This epoxy manual is relatively brief and we will try to explain in simple terminology the more basic procedures of epoxy gluing, coating and fiberglassing. There are many fine, readily available publications on the market that explain a multitude of advanced techniques using epoxy if this manual does not address your questions. Study the work of at least two authors, for each has his own methods. Some authors may have an affiliation with a certain brand of epoxy, but we can assure you that as a general purpose marine epoxy, ours is second to none. We base this statement on published manufacturers data, our experience and feedback from the many repeat customers that call us daily.

Please read this manual carefully and always practice proven techniques. Because epoxy has so much strength, the difference between a good and a bad job may not always be easily recognized. If failure happens, it will come at the worst possible time. The epoxy will be blamed, when the real problem lies in the user not applying the proper mixing or application procedures. If you have a problem, or don't understand something in this manual, don't hesitate to give us a call.

THE MANY USES OF EPOXY

Epoxy is not just for boats, but is also excellent for crafts, woodworking, car body repair and hundreds of other home and industrial uses. With epoxy, even a crude patch-up repair can often be stronger than the original design. Though most of our customers are using epoxy in the construction and repair of boats, it also can be an excellent adhesive and filler that bonds well with metals, concrete and some plastics.

The production fiberglass boats of today are usually constructed with the cheaper polyester type resin. Polyester resin is used because of its low cost and quicker cure time. Its shorter shelf life is not a problem for large volume users. Epoxy resin and hardener on the other hand has an indefinite shelf life, is much stronger, more flexible and is much more waterproof. Epoxy resin products not only have a greater bonding strength, but also will bond to a greater number of different materials, including cured polyester resins. It’s for these reasons epoxy is used for so many boat repairs.

A FEW FACTS ABOUT EPOXY PRODUCTS

We have tried many of the epoxy products that you see in your local marine and hardware stores, from thick pastes to thin penetrating epoxies. I find, for the most part, they are of high quality and do the job for which they were intended. The problem is that they can be quite exorbitant in cost. We have found that for most boat and shop applications you can custom make your own epoxy products. Take our low viscosity epoxy and mix with one or more of our fillers and you can have an epoxy product tailored to your specific needs.

WHAT IS OUR RAKA EPOXY SYSTEM?

We have several different epoxies with a variety of mixing ratios and curing times. We purchase the basic epoxy resins and hardeners in bulk from different manufactures and then blend them to get a finished Raka Epoxy. One way, Raka Epoxies are different from many industrial epoxies is that we mix in different and expensive additives that help with better flow and air release. Especially in thin coats, you

will notice less pin holing and cratering. The products we ship to our customers with our Raka name will be easy to use and give consistent performance. We can offer lower prices because we don't have distributors and dealers to support so we are free to sell directly to the customer.

BASIC TECHNICAL INFORMATION

Our main epoxy resin 127 is a low viscosity [thin] liquid. It is basically thick standard grade resin that has been thinned with special additives and reactive diluents. When mixed with its companion hardeners [activator], it will cure to a very tough waterproof plastic. We have several hardeners with different mix ratios and curing times. Raka mix ratios are by volume and not by weight. Please note that our epoxy resins and hardeners have no evaporating solvents, so you will get very little shrinkage compared to polyester resins and some solvent loaded epoxies. Some people prefer a one to one mix ratio because of the simplicity of mixing, Our Table Top System mixes together at one part resin to one part hardener, It is designed primarily to be used as a thick coating epoxy for tabletops, bars and crafts. It is a very clear non blushing epoxy system with a forgiving mix ratio that allows up to 20% off ratio mixing to get harder of softer cures. The high viscosity of Table Top also makes it and excellent general purpose gluing and repair epoxy. Table Top epoxy tends to be more flexible and has somewhat less strength. Pot life is approximately 40 minutes.

The hardener 631, is a medium fast curing agent that can be mixed at a ratio of five parts resin to one part hardener. 631 gives the most strength and heat resistance, but you have to give more care to the critical mix ratio and is subject to more blushing. 631 is not recommended for clear coating.

