PML AIRFRAMES FAQ

3/2/03

Airframe Tubes

Our tubing is specified by ID. Be sure to add 2x the wall thickness if you need to determine the OD. Stock, full length tube length tolerance: -0.00, +0.25".

Airframe Selection Criteria

Quantum Tube airframes are the best choice for most sport rocketry applications. QT is very easy to work with and finish, with no spiral grooves to fill. It's very strong for most rocket flying, and is also very forgiving to the impacts of rough landings. However, QT is NOT a replacement for fiberglassed phenolic; it is simply an easier-to-use material in applications that do not require the specific features of phenolic. PML parts such as nosecones, centering rings, couplers, etc., all fit QT just as well as they fit phenolic. However, there are some limitations with QT:

1. It comes only in 2.1, 2.5, 3.0 and 3.9" diameters
2. It is not intended for near-mach (transonic) or above-mach (supersonic) flights. (See our online FAQ for information on mach and near-mach flying)
3. It is not intended to be used as a base for fiberglassing, Kevlar, or other typical tube-strengthening methods.
4. It is not intended for use in minimum-diameter rockets (rockets where the airframe IS the motor mount; the motor casing touches the airframe directly)

If your rocket does not fit any of the above special applications (and about 90% of most fliers' rockets don't), QT's right for you.

Phenolic airframe tubing is the "staple" of high-power rocketry. It was first introduced because it is much stronger than cardboard tubing, with almost 5x the compression strength. It also comes in all sizes, from 1.1 to 11.4". It fits all PML components such as nosecones, centering rings, and etc. perfectly. It is also a very good base for rockets that will require the strengthening of fiberglass, Kevlar, carbon fiber, or similar materials. For this reason, we recommend phenolic as the appropriate tubing for rockets that are 6.0, 7.5, or 11.4" in diameter, or rockets that will require strengthening for the rigors of transonic or supersonic flight. We also recommend phenolic for transonic or supersonic flights in kits of 2.1" diameter, as phenolic can withstand those flights without strengthening in most instances.

Fiberglassed phenolic is THE choice when high-stress flights of transonic, supersonic, or "BIG-motor" flights are planned. Level 3 flights should all begin with fiberglassed phenolic as the airframe tubing, as should any rocket above 2.5" diameter that will fly greater than 950fps (see our online FAQ in the Kit Strengthening section for more). Fiberglassed phenolic tubing is extremely strong and able to handle nearly any flight profile you can imagine. PML fiberglassed tubes are manufactured using the latest high temperature compression process to guarantee superior laminate bonding and the best possible cloth to resin ratio (read: highest strength/lowest weight). It comes to you pre-

glassed, initially sanded, and almost ready to paint. If you want the best, or need ultimate strength, PML pre-glassed phenolic is for you.

QT Kits/Phenolic Kits

All kits from 2.1-3.9" diameter (except Nimbus) come standard in QT. All kits 6.0" and larger are phenolic, as QT is not available larger than 3.9". Any of our QT kits can be special-ordered in phenolic. Contact "PML Central" about it at 586-421-1422 9-5pm EST Mon-Fri or pmlhighpowersales@compuserve.com for pricing and delivery details. (It usually costs a little more and takes longer since it's a special request).

Premium Kraft Phenolic Tubing

- Tests show nearly 5x greater compression strength than cardboard.
- Doesn't fray when cut or "fuzz" when sanded.

Phenolic is more brittle than cardboard, but:

- Damage is localized; impact damage doesn't "travel" up the tube like cardboard.
- No "accordion" damage like cardboard with compression loading; again, damage stays localized and is easily repaired by cutting off the damage and splicing on a new piece. Accordion damage ruins the entire tube with cardboard in most cases.
- Phenolic is waterproof; good for wet sanding or if rocket lands in water, or if rocket is lost and is exposed to the elements until found.

Real PML phenolic tubing has the PML logo printed inside the tubing. If it doesn't have the logo, it's not real PML tubing. Beware of imitations, because all tubes are not the same. One manufacturer's 4" tube may not be the same size as another.

PML Tubing/Component Compatibility With Other Brands

We cannot tell you with certainty whether our tubing is compatible with that of another manufacturer. This also includes whether our couplers, nosecones, pistons, CPR parts, etc. will fit another manufacturer's tubing. With the variation in tubing from one manufacturer to another, we simply cannot tell you with certainty if our components will match well with non-PML tubing.

PML Phenolic Tubing vs. "Flexible" Phenolic Tubing

The so-called "flexible" phenolic tubing available from others is nothing more than plain cardboard with an inside and outside skin of phenolic, or interlaced layers of phenolic and cardboard. In our testing, the tubing was not nearly as flexible as the claims would lead you to believe, and doesn't have the characteristics of true PML phenolic that have made ours the industry standard for high power rockets for the last 10 years.

