Bird-Shots PAP Kit
Assembly Instructions
April 1, 2007

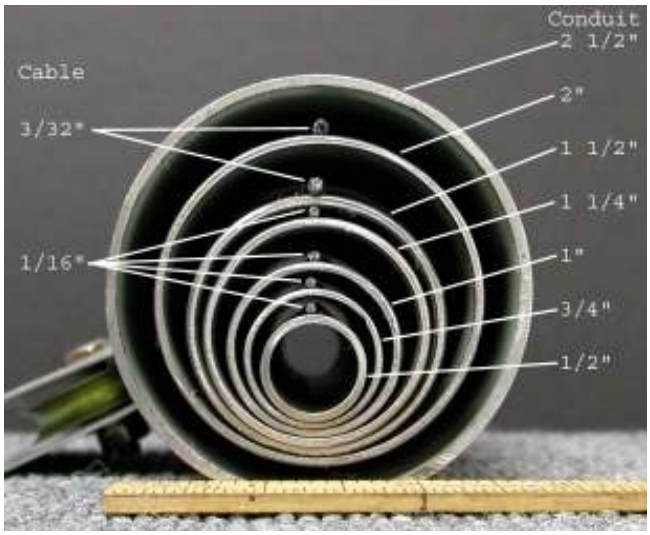
(Please Read Carefully BEFORE Starting)

Why a kit ?

Over the past several years I have tried several platforms to obtain commercial low-level aerial photographs…Kites, Balloons, and RC Planes. All have their limitations, the biggest problem being safety…crowds, power lines, etc. Therefore, I decided to design and build a telescoping pole to at least get the effect of aerial photography, but in a safe way.

The goal here is to provide everything needed…including images…to build a 50' telescoping pole. The only thing not provided is the EMT. The included CD contains real-time videos of various stages of assembly. Estimated time to complete the project...2 days.

Having built several versions of telescoping photography poles, I have decided that EMT…Electrical Metal Tubing (also known as Thin-wall Electrical Conduit) is by far the best for this application. It is readily available anywhere in the US…and all but the two larger sizes are available at Lowes and Home Depot. The result is a pre-engineered kit permitting those with limited skills and resources to enjoy Pole Aerial Photography as I have.



The above image illustrates the different sizes of commercially available EMT. Due to minimal clearance between the 1¼" and 1½" sections, the 1¼" section was not used in the telescoping EMT.
The major obstacle in this type pole is cable clearance. To eliminate the possibility of cable abrasion, special bushings were designed that provide sufficient clearance between EMT sections.

NOTE: The kit was designed based on the inside diameter and wall thickness of EMT made to US Standard. Other tubing, such as aluminum, WILL NOT work with this kit.

Safety:

Although anyone can build this kit, its safe use is dependent on good common sense, and the use of a checklist similar to the one below.

PAP Checklist

Pole

Setup

Cable (Condition, Crimps, etc)
Pulley assemblies
Pole bushings
Swivel pin

Trailer hitch pin
Winch assembly
Guy line attached for wind / height
Attach plumb level
Plumb to vertical
Adjust safety cable

Takedown

Set pivot pole to travel position
Attach compression cable
Cover pulley brackets with boot
Attach tie down cord
Secure swivel and lockdown pins
Adjust safety cable

The maximum recommended payload was established based on experience. Although the cable system will hold larger loads, the recommended safe height limitation is 3.5 lbs @ 50'. Therefore, the pole is rated as follows:

- 3.5 lbs – 50'
- 4.5 lbs – 45'
- 5.5 lbs – 40'
- 6.5 lbs – 35'
- 7.5 lbs – 30'

The pole should never be raised:

- more that 6'…shackle pulled down to fairlead
- above 40' in windy conditions without guy-wires
- near powerlines
- without using a checklist
- with a payload exceeding the recommendation herein
- on a trailer that is lighter or narrower than recommended
- unless plumbed properly
- in inclement weather

The following chart contains the design criteria used to size the cable.

Example Cable Loading Chart:

	Wt.	Accum Wt	(+) Load	(-) Load	Net	Cable
Cradle	3.5					
1/2"	3	6.5				
3/4"	5	11.5		6	6	1/16"
1"	7	18.5	6	18	12	1/16"
1 1/2"	12	30.5	18	36.5	18.5	1/16"
2"	15	45.5	36.5	67	30.5	3/32"
2 1/2"	22	67.5	67	112.5	45.5	3/32"
3"	27	0	112.5	180	67.5	3/32"
	94.5	180				

The breaking strength of 1/16" stainless 7x7 is 480 lbs and for 3/32" stainless 7x19 its 920 lbs. To ensure maximum sleeve strength…80% of breaking strength…each crimp is checked with a swage gage during assembly.

