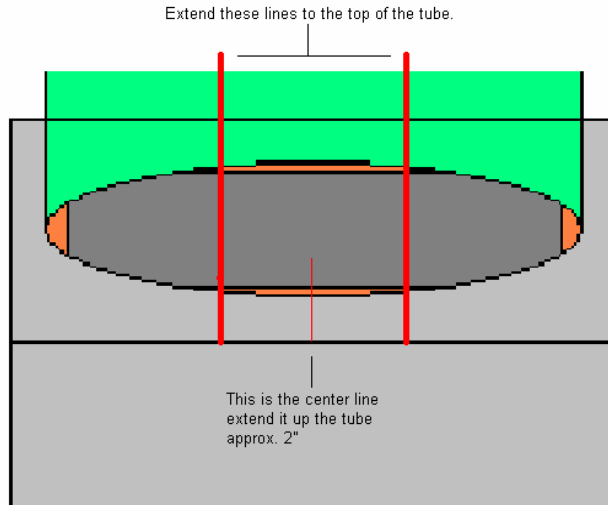
- 1) Okay, if you completed all the steps above you now have a base for your tornado wonder. We will attach the bottom plate later, as we will need access to the inside of the base to complete construction.

2) Mounting the Tornado Chamber to the Base

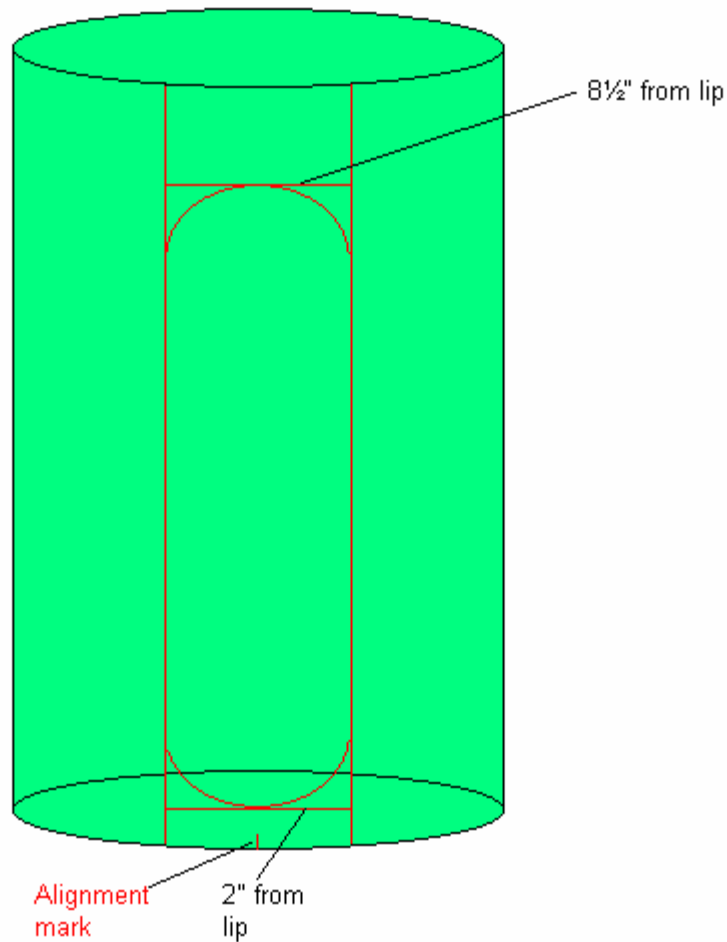
- a) **First inspect the tube (tornado chamber). Make sure the ends of the tube have been cut straight and are level. If not, the best way to trim the ends is with a small hand plane used for wood.**
- b) **Need to check the fit of the tube into the circle cut out of the top plate of the base.**
 - i) Set the base on the floor with the top plate facing the ceiling.
 - ii) Take the tube and set it in the circle of the base plate. This may require turning the tube for the best fit or even for the tube to drop into the circle. The tube may not be perfectly round. So adjust the position of the tube for the best fit that satisfies you. If the tube does not want to drop in to the circle, you may have to trim the circle. When you are satisfied you will have something similar to the picture and drawing below.



- c) **Now we need to mark the tube for cutting out the viewing port and for realignment when set back into the base.**
 - i) Pick one of the four sides of the base to be the front and measure from one corner to the other.
 - ii) Find the center of that measurement and make a mark on the top plate. Using a machinist square, draw a line (suggestion: use a permanent marker for drawing all lines) on the top plate square to the side. Draw the line from the side to the base of the tube. Now extend that line up the tube at least an inch. This will be used for an alignment mark.
 - iii) You can choose how big you want your viewing port. We used 10". I would not go bigger than 1/5 of the circumference, because you will get the affects of the air movement outside of the chamber felt on the tornado. So I will use 10" for explanation purposes.
 - iv) Using the line just drawn on the top plate measure 5" from the line on each side and make a mark. Using the square, draw a line on the top plate square to the side. Draw the line from the side to the base of the tube. Make a mark on the tube where the line meets the tube. Reference the drawing below.