The flexibility features of the other tubing do not prevent damage, they simply "damage differently". Our tubing takes a big impact to fail at all, and fails by obvious cracking or chipping. The competitors will fail through less impact specifically because of their "flexibility". Their flexibility allows the tubing to flex and the layers to delaminate with an impact that our tubing would take without damage. Said another way, once you get to a certain point, our tubing will crack or chip, but ours will take a bigger hit for it to suffer

any damage at all. For this reason, we believe our tubing to be better overall because it can absorb the smaller impacts that will begin hidden structural damage with competitor's flexible phenolic tubing. Better to have an airframe chip or crack on the ground where you can see it and fix it first than to have the whole rocket destroyed under the stress of flight from hidden structural damage.

PML Pre-Glassed Tubing Service

PML offers a fiberglassing service for our phenolic airframe tubing. All tubing is vacuum bagged. The fiberglassing service leaves the tubes with a smooth finish, ready for priming and painting with little if any prepwork required. Our pre-glassed tubing is available on the Airframes section of the webstore.

- Airframe tubes 2.1" through 3.9" get 3 wraps of 6-oz. cloth.
- Airframe tubes 6.0" through 11.4" get two wraps of 16-oz. cloth.

Quantum Tube

These great airframe tubes are made in the USA from a special blended polymer that is extremely durable and easy to use. Quantum Tube can be squeezed, dropped, or even thrown and will not suffer any damage as can sometimes occur to cardboard or phenolic tube. You will find this new material easy to work with and very forgiving, even during those "less than perfect" flights. All components that fit PML phenolic tubing fit QT also.

- The Quantum Tube (QT) has been tested and found compatible with the following paints: lacquer, enamel, epoxy and urethane, as well as many different primers. As with any paint, apply several light coats allowing each to flash before re-coating.
- Most brands of epoxy adhesive bond well with no adverse affect to the tubing. The bonding area must be sanded prior to applying epoxy. Follow the suggestions in "Do's and Don'ts" below.
- The Quantum Tubes are molded in medium gray and have a glass smooth finish, with NO SPIRAL GROOVE! You no longer have to fill and sand the airframes to achieve the perfect finish.
- All QT part numbers will be prefaced with the letters QT, such as "QT-2.15".
- The Quantum Tubes are resistant to the heat of ejection charges. As with any tube, repeated ejections will leave a black, gritty residue inside the tube. To remove the residue simply wipe the tube interior with a wet cloth wrapped around a dowel or broom stick and allow to dry.
- QT can be cut easily by hand with a hacksaw, and cuts nicely with a power miter box or bandsaw as well.
- QT does not fiberglass well for body tube strengthening. We DO NOT recommend QT for 0.85+ Mach kit strengthening as mentioned elsewhere in this FAQ.

Some customers have thought that QT is a replacement for 'glassed phenolic. This is not the case! **Quantum Tubing is not intended for super-high-stress applications.** It is intended as a replacement for standard phenolic for sport rockets. QT makes it easier and faster for flyers to achieve a nice finish, and to eliminate some of the problems of plain phenolic in high-impact situations like landing on rocks, cold-weather flying, etc. **Fiberglassed phenolic is the best product for high stress flights.** Also, follow the

recommendations in the *Kit Strengthening* section of this FAQ if the flight will be near or exceed 0.85 Mach.

Do's and Don'ts for Quantum Tube (QT)

Do's:

- Before applying paint to the QT lightly sand the outside of the QT using 320 or 400 grit sandpaper.
- Sand the fin fillet area on each side of fin slots using 150-grit sandpaper before applying epoxy to fin and tube.
- Use the edge of an X-Acto knife to de-burr cut ends of QT. This will remove minor deformation of the ID of the tube when it is cut.
- Sand the inside area of the QT using 120 or 150 grit sandpaper wherever parts are to be epoxied to the QT. Sandpaper flappers on a drill, sandpaper glued to a large wood dowel, sandpaper on the end of a stick, etc. can be used to prepare the inside of the QT for epoxy.
- Using alcohol or mineral spirits will not damage the gloss finish on the QT.

Don'ts:

- Do not wipe or spill lacquer thinner or acetone on the Quantum Tube, either will melt or distort the tube.
- CA (cyanoacrylate, "super glue") may be used with QT, but only in "normal" amounts. Heavy amounts of CA may distort the QT.