Tools you will need:

Center Punch
Hammer
Phillips screwdrivers #2 & #3
Drill
Drill bits…1/16, 3/32, 1/8, ¼, 5/16, and 3/8
Dremel with cutoff wheel & ¼" sanding drum or chainsaw file
Wrenches…5/16, 3/8, ½ and 9/16
3" 'C' clamp
Bar type clamps (several)…I use Quick-Grip

(Optional)
Vise
Automatic center punch

Materials Shopping List

You will need to purchase 7 sizes of EMT which comes in standard 10' sections: ($150 estimated)

1 ea - 1/2"

2 ea - 3/4" (front pole rest brace)(plumbing assembly)

1 ea - 1"

2 ea - 1 1/4" (plumb arms)(front pole rest)

1 ea - 1 1/2" (1 piece for front rest)

2 ea - 2" (1 piece for pivot pole)

1 ea - 2 1/2"

1 ea - 3"

1 1/4" Couple - (to mount front rest saddle)

Most local hardware stores…including Lowes and Home Depot…carry sizes up to and including 2". The 2 ½" and 3" are available at electrical supply houses.

Miscellaneous Hardware ($5) - Nuts and bolts for mounting pole-rest and pivot pole, braces, etc to vehicle.

Electric ATV Winch w/remote switch (Hand winch not recommended): - Warn 2.5ci ATV winch or equivalent...(From - $120 for a Warn clone to a $290 Warn)

Extra long heavy duty (4 guage) jumper cables for the winch. ($20 @ Walmart)

At least a 75 amp gel battery ($75).

EMT selection:

For a nice look, all the EMT sections should look the same…all bright or all dull. This is sometimes difficult to achieve without some shopping around. In other words, a single store may not have consistent looking stock in all sizes.

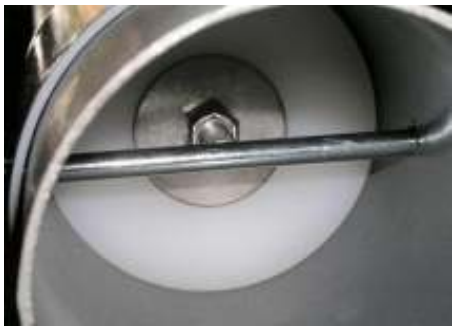
EMT is made from sheet metal rolled into a tube shape and welded together. As a result, it has a small seam inside. Before purchasing, check to make sure the welded seam is not excessive, as it will interfere with bushing travel inside the EMT. Look carefully at each piece of EMT. Do not select pieces that have nicks or dents. They interfere with bushing travel, and could possibly cause failure.

Select straight pieces. Smaller sizes are more likely to be bowed than larger ones. Lay each piece on a smooth surface and roll it. Any bowing will be evident.

POLE ASSEMBLY

Install Lockdown/Winch-Mount bracket:

Bracket hardware has been assembled for shipment. Observe the location of the hardware then disassemble using a Quick Clamp to relieve the pressure. Position the bottom of the bracket 2" from the bottom of the 3" section and with the winch plate on the cable side of the EMT. Use a Quick Clamp to squeeze the flanges together and install the 3 torque tubes (½" EMT 2 inches long) and 3" X 5/16" bolts. With the winch plate perpendicular to the pulleys, tighten the two bolts nearest the 3" pole…the middle bolt is tightened after the pole is mounted on the pivot pole to ensure proper clearance.



To complete the installation, drill a ¼" hole in each side of the EMT and install the stop bolt.

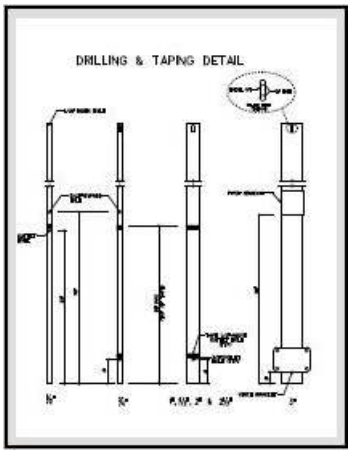
Install Pivot Bracket Assembly:

Bracket hardware has been assembled for shipment. Observe the location of the hardware then disassemble using a Quick Clamp to relieve the pressure. Position the bottom of the pivot bracket 48" from the bottom of the 3" pole. The flanges on the pivot bracket should be aligned with the flanges on the winch bracket. Use a Quick Clamp to squeeze the flanges together and install the 2 torque tubes (½" EMT 2 inches long) and 3" X 5/16" bolts. Tighten the bolts so that the tubes are secure.