- v) Now we will extend the lines the length of the tube. First remove the tube from the base.
- vi) Stand the tube on its end with the two marks and the line at the top. The way I found to mark the tube was a little bit of country ingenuity. Take a piece of string at least five feet long and tie an 8 or 16 penny nail to one end. Take the other end and drape it over the lip of the tube. Line the string up with one of the two marks, let the nail stop swing, gently press on the string above the nail and make several marks along the string. Once I had the string line up with the mark, I taped the string to the inside of the tube. Before making any marks make sure the string is lined up with the mark. Now repeat the above steps with the other mark.
- vii) Take and lay the tube down. Find a straight edge long enough to draw a line the length of the tube along each set of marks.
- viii) Find the line you drew in Step c.ii. This is the bottom of the tube. Measure 2" from the lip down each line, that runs the length of the tube, and make a mark. Now draw a line between the two marks. Reference drawing below.
- ix) Now go to the top of the tube and repeat the process from Step c.viii, except use 8½" instead of 2".
- x) You can stop here and cut the viewing port out or you can fancy it up like we did.
- xi) We took a piece of poster board and lined it up with the 8½" line. Marked where the two lines ran the length of the tube. Found the center between the two marks. Took two pencils and a piece of string, tied the string to one pencil, placed the point on the center mark, took the other pencil and placed it on one of the marks from the tube and tied the other end of the string to it. Took the pencil on the mark from the tube and drew an arc to the other mark from the tube. Cut out the half circle and line it up below the 8½" line and between the two lines that run the length of the tube. Trace the arc. Repeat the steps for the 2" line. When all lines have been drawn your tube should look similar to the drawing below.



d) Now we need to cut the viewing port.

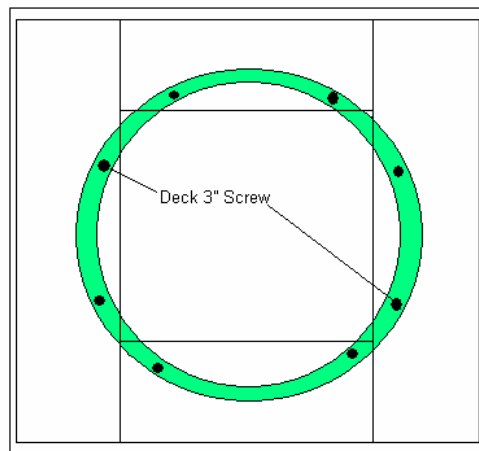
- i) We did this with a saber or jig saw and a plexiglass blade. We drilled two $\frac{1}{2}$ " pilot holes on the inside of the lines running the length of the tube and right below the semicircle. Take your time, the blade will get hot. If it gets too hot it will break. When you are done, you should have something similar to the picture below:



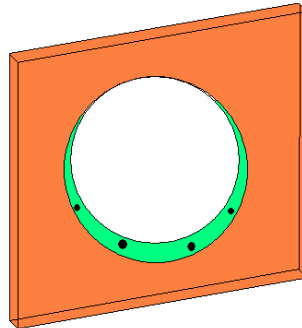
e) Now we will permanently mount the tube to the base.

- i) Place the tube onto the base. Align the marks. Now take a pencil and trace the inner circle onto the 2" X 4" supports. Remove the tube.

- ii) Drill pilot holes into the 2" X 4" supports for the Deck 3" screws. (I do not remember what size drill bit. Make sure it is smaller than the screws.) Drill two pilot holes per 2" X 4" support. Use the drawing below for reference.
- iii) Set the tube up on its end. With the 8½" measurement down. Run a bead of silicon sealant inside the pencil mark on the 2" X 4" supports of the base. Place the base on the tube and line up the alignment marks.
- iv) Make sure the base and the tube are bottomed out and making good contact with each other. Make sure the alignment mark is aligned before proceeding. Now take and extend **one** of the pilot holes in the 2" X 4" supports into the tube. Now run one of the Deck 3" screws into the hole. Do not over tighten; this could cause the base to lift up opposite the screw. This first screw will hold the base and tube in place. Repeat the process for the seven other pilot holes. Tighten all screws by hand. Too much torque will cause the screw head to snap off. Wipe off excess silicon sealant.



- f) **Once you have completed the above steps, turn the tornado machine over and set it on its base.**
 - i) On the inside of the tube measure from the bottom lip of the tube up 3/8". Using the drawing below as a reference, pre drill 8 pilot holes into the wall of the tube at the 3/8" height for the Drywall 2" screws. Be careful and drill the holes as straight as possible.
 - ii) Now run the Drywall 2" screws into each pilot hole. This securely attaches the tube to the base.



iii) One problem we ran into was the pizza pan was just a tad too small. We use the end off a cable spool to insert into the inside of the tube. We cut the end of the cable spool down to the inner diameter of the tube and then came in 1½” and cut the center of the circle out. This gave us a 1½” lip on the inside to set the pizza pan on.

g) If all has gone well up to this point you should have something that looks similar to the picture below:



3) Now let's start putting the innards inside the tube and base.