Our best selling hardeners are the 610 which is very fast curing and the 606 which is slow curing. They are mixed at a ratio of two parts resin to one part hardener. The two to one ratio epoxies are probably the most popular because they give a good compromise in ease of use, are low blushing and have good overall physical properties.

I'll give a brief description of our two to one epoxies because these are what our customers most often request. Depending on the job requirements, you can choose a fast or slow hardener or a combination at no extra cost. At 77 degrees [F.] the pot life (using 3 mixed ounces) of the fast hardener-resin mix is about 8 minutes. Three ounces of slow hardener would give you about 25 minutes of working time. A mixture using only fast hardener 610, can be used down to 50 degrees F and suing only slow hardener 606, should no be used below 60 degrees. A useful feature of the two hardeners is their ability to be blended together to customize a cure time for your particular requirements. We recommend when working under 70 degrees to use a blend of hardeners if you want a working cure within 24 hours. The majority of our customers divide their purchase of hardeners into equal amounts of slow and fast.

When epoxy systems are described scientifically you will hear frequently used terms such as hardness, flexibility, impact strength, resiliency and modulus, etc. These are measurements of physical properties. You must be aware that you can't have all the best properties in any single epoxy. A good characteristic in one area is likely to give you a poorer showing in some other area. When we selected our Raka system epoxies, the prime considerations were to get good general purpose boat building and woodworking characteristics.

One of the outstanding qualities of our epoxy is that the mixed resin and hardener has a lower viscosity than some other epoxy systems. This allows deeper penetration into the wood and very thorough saturation when wetting out fiberglass cloth. Bubbles that are introduced when mixing dissipate very well to give you a smoother unblemished coating. A thinner mix also allows easier mixing and a higher loading of the many fillers that are available. An example would be loading your epoxy with a higher proportion of micro balloons to achieve easier sanding of the cured epoxy.

SAFETY

Needless to say, epoxy should be stored in a safe manner, so that anyone, especially children cannot ingest it or get it on their skin. Most people, even those who frequently work with epoxy, do not have any health problems associated with epoxy use. Hardeners are generally more caustic than the resins. If splashed in the eyes, wash out with warm water for several minutes and see a physician. Some users can, over time, develop some skin sensitivity. This is basically an allergic reaction, so stay away from epoxy for awhile. It's recommended to use eye and skin protection at all times when handling epoxy. Do not use chemical solvents to remove epoxy from your skin. Use a waterless hand cleaner. Uncured epoxy resin and hardener is considered a toxic substance, and must be disposed of in an approved manner. Epoxy resin and hardener have a very low flammability, but keep in mind that many of the thinning and cleanup solvents such as acetone are flammable and explosive. Keep your mind on the job. See a physician if any health problems develop.

MIXING

The different Raka epoxy resins and their companion hardeners are engineered to be mixed in a precise way using a certain volume or weight of resin for each volume or weight of hardener. Some of our manufacturer’s specifications give the mixing ratios by weight and some by volume. We feel that mixing by volume is simpler and the mixing instructions on our labels specify using volume measurements. In some cases we round off the exact scientific mix ratio to avoid confusion. Correct mixing volumes can be obtained by the use of measuring cups or by the use of our pumps. Before starting any project, check the pumps for metering accuracy and also check your measuring cups as many cheap cups and pots have inaccurate marks. In a clean pot, mix thoroughly in a non beating motion and not too fast as you will introduce air bubbles. Make sure that the liquid that slops up on the side of your bowl and on your mixing tool gets mixed also. Ideally you will pour the mixed epoxy from the first pot into another container and mix again for the most consistent mixing of all the hardener and resin. This may be extreme and too time consuming for most people but will insure a more consistent mix. If you plan to add any fillers, do so only after completing your initial mixing. Mixed epoxy that is in a mass can heat up and become unworkable very fast. Experienced users work with small batches so there is less waste. It is important to remember that epoxy applied in a layer thicker than 1/8 inch may produce enough heat to damage the substrate or cause the epoxy to foam (especially of concern when using fast hardener under warm conditions). Immediately after mixing (especially when using the fast hardener), spread the epoxy out on a flat surface in a larger container (a plastic plate works fine). In some cases, if you want a faster set up and cure time it is better to leave the mixed epoxy in its pot for a few minutes so it will get

a chance to heat up. The epoxy curing process depends on the heat from it's own reaction and the ambient temperature. You will have to experiment to understand each epoxies properties.