Pistons, QT Tubing, and Cold Weather Flying

- The first time you fly a QT rocket in cold weather, take it with the piston OUT to the launch site with you, and set it outside while you're doing other things. Once the rocket's come to ambient temperature, try to fit the piston; it'll probably be too tight. Sand it until it has the nice slip-fit you'd expect. Voila...you're done. Your QT rocket is now ready to go now and forever. Basically once you sand the piston for cold flying conditions it'll fit well then, and also will be fine in warmer weather, as it's nearly impossible to sand a piston so much it's too loose. Think of it sort of like setting CG/CP...when you build the rocket, you add as much weight as the heaviest motor you'll fly to the tail, then adjust the noseweight once until it's right. It's something you do one time to make sure you're set for the future. Same thing with the piston.
- It's no secret that all materials get brittle in the cold, plastics in particular. It's not that QT becomes unusable at temps below, say, 30 degrees, it's just that it's not as forgiving when things go wrong as it is when it's warm. Customers have asked us to specify a temperature at which QT should not be flown, but there's no specific number to be given…you just need to realize that the colder it is, the more likely you'll have a problem with plastic cracking due to the cold. There is no perfect material but we truly believe our QT is the best all-around material for airframes on the market, especially for the price. If we thought there was something better, we'd be selling it.

Pressure Relief Holes

There are many debates about the necessity of pressure relief holes. We think it is only necessary in extremely fast-burn motors with rockets that will pass 5000' very, very quickly. If you are unsure or don't want to take any chances then drill the following holes: One 1/8" hole just above the uppermost centering ring of the MMT, one 1/8" hole near the top of the main airframe (but below where a coupler or nosecone shoulder might be), and one in the payload section. This should work with most sub-sonic rockets of 4" dia. or less.

Working with PML Airframe Tubing

Cutting Phenolic or Quantum Tubing

Cutting phenolic tubing is a little different than cutting cardboard. First of all, put away your X-ACTO knife and get an X-ACTO razor saw. It is possible to cut phenolic with a knife, but it will take a dozen or so passes to get through. You should use the razor saw to do almost all of your cutting. A hacksaw with a fine-toothed blade can also be used. A good tip to ensure a straight cut is to put an automotive-style hose clamp around the tubing when cutting to act as a guide for the hacksaw. If you have access to power wood working tools, they can be used to cut PML tubing. We have used band saws, miter saws and table saws, all with very good results. After cutting, it may be necessary to deburr the edges inside and out using 150 grit or finer sandpaper. This is especially true with QT, as the cutting process may "squeeze" the cut end ever so slightly, making it tight for inserting a nosecone or for inserting the piston. Deburring or chamfering the inside edge of a QT will eliminate those problems.

Filling Phenolic Tube Spiral Seams

Over the years, we have tried just about every kind of filler imaginable. Our favorite is Elmer's Professional Carpenter's Wood Filler. It is easy to apply, inexpensive, dries quickly, and sands easily. One can will finish at least 8 average rockets.

1. The wood filler sometimes is a little dry and chunky. It is water-soluble, so you can put some into a separate container and add water, literally a drop or two at a time! Water goes a long way in thinning the filler; if you make it too thin, add a little more filler and mix it up again.
2. Spread the filler over the areas you want to fill using a putty knife, your finger, or an auto body filler ("Bondo") spreader. (You can find Bondo spreaders in any automotive store or store like Kmart that has an automotive section). Using the spreader, push the filler into any seams or grooves you want to fill. Using the spreader will force the filler into the grooves and will scrape away any excess on the body tube outside the seams. Wipe off any globs that occur. Allow to dry for an hour.
3. Sand the filler with 120 grit sandpaper until it is even with the surrounding surface. Usually you will need a second coat, since the filler shrinks somewhat. After the second coat, let dry and resand.
4. If needed, you can apply a final coat using automotive spot putty, again available at automotive stores. Only squeeze out a little at a time and recap it, because the solvent in it evaporates quickly and any unused portion will become thick and globby. You

want the spot putty to be very spreadable, since it has a finer material grain size than the Elmer's filler and will provide a very smooth final finish.

5. Sand the entire surface smooth using 220 grit sandpaper. Do not apply any primer coat at this time as the epoxy used in assembly must adhere to the raw tubing.

Custom Work

Custom Tube Slotting

- Pricing of custom tube cutting and slotting is covered in the Airframes section of the webstore.
- There will be additional charges for the following slotting set-ups: Unequal slot spacing around circumference of tube, odd number of slots (except 1 and 3), and/or variations of slot width, length, or start point from one slot to the next on same tube.
- For tubes with four slots or less around the circumference of the airframe all slots have an overall slot length limit of 22". However, they must have 1" unslotted (skip) section for any continuous slot over 14". If there are more than four slots around the airframe, they must have 1" unslotted every 10". This is necessary because once the first slot or two is cut, it is difficult to keep the remaining slots straight due to the more-flexible tubing. Having a 1" skip section helps to be able to complete the remaining slots. (Example: You need three 19" slots. Since this slot is longer than 14", it must be interrupted for 1" at some point, such as making a 12" slot, a 1" gap, then a 6" slot. Your fin tang must be then be notched to bridge the gap, and a CR should be installed at the gap.)
- Dado slots for any tube size, in any length, and in any type cannot be wider than 0.125". This is because the wider the dado, the deeper you must go to get usable depth at the edges because the tube is round. With dados wider than 0.125" you have to go nearly through the tube to get well-defined edges.