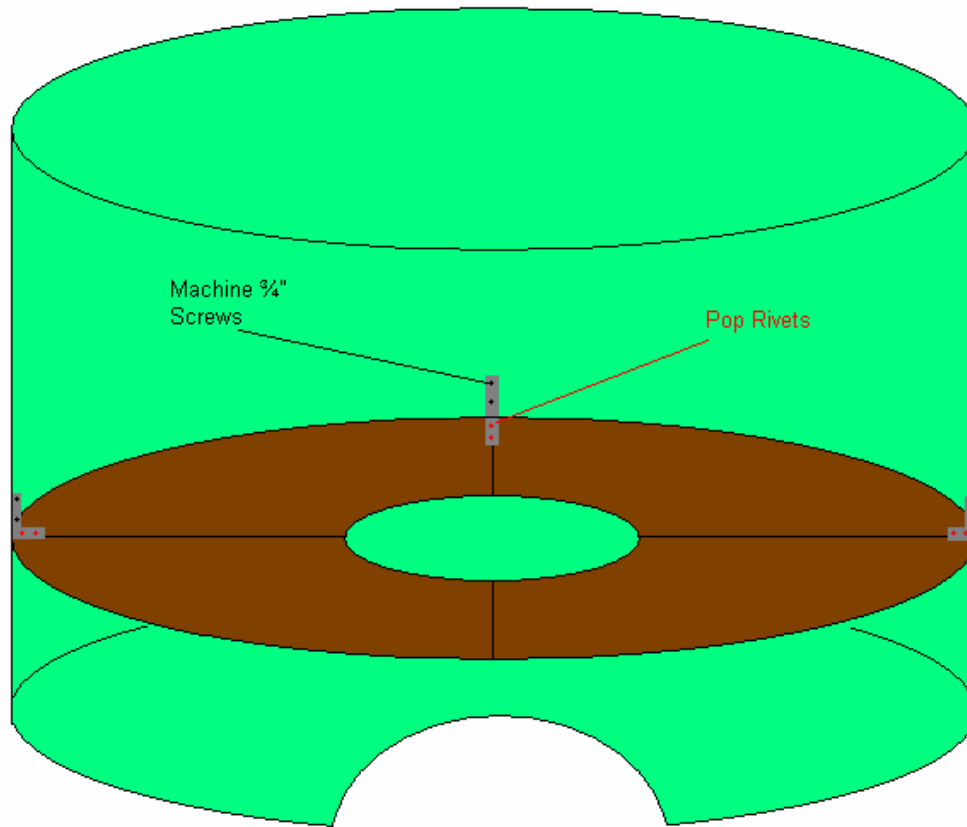
a) Mounting the top shelf requires a few steps:

- i) First measure down from the lip 7" and make several marks around the inside of the tube. These will be reference marks to align the shelf.
- ii) Take and measure the sides of your exhaust fan. They should be approx. 7" to 8" per side. Take 1/2" off the side length and that becomes the diameter of the hole you will cut into the circle cut from the 2' X 2' X 1/4" Masonite board. So if you have an 8" side and we take 1/2" away you will have a diameter of 7 1/2". To draw your circle we need the radius which is half the diameter, which in our example would be 3 3/4".
- iii) Take the circle cut out of the Masonite board and find which side has the 'X' drawn on it. Measure out from the center of the circle along one of the lines and mark the radius you found (example: 3 3/4"). You can use the pencil set up in Step 2.c.xi to draw your circle.
- iv) Once your inner circle is drawn using a saber or jig saw cut out the circle. This will be the intake for your exhaust fan. Place the fan over the circle and line the corners up with the lines from the 'X', make sure the hole is not too big.
- v) Next we will mount four L brackets on the shelf. Take and lineup one L bracket on each of the four lines. Back the L brackets right to the outer edge of the Masonite board circle. Mark the holes onto the Masonite board circle. Drill the mark holes out. Using a pop rivet device, pop rivet the L brackets onto the top side of the circle. Insert the pop rivet from the bottom through the Masonite board and into the L bracket hole. This will give a clean look on the bottom of the circle. If you have become confused reference the picture below.



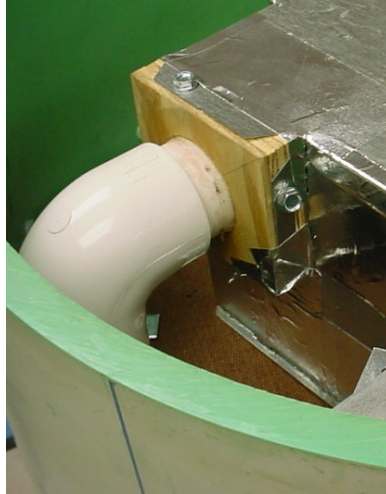
- vi) With all four L brackets mounted insert the shelf into the top of the tube and ease it down to the 7" marks made in Step 3.a.i. Center one of the L brackets with the viewing port. This will ensure a bracket will not interfere with the exhaust tube from the fan.
- vii) Once you have the shelf align at 7", pick one of the L brackets and pre drill the top hole for a screw. **(Caution Do Not Drill through the Tube Wall.)**
- viii) Run the Machine 1/2" screw into the pre drilled hole. This will support the shelf.