I want to emphasize the importance of proper mixing. Epoxies strength and desirable properties come from the complete mating of the resin and hardener molecules in the correct ratio. Too little hardener produces brittleness, and too much hardener makes your epoxy softer with the accompanying loss of strength. If you make an error, you're safer to use a little less hardener, than too much. Generally speaking you can have a 20% error tolerance on the minus hardener side and 10% on the plus side and still get an acceptable cure. Regardless, your cure will have less strength than its ultimate potential!

FILLERS

With the proper selection of fillers and the basic resin-hardener mix, you can create a dozen products that you would pay dearly for in your local marine store. Just five of the more common fillers will be explained here.

(1) Silica: It's sold under a variety of names and product codes (fumed silica, aerosol, cabosil, etc). For general purpose use, silica is an economical and widely used filler. Though any filler can thicken a liquid, silica has the unique properties of being very smooth spreading, strong and thixotropic (non-sagging). Thixotropic qualities are especially helpful in allowing your fairing paste to hold its shape, and preventing run-off on vertical and overhead work. According to the amount added, you can achieve a viscosity from thin ketchup to peanut butter. It can be used for gluing, laminating and making a very smooth fairing compound. Silica is also very useful for making fillets that are useful in structural and cosmetic applications. Fillets are probably most commonly used to fill in sharp corners between two glued pieces. Strength increases because your glued surfaces are spread over a larger area. Silica sands very hard, so smooth it and clean up well before the mixture cures.

(2) Micro balloons: Tiny glass spheres used to thicken epoxy and make an easily sanded fairing putty. Though not as strong as silica, it is much easier to sand. It's usually wise to add some silica. It makes your putty easier to spread and helps it hold its shape once applied to your project.

(3) Milled glass fibers: Finely ground glass fibers that are added to epoxy to thicken and add high strength. Adding silica also improves the properties of the mixture.

(4) Chopped Glass Strand: One quarter inch chopped course fiberglass strand that makes a very rough filler for exceptional strength and large gap filling.

(5) Wood Flour: Makes a good wood toned non sagging putty for fillets and gluing.

EPOXY THINNING AND CLEAN-UP SOLVENTS

Acetone, lacquer thinner, and denatured alcohol are three common economical solvents that work well with epoxy. Denatured alcohol doesn't cut the epoxy quite as well as acetone, but is much safer if skin contact occurs. Generally it's not recommended to thin your epoxy with non-reactive diluents because you will lose strength, have less water resistance and will get epoxy shrinkage. The curing process may

also be affected. If you must add a local shop solvent, then denatured alcohol is a good choice (no more than 5%). They evaporate slower out of the cure than other solvents like acetone and work well for may have some saturated rotten wood. The best way to thin epoxy without losing strength is to moderately heat the unmixed resin and hardener. Warm epoxy generally gives better results and if its possible try to heat the area to which you are applying the epoxy.

GLUING

Because of Epoxies strength and tremendous adhesive power, users will often do quick and sloppy work and maybe get away with it. I'll explain the correct method; if you want to leave out some recommended steps, it’s your project. The surface quality of your job may look fine, but the ultimate bonding strength will not always be immediately apparent. Murphy's law is ever present.