<u>Slot Tolerances</u>

- The following slots are actually 0.015" larger than listed because of G-10 variations to ensure the G10 will fit even if it runs on the "high side" of thickness tolerances: 0.062", 0.093" and 0.125".
- The following slots are exactly as listed: 0.188", 0.25", 0.375", 0.5".
- Slot length tolerance: ± 0.062" for 3.9" and smaller. ± 0.125" for 6.0" and larger.

Slotting 3.9" tubes and smaller (PT and QT):

- Minimum start point from end of tube 0.375".
- Maximum uninterrupted slot length is 12" (except for 0.188" wide slots; the maximum slot length for these is 8"). If a longer slot is required, we must leave a minimum of a 1" gap in slot. (Example: You need a 14" slot. Since this slot is longer than 12", it must be interrupted for 1" at some point, such as making a 6" slot, a 1" gap, then a 7" slot. Your fin tang must be then be notched to bridge the gap, and a CR should be installed at the gap.)
- Maximum total slot length is 18" (again except for 0.188" wide slots; the maximum slot length for these is 8").

- The following slot widths are available for tubes 3.9” and smaller (PT, QT, and glass): 0.062”, 0.093”, 0.125”, 0.188” and 0.250”.
- For fiberglassed tubes only, 0.062” – 0.093” slot widths are available with a maximum of 10” slot length.
- For fiberglassed tubes only, 0.125” – 0.250” slot widths are available with a maximum of 18” slot length.

Slotting 6.0” tubes and larger:

- Minimum start point from end of tube 0.75”.
- Maximum total slot length is 26”
- The following slot widths are available for NON-glassed 6.0” and larger: 0.062”, 0.093”, 0.125”, 0.188”, 0.25”, 0.375”, and 0.5”.
- The following slot widths are available for fiberglassed tubes 6.0” and larger: 0.093”, 0.125”, 0.188”, 0.25”, 0.375”, and 0.5”.
- For fiberglassed tubes only, 0.093” slot widths are available with a maximum of 8” slot length.
- For fiberglassed tubes with slot widths from 0.125” – 0.5” the maximum slot length is 26”.

Custom Tube Cutting

- Tube cutting ± 0.050” for 3.9” and smaller.
- Tube cutting ± 0.125” for 6.0” and 7.5”.
- Tube cutting ± 0.25” for 11.4”

Kit Strengthening

Any of our kits that are 2.56" or greater that will reach equal or greater than 0.85 Mach need to be strengthened. Here are the calculations so you know the raw numbers:

Mach 1 @ STP (Standard Temperature & Pressure) = 1116 ft/s (fps) = 760.9 mph
1116 fps x 0.85 = 948.6 fps
760.9 mph x 0.85 = 646.7 mph

Therefore, PML kits 2.56" and larger should be reinforced for >950 fps or >650 mph flight. We feel that kits 2.1” and smaller can be flown without body tube fiberglassing, though all other items listed below should be done, as well as building the rocket with plenty of epoxy and good sanding of areas to be bonded.

As mentioned in the chart itself, the Motor Recommendations Chart is highlighted for kit/motor combinations that require strengthening. We recommend the following changes for any "yellow-highlight" kit and motor combination:

- Fully-glassed airframe, which requires phenolic as a starting point, not QT. **You must special-order your kit with phenolic as all kits 3.9” and under (except Nimbus) come standard with QT.**
- Thicker fins (0.063" should go to 0.093", 0.093" should go to 0.125")

- Fin-to-airframe joints should be glassed
- 30-minute epoxy should be used throughout the build.

Also, we say so in all the instructions, but **make sure you lightly sand any area to be bonded**! This is important to get a good "bite" on the materials for the epoxy, and is especially important in high-stress applications.

Something else to remember about strengthening your kits: you probably should upgrade one 'chute size to compensate for the weight of the 'glassing as well. A larger chute should also be considered due to the extra weight of many of the longer motor casings that will generate flight conditions where reinforcement may be required.

Nimbus 'Glassing Kit

When you purchase the Nimbus Fiberglassing Kit, the glass wrap kit supercedes/replaces the glass patches for the fins in the base Nimbus kit. Follow the fiberglassing kit instructions rather than applying the 'glass fin patches as discussed in the Nimbus instructions. The cloth in the Nimbus Fiberglassing Kit is 10 oz, and the mixing ratio of the two-part epoxy is 4 parts white to 1 part clear.