- ix) Next take a level and level the L bracket opposite the one you just placed the screw in. Pre drill the top hole and run a screw into the hole. Do this for the remaining two L brackets.
- x) With all four top holes completed, continue with the bottom holes. When this is completed you should have something similar to the drawing below.



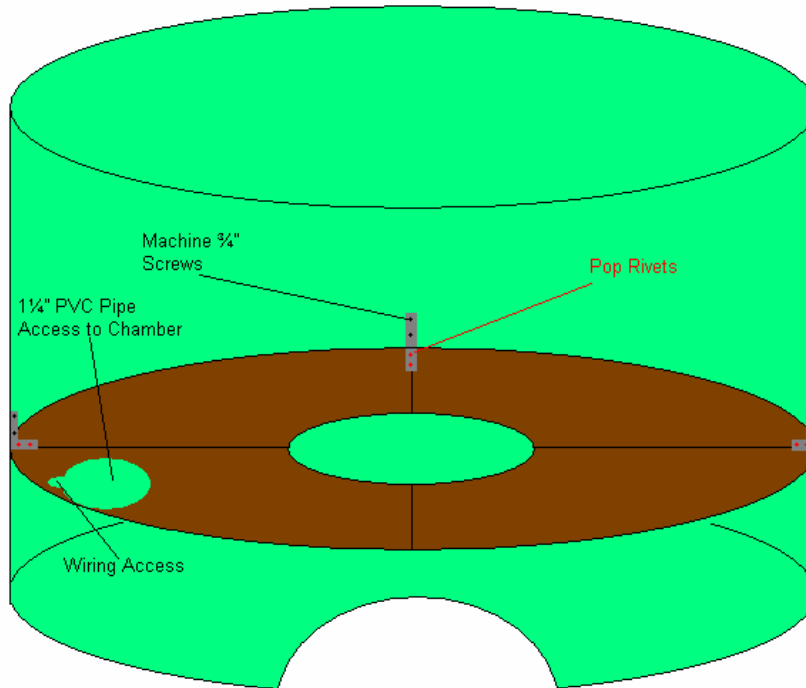
b) Modify the fan to suit our purpose.

- i) Your exhaust fan came with a plastic square to round conversion piece. Take this and throw it away. Take a piece of plywood or whatever scrap you have and cut a square to fit into the exhaust port. The thickness should be around $\frac{3}{4}$ ".
- ii) Now bore a $1\frac{1}{2}$ " hole centered on the square of wood. Cut a 3 to 4" piece of the $1\frac{1}{4}$ " PVC Pipe. Take the PVC elbow glue and slide the PVC pipe just cut into it. Make sure the pipe is fully inserted. Now mount the wood into the fan exhaust port. Insert the PVC pipe and elbow into the hole in the wood. Place the Hose Clamp on the PVC pipe on the inside of the fan housing. Leave plenty of play for adjusting the pipe. The picture below gives an idea of how the pipe and wood looks after mounting.



- iii) Take the exhaust fan and place it on the top shelf in the tube. Looking from the viewing port side of the tube the exhaust port of the fan will be to your left. Position the fan so that the center of the elbow is 3 to 4" from the left side of the viewing port and the fan is centered over the intake cut into the shelf. Once you have the fan positioned to your satisfaction have someone hold it in place while you trace around the fan. Mark and 'X' on the shelf to identify the side of the exhaust port. This is to place the fan in the same position later. While the person is still holding the fan in place take the PVC pipe/elbow and slide it out until it touches the tube wall. Mark the pipe next to the wood. This will be the length of the PVC pipe/elbow.
 - iv) Now remove the fan. However you want to do this, remove the wood from the exhaust port or leave it in place, we are going to seal the pipe.
 - v) Remove the Hose Clamp from the PVC pipe/elbow and remove the pipe from the hole. If you need to trim the PVC pipe ensure you leave enough length to reinstall the Hose Clamp. Run a good bead of silicon sealant around the pipe close to the end opposite the elbow. Insert the pipe into the hole in the wood. Adjust the PVC pipe/elbow until the mark lines up with the hole in the wood and make sure the elbow is square to one of the sides of the wood. The elbow needs to be pointing down and square to insert the 1¼" PVC Pipe. If it appears you did not get enough silicon on the pipe remove and add more. Take the Hose Clamp and place it against the wood on the inside and tighten. This will keep the PVC pipe/elbow from being pulled out. Clean off excess silicon. While the silicon is curing try to ensure the pipe and wood are square to each other. If you removed the wood allow the silicon to fully cure and reinstall the wood with the elbow pointing down.
- c) Preparing the 1¼" PVC Pipe.**
- i) Take the fan and place it on the top shelf and align it within the lines you drew in Step 3.b.iii. Now measure from the open end of the elbow to the top shelf. Take that measurement and add ¼". Cut a piece of the 1¼" PVC Pipe the length of your total measurement. Remove the fan and insert the PVC into the elbow. Do not push the pipe into to far, just enough so it will stay. Now place the fan again on the top shelf and align. With the fan properly aligned, adjust the PVC pipe in the elbow until it just touches the shelf. Trace around the pipe with a pencil.
 - ii) Remove the fan, remove the pipe in the elbow, and take a hole saw and cut out the circle just drawn.
 - iii) Cut a 4' section of the 1¼" PVC Pipe, from the top of the tube insert the PVC Pipe through the hole just cut in the top shelf. Run the pipe down until it stops on the 1½" lip at the base of the chamber. Measure the pipe from the chamber wall, and ensure it is equal distance from top to bottom. Trace the outer diameter of the pipe on the 1½" lip. Cut the circle out with the hole saw.
 - iv) Take and insert the PVC Pipe through the hole cut in the top shelf and also the hole cut into the 1½" lip. The pipe will likely be to short and fall through the hole in the top shelf. That is fine, just leave it for now. Now place and align the fan on the top shelf. Insert the pipe into the elbow. Below the 1½" lip, mark the pipe for cutting. Be sure to take into account the end cap and add ½". Mark where the pipe goes through the top shelf from the bottom. Remove the pipe.