1. The surface to be bonded must be clean, dry and free of contaminants.

2. Sand the surface with medium sandpaper to provide tooth for the epoxy to grab on to.

3. Brush your mixed epoxy onto the bonding surfaces. If you have time, allow it to soak in for a few minutes and recoat.

4. Add your filler to the leftover mixed resin in your pot. Silica is a good choice. Mix very thoroughly, making sure all the stuck together balls of silica are completely broken up. The past does not have to be very thick. Apply the paste to your two pre-coated bonding surfaces. When the two bonding pieces are pressed together the paste just needs to be able to squish around and fill all the voids. Adding too much filler may make the paste dry with less sticking ability and less flexibility. If you try to glue using only unthickened resin, it could all soak into the wood or sun off, leaving a dry bong with a possible later failure.

5. Very lightly press the parts to be bonded together, and clamp loosely. It's to the epoxy's advantage not to all pressed out of the bond.

6. Cleanup or use the epoxy squeezed out of the bond. Remember, how you clean yup and do your final shaping will save you a lot of sanding later.

7. When the curing epoxy can't be dented with your thumbnail you may start to sand. Please be aware that the final cure may only be 70% complete at this stage.

8. Be careful of the type of wood your are gluing as some hardwoods that are dense or oily may require special preparation. A clean surface, very course sanding and having the epoxy warm or as thin as possible may be required. Test and experiment before committing to a large project.

COATING

Epoxy coating wood prevents water penetration. Moisture soaking into wood causes serious long term problems. Rot, swelling, weakening and de-lamination all can occur. The wetter the wood becomes, the less strength it has and the heavier it will be. Some boat builders coat their vessels with epoxy only on

the outside. With the economy of Raka Epoxy, there isn't any reason not to fully seal every wood piece used in the construction of your new vessel. The value of your vessel will increase and you'll save yourself a lot of worry and eventual repair work.

Epoxy coating and fiberglassing on the outside has rescued many older wooden boats. It's probably not advisable to try to saturate and coat the inside of a larger older vessel. Its difficult to get complete coverage and you may be just providing a coating to trap water inside the wood. Epoxy on the outside and coating liberally with a good copper based wood preservative on the inside is our recommendation for older boats. Wood preservatives can cause staining or other coating problems if you try to cover it with paint or epoxy.

COATING METHOD

Some builders prefer to coat all pieces individually before building the project. It will be much easier to have access to all the edges and sides. A flat wood surface will absorb epoxy much better without leaving drips and runs. This method requires more work and may make it more difficult to bend and fit your pieces together. It may not be advisable for cheap and quick projects. Wood has air in its pores. If you epoxy the wood early in the day as the temperatures are rising, the expanding air in the wood can force bubbles in your coating. The best time to coat is when temperatures are dropping, or after you artificially heat the wood and it starts to cool, causing the epoxy to be sucked in the pores. Raka epoxy has low viscosity and resists bubble formation, but warming the epoxy will thin it even more for better penetration and dissipation of bubbles. Most of your bubbles are introduced in the mixing process so high speed electric mixers are not advisable. One way to pop the bubbles that form is to run a blowtorch back and forth a few inches above the epoxy surface. Some builders initially coat all their wood pieces with one or two coats. They later add extra coats when fiberglassing or doing finishing construction. Wood coming into continuous contact with the water such as that below the water line needs a minimum of five coats to resist water penetration. The following example lists the steps for coating a sheet of plywood.

(1) Lay the plywood on sawhorses. Make sure the plywood and sawhorses are clean, dry and free of dirt or grease. If contaminated, use the proper solvent to get it clean. Dry the wood before proceeding.

(2) Give the wood a light sanding with medium grit sandpaper. Clean the dust off with a brush. Be aware that pressurized air and air tools can blow oil and water on to the surface that you’re trying to keep clean.

(3) Pour the resin-hardener mixture in S-shaped trails across the surface of the plywood. Using a brush or a foam roller spread the epoxy in an even thin coating across the surface. Especially for the first coat, use lots of brush strokes to get the epoxy worked into the surface. Make sure any surface cracks and defects get well saturated. Do the plywood edges at the same time. End grain will absorb lots of epoxy so be prepared to make repeated passes.