Prepare the EMT for assembly:

NOTE: The exterior of the 3" section may be painted, however, under no circumstances should any of the internal EMT sections be sanded or painted. Sanding WILL cause it to rust…and painting WILL inhibit performance and may cause failure.

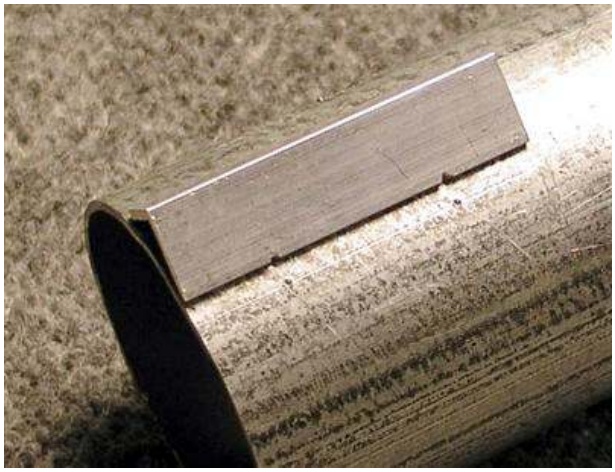
Three holes are necessary for cable routing…Pulley, Outlet & Bypass. The included “Drilling and Tapping Detail.pdf” details the location and size of holes and where permanent tape is to be applied.



Pulley Hole – (video)

This 3/8” wide elongated hole allows the pulley to intrude into the EMT just far enough to prevent the cable from rubbing against any EMT.

Secure the EMT either in a vise or by clamping it down. Flush the included drilling guide with the end of the EMT with a center punch, make a punch mark at the notches.



Drill a pilot hole at each punch mark with say a 1/8” bit then enlarge the holes to 3/8”.

Using a Dremel tool with the thinnest cutoff wheel available, remove the EMT between the holes.

It is critical that the pulley hole be no less than 3/8" wide from end to end so that the pulley doesn't touch the EMT…a tad wider is better. Thoroughly de-bur the hole…INSIDE and OUT. The finished hole should look like this…

Cable Outlet Hole – (video)

The purpose of this hole is to route the cable outside the EMT. On all but the ½" section it is located near the bottom so as not to interfere with the travel of the bushing above it.

The location of this hole is very important, as it determines the ultimate alignment of the pulley assemblies. It must be DIRECTLY UNDER the pulley slot when the pole is vertical. In other words, if you snapped a lined from top to bottom of the pole, the center of both holes would be on the line.

To protect the cable from possible wear where it exits the EMT, a small crease is added to the upper side of the hole.

This can be accomplished with a “C” clamp and a drill bit, rod etc. Lightly attach the clamp to the bottom edge of the hole and put a slight bend in the upper side of the hole. The clamp will ensure that only the upper side of the hole is deformed. This will provide a smooth rounded surface for the cable to exit the EMT. Thoroughly de-bur the hole inside and out.

Loop Bypass Hole – (video)

This hole is used only during assembly. Unlike the bottom four loops, the top two are larger than the space between sections and must be “hidden” inside the EMT for assembly.

Clean the Inside of EMT

After all drilling and de-burring has been completed; each section of EMT should be thoroughly cleaned.

NOTE: Thoroughly clean EMT inside and out - DO NOT LUBRICATE!

Install Bottom Bushing Assemblies:

Alignment

Bottom bushing assemblies have been marked on the side that provides maximum cable clearance.

To ensure proper cable clearance, the mark should be on the cable side of the EMT.

NOTE: Improper alignment in the top two bushings will cause severe binding and ultimate cable failure.

Check For Binding:

Be aware that the nominal OD of EMT is more consistent than ID. The bushings provided should handle all of the variations in wall thickness, however, some bushings may need to be trimmed to accommodate EMT variances.

The following procedure should reveal any tendency toward binding:

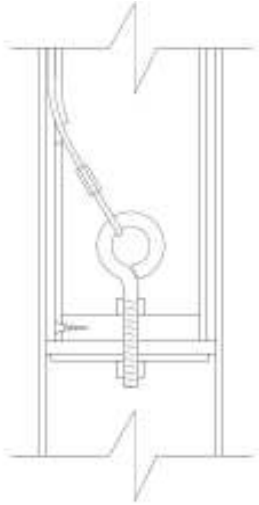
On each section, route the cable up through the outlet hole. Pull tension on the cable and apply temporary tape at the pulley hole. Insert each into the next size up and feel for any binding whatsoever.

Should binding occur, determine the cause. It may be a ding, excessive seam weld, or a wall thickness issue. If it's the later, adjust the bushing to eliminate the bind…if not replace the section.