- v) Cut the pipe to length. Starting $\frac{1}{2}$ " below the mark where the pipe goes through the top shelf draw a straight line the length of the pipe. Now make a mark every 1" across the line down the length of the pipe. Drill a $\frac{15}{64}$ " hole at each junction of the line and the 1" mark.
- vi) With the pipe remove, we need to cut access holes for the wiring. Using the drawing below as reference, drill a $\frac{1}{2}$ " hole for wiring access from the base to the top shelf. Drill the access hole to the back of the $\frac{1}{4}$ " PVC Pipe access. This will enable you to hide the wiring behind the $\frac{1}{4}$ " PVC Pipe. Repeat these steps for the access hole cut in the $\frac{1}{2}$ " lip at the base of the chamber.



d) Wiring the Base.

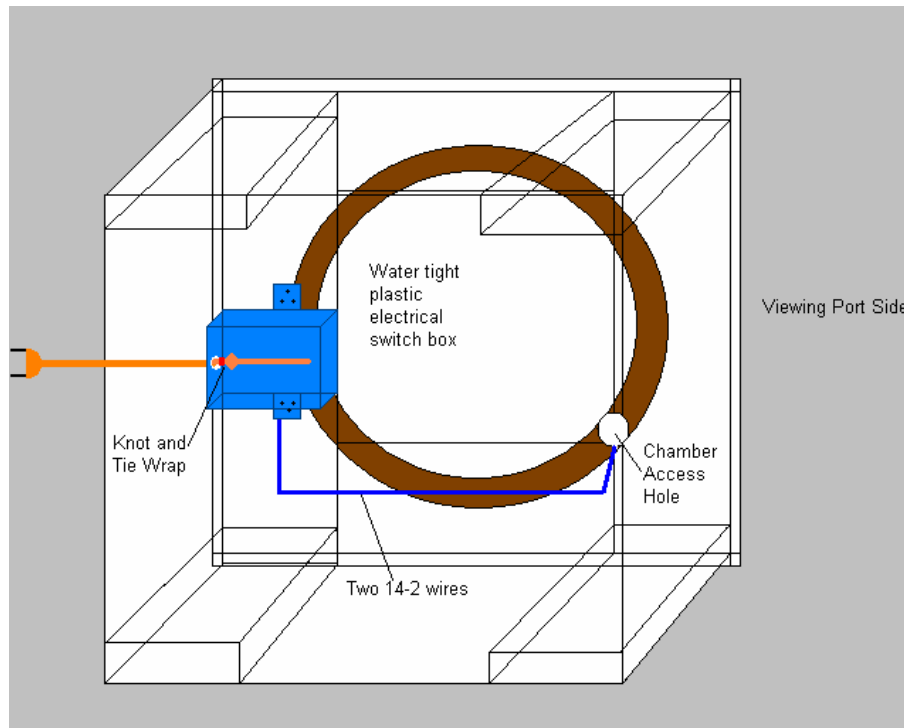
- i) However ever you want to position the tornado machine, you need access to the bottom of the base. We turned it upside down for ease of working.
- ii) Opposite the viewing port, centered on the 2" X 4", and up against the side, mount one of the Remodeling plastic electrical switch box (shown below). Drill a hole the size of your power cord through the box and through the side wall.



- iii) Pass the power cord wire through the hole. Take and tie a knot in the power cord and place a large tie wrap between the knot and the hole. Leave enough length in the box to make connections. This will keep anyone from pulling the cord out of the box.
- iv) Place a wire clamp on the bottom of the box with the clamp outside. Take the box of 14-2 wire and run two wires from the switch box in the base through the chamber to the top shelf. Leave enough

length in the box for connections and secure them with the clamp. Leave 2' in the top shelf. Mark one of the wires on both ends with electrical tape for easy identification.