(4) Immediately after coating the top surface and edges, add some silica to your left over mixture to make a fairing putty. This is the time to fix any voids and defects. Depending on the grade of plywood,

including the so-called marine plywood, there is always some voids in the edges and surfaces. Using your fairing putty, fill these in with a putty knife. Make your fairing job as smooth as possible, you'll appreciate less sanding later.

(5) There are some variables as to when to apply a second coating. To prevent dripping and runoff, don't re-coat until the epoxy has started to set, or has soaked well into the wood. If you have the time, it's probably to your advantage to use the slow hardener. The epoxy will have more time to penetrate before it sets up. Generally speaking, for up to twenty four hours you can re-coat without sanding and still get a good chemical bond. The air temperature, hardener speed and possible blushing will of course have to be considered in the curing and re-coating process. Epoxy blush on a cured epoxy surface must be washed off before re-coating.

(6) When the plywood surface has partially hardened, turn the plywood over and finish the uncoated side by repeating all of the above steps. It's a good idea to give the edges another coat also.

FIBERGLASSING

In the past, before the marvelous properties of epoxy were realized, people fiberglassed wood with polyester resin. Polyester resin has much less waterproofing and adhesive qualities than epoxy. Water will eventually find its way between the fiberglass and wood and start to creep. De-bonding of the fiberglass can occur above the waterline and most certainly below the waterline. This is not just theory. Most of your older production built yachts that have fibreglassed plywood decks have de-bonding problems. The following is a very basic and brief explanation of fiberglassing. If you are inexperienced and planning a big job, definitely research more detailed information on the many methods and types of materials in use today. In our example we'll use the sheet of plywood that we previously epoxy coated. Remember, you will get a better saturation of your fiberglass, and better bonding, if you do your fiberglassing on previously epoxy coated wood. You can fiberglass on raw wood, but there is the danger of your wood or fiberglass not getting properly saturated. Fiberglass comes in various weights and widths. Generally when fiberglassing the hull and deck of a wooden boat, builders use one or two layers of light 6 to 10 oz. cloth. It is common to use one layer above the waterline and two below. In some cases, heavier cloth or a strong material such as a biaxial is used in structural joints and corners.

Be aware that some fiberglass mat and other fiber materials should not be used with epoxy because it may have an incompatible chemical binder that was designed only for the polyester type resins. All the fiberglass and other boat cloths we sell at Raka Marine are both epoxy and polyester compatible. When fiberglassing, remember that most wooden boats designs get their strength from the wood. Epoxy and wood have different strength characteristics. Usually a plywood boat has a light layer of fiberglass applied to the surface for water and abrasion resistance only. Too heavy a fiberglass covering will just increase weight and expense. This advice of course is general and a designers specifications should always be followed, especially when choosing materials for reinforcing things such as in seams and bulkheads.

METHOD

(1) Lay your plywood on your sawhorses. When possible try to have your work as flat as possible. Wash off any blush that may have formed with soapy water. In the case of grease or other contamination, use a proper shop solvent(make sure the solvent is cleaned off and is not something that increases contamination). Take the time to get a clean surface.

(2) With medium sandpaper, sand smooth all ridges and runs that may have developed during the previous epoxy coating. The sanding of course, is always necessary to get a mechanical bond on fully cured epoxy. You need a rough tooth for the next coating to have something to attach to.

(3) Lay the full width of your cloth on one end of the plywood with a little overlap on the edges.

(4)If you're inexperienced, be aware of your mixed Epoxies pot life, and use smaller batches until you get the hang of it. Starting at one end, do one section of fiberglass at a time, pouring the entire pot in an S-shaped pattern over this section. Remember, once spread out, you'll have more working time before the epoxy sets up. Using a squeegee (or a special fiberglass roller) gently massage the epoxy into the weave until completely saturated. Once completely wet out, you can put more pressure on the squeegee and force the cloth tightly to the wood. The weave pattern should be showing as you drag the excess epoxy to the next area. This exposed weave will be filled in with later coats.