CAUTION: Do not proceed until all binding has been eliminated!!!

Secure Bushing Assemblies to EMT

To maintain proper alignment, stainless steel wood screws have been provided to secure the bushing assemblies in the EMT sections.



The above figure illustrates a properly installed bushing assembly.

Install 2 ½" Bushing Assembly –

With the bushing in the properly aligned position, butt the drilling guide up to the metal plate and put a punch mark at the 3/16" notch about an inch each side of the cable outlet hole.

Drill a 3/32" hole through the EMT and into the bushing. Then use a larger drill bit to countersink the hole in the EMT. Use two of the large screws for this section. Be careful not to over tighten the screws.

The image above is a properly installed 2 ½" bushing assembly.

Install 2" & 1 ½" Bushing Assemblies –

With the bushing assembly in the properly aligned position, butt the drilling guide up to the bushing and put a punch mark at the 3/16" notch under the outlet hole.

Drill a 3/32" hole through the EMT and into the bushing. Then use a larger drill bit to countersink the hole in the EMT. Use one large screw for each section.

Install 1" & ¾" Bushing Assemblies –

With the bushing assembly in the properly aligned position, butt the drilling guide up to the bushing and put a punch mark at the 3/16" notch under the outlet hole.

Drill a 1/16” hole through the EMT and into the bushing. Then use a larger drill bit to countersink the hole in the EMT. Use one of the small screws in each section.

Install ½” Bushing Assembly –

This installation is a little different. The retaining screw is to be installed on the side opposite the cable.

Install the bushing assembly with the mark aligned with the pulley hole. On the opposite side of the EMT, flush the drilling guide with the end of the EMT and put a punch mark at the 3/16” notch.

Drill a 1/16” hole through the EMT and into the bushing. Then use a larger drill bit to countersink the hole in the EMT. Before installing one of the small screws, file a little off the end to ensure that it will countersink completely. After installing the screw file it flush with the EMT.

Insert the cables on the ½” and ¾” sections into bypass, remove slack then apply temporary tape to keep the cable taught.

Procedure for Permanent Tape

Tape the cable to the EMT ½” above the outlet holes and 4” below the two bypass holes with one and one half wraps of electrical tape. Due to minimal clearance, only one layer of tape is permitted on the side opposite the cable on the ½” and ¾” sections. **VERY IMPORTANT: Proper taping technique…tape ½”- stretch and wrap - relax last inch or so to prevent lifting.**

The bottom tape holds the cable to the pole as it exits the EMT through the cable outlet hole. The upper tape helps keep the cables in the proper position while the pole is horizontal should any slack occur.

Temporary tape Permanent tape

The pole is now ready to assemble.

Assemble Pole: (video)

Brackets are shipped assembled for two reasons: (1) it helps ensure that all the parts have been included and (2) to show where each part is intended to go in the assembly process. Observe the location of the hardware and disassemble.

The assembly sequence is critical. Follow each step exactly as described below:

NOTE: Keeping tension on the cable during assembly of the top two sections is critical. Binding will occur if the cable is allowed to sag. Manhandling a bound cable will cause kinking and render the cable useless. Pull cable NOT EMT when removing.

Step 1 – Beginning with the 3” section (pulley slot up)…carefully slide the 2 ½” section (pulley slot up), into the 3” section until it touches the stop bolt in the winch bracket. The eyebolt will rest against the stop bolt in the winch bracket. Feed the cable loop on the 2 ½” section up through the pulley hole of the 3” section.

Step 2 – Slide the 3” pulley bracket in place. Seat the top bushing against the top of the 3” section.

Step 3 – Temporarily install pulley and check to see that everything fits properly and that the pulley slot is sufficiently wide and aligned properly. Some adjustment may be required to ensure the pulley does not rub against bracket or EMT. Improper alignment or insufficient width will cause the pulley to bind resulting in broken cables and ultimate pole failure. Remove the pulley from the bracket and continue assembling the pole.

Using steps 1-3 above assemble all but the ½” and ¾” sections. These sections have bypass holes. Use the cable extractor and carefully retrieve the cable out through the pulley hole. Keeping tension on the cable, slide the EMT in all the way.

The pole is now ready for gluing.

Caution: Do not attempt to weld brackets to EMT. The heat will deform the bushings and also weakens the stainless cables.

Gluing: (video)

Clean where the bracket will fit with a damp cloth. Squeeze about an ounce of Gorilla glue into a small cup. Using a soldering brush or a similar stiff brush,

apply a thin even coat of glue around the EMT from the bottom of the pulley opening to ¼" below the top of the EMT.