- v) Using the drawing below route the two 14-2 wires as shown. Use a couple of wiring staples to hold the wire in place.



e) Mounting the Water tight metal electrical switch boxes, making and mounting the handle and mounting the last plastic electrical box.

- i) The handle is made out of 1/2" electrical conduit. We had our Facility Tech bend and form the handle to the tube. Use the picture below for the shape we used. We mounted the handle after we mounted the electrical boxes. We drilled four holes in each arm and then placed it against the tube where we wanted it positioned and marked a hole. We drilled a pilot hole and ran a screw through the handle and into the wall of the tube. Then we drill each hole separately and ran a screw into the hole. We did it this way to ensure the handle was straight. I do not remember what size screw we used.
- ii) Using the picture below mount the boxes inside of the handle for protection, when moving the tornado machine.

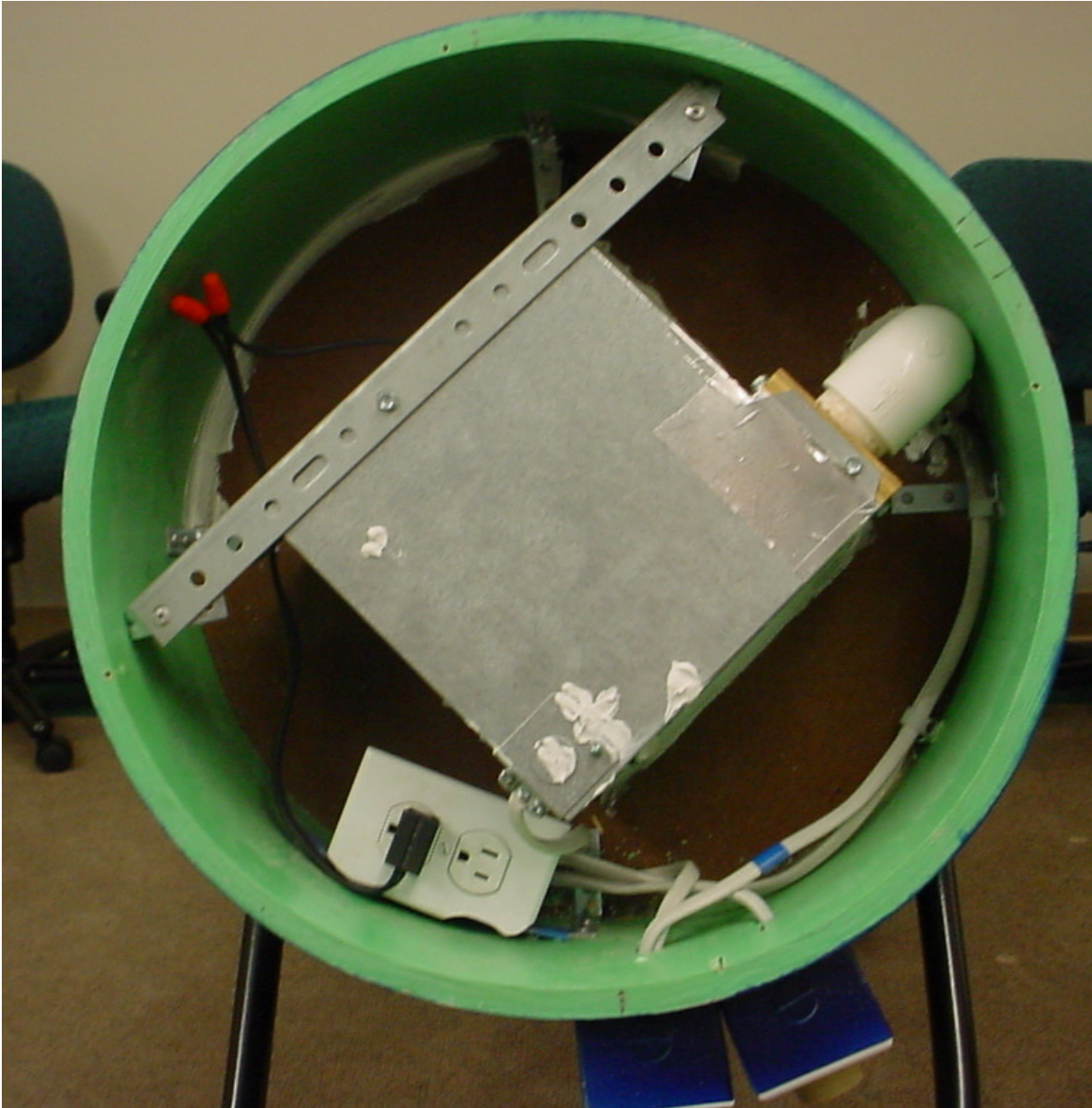


- iii) Remove the plug from the back hole of the box if there is one. Position the box where it will reside. If there are no mounting holes in the back, drill two holes for mounting. Do not worry about the screw going through the wall, this area is not seen. Once both boxes are mounted, drill a $\frac{1}{2}$ " hole through the tube wall where the hole in the back of the box is located.



- iv) Now mount the handle.