(5) When the entire piece of cloth has been finished, lay down the next piece, preferably overlapping by about two inches. Overlapping gives strength and any ridge mark can be filled in or sanded down later. Continue with the same procedures until finished.

(6) After a few hours the epoxy starts to firm up, you can now take a sharp knife and trim the fiberglass off the edges very easily.

(7) The fiberglass weave can be filled in smoothly by two methods: Mixing some silica in your epoxy and using the squeegee to smooth the thickened mixture across the surface and or building up your coating thickness with successive thin coats of epoxy. Thin coats make for a smoother job and avoids sags and runs when you have sloping or vertical surfaces. If good waterproofing is important, then you should apply several coats.

(8) Any pigments or additives should be stirred into your mixture for the final coats.

(9) Epoxy is subject to gradual breakdown in sunlight. Painting is the best protective measure. Varnishing is also sometimes done. Varnish used on bare wood has normally a short life in the tropics. When applied over a good base coat of epoxy, its useful life can be extended by about two or three times. It should be mentioned that there are a number of pigments and ultra-violet inhibitors that can be added to your varnish or epoxy. Note: On vertical and overhead applications you have to use some ingenuity to get the fiberglass to stay in place. You may have to first wet out the surface and let it get tacky. Now you can stick the fiberglass to it and it should hold in place while you finish wetting out. The use of tape and copper tacks can also be used as a holding device.

RESTORING ROTTED WOOD

Wood can be over half rotten and its strength and appearance can be greatly improved by injecting epoxy into it. In important structural areas and where safety is involved, of course always replace with new wood. With older boats, you may feel it's not worth the time, money or expertise that's necessary to replace rotted wood. Method: Sand and clean off the surface area of the rotted wood and adjoining solid wood areas. Drill 1/4 inch holes deep into the rotted wood and also into the surrounding solid wood. Space the holes approximately one half inch apart. Preferably using a syringe, inject heated thinned epoxy into the holes. The rotten wood will gradually soak up the epoxy. Using a slower hardener will allow more penetration before curing. You will probably have to keep injecting over a period of time until the wood will absorb no more. After the epoxy has at least partially cured, make an epoxy putty and smooth over the holes. After curing, you can sand and paint. It will be hard, solid and look as good as new. Remember, this is for non-critical areas as you can never know how deeply the epoxy has penetrated. There may still be voids and unsaturated rotten wood.

TROUBLE SHOOTING

(1) The most common mistake is to add extra hardener to the epoxy mix. This is only for experienced users who in rare cases want the softer epoxy that they will get as a result.

(2) Another common problem is contamination. This can occur on the surface to which the epoxy is applied or it can occur in an improper or dirty mixing pot. Do not mix in waxed paper cups or any other container that is not stable to the heat and chemical reaction of mixed epoxy. Take extra care that your mixing pot and application surface are free from water, grease, oils and waxes etc. Consider rain, dew, dust, insects or other things that can fall into your curing epoxy. Plan ahead.

(3) Always wash off any epoxy blush that may form before applying your next coat of epoxy. A cured epoxy surface needs to be sanded to get a good bond before recoating or fiberglassing.

(4) Always be aware of the temperature you are working in. My slow hardener can be very slow in temperatures of less than 80 F. Mix together a combination of fast and slow hardeners to suit your conditions. Take into consideration that it may be warm in the day when you start applying your epoxy, but at night perhaps it will be exposed to freezing conditions. Cure speed depends on the hardener type and ambient temperature!

(5) Periodically check all pumps and mixing containers for accuracy.

(6) Epoxy has an indefinite shelf life but can crystallize over time, especially in cooler temperatures. Try to store your epoxy at room temperatures. Never store it in freezing temperatures and don’t store it on a cold concrete floor. Crystallized and freezing exposed epoxy can be brought back to normal with no loss of properties by moderately heating and stirring it. Placing your epoxy containers in a pail of 120 degree water should be sufficient.