NOTE: Stay at least ¼" from each side of the pulley slot, as the glue expands as it cures.

Carefully position the bracket over the pulley opening. Place a clamping block in place and clamp the bracket to the EMT. The grove in the bottom is for cable clearance. The block should be placed just below the bushing.

NOTE: Clamping blocks provided in the kit must be used when gluing brackets to ensure proper alignment. Before clamping, make absolutely sure that the backside of the bracket fully contacts the EMT with no gap, and that the bushing is fully seated against the EMT.

Any gap between the bracket and the EMT on the front side will be filled with the expanded glue. The gap will close when the pulleys are installed.

Clean up excessive glue with alcohol BEFORE glue sets up.

NOTE: DO NOT install pulleys for at least 8 hrs.

Install Pulley Bracket Hardware:

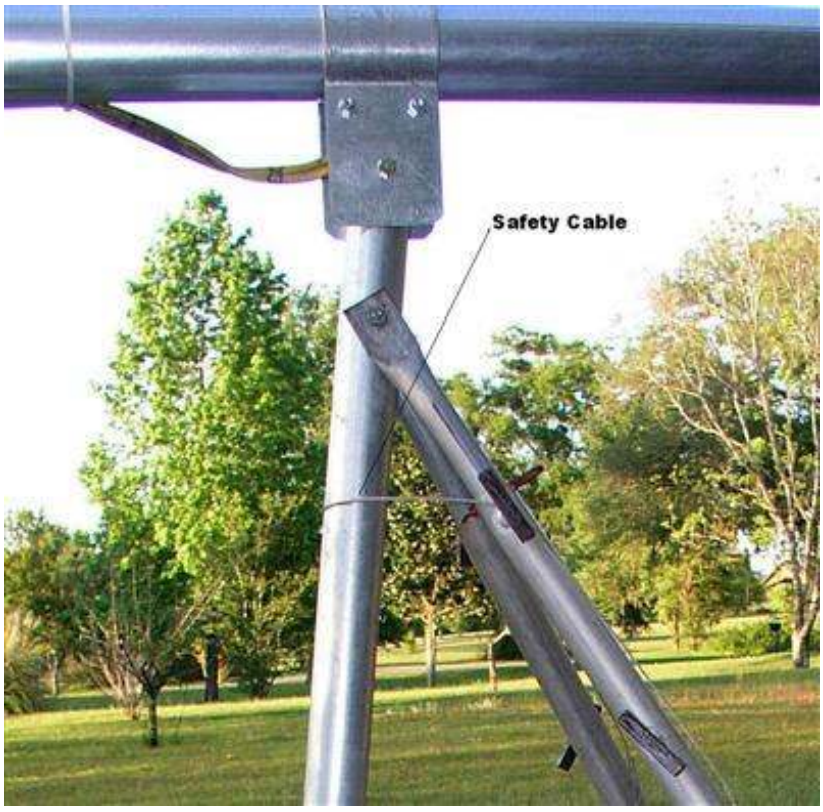
After all brackets have been installed and glue cured, install pulleys, then the cable loops. Remember to install the polypropylene cable protectors for each loop. The winch cable should be looped and taped temporarily to the pole until ready for mounting.

Build Plumbing Clamp Assemblies (2 ea):

These clamps are an essential part of the PAP rig. They are to be used to plumb the pole regardless of what it's mounted on.

Referring to ***plumber.pdf,*** - a vise or hammer can be used to flatten about 1 ½"of the 24"x ¾" EMT. Then drill a 3/8" hole ¾" from the end and use a 3"x 3/8" bolt to fasten the tubes to the pivot pole.

Three wraps of electrical tape 6" from the end and three wraps flush with the end will take up the slack between the pipes and will prevent electrolysis due to dissimilar metals.



The kit includes a 3/32" safety cable. It is designed to limit the travel of the pivot pole. The loops fit over the plumbing clamp tubes.

The eyebolts are to be hand tightened…DO NOT USE a wrench, bar etc. as the threads may strip out.

Trailer Preparation:

Minimum recommended trailer width is 62” with a minimum gross weight…pole mounted…of 300 lb. For added weight, the battery should be mounted near the rear of the trailer

Refer to the ***suggested trailer geometry.pdf*** file for SUGGESTED geometry. Additional photos are posted on www.bird-shots.com.

Trailering:

The pole should be in the forward position…3” section resting in the saddle. This will ensure that the 48” maximum legal overhang without a red flag is not exceeded.

Refer to the ***suggested travel configuration.pdf*** file.

A 1/16” compression cable has been included to help eliminate slack while in the horizontal travel position.