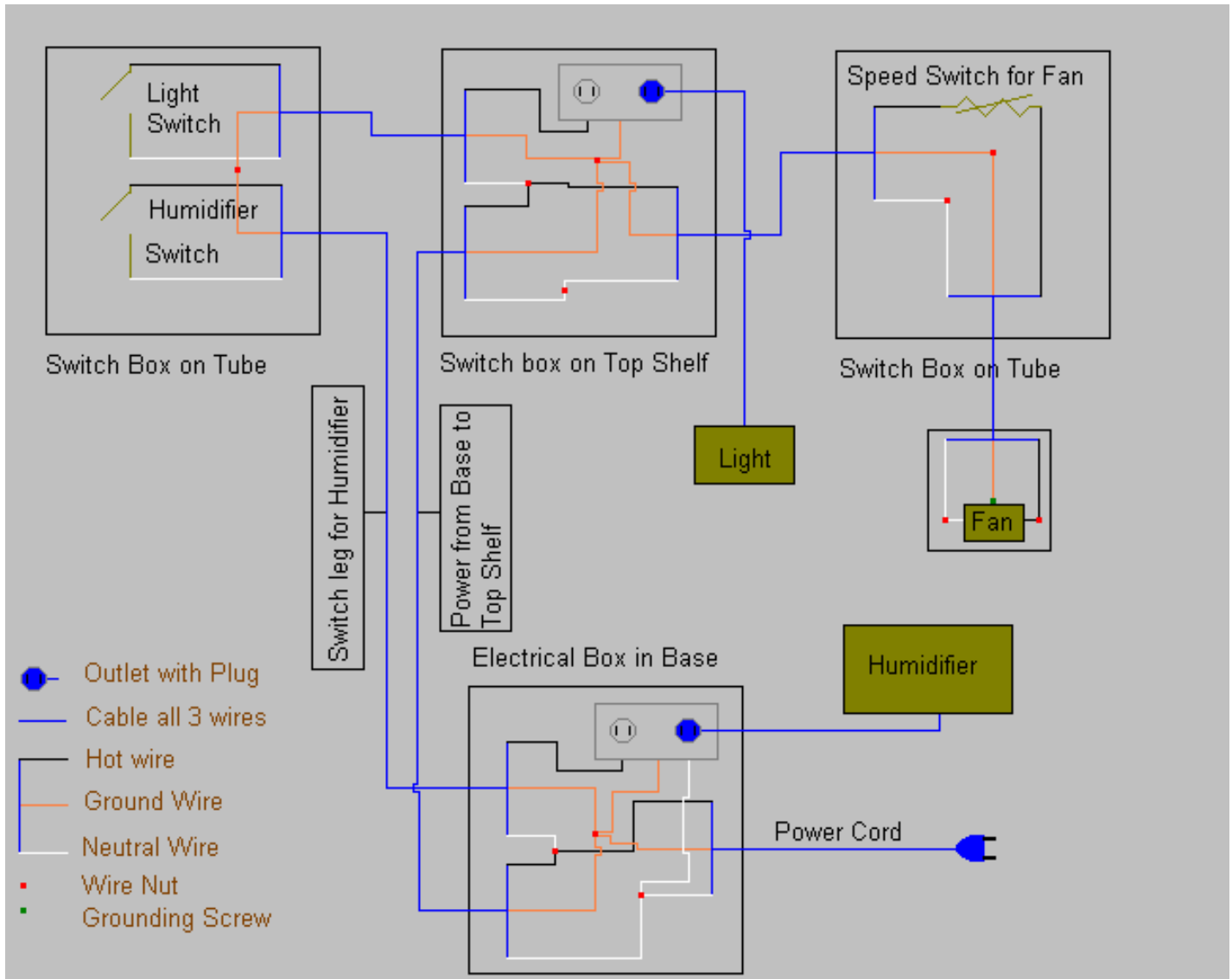
- v) Take the wire with the electrical tape and choose one of the boxes and run the wire into the box. This will be the switch leg to turn the humidifier on and off.
- vi) Position the fan on the top shelf. Take the last plastic electrical box and mount it as shown in the picture below. Room is tight so be sure to give yourself room to work with the wiring. Place a clamp in the hole for the wires. Take the other wire from the base and run it into the box.



f) Completing the wiring.

- i) Currently you have one wire run into one of the metal electrical switch boxes. This wire should have the electrical tape on it. Run another wire from the metal box to the plastic box on the top shelf. This will be your switch leg for the light.
- ii) Here we have made a change in the wiring so, it does not follow the picture above. From the metal box that has no wires, run one wire from the box to where the fan electrical access will be and another wire to the plastic box on the top shelf. This will be the power for the fan and switch/speed control leg.

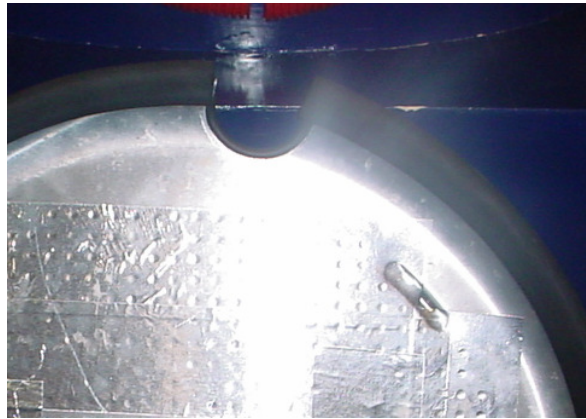
- iii) Now following the diagram below connect the wiring and install all plugs and switches. Install all face plates. The fan will be connected later after mounting.



4) Mounting the fan and 1¼” PVC pipe.

a) Mounting the fan.

- i) Slide the 1¼” PVC Pipe into the access hole in the top shelf and lower the pipe into the access hole in the 1½” lip. Let the pipe sit for a minute below the top shelf. Take the fan and position it. Now take a piece of angle iron and attach it to the fan as shown in the picture in Step 3.e.vi. Use a self-tapping sheet metal screw. Now take 2 L brackets and mount them to the tube wall as shown in the picture. Line the bracket’s holes up with the ones in the angle iron so you can place a screw and nut in them.
- ii) Wire the fan into the electrical system.
- iii) Now take and insert the 1¼” PVC into the elbow. (Align holes pointing towards viewing port.) Place the end cap on the pipe.
- iv) Plug in your humidifier and add water.
- v) Place the pizza pan over the humidifier. (You may have to cut out for the 1¼” PVC as we did.)



- vi) Plug in the tornado machine. Turn on the humidifier and the fan. When you have a funnel, adjust the 1¼" PVC by twisting for the best funnel.

5) Finishing touches

a) Installing the light

- i) If you have the round halogen light, you will need to take the wire loose from either the plug or the light itself. Drill a hole to pass the wire for the light through the top shelf. Take the cover off the light and mount the light on the inside of the chamber to the front of the viewing port (see picture below).



- ii) Attach the wire to the light or plug and plug into the receptacle on the top shelf.
- ### b) Installing the bottom plate of the base
- i) Turn the tornado machine upside down. Take the bottom plate and check for the best fit. When satisfied, lay the bottom plate to the side, and run a good bead of silicon sealant around the bottom of the base. Be sure to run a bead around the internal frame legs.

- ii) Take the bottom plate and place it where you determined the best fit. Take the Drywall 2" screws and attach the plate to the base. Be careful you will be running the screws into the side walls of the base. If you need to mark a line for each side, measure 3/8" at two places on each side and using a straight edge draw a line through the 3/8" marks. Run the screw in on the line. Locate the internal frame legs and run two screws into them. Clean the excess sealant.

c) Sealing the chamber

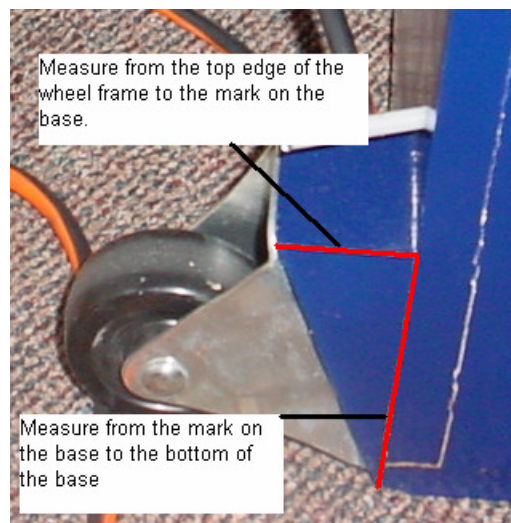
- i) We did not glue the 1 1/4" PVC pipe into the elbow. If you feel it is needed please do. Seal around the pipe where it passes through both access holes with silicon sealant.
- ii) Take a look at the picture in Step 3.e.vi and seal everything you can, leading to the chamber below. You do not need to seal the holes for the switch boxes.
- iii) Make sure the base is sealed. You do not want water on the floor when kids are around.

d) Placing the lid on top of the chamber

- i) This is real simple. Take the circle of plywood cut from the top plate and place it on the top of the chamber. Position the circle for the best fit. Drill 4 holes for screws through the plywood and into the wall of the chamber. Run the Drywall 2" screws into the holes. This will enclose the equipment on the top shelf.

e) Installing the casters

- i) I cut wedges from the leftovers of the 2" X 4" boards.
- ii) Take one caster and set it against the base at the back. The wheel should be touching the floor and one edge of the wheel frame should be touching the bottom of the base. Reference picture below. Place two quarters (50 cents) under the wheel to raise it off the floor.
- iii) With a level, level between the top edge of the wheel frame and the base. Make a mark on the base level with the top edge of the wheel frame. Measure from the top edge of the wheel frame to the mark on the base. Measure from the mark on the base to the bottom of the base.
- iv) Transfer these measurements to the 2" X 4" board and cut two wedges.
- v) Attach the wedge to the base and the wheels to the wedges.



If you followed all the instructions you should have a heavy duty mobile indestructible tornado machine. You can decide how pretty you want it. If you find any mistakes contact me at brian.burgess@noaa.